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# Banks, credit supply, and the life cycle of firms: Evidence from late nineteenth century Japan

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ABSTRACT

How does local credit supply affect economic dynamism? Using an exogenous bond shock in historical Japan and new genealogical firm-level data, we empirically examine the effects of credit availability on firm life cycles. We find that the lifespan of firms decreases with bank capital and that capital-abundant regions have more firm creation and destruction. These effects are amplified for manufacturing, while service sector firms experience no change in longevity and have less creation. Our results suggest that samurai bonds were conducive to the emergence of banking, which eased firms' financial constraints and led to more capital-intensive investment and economic dynamism.



## 1. Introduction

The recent financial crises in most developed economies underscore the importance of the availability of credit and banking capital for firms. At the macro level, there exists a consensus that credit booms are associated with economic expansions (Levine, 2005) and that the recessions following them tend to be deeper and longer than normal recessions (Schularick and Taylor, 2012; Jordà et al., 2013). At the micro level, the effects of credit booms are less clear. Some empirical evidence shows that the credit booms in Spain and other euro-area countries in the 2000s had heterogenous effects on investment of existing firms (Gopinath et al., 2017; Basco et al., 2021). However, there is no evidence on whether new firms that are created during a credit boom differ from those in other credit conditions.[1]

One observable difference from the effect of credit availability is in the life cycle of firms. Firm dynamics, measured in terms of entry and exit, are an important determinant of economic growth. This Schumpeterian "creative destruction" has been shown to be affected by changes in financial access, regulation, firm organization, and international trade.[2] In particular, there is a large quantitative macro literature emphasizing the effects of financial constraints on entrepreneurship at the micro level.[3] Largely absent in this scholarship are the micro-level effects of credit availability, specifically credit increases, in a developing economy, and from a historical perspective; for both scenarios there are limited data.[4] This is unfortunate given that the aforementioned factors may be exacerbated in a financially immature economy undergoing structural change. At the same time, historical contexts may provide a

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[1] For example, Amazon and Pets.Com were both created during the dot-com bubble (1996-2000). The former is now one of the most valuable companies in the world and has contributed to increase aggregate productivity, while the latter did not survive past its first year; see Abelson (2000).

[2] Per Schumpeter, creative destruction refers to the "process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one" (1942, pp. 82-83). As applied to firms, it can describe intra-industry churn as well as the reallocation of resources within firms over their life cycles. See Caves (1998) for a survey of empirical studies on firm dynamics, with Dunne et al. (1988) and Foster et al. (2008) as prominent examples. Relatedly, Decker et al. (2014) underlines the diminishing share of young firms and entrepreneurship to explain the decline of economic dynamism in the United States.

[3] See Buera et al. (2015) for a review of recent studies.

[4] A notable exception is Gregg and Nafziger (2019), which uses the universe of Russian incorporation data in the late nineteenth and early twentieth centuries to analyze firm dynamics.

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cleaner economic framework that makes disentangling the relative influence of these factors possible.

Late nineteenth century Japan offers a unique setting to analyze the effect of a credit supply shock on the life cycle of firms.[5] We use a quasi-natural experimental setting to proxy for the changes in credit supply and a novel firm-level dataset to estimate economic dynamism. During this period, Japan transitioned from an internally fragmented, internationally isolated economy to an increasingly industrialized and globally integrated one. In 1876, the new central government under the Meiji regime (1868-1912) unilaterally converted annual hereditary stipends to former samurai into public bonds worth 174 million yen, the equivalent of nearly a third of Japanese national income and six times the government's total spending that year. This bond issuance was also exceptional in that it improved the government's fiscal position, more than trebled the amount of public bonds by value, and was actively resisted by the samurai recipients (Basco and Tang, 2020).[6] Moreover, bond value per capita at the time of issuance was unrelated to pre-1876 regional product per capita, further suggesting exogeneity in subsequent economic outcomes from this credit shock.[7]

We use this bond issuance as a discrete change in the availability of financial capital to entrepreneurs, with bond holders (i.e., samurai, subsequent buyers) acting as providers and banks as intermediaries.[8] Theoretically, this change in the composition of the stream of endowments should lead to an increase in savings (i.e., permanent income hypothesis), which in turn could be channeled towards the banking sector. For Japan, this channel was the case as the government revised the National Banking Act in 1876 to allow chartered national banks to use these bonds along with specie as paid-in capital. As a result, banks increased both in size and number, from 6 to 153, in the three years following the bond issue and were established throughout the country (Goldsmith 1983, p. 25). Bonds issued to samurai represented nearly 60 percent of these banks' capital as late as 1884, when redemption of bonds had already begun, as shown in Table 1.[9]

Standard models of credit rationing (Stiglitz and Weiss, 1981; Mankiw, 1986) predict that firms obtaining funds in the credit market are, on average, riskier. Furthermore, an increase in the demand for savings or bank deposits make the existence of a credit market more likely. This is due to adverse selection and an inverse relationship between savings demand and the cost of obtaining credit, respectively. If the risk profile of entrepreneurship corresponds with firm dynamics, we can test the following hypotheses: (i) the lifespan of firms decreases with increased bank capital, (ii) firm destruction increases with bank capital, and (iii) firm creation increases with bank capital.

These hypotheses assume that the marginal firm obtaining credit is a riskier investment than already funded firms and thus would be affected by the availability of credit. At the same time, relaxing credit constraints may also increase competition between firms as entry increases, causing less efficient ones to exit the market regardless of investment risk.[10] Relaxing our assumption about risk, we would still expect bank capital to be positively associated with increased firm entry due to lower barriers to entry. Similarly, if we assumed a homogenous and constant exit probability, we would also observe more firm destruction. The only difference in our predictions would be in the lifespan of new firms, which should not differ on average across periods with different credit availability if investment risk or efficiency were the same. Thus, our analysis indirectly tests whether the marginal firm is a riskier investment or less efficient depending on the credit environment in which the firm is established.[11]

For our empirical analysis, we use a recently developed firm-level dataset based on Japanese corporate genealogies (Tang, 2011 and 2014; Onji and Tang, 2017) and an instrumental variable approach. Although qualitative in nature and thus limiting the analysis to extensive measures of firm activity, the sample of firms in the data spans most regions in the country and all sectors in the years immediately preceding and following the 1876 bond issuance. To our knowledge, no other firm-level data with the same geographic and industrial coverage exist for Japan over the same period. The genealogical structure provides the year of entry and exit for each firm, from which we can estimate the impact of differential credit supply by region, instrumented by per capita bond value in 1876, on firm lifespan, creation, and destruction.[12] Our identification comes from the exogenous nature of the bond issuance and the variation across regions, aka prefectures, in per capita bond values. We also include covariates to account for prefectural differences in income, urbanization, and population.

Our findings largely align with those predictions from credit rationing models. First, the lifespan of new firms is inversely related to per capita bank capital. Second, both firm entry and exit increase in prefectures with a larger increase in per capita bank capital. At the sectoral level, all three predictions hold for manufacturing. The improved fit is consistent with differential external financing constraints among sectors like manufacturing where firms face a higher financial constraint (i.e., larger initial fixed cost of project investment to available credit) compared to those in other sectors and the economy at large (Rajan and Zingales, 1998). In contrast, our results using firms in the service sector, which may have a lower funding threshold, show no effect on lifespan and decreased firm entry with additional bank capital. Our results are also robust to using samurai bonds as an instrument for different banking series as well as directly in the empirical specifications.

Our main contribution is to show that differences in credit supply affect the life cycle of firms. We argue that the involuntary samurai bond conversion increased aggregate savings, which translated into an increase in bank deposits and, thus, bank capital. In the presence of credit rationing and adverse selection, firms receiving bank loans had on average riskier projects and, thus, shorter lifespans. This theoretical prediction is corroborated by our empirical evidence of entrepreneurial activity in late nineteenth century

[5] An important question not addressed by our analysis is whether credit booms are driven by an increase in the supply or demand of credit, which itself is subject to debate. For example, Mian and Sufi (2009) argue that the mortgage boom in the United States in the mid 2000s was supply driven and emphasize the expansion of mortgage credit in subprime (riskier) areas, where income growth did not increase. More recently, Adelino et al. (2018) offer a more nuanced view arguing that both credit supply and demand were driving the mortgage credit boom. For our analysis, we interpret the change in credit as supply driven while acknowledging that alternative demand-side explanations may also be valid.

[6] The 1876 policy resulted in samurai losing their hereditary payments and receiving an asset (bond), whose value was lower than the present value of the stream of promised future payments (hereditary stipends). The 1877 Seinan war (aka, Satsuma rebellion) was led by samurai opposed to the compulsory commutation (Flath, 2014, p. 33).

[7] See discussion in Section III.

[8] It is also possible for samurai to directly invest in firms without using financial intermediation, but in the absence of systematic financial data for firms during this period, how intensively this channel was used is unclear. See the next section for further discussion.

[9] The correlation between National Banks capital per capita and samurai bonds per capita is 0.72 at less than 1 percent statistical significance.

[10] Given the lack of detailed firm information from the genealogies, we are not able to distinguish between or directly assess the risk profile (e.g., borrowing cost, credit rating) or efficiency (e.g., productivity, prices) of firms in our sample.

[11] Another approach to assess risk would be based on the type of technology used by firms within sector categories, per Tang (2011). We show these results in Appendix B.

[12] We use per capita bond value as an instrument for both per capita national bank capital and per capita total bank capital. These IV estimates are also directly compared to both OLS and Poisson estimates using both banking series as well as that of samurai bond value by region.

**Table 1**
Financial assets distribution by prefecture.

| | Samurai Bond Value (1876) | | National Bank Capital (1884) | | All Bank Capital (1884) |
|---|---|---|---|---|---|
| | Total | Per Capita | Total | Samurai Share | Total |
| Japan[a] | 173,844,631 | 5.68 | 52,536,000 | 58.5% | 85,203,000 |
| Tokyo | 39,846,950 | 40.42 | 28,046,000 | 73.2 | 32,029,000 |
| Kagoshima | 13,146,225 | 15.62 | 530,000 | 90.8 | 597,000 |
| Ishikawa | 12,545,215 | 17.64 | 190,000 | 63.9 | 190,000 |
| Toyama | | 17.64[b] | 300,000 | 21.1 | 1,044,000 |
| Kochi | 9,110,350 | 16.63 | 650,000 | 64.0 | 650,000 |
| Tokushima | | 16.63[b] | 260,000 | 76.3 | 896,000 |
| Fukuoka | 8,741,465 | 8.14 | 640,000 | 72.2 | 1,144,000 |
| Nagasaki | 8,016,580 | 11.57 | 370,000 | 35.7 | 805,000 |
| Saga | | 11.57[b] | 390,000 | 94.1 | 1,185,000 |
| Yamaguchi | 6,518,215 | 7.52 | 680,000 | 89.9 | 680,000 |
| Aichi | 5,945,745 | 4.71 | 670,000 | 40.0 | 1,583,000 |
| Kumamoto | 5,885,420 | 5.93 | 265,000 | 96.9 | 365,000 |
| Shimane | 5,092,970 | 8.14 | 80,000 | 70.6 | 159,000 |
| Tottori | | 8.14[b] | 200,000 | 86.9 | 224,000 |
| Ehime | 4,807,515 | 5.90 | 440,000 | 53.3 | 976,000 |
| Shizuoka | 3,839,715 | 4.43 | 750,000 | 17.7 | 4,411,000 |
| Hyogo | 3,737,980 | 2.74 | 790,000 | 37.1 | 1,250,000 |
| Yamagata | 3,351,640 | 5.00 | 590,000 | 37.5 | 764,000 |
| Oita | 2,978,155 | 4.11 | 340,000 | 73.1 | 924,000 |
| Okayama | 2,975,130 | 3.25 | 380,000 | 81.5 | 1,069,000 |
| Wakayama | 2,834,755 | 4.84 | 200,000 | 74.1 | 317,000 |
| Akita | 2,732,040 | 4.42 | 100,000 | 31.6 | 100,000 |
| Shiga | 2,531,845 | 4.22 | 500,000 | 17.7 | 710,000 |
| Gunma | 2,426,385 | 4.05 | 570,000 | 47.4 | 1,393,000 |
| Niigata | 2,401,415 | 1.57 | 1,300,000 | 15.8 | 4,538,000 |
| Kyoto | 2,398,805 | 2.62 | 400,000 | 38.4 | 730,000 |
| Nagano | 2,385,160 | 2.40 | 760,000 | 34.9 | 3,546,000 |
| Hiroshima | 2,173,650 | 1.73 | 440,000 | 50.5 | 440,000 |
| Ibaraki | 2,138,681 | 3.01 | 420,000 | 76.4 | 836,000 |
| Gifu | 2,072,720 | 2.69 | 760,000 | 30.6 | 1,340,000 |
| Mie | 1,836,640 | 2.27 | 350,000 | 65.8 | 350,000 |
| Chiba | 1,745,290 | 1.39 | 215,000 | 73.7 | 490,000 |
| Aomori | 1,671,155 | 3.41 | 300,000 | 78.4 | 481,000 |
| Saitama | 1,321,790 | 1.91 | 200,000 | 25.8 | 1,659,000 |
| Miyagi | 1,278,800 | 2.58 | 250,000 | 42.4 | 282,000 |
| Fukushima | 1,192,720 | 1.75 | 930,000 | 20.4 | 1,606,000 |
| Osaka | 1,187,045 | 1.16 | 2,590,000 | 12.7 | 4,232,000 |
| Kanagawa | 1,012,315 | 1.44 | 3,100,000 | 27.0 | 5,224,000 |
| Iwate | 945,795 | 1.30 | 150,000 | 64.9 | 170,000 |
| Tochigi | 697,035 | 1.06 | 300,000 | 27.3 | 614,000 |
| Hokkaido | 236,300 | 1.56 | 330,000 | 40.7 | 430,000 |
| Yamanashi | 54,445 | 0.14 | 250,000 | 5.8 | 2,317,000 |
| Okinawa | 0 | 0.00 | 0 | 0.0 | 100,000 |

*Source:* Japanese Ministry of Finance (1904), Japan Statistical Association (1962), and authors' calculation. All values except where noted are in nominal yen. [a]Includes 5 percent bonds valued at 30,575 yen distributed to the imperial household, which are not prefecture specific. [b]Okinawa, Saga, Tokushima, Tottori, and Toyama prefectures were unincorporated or part of other prefectures at the time of the stipend commutation. Also, Hokkaido was a colonial territory at the time.

Japan, where firms in areas with a larger supply of credit were also those experiencing proportionately more births and deaths.

## 2. Related Literature

There is a large and increasing empirical literature on the effects of credit supply, most of which focuses on long-run aggregate outcomes (Levine, 2005). Our approach relates more closely to recent studies that use historical data to examine the short- and medium-run effects of fluctuations in credit supply.[13] However, instead of aggregate measures, our study uses firm-level data, which allow us to analyze how firm dynamics are affected by credit supply and to provide a more comprehensive view of the effects. Our quasi-natural experimental approach also allows us to better identify the credit supply shock, which may be endogenous in other contexts. This identification has been previously used in Basco and Tang (2020), which finds a positive and long-run relationship between the samurai bond conversion on economic growth.

Our work is also informed by the literature on financial intermediation and how credit is channeled to firms through banks. In our theoretical motivation and empirical analysis, we focus on the intermediary role that banks play between firms and households. While banks may also serve other functions, our interest in the paper is to highlight the importance of banking on resource allocation and economic development (c.f., Gerschenkron, 1962; Greenwood and Jovanovic, 1990). The assumption of households not investing directly into firms (e.g., through equity markets) would be reasonable for Japan in this period given its nascent stock exchanges in Tokyo and Osaka, both established in 1878; high barriers to equity finance; and the relative paucity of corporations (Morikawa, 1992, pp. 93-94, Goldsmith, 1983, p. 61).[14] Indeed, Allen and Gale (1995) emphasize the difference between bank-oriented economies like Japan, with households holding mostly

[13] See Jordà et al. (2013), Jordà et al. (2017), Kaminsky and Schmukler (2008), Loayza and Ranciere (2006), Mendoza and Terrones (2012), and Schularick and Taylor (2012).

[14] This extra-banking investment channel is tested with our pseudo-IV specifications in the results section.

safe assets, versus equity market-oriented economies like the United States.

Furthermore, there are several studies that examine the effect of credit supply on the quality or risk of the loans granted by banks. In a recent work, Jiménez et al. (2020) argue that the Spanish housing boom in mid 2000s was akin to a credit supply shock. Banks obtained liquidity via securitization of real-estate assets. More importantly, Spanish banks took more risk by relaxing borrowing standards. Similar results have found for the recent mortgage debt boom in the United States (Demyanyk and Van Hemert, 2011; Keys et al., 2010). While we do not have direct evidence on which firms obtained bank loans after the credit supply shock, our findings on firm lifespan and destruction are consistent with this literature and corroborate our interpretation. Our contribution to this strand of the literature is to investigate the effect of the credit supply shock on the life cycle of firms.

A third area of related scholarship is understanding how firm dynamics affect economic growth in line with Schumpeterian dynamics (Schumpeter, 1942). More recent contributions include Dunne et al. (1988), who provided the first statistics on firm creation and destruction across industries in the United States, while Foster et al. (2008) underscore the importance of firm entry in aggregate productivity growth in the United States. These studies, however, use highly detailed (and confidential) firm data and observe firms in a developed economy context, neither of which applies to our historical study. A closer fit would be studies on how credit constraints can act as barriers to firm creation and growth, as shown by Aghion et al. (2007), Banerjee and Duflo (2014), Banerjee et al. (2019), Barrot (2016), and Beck and Demirguc-Kunt (2006)[15]. Our paper follows this empirical approach, but also utilizes a quasi-natural experimental setting that allows us to study a change in credit availability in a developing economy.[16] To this we add evidence on firm destruction and lifespan, which is absent in most of this literature.[17]

Finally, we contribute to the economic history and development literatures that relate the banking sector with economic activity. There is extensive work that examines the collapse of the banking sector in the United States during the Great Depression (e.g., Bernanke, 1983; Richardson, 2007; Richardson and Van Horn, 2009). The findings suggest that through bank failures, credit availability decreased and exacerbated the decline in output. Our study shows similar, but obverse, patterns when credit expanded. We also provide micro-level evidence that the financial revolution experienced in Japan, which preceded its industrialization at the end of the nineteenth century, may have had its origins in the government's policy to expand credit through banking (Rousseau, 1999; Tang, 2013). Our analysis underscores the role of public bonds in increasing bank lending capacity as was true in early twentieth century China (Ma, 2019). It also complements modern studies in Thailand and India that find increased credit accelerated the growth and sales of firms, relaxed the constraint for high productivity households who may not have had credit access otherwise, and raised total entrepreneurial activity (Banerjee and Duflo, 2014; Banerjee et al., 2019; Paulson and Townsend, 2004). We further discuss this mechanism in the context of firms following the historical overview.

## 3. Historical Background

Late nineteenth century Japan was a country in transition, moving from an agrarian, semi-autarkic economy to an industrial and internationally integrated one over the course of a few decades. Institutional reforms undertaken by the new central government included the adoption of a modern banking system and commercial code, which complemented the establishment of a central bank and equity exchanges as well as public bond offerings (Lockwood, 1954). By many accounts, Japan had a successful financial revolution that underpinned its economic growth, becoming the first non-western country to industrialize and the economic leader in the region for most of the twentieth century (Rousseau, 1999; Tang, 2013). Figure 1 shows how firms in modern sectors like textile and machine manufacturing grew rapidly in number and size relative to firms in primary production or services. This growth was facilitated in part by their access to newly available investment capital, formal financial intermediation, and an integrated domestic market.

Immediately preceding the country's modern financial development was the central government's 1876 policy that converted the hereditary stipends of former samurai into interest bearing government bonds (Tomita, 2005; Basco and Tang, 2020). Along with two earlier, smaller bond issues, these "samurai bonds" were collectively valued at 210 million yen, or half of Japan's national income and seven times total government revenue in that year.[18] This policy was enacted to reduce annual government outlays on liabilities carried over from the previous Tokugawa shogunate regime, to provide samurai with a financial security that could be sold or invested, and to increase the amount of capital available to the country's emerging banking sector (Tomita, 2005).[19]

To facilitate the latter, the government also revised its National Banking Act in the same year to explicitly allow for these bonds to be used by banks as capital for currency and loan issue through reserve lending (Yamamura, 1967; Harootunian, 1960). As shown in Table 1, former samurai owned the majority of the national banks' stock by using their bonds as collateral, and banks themselves bought additional bonds from samurai and subsequent owners as investments.[20] These national banks, which were privately owned but received charters from the central government, preceded the expansion of private and quasi-banks in the 1880s as part of the government's fiscal retrenchment and monetary consolidation following the establishment of the central bank in 1882.[21] Despite the government capping the issuance of banknotes for each prefecture

[15] See also Buera et al. (2015) for a review of the quantitative macro literature on the effect of financial frictions on entrepreneurship. We depart from this literature by having a more macro approach and exploit within-country variation in samurai bonds to assess the effect of credit supply on firm lifespan, creation, and destruction.

[16] Kaboski and Townsend (2012) similarly use a governmental microfinance program in modern Thailand to find that increased household credit provided increased financial intermediation, which in turn raised borrowing, investment, and wages in the short run. Our approach abstracts from the household and measures extensive firm activity for a longer period of time.

[17] An exception is Barrot (2016) which studies a reform in trade credit regulation in the French trucking industry. One main difference with our analysis is that we have data on all sectors and our credit supply shock represented a large increase in bank capital in the country.

[18] The two earlier bond issues, in 1873 and 1874, were voluntary conversions of samurai stipends and worth 36 million yen in current terms. Bonds varied in their payable interest rates depending on the former rank of the recipient samurai and his hereditary or life income. The highest ranked samurai received the largest payments in bonds but at the lowest interest rate, while the lowest ranked samurai the opposite. The conversion of annual incomes into lump sum bonds was not a one-for-one change in the government's liabilities, however, as higher ranked samurai took a loss of up to 75 percent of the present discounted value of their previously non-securitizable incomes (Flath, 2014, p. 33).

[19] All bonds issued in 1876 had a maturity term of twenty-five years starting in 1882 but could be sold starting in 1878 (Goldsmith, 1983, pp. 22-24). The government retired a large proportion of these bonds in the early 1880s.

[20] The 58.5 percent ownership share in 1884 is a decrease from the 75 percent share in 1882; however, prefectural disaggregation is not available for the latter figure (Harootunian, 1960, p. 440).

[21] The national banking system was initially based on the American model in use at the time, which was considered compatible for Japan given the economy was similarly decentralized, unlike those in Europe (Shizume, 2018).

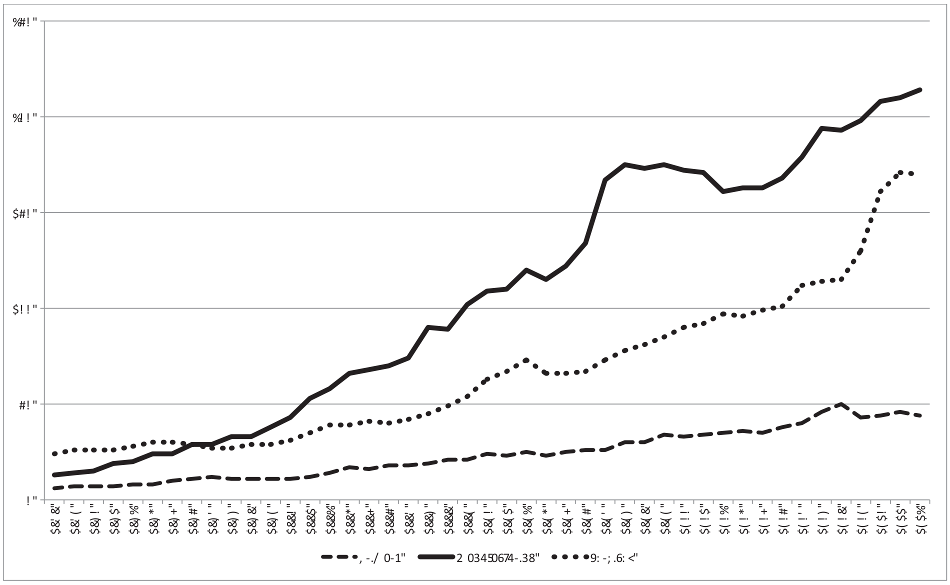

**Fig. 1.** Number of firm startups by major industry, 1868–1912.
Source: Tang (2013), p. 118.

to a national limit of ¥34 million so as to counter inflation, total financial assets in the economy still increased nine-fold between 1875 and 1885 to ¥273 million.[22] Of this amount, national banks had a dominant share with 41.4 percent of the total compared to ordinary private banks, quasi-banks, or other financial institutions (Goldsmith, 1983, p. 218). This was equivalent to 14.1 percent of gross national product, compared to the 1.2 percent just ten years prior.

The average per capita bond value by prefecture is 5.68 yen across bonds with different payable interest rates. As shown in the table, the top three prefectures receiving bonds in per capita terms were Tokyo (¥40.42), Ishikawa (¥17.64), and Kochi (¥16.63) while the bottom three prefectures were Yamanashi (¥0.14), Tochigi (¥1.06), and Osaka (¥1.16).[23] Figure 2 shows the distribution of these per capita bond values in 1876 along with per capita income levels in 1874. The substantial geographic and economic development variation in regions at the time of the bond issue provides identification in assessing the relative impact of credit availability on subsequent firm activity. It is also indicative of the exogeneity of the commutation policy given pre-existing conditions, which has been confirmed by earlier empirical analysis (Basco and Tang, 2020).[24]

To further illustrate that the value of these bonds per capita are not explained by income per capita in 1874, we regress per capita bond value on per capita income. Even though the coefficient of prefectural income per capita is positive, it is not significant (i.e., the $p$-value is 0.27). Thus, even though there is a weak positive correlation between both variables, it is not strong enough to indicate causality. The absence of a strong correlation can be graphically observed in Fig. 3, which also highlights the difference between the two richest prefectures, Tokyo and Osaka, that had received very different amounts of samurai bonds per capita.

An important consideration is whether the samurai bonds were exclusively channeled into banks. While it was possible for samurai to sell their bonds and use the funds to directly invest into firms, thus circumventing the financial intermediation of banks, there is no documented evidence that this occurred systematically (Goldsmith, 1983, pp. 23,24). Rather, anecdotal studies indicate that samurai were less entrepreneurial than the farming or merchant classes and preferred bureaucratic or military employment, which corresponded to their higher education levels and historic occupations (Kinmouth, 1981, pp. 35 and 79). Government policies to induce samurai to pursue land reclamation or colonial expansion attracted approximately 30,000 samurai and their families by the late 1880s out of two million samurai that lived in country at the time (Harootunian, 1960, pp. 437–439). Separate government loans to former samurai for the specific purposes of starting businesses totaled ¥5.3 million, or less than one fifth of the value of samurai ownership in national banks (*ibid*, p. 443). What is unknown is the share of funds invested into these enterprises that was derived from these loans versus the original commutation bonds, and the relative magnitudes in our analysis suggest an emphasis on the latter.

## 4. Theoretical Motivation

Our theoretical motivation comes from the standard corporate finance literature that examines the interaction between banks and credit rationing; see, for example, Freixas and Rochet (2008). In

[22] National banks were allowed to issue banknotes based on the amount of capital that they held (which included the samurai bonds). To centralize control over the money supply and make banknotes convertible into specie, the Bank of Japan took over this responsibility and no additional charters to national banks were granted (Shizume, 2018). There was subsequently a consolidation of national banks as their charters expired, with regular private banks increasingly dominant in the financial system starting in the 1880s (Yamamura, 1967).

[23] At the time of the samurai stipend commutation, there were eight (out of 47) prefectures that did not exist formally as they were part of other prefectures: Fukui, Kagawa, Miyazaki, Nara, Saga, Tokushima, Tottori, and Toyama. These are given the same per capita bond values as their former larger entities, which included the populations of these later administrative units. Another prefecture, Okinawa, was not formally incorporated into Japan until 1879, and thus did not receive any bonds at the time of the commutation. Hokkaido did receive commutation bonds for samurai stationed there, but these were recently arrived as part of Japan's colonial expansion northward.

[24] The relatively high share of samurai bonds in southwestern Japan reflects the country's political history and geography: external threats and international trade (via Nagasaki) before the mid-nineteenth century were largely to the west of Japan, which required the stationing of samurai for security and government administration. Samurai mobilized for the failed invasions of Korea in the 1590s also remained in the region, and local daimyo lords maintained larger garrisons since they ruled geographically larger domains and historically owed less allegiance to the shogunate government based in the east (Cullen, 2003, pp. 31-56).

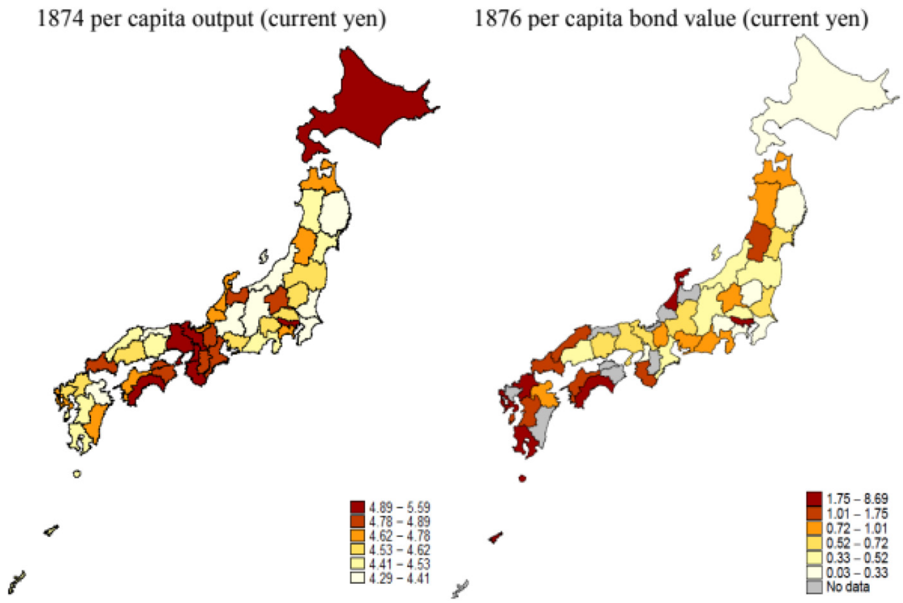


**Fig. 2.** Prefectural variation in output and bond values.
Source: Fukao et al. (2015), Japanese Ministry of Finance (1904).

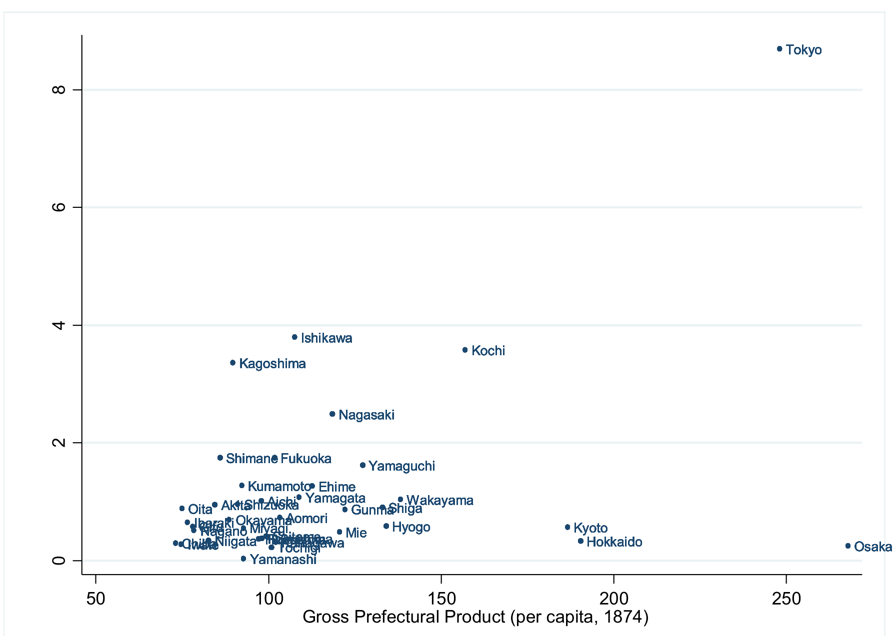


**Fig. 3.** Histogram of per capita bond value and gross product.
Source: authors' calculations; see text for details. Per capita gross prefectural product and bond value are measured in nominal yen for the years 1874 and 1876, respectively.

particular, we follow the theoretical models with bank intermediation and credit rationing found in Stiglitz and Weiss (1981) and Mankiw (1986). The basic assumption from these models is that savings from households are channeled toward firms via bank intermediation. This is reasonable for a developing economy like late nineteenth century Japan that is banking oriented as opposed to economies relying more on equity finance (Hoshi and Kashyap, 2001; Levine, 2005).[25]

Relevant to our analysis, a feature of these models is that, due to the presence of borrowing constraints and asymmetric information, only a fraction of the pool of entrepreneurs would be able to obtain funds to become viable. We interpret the issuance of samurai bonds as an increase in the endowment of households, which translates into an increase in banking capital. Additional considerations favoring intermediation include diversification of household savings into otherwise indivisible large entrepreneurial investments as well as improved intertemporal risk sharing.

[25] This assumption also aligns with the historical experience of Japan, which had two stock exchanges established in 1878 in Tokyo and Osaka but these were mainly for large scale enterprises like railways and cotton spinning factories. These firms were few in number for our period of analysis and represent 7 percent of our sample (28 spinning, 3 railways).

Before the issuance of the samurai bonds, most Japanese prefectures had limited pools of savings and no formal banking activity. With the introduction of samurai bonds, which varied in value across regions due to the non-uniform and exogenous distribution of resident samurai, prefectures gained a source of financial capital that was transferable and long term. Samurai were given bonds, redeemable after five and up to 30 years, in exchange for their hereditary annual stipends, whose value fluctuated depending on the price of rice. A primary motivation for the central government to issue these bonds was that they were on average lower in value than the net present discounted value of the stipends they replaced, thus reducing public expenditures and liabilities (Flath, 2014). Samurai were then encouraged to use these bonds to fund banks in the form of paid-in capital as indicated by the revision to the National Banking Act in 1876 (Tomita, 2005).

We focus on the banking channel because this can be precisely tested with empirical data across regions during this period, whereas direct investment into enterprises with these bonds is not documented. In other words, we assume that the issuance of samurai bonds increased the demand for deposits, which banks used to fund entrepreneurs. While samurai could have used the bonds to self-finance enterprises themselves, it is unclear how many did so, and once the bonds are sold the identity of the holder no longer is relevant. What is not speculative is that all prefectures that received samurai bonds had some invested into the national banks that were established thereafter, with capital ownership shares for samurai ranging from six to 94 percent. Banking activity was also negligible before the issuance of samurai bonds, and both the extensive and intensive development of the modern financial system took place following this reform (Shizume and Tsurumi, 2016; Tang, 2014). With the 1876 samurai bond issue, formal banking intermediaries like the national banks rapidly increased from six to 153 three years later.

How would the issuance of samurai bonds affect firm activity? For financially constrained entrepreneurs, the newly available capital would allow them to establish firms. What is less obvious is whether these firms would have been viable without the regime change, which the credit rationing models would predict not to be the case. If adverse selection were present, then firms established during (but not before) the period when samurai bonds are available would be more likely to fail since they have riskier projects, and thus be shorter lived.[26] We test the following predictions: 1) the lifespan of firms decreases with bank capital, 2) average firm creation increases with bank capital, and 3) average firm destruction increases with bank capital. In our empirical analysis, we also qualify these predictions based on major industry type since some (e.g., manufacturing) require larger amounts of external capital to be established.

## 5. Empirical Approach and Data Sources

### *5.1. Empirical Strategy*

Given the above predictions, our main variable of interest is bank capital per capita. Bank capital availability was heterogenous across prefectures in Japan, which allows us to examine whether variation in bank capital affected the life cycle of firms. A concern with directly using bank capital per capita in a given prefecture is endogeneity as it may be correlated with the demand of credit in that particular prefecture. Historical data limitations also mean that annual series of banking capital by region are limited before 1880.

[26] We further divide the years following the 1876 bond issue into five-year subperiods given differences in fiscal and monetary regimes in the post-bond period (e.g., the Matsukata deflation).

To circumvent these issues and to identify the credit supply channel, we use an instrument variable approach, with a prefecture's per capita samurai bond value instrumenting for per capita bank capital. The exclusion restriction is satisfied as the bond issuance occurred before the development of the banking system in Japan, so there is no simultaneity concern. Both banking series are shown in Table 1 along with reported the total ownership share of samurai of national banks. Although we have only direct evidence of samurai ownership in national banks, not all banks, the effect of samurai bonds is likely to affect the entire local banking environment, so we report estimates for both series. This is also historically justified since national banks were reformed in response to the bond issuance and emerged before most other banks in the country. One drawback to using samurai bond value as an instrument, however, is that since it is time invariant any differences in firm outcomes would be based on cross-sectional variation among prefectures, with the instrument absorbing any other prefecture-specific effects.[27]

Our main empirical prediction is on lifespan, which can be tested using individual firm-level data. Our OLS regression model is as follows,

$$Lifespan_{ijt} = \beta B_{it} + \gamma X_i + \delta_j + \delta_t + \varepsilon_{ijt}, \tag{1}$$

where $Lifespan_{ijt}$ is the number of years that a firm created in prefecture $i$ and sector $j$ in year $t$ survives, $B_{it}$ is the per capita value of bank capital in prefecture $i$ in year $t$, $X_i$ are prefecture level control variables, $\delta_j$ are sector fixed effects, and $\delta_t$ are year fixed effects. Control variables for initial conditions include per capita income, population, and urbanization level of the prefecture in 1874. Industry fixed effects control for potential idiosyncratic differences between four major sectors.[28] Year fixed effects control for aggregate shocks taking place in Japan during these years.

The sample coverage is firms born between 1880 and 1890, since earlier banking data disaggregated by prefecture do not exist. That said, the year marking firm exit is not constrained to this time range. We test the prediction that $\beta < 0$, meaning we expect the lifespan of firms decreases with credit supply. This is because prefectures with higher per capita samurai bond value would have more bank capital, which was allocated to riskier firms on average due to adverse selection. Separately, to account for potential endogeneity in bank capital, we instrument $B_{it}$ with samurai bond value per capita, $S_i$, in the above specification, Eq. (1) and report both the first stage F-statistic and coefficient on samurai bond value.

To test the firm entry and exit predictions (i.e., firm creation and destruction), we use analogous regression specifications. These specifications differ from that for lifespan in that the unit of analysis is the prefecture instead of individual firms. In addition, given the limited number of entry and exit observations in our sample and to conserve degrees of freedom, we use five-year periods instead of individual years and include the latter as fixed effects. Periodization follows the historical evidence on economic cycles in Japan: (i) pre-samurai bond conversion (1870–75), (ii) economic boom after the samurai bond issuance (1876-80), (iii) the Matsukata deflation (1881–85), and (iv) the recovery period typically identified as the start of Japan's industrialization (1886-90).[29] The analogous version of Eq. (1) is the following,

$$N_{ijp} = \beta B_{ip} + \gamma X_i + \delta_j + \delta_p + \varepsilon_{ijp}, \tag{2}$$

[27] Note that we transform all monetary values (i.e., bank capital, samurai bonds) using an inverse hyperbolic sine. This allows us to retain the zero-bond value for firms created before 1876 when the bond issuance occurred. The inverse hyperbolic sine can be interpreted similarly to a logarithmic transformation, with changes to a variable approximately percentage changes (Bellemare and Wichman, 2019).

[28] Sectors include primary, manufacturing, finance, and services (retail, transport, and other services).

[29] See, for example, the gross national income estimates in Japan Statistical Association (1987, Table 13-3).

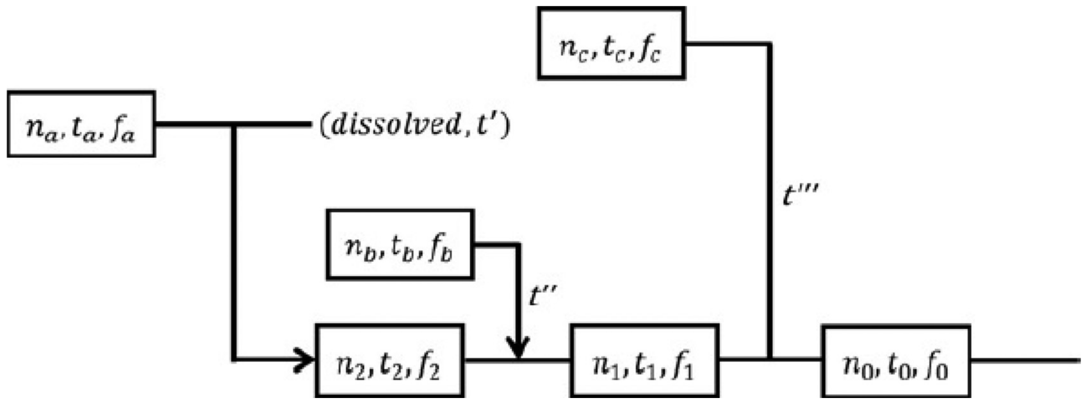


**Fig. 4.** Stylized example of a firm genealogy.
Source: Onji and Tang (2017). Firm names are distinguished by n, changes in firm lifecycle are indicated by time t, and organizational type by f. Firm entry is based on first appearance in a genealogy while exit is by a change in n or f. Longevity is measured as the change in t between entry and exit. See text for details.

where $N_{ijp}$ is the average number of firm entries or exits in prefecture *i*, sector *j*, and period *p*.

Since both firm entry and exit are measured as count events, instead of the OLS model for lifespan, we use a Poisson maximum likelihood estimation model.[30] We also use the same control variables as above except with the substitution of period ($\delta_p$) for year fixed effects. The empirical prediction for both firm creation and destruction is $\beta > 0$. We also report the estimates using our IV with samurai bond value per capita, $S_i$. The rationale is that with the bond issue, more entrepreneurs would have received funds from banks but these firms were on average riskier due to adverse selection. Moreover, differences in the distribution of bonds would similarly apply to the amount of entrepreneurial activity.

To add precision to our results, we separately estimate Eqs. (1) and (2) for the two main sectors of manufacturing and services, which also includes retail and transport.[31] As discussed at the end of the previous section, we expect that the effects of bank capital being amplified in the manufacturing sector given its greater dependence on external finance. That is, for lifespan $\beta^{Mfg} < \beta^{Serv}$, and for both firm creation and destruction $\beta^{Mfg} > \beta^{Serv}$.

### *5.2. Data Sources and Measurement*

Our firm data come from corporate genealogies that provide some of the oldest existing evidence of firm establishment in Japan. Collected by Japanese business historians from 1,089 corporations listed in the Tokyo Stock Exchange in 1984, the genealogies contain over 14,000 unique entries of firm establishment (Yagura and Ikushima, 1986). The qualitative nature of these sources notwithstanding, there is information on the dates of firm appearance, industry classification, ownership type and change, and geographical location.[32] Structured as firm-level observations, these data provide a systematic way to examine firm dynamics at the extensive margin, such as the number of new establishments each year, the dates of their death or reorganization, and thus the longevity of individual firms.

A stylized example of a firm genealogy is shown in Fig. 4. Given that firms listed in genealogies are subject to survivorship bias, there may be selection by industry and viability. However, this issue is partially mitigated by our research design since we compare only outcomes for firms within our sample, all of which are affected by this potential bias. An additional point is that the genealogies include both direct line parent firms that survive as well as any unsuccessful firm whose assets were transferred to a surviving line firm (as well as their ancestor firms). We also note that the firm observations used in this analysis, from the year 1870 to 1890, have the least mechanical selection of survivorship since the number of firms increases over this period whereas for the genealogies as whole the number decreases over time.

Earlier scholarship (Onji and Tang, 2017) has indicated that the sample of firms in the genealogies is generally reliable in representativeness and regional distribution, with a Pearson's correlation coefficient of 0.97 at less than 1 percent statistical significance for non-financial corporations in the dataset and with national aggregates when the latter are available.[33] More importantly, we use these genealogical data since the 1876 commutation of samurai stipends into government bonds precedes the availability of official firm data starting in 1893. Another useful feature is that these firm observations allow us to examine gross flows of entry and exit, unlike studies that rely on periodic censuses.

A final characteristic of our dataset is that it includes all firms by ownership type, including sole proprietorships, partnerships, and corporations for a developing economy. Unlike other studies that focus on the behavior of corporations (e.g., Gregg and Nafziger, 2019), which are generally better documented, our analysis does not select on firm size and thus can show how informal enterprises without financial records may also respond to changes in the economic environment such as shocks to credit supply and institutional reform. This is particularly salient in a developing economy context as credit availability is more constrained, which disproportionately affects younger, smaller, and less efficient enterprises (Aghion et al., 2007). These smaller firms are more likely to exit but are also responsible for a significant share of job growth and economic dynamism (Brown et al., 2015).

Our analysis uses the sample of 440 firms that were established between 1870 and 1890 in 42 prefectures across the country; their summary statistics on entry, exit, and lifespan are shown

[30] For our exit regressions, we use a right-side truncated IV Poisson specification since the number of exits cannot exceed the number of existing firms (i.e., incumbents) in a given industry or economy.

[31] There are too few primary sector firms to generate statistically meaningful estimates. See Table 4 for summary statistics of our dataset.

[32] We refer to each entry as a firm, although the definition of the business enterprise (e.g., sole proprietorship, partnership, and corporation) was not formalized until the promulgation of the 1893 Commercial Code; see Onji and Tang (2017) for more information.

[33] See Onji and Tang (2017) for a more detailed discussion of the dataset. These data have been used to analyze the adoption of foreign technology in Japan (Tang, 2011), the impact of tax reform on incorporation (Onji and Tang, 2017), and the extensive growth of financial intermediation and modern industries (Tang, 2013).

**Table 2**
Firm summary statistics.

| | Total | Primary | Manufacturing | Finance | Services |
|---|---|---|---|---|---|
| Firm entry (N) | 440 | 18 | 145 | 224 | 53 |
| 1870-75 | 43 | 4 | 20 | 10 | 9 |
| 1876-80 | 142 | 1 | 20 | 114 | 7 |
| 1881-85 | 122 | 7 | 38 | 64 | 13 |
| 1886-90 | 133 | 6 | 67 | 36 | 24 |
| Firm exit (N) | 84 | 0 | 46 | 31 | 7 |
| 1870-75 | 6 | 0 | 2 | 2 | 2 |
| 1876-80 | 12 | 0 | 6 | 4 | 2 |
| 1881-85 | 25 | 0 | 9 | 13 | 3 |
| 1886-90 | 41 | 0 | 29 | 12 | 0 |
| Lifespan (year) | 20.6 | 29.6 | 17.1 | 21.7 | 22.7 |
| 1870-75 | 18.9 | 33.8 | 17.2 | 13.3 | 22.7 |
| 1876-80 | 19.3 | 51.0 | 20.5 | 18.2 | 29.4 |
| 1881-85 | 23.1 | 30.9 | 17.2 | 25.0 | 26.4 |
| 1886-90 | 20.4 | 23.0 | 16.0 | 29.3 | 18.7 |

*Source:* authors' calculations. Entry is defined as first appearance in a corporate genealogy; exit is a break in the lineage through a change in ownership, organizational form, liquidation, merger, or name; and lifespan is the difference between entry and exit years. See text for more details.

in Table 2.[34] We can further disaggregate our sample across four major sectors: primary (18), manufacturing (145), finance (224), and other services (53). For our regression analysis we exclude firms that were established before 1880 to align with bank capital data availability and firms in Okinawa and Hokkaido, which were colonial territories prior to the bond issuance. We include firms located in prefectures that were not autonomous prior to the 1876 bond issuance, using the per capita bond value for the older, composite-level prefecture as shown in Table 1. Together, this leaves 270 firms for our benchmark OLS, Poisson, and equivalent IV regressions.

To clarify the definitions of entry and exit, we consider firm entry as the first appearance of a firm in a corporate genealogy (Onji and Tang, 2017); if there are multiple references to the same firm across different genealogies, the earliest record is used. A firm that merged with another is not considered a different firm if the name remains the same, even if the ownership type or location changes. A firm that changes name without any merger or acquisition activity is still considered the same firm. For firms emerging from merger activity and with a name change, the oldest firm participating in the merger is considered the ancestor firm and continues that firm's record and birthdate. Firm exit is when a firm is merged into another firm and loses its identity or undergoes liquidation with its assets transferred to another firm. Firm lifespan is measured as the difference between exit and entry years.[35]

As shown in Table 2, the number of new firm establishments in our full period of analysis (1870-1890) conforms with our priors about credit access. Both entry and exit increase significantly after the 1876 bond issuance, but the largest relative change occurs for entry in the five years after the bond issue. For exit, this is largest during the macroeconomic contraction in the first half of the 1880s (i.e., the Matsukata deflation). Lifespan is also lower for firms created in the 1870s, which includes the years immediately following the bond issue, and there is more heterogeneity in age by sector than in the years before 1876 and after 1880. Fig. 5 shows a kernel density plot of lifespan over the period of analysis. The average firm in our sample lasted 20.8 years, similar in magnitude to the median age of 19 years.[36] Given this distribution, our results are less likely to be driven by outlying observations.

Our financial data comprise three separate series: national bank capital, total bank capital, and samurai bond value. Both bank capital series are annual (1880-1890) and were compiled from all prefectures by the Cabinet Bureau of Statistics (Japan Statistical Association, 1962). The 1876 data on samurai bonds by prefecture were recorded by the Japanese Ministry of Finance (1904). All three series are in nominal yen.

Since the bond value per capita variable is time invariant, we are unable to include prefecture fixed effects. Thus, we control for other observable differences with initial prefecture-level income data (Fukao et al., 2015), demographic measures of population, and a proxy of urbanization (i.e., population density by habitable land gradient) (Japan Statistical Association, 1962). These variables also partly address the issue of exogeneity of bond distribution across regions. In principle, it may be the case that prefectures receiving a greater credit supply shock were ex ante different in their levels of economic activity and market access. Earlier studies (Tang, 2014; Basco and Tang, 2020) indicate that initial income levels were not associated with either the placement of the railway stations or the per capita value received in bonds.[37]

## 6. Empirical Results

### 6.1. Effect of Bank Capital on Lifespan

We first test the prediction that the lifespan of firms decreases with bank capital. Table 3 reports the coefficients of Eq. (1) using the total bank capital and national bank capital series. The top panel shows the estimates using the OLS regression model while the bottom panel has the analogous IV specification. Our dependent variable is the lifespan of a firm measured in years between its creation and destruction in a given prefecture between the years 1880 and 1890. All specifications include year and sector fixed effects, and robust standard errors are clustered by prefecture.

As a first pass, we report in columns 1 and 3 the baseline coefficient on banking without adding the prefectural control variables for each bank capital series, respectively. We find that, consistent with our theoretical motivation, the coefficient for bank capital is negative and statistically significant in both capital series. The difference between the two bank capital series is that while the impact of the samurai bond issuance should theoretically affect the entire banking sector, our estimates for national banking are more precise since we have only direct estimates of samurai ownership in these banks. Including the prefectural control variables in columns 2 and 4 does not change the sign and both coefficients remain statistically significant. Thus, we interpret this finding as indicating firms in prefectures with increased bank capital are shorter lived.

Given possible endogeneity between bank capital and prefectural demand, we use the samurai bond values from 1876 as an instrument for both bank capital series, shown in the bottom panel. Before discussing the IV results, we graphically illustrate in Fig. 6

[34] The five excluded prefectures are Hokkaido, Kagawa, Miyazaki, Nara, and Okinawa. Both Hokkaido and Okinawa were not considered part of Japan proper until after the late 1870s, postdating the historic distribution of samurai, and the remaining prefectures do not have firms recorded in the genealogies during this period.

[35] See Onji and Tang (2017, data appendix) for a more detailed description of the corporate genealogies used in this analysis.

[36] We separately estimate a pseudo-IV model that regresses firm lifespan on samurai bond value per capita in Table A1 (Appendix A). This utilizes the entire sample of firms between 1870 and 1890 and corroborates the results from our bank capital regressions. Furthermore, while our baseline estimates for lifespan are based on OLS, for robustness we report in Table A2 (Appendix A) our estimates using a Poisson regression model since longevity can also be interpreted as a count variable in years. Table A3 shows our results when we drop either the top 1 or 0.5 percent of the distribution.

[37] Fig. 2 also shows the geographical distribution of bond per capita in 1876 and prefectural output per capita in 1874, which are not correlated at least to the ten percent significance level.

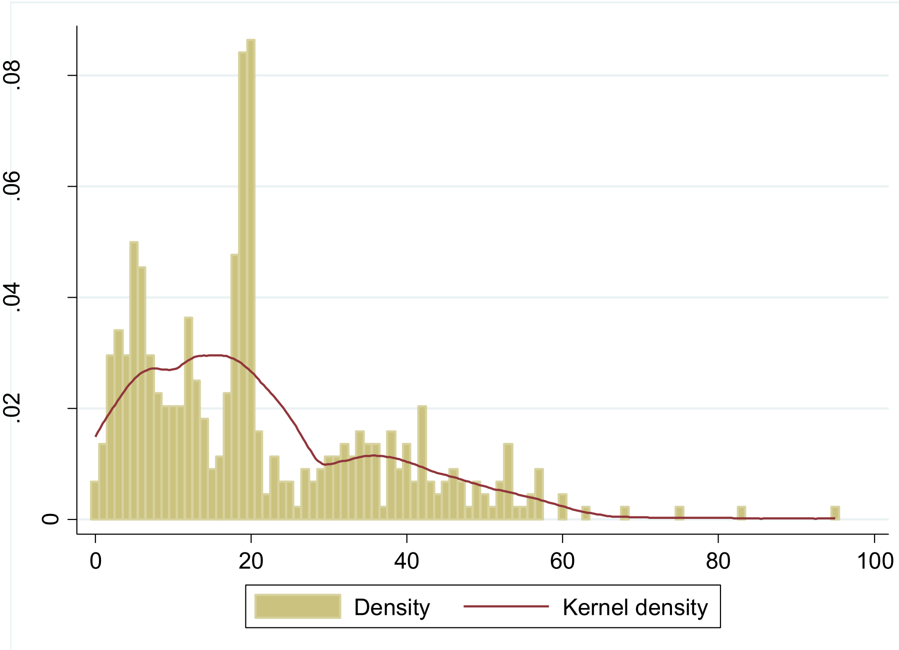


**Fig. 5.** Distribution of firm lifespan.
Source: authors' calculations; see text for details. Lifespan is measured as years between entry and exit.


**Fig. 6.** Samurai bond value and firm lifespan correspondence, by subperiod.
Source: authors' calculations; see text for details. The ranges shown for each subperiod are at 95 percent confidence.

the relationship between per capita bond value and firm lifespans. These results, which we report in Table A1 in Appendix A, are from a pseudo-IV regression that directly substitutes per capita samurai bond value for bank capital instead of in two stages. As shown, samurai bond value varies by subperiod, with firms in prefectures with higher per capita bond value having shorter lifespans.[38]

The IV coefficients in Table 3 are larger than their OLS analogues in absolute value, which may be correcting the downward bias from the OLS specification. Adding in our prefectural control variables in columns 2 and 4, the coefficient on bank capital increases in magnitude and remains negative and statistically significant. For both IV specifications, bank capital further increases in magnitude and statistical significance compared to their OLS equivalents and the F-statistic of joint significance increases with the added control variables. Our test for weak instruments also indicates that samurai bond value is highly relevant for the bank capital series.[39] Quantitatively, according to our preferred specification (bottom panel, column 2), the coefficient on bank capital per capita shows that a 10 percent increase in total capital per capita trans-

[38] The four subperiods are: (i) pre-bond issuance (1870-75), economic boom following the bond issuance (1876-80), (iii) Matsukata deflationary period (1881-85) and (iv) recovery (1886-90).

[39] Based on benchmark F-statistic thresholds in Stock and Yogo (2001).

**Table 3**
Lifespan by banking capital, all sectors.

| DV: Firm lifespan in years | All bank capital | | National bank capital | |
|---|---|---|---|---|
| | | *OLS* | | |
| Bank capital p.c. | -1.306** | -1.748* | -0.993* | -1.633** |
| | (0.626) | (0.987) | (0.552) | (0.760) |
| Prefectural income p.c. | | 28.972* | | 29.826** |
| | | (14.666) | | (13.797) |
| Population | | 9.741** | | 10.035** |
| | | (4.422) | | (4.494) |
| Urbanization | | 2.049 | | 2.142 |
| | | (1.463) | | (1.446) |
| R-squared | 0.121 | 0.164 | 0.118 | 0.163 |
| F-statistic | 4.35 | 3.78 | 3.20 | 4.83 |
| Observations | 270 | 270 | 270 | 270 |
| | | *IV* | | |
| Bank capital p.c. | -2.472** | -3.367*** | -2.223** | -2.988*** |
| | (1.162) | (1.096) | (1.039) | (0.951) |
| Prefectural income p.c. | | 45.627*** | | 45.482*** |
| | | (12.699) | | (12.726) |
| Population | | 8.496* | | 9.163* |
| | | (4.657) | | (4.652) |
| Urbanization | | 1.472 | | 1.699 |
| | | (1.391) | | (1.370) |
| F-statistic | 4.52 | 6.24 | 4.58 | 6.12 |
| Observations | 270 | 270 | 270 | 270 |
| Samurai bond value p.c. | 0.927*** | 0.724*** | 1.031*** | 0.815*** |
| | (0.206) | (0.084) | (0.222) | (0.086) |
| First-stage F-statistic | 20.13 | 73.861 | 21.50 | 89.93 |
| Cragg-Donald Weak Instrument test | 349.16 | 320.56 | 451.18 | 494.74 |

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors clustered by prefectures in parentheses. Bank capital and samurai bond values are in nominal yen, which we transform with an inverse hyperbolic sine function because the value of bonds per capita was zero before 1876. All specifications include year and sector fixed effects.

lates into a decrease in life by approximately one-third of a year or 1.6 percent for an average firm.[40]

Since lifespans may vary depending on relative differences in bond value, we show in Fig. 7 the evolution of firm lifespans between those in top (red) and bottom (blue) quartiles of prefectures by bond value distribution. Consistent with our findings, firm in prefectures with more samurai bonds (which had more banking capital per capita during this period) had, on average, lower lifespan than firms in prefecture with fewer samurai bonds (and banking capital).

As a robustness check, Table A4 in Appendix A reproduces the same baseline estimates in Table 3 but excludes firms in the financial sector. These results check whether the increase in bank capital corresponded with overall firm activity as opposed to simply a larger financial sector measured in firm numbers. The IV coefficients on bank capital are quantitatively smaller in absolute terms but remain statistically significant. In particular, the coefficient in our preferred specification (column 2, bottom panel) halves in magnitude from -3.367 to -1.699. One interpretation of these results is that financial institutions were considered riskier enterprises compared to firms in other sectors and thus more prone to fail or be sold. Excluding them from the analysis would lower the average risk profile of the remaining firms in the sample and thus the magnitude on the bank capital coefficient would commensurately decrease.

[40] Given the inverse hyperbolic sine transformation, changes to the bank capital variable can be interpreted as approximate percentage changes. For a coefficient of -3.367, a ten percent increase thus represents a decrease of 0.337 years. Since the average lifespan of firms is 20.8 years, this is equivalent to a 1.6 percentage decrease.

**Table 4**
Lifespan by banking capital and sector.

| DV: Firm lifespan in years | All bank capital | | National bank capital | |
|---|---|---|---|---|
| | OLS | IV | OLS | IV |
| | | *Manufacturing* | | |
| Bank capital p.c. | -1.751* | -1.798** | -1.706** | -1.602** |
| | (0.969) | (0.846) | (0.820) | (0.745) |
| Prefectural income p.c. | 43.842*** | 44.313*** | 45.248*** | 44.082*** |
| | (11.967) | (11.513) | (12.080) | (11.711) |
| Population | 4.144 | 4.089 | 3.977 | 4.115 |
| | (7.566) | (7.497) | (7.490) | (7.426) |
| Urbanization | 2.369* | 2.350* | 2.427* | 2.469** |
| | (1.252) | (1.221) | (1.179) | (1.173) |
| R-squared | 0.152 | | 0.153 | |
| F-statistic | 6.05 | 6.69 | 6.51 | 6.84 |
| Observations | 111 | 111 | 111 | 111 |
| Samurai bond value p.c. | | 0.741*** | | 0.832*** |
| | | (0.066) | | (0.072) |
| First-stage F-statistic | | 127.82 | | 132.30 |
| Cragg-Donald Weak Instrument test | | 212.75 | | 278.62 |
| | | *Services* | | |
| Bank capital p.c. | -0.773 | 0.709 | -0.163 | 0.650 |
| | (1.752) | (2.458) | (1.841) | (2.250) |
| Prefectural income p.c. | -50.681 | -64.521 | -56.367 | -64.001 |
| | (37.391) | (39.127) | (39.830) | (38.084) |
| Population | 32.284** | 33.630*** | 32.840** | 33.570*** |
| | (13.955) | (13.363) | (14.058) | (13.331) |
| Urbanization | -0.773 | 0.118 | –0.415 | 0.118 |
| | (3.079) | (3.366) | (3.254) | (3.359) |
| R-squared | 0.295 | | 0.293 | |
| F-statistic | 3.10 | 1.86 | 2.52 | 1.86 |
| Observations | 40 | 40 | 40 | 40 |
| Samurai bond value p.c. | | 0.752*** | | 0.821*** |
| | | (0.141) | | (0.141) |
| First-stage F-statistic | | 28.25 | | 34.09 |
| Cragg-Donald Weak Instrument test | | 28.33 | | 32.61 |

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors clustered by prefectures in parentheses. Bank capital and samurai bond values are in nominal yen, which we transform with an inverse hyperbolic sine function because the value of bonds per capita was zero before 1876. All specifications include year fixed effects.

To explore heterogenous impacts from credit on different sectors given potential variance in external finance dependence, we regress bank capital on firm lifespan for manufacturing and service firms separately. Columns 1 and 2 in Table 4 show the results for all bank capital per capita and columns 3 and 4 the results when using national bank capital per capita. Per the earlier specifications, we include year fixed effects. To ease the exposition, we only report the regressions when including all control variables for both the OLS and IV specifications.

In the top panel, the bank capital coefficients in both series are negative and statistically significant for manufacturing firms. Quantitatively, this means that a 10 percent increase in bank capital per capita decreases a firm's lifespan between 58 and 66 days, or 0.9 and 1.0 percent.[41] In contrast, the firm lifespan results in the bottom panel for the services industry show that the coefficients on bank capital are not statistically different from zero. The fact that the effect of bank capital is exacerbated in the manufacturing sector is consistent with bank capital easing financial conditions of financially constrained firms (Rajan and Zingales, 1998).

[41] Based on an average lifespan of 17.2 years for manufacturing firms in our sample.

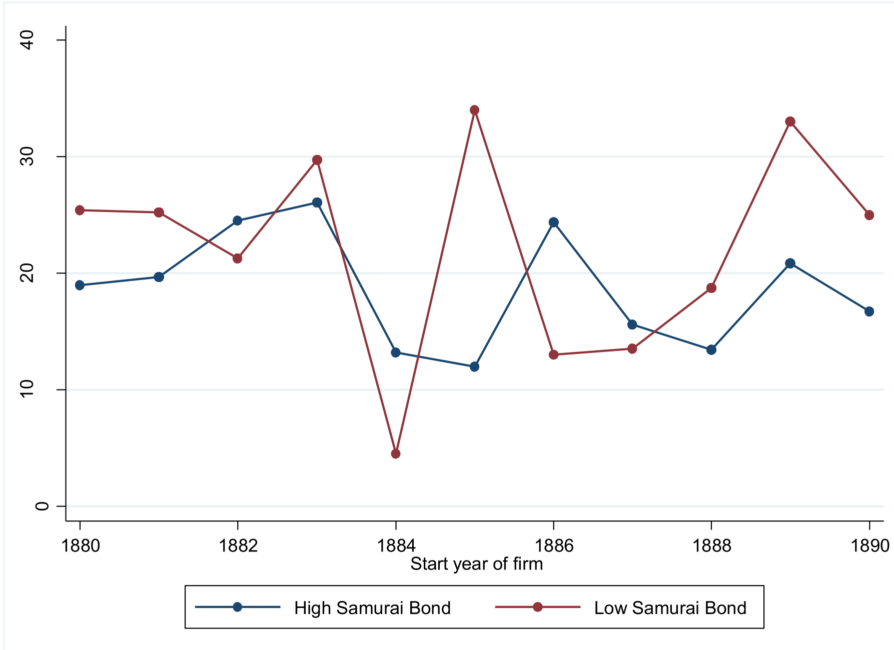


**Fig. 7.** Firm lifespan, by bond quartile and starting year.
Source: authors' calculations; see text for details.

**Table 5**
Firm entry by banking capital, all sectors.

| DV: Number of entries in prefecture and period | All bank capital | | National bank capital | |
|---|---|---|---|---|
| | | *Poisson* | | |
| Bank capital p.c. | 0.532*** | 0.232** | 0.511*** | 0.182** |
| | (0.037) | (0.095) | (0.033) | (0.074) |
| Prefectural income p.c. | | 6.720*** | | 7.156*** |
| | | (1.904) | | (1.681) |
| Population | | 1.019*** | | 1.004*** |
| | | (0.271) | | (0.263) |
| Urbanization | | -0.118** | | -0.137** |
| | | (0.056) | | (0.056) |
| Pseudo R-squared | 0.179 | 0.246 | 0.175 | 0.241 |
| Wald statistic | 302.12 | 1194.32 | 495.27 | 1679.27 |
| Observations | 270 | 270 | 270 | 270 |
| | | *IV Poisson* | | |
| Bank capital p.c. | 0.414** | 0.096* | 0.375** | 0.088* |
| | (0.185) | (0.051) | (0.177) | (0.048) |
| Prefectural income p.c. | | 8.301*** | | 8.329*** |
| | | (0.958) | | (0.965) |
| Population | | 0.998*** | | 0.993*** |
| | | (0.252) | | (0.252) |
| Urbanization | | -0.153*** | | -0.158*** |
| | | (0.055) | | (0.055) |
| Observations | 270 | 270 | 270 | 270 |
| Samurai bond value p.c. | 0.472*** | 0.273*** | 0.641*** | 0.358*** |
| | (0.148) | (0.058) | (0.165) | (0.058) |
| First-stage Wald statistic | 270.32 | 588.89 | 535.57 | 776.87 |

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors clustered by prefectures in parentheses. Bank capital and samurai bond values are in nominal yen, which we transform with an inverse hyperbolic sine function because the value of bonds per capita was zero before 1876. All specifications include sector and period fixed effects

### 6.2. Effect of Bank Capital on Firm Entry

Our next measure of firm dynamics is on firm entry, and Table 5 reports the coefficients from running Eq. (2) that regresses the number of new firms established in a prefecture for each sector and period on bank capital and other variables. Our specifications include sector and period fixed effects and the robust standard errors are clustered at the prefecture level.

The bank capital coefficient, as predicted in our theoretical motivation, is positive in all specifications. This suggests that firm entry is positively associated with bank capital availability. In the full specification with all prefectural control variables the IV specification, while statistically significant for both bank capital series, reduces in magnitude to 0.096 and 0.088, respectively. This may be due to the lag between the introduction of samurai bonds in 1876 and the bank capital series starting in 1880, where financial market development and divergence between prefectures may have amplified the effect of the bonds on entrepreneurship in some areas.[42] In relative terms, a 10 percent increase in bank capital per capita for our preferred specification is associated with a 0.7 percent increase in firm entry.[43] Fig. 8 also suggests a positive correlation between bank capital per capita and firm entry in both periods, which would be consistent with the results in the table.

The sector-specific estimates shown in Table 6 provide some nuance and explanation to the economy-wide results. In the top panel for manufacturing firms, the coefficient on both bank capital series is positive and statistically significant for the Poisson and IV Poisson specifications. In contrast, the bottom panel for service firms shows a negative and statistically significant coefficient in the IV Poisson specification. This decomposition of the economy by sector indicates that entry behavior was highly heterogenous, which is masked in the aggregate. Quantitatively, according to our preferred specification for manufacturing (column 2), the coefficient of 0.178 means that a 10 percent increase in total bank capital

[42] Table A5 in Appendix A provides analogous results to Table 5 when excluding financial firms. The magnitude of the coefficients is similar, and we cannot reject the hypothesis that they are the same. These results differ in that we have higher statistical significance when excluding financial firms, which suggests that non-financial firms experience a greater impact from additional bank capital.

[43] This is calculated using the average number of firm entries by prefecture and period of 1.430, where a 10 percent increase in total bank capital per capita correspond with a 0.0096 increased entry, which is 0.7 percent of the average.

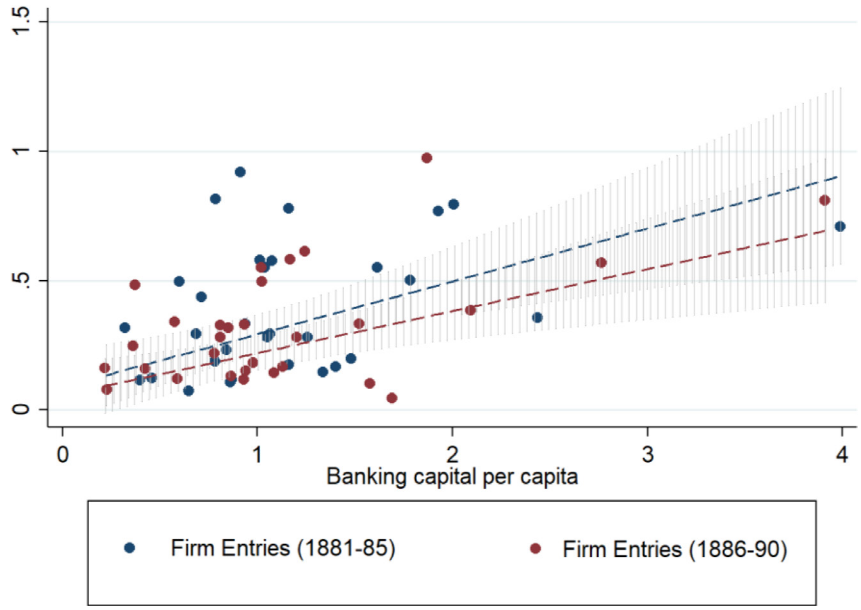


**Fig. 8.** Histogram of bank capital and firm entry, by period.
Source: authors' calculations; see text for details.

increases manufacturing firm entry by 0.6 percent.[44] The equivalent for a service sector firm is a decrease in entry by 2.7 percent, although the service sector results may be sensitive to the smaller sample size.[45] Thus, the results are consistent with the theoretical prediction that the effect of bank capital availability is amplified in sectors with greater external financial dependence (e.g., manufacturing vis-a-vis services).

### 6.3. *Effect of Bank Capital on Firm Exit*

We finally test whether bank capital abundant prefectures experience increased firm exit, and Table 7 reports the results from running Eq. (2). The dependent variable is the number of firm exits in a given prefecture, sector, and period. All specifications include sector and period fixed effects, and robust standard errors are clustered at the prefecture level. The top panel reports the results when using a Poisson regression model for both banking series while the bottom panel uses a generalized method of moments (GMM) IV Poisson model to account for possible endogeneity.[46] An important difference with the entry regressions is that we use a right-side truncated Poisson model in both panels since the number of exits cannot exceed the total number of incumbents. Thus we limit exits to the maximum number of existing firms in a given prefecture, period, and when appropriate sector.

Consistent with our priors, the coefficient on bank capital is positive and significant in specifications for both bank capital series and both regression models. Unlike in the lifespan regressions, adding prefectural control variables reduces the bank capital coefficients but does not affect statistical significance. Even more interesting is that the added control variables are generally not statistically significant, which suggests that bank capital availability is the main determinant of firm exit.

The results from the IV model indicate that the increase in bank capital via the issue of samurai bonds increased firm destruction. Quantitatively, according to our preferred specification (bottom panel, column 2), the coefficient 1.742 means that a 10 percent increase in total bank capital per capita translates into an average 61.1 percentage increase in firm exits.[47] This positive correlation between prefectural bank capital per capita and firm exit can also be seen in Fig. 9 in the two periods with bank capital data, where the dots represent the prefectural averages.

Table 8 reports the effect of bank capital on firm exit for the manufacturing sector. We cannot report the results for services because of small sample size. All specifications include period fixed effects and all prefectural control variables. Similar to the results for firm exit in all sectors, the coefficient of bank capital is positive and significant across both bank capital and estimation model specifications. Quantitatively, a 10 percent increase in total bank capital per capita (column 2) translates into an increase in manufacturing firm exit of 23.9 percent.[48] Although we cannot compare the results of manufacturing with services, our estimates for manufacturing firms are consistent with the predictions from our theoretical motivation.

## 7. Discussion and Conclusion

Japan experienced an unexpected positive credit supply shock when the government replaced the hereditary stipends of samurai for government bonds in 1876. Samurai, who also lost all their other privileges, had many incentives to use this money relatively quickly to invest in existing firms, to create new firms, or to fund

[44] This is calculated using the average number of manufacturing firm entries of 1.894 per prefecture and period (i.e., a 10 percent increase in total bank capital per capita represents a 0.018 increase in manufacturing firm entry, which is 0.9 percent of total manufacturing firm entries).

[45] This is calculated using the average number of service firm entries of 0.830 per prefecture and period (i.e., a 10 percent increase in total bank capital per capita represents a 0.023 decrease in service firm entry, which is 2.7 percent of total service firm entries).

[46] Estimates from our Poisson regression specifications are also robust to using the negative binomial distribution (not reported).

[47] This is calculated using the average number of firm exits of 0.285 per prefecture and period (i.e., a 10 percent increase in total bank capital per capita represents a 0.174 increase in firm exit, which is 61.1 percent of total firm exits). In Table A6 in Appendix A, we run the same specification for firm exits when financial firms are excluded and obtain similar results.

[48] This is calculated using the average number of manufacturing firm exits of 0.666 per prefecture and period (i.e., a 10 percent increase in total bank capital per capita represents a 0.159 increase in manufacturing firm exit, which is 3.4 percent of total manufacturing firm exits).

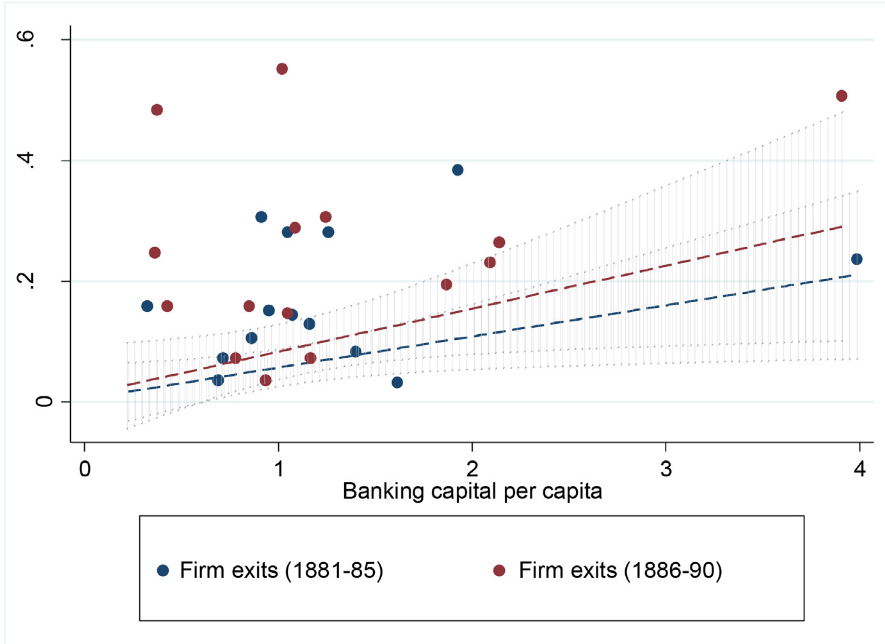


**Fig. 9.** Histogram of bank capital and firm exit, by period.
Source: authors' calculations; see text for details.

**Table 6**
Firm entry by banking capital and sector.

| DV: Number of entries per prefecture and period | All bank capital: Poisson | All bank capital: IV Poisson | National bank capital: Poisson | National bank capital: IV Poisson |
|---|---|---|---|---|
| | | *Manufacturing* | | |
| Bank capital p.c. | 0.193*** | 0.178*** | 0.199*** | 0.159*** |
| | (0.045) | (0.023) | (0.041) | (0.021) |
| Prefectural income p.c. | 12.711*** | 12.860*** | 12.417*** | 12.820*** |
| | (1.279) | (1.053) | (1.364) | (1.035) |
| Population | 1.188** | 1.182** | 1.188** | 1.176** |
| | (0.493) | (0.477) | (0.490) | (0.475) |
| Urbanization | -0.162*** | -0.168*** | -0.174*** | -0.185*** |
| | (0.060) | (0.059) | (0.058) | (0.058) |
| Pseudo R-squared | 0.521 | | 0.731 | |
| Wald statistic | 455.54 | | 473.56 | |
| Observations | 66 | 66 | 66 | 66 |
| Samurai bond value p.c. | | 0.283*** | | 0.382*** |
| | | (0.087) | | (0.065) |
| First-stage Wald statistic | | 278.88 | | 370.61 |
| | | *Services* | | |
| Bank capital p.c. | -0.092 | -0.228*** | -0.085 | -0.205*** |
| | (0.093) | (0.050) | (0.089) | (0.042) |
| Prefectural income p.c. | 8.511*** | 9.826*** | 8.477*** | 9.669*** |
| | (1.681) | (0.762) | (1.650) | (0.756) |
| Population | 0.113 | 0.068 | 0.112 | 0.067 |
| | (0.313) | (0.323) | (0.309) | (0.315) |
| Urbanization | -0.090 | -0.185* | -0.084 | -0.167* |
| | (0.096) | (0.098) | (0.096) | (0.096) |
| Pseudo R-squared | 0.231 | | 0.237 | |
| Wald statistic | 256.46 | | 331.46 | |
| Observations | 53 | 53 | 53 | 53 |
| Samurai bond value p.c. | | 0.257*** | | 0.325*** |
| | | (0.053) | | (0.058) |
| First-stage Wald statistic | | 380.75 | | 495.55 |

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors clustered by prefectures in parentheses. Bank capital and samurai bond values are in nominal yen, which we transform with an inverse hyperbolic sine function because the value of bonds per capita was zero before 1876. All specifications include period effects.

**Table 7**
Firm exit by banking capital, all sectors.

| DV: Number of exits in prefecture and period | All bank capital | | National bank capital | |
|---|---|---|---|---|
| | | *Poisson* | | |
| Bank capital p.c. | 0.891*** | 0.605*** | 0.803*** | 0.499*** |
| | (0.081) | (0.138) | (0.073) | (0.106) |
| Prefectural income p.c. | | 5.815* | | 6.292** |
| | | (3.085) | | (2.798) |
| Population | | 0.915 | | 0.886 |
| | | (0.684) | | (0.663) |
| Urbanization | | -0.133 | | -0.195 |
| | | (0.173) | | (0.176) |
| Pseudo R-squared | 0.363 | 0.389 | 0.348 | 0.375 |
| Wald statistic | 4774.12 | 6325.29 | 7408.03 | 7176.08 |
| Observations | 270 | 270 | 270 | 270 |
| | | *IV Poisson* | | |
| Bank capital p.c. | 2.046*** | 1.742*** | 1.603*** | 1.423*** |
| | (0.207) | (0.234) | (0.162) | (0.193) |
| Prefectural income p.c. | | 1.067 | | -0.298 |
| | | (2.839) | | (2.986) |
| Population | | 1.219** | | 1.273** |
| | | (0.612) | | (0.613) |
| Urbanization | | 0.003 | | -0.079 |
| | | (0.194) | | (0.186) |
| Observations | 270 | 270 | 270 | 270 |
| Samurai bond value p.c. | 0.160*** | 0.105*** | 0.204*** | 0.127*** |
| | (0.021) | (0.009) | (0.026) | (0.008) |
| First-stage Wald statistic | 360.21 | 652.79 | 629.90 | 1404.1 |

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors clustered by prefectures in parentheses. Bank capital and samurai bond values are in nominal yen, which we transform with an inverse hyperbolic sine function because the value of bonds per capita was zero before 1876. All specifications include sector and period fixed effects. Poisson and IV Poisson MLE are right truncated at the maximum number of incumbents; see text for details.

**Table 8**
Firm exit by banking capital, manufacturing.

| DV: Number of exits per prefecture and period | All bank capital | | National bank capital | |
|---|---|---|---|---|
| | Poisson | IV Poisson | Poisson | IV Poisson |
| Bank capital p.c. | 0.521*** | 1.591*** | 0.518*** | 1.390*** |
| | (0.171) | (0.260) | (0.142) | (0.227) |
| Prefectural income p.c. | 11.315*** | 8.796*** | 10.484*** | 5.514*** |
| | (2.449) | (1.953) | (2.515) | (2.155) |
| Population | 1.434* | 2.036*** | 1.462* | 1.939** |
| | (0.818) | (0.768) | (0.830) | (0.768) |
| Urbanization | -0.065 | 0.115 | -0.103 | 0.005 |
| | (0.197) | (0.2020) | (0.186) | (0.190) |
| Pseudo R-squared | 0.498 | | 0.501 | |
| Wald statistic | 90.84 | | 88.75 | |
| Observations | 66 | 66 | 66 | 66 |
| Samurai bond value p.c. | | 0.120*** | | 0.137*** |
| | | (0.028) | | (0.015) |
| First-stage Wald statistic | | 339.58 | | 541.47 |

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors clustered by prefectures in parentheses. Bank capital and samurai bond values are in nominal yen, which we transform with an inverse hyperbolic sine function because the value of bonds per capita was zero before 1876. All specifications include period effects. Poisson and IV Poisson MLE are right truncated at the maximum number of incumbents; see text for details.

the nascent banking industry. In this paper, we examined the effect of samurai bonds on the life cycle of firms through the banking channel.

The theoretical motivation of our analysis, based on credit rationing models à la Stiglitz and Weiss (1981) and Mankiw (1986), relies on two intermediate assumptions. First, we assume that the issuance of samurai bonds increased bank capital, which is supported by the ownership shares in national banks by samurai. Second, firms obtaining funds from the credit market are on average riskier, which we indirectly show through the results on lifespan.[49] The historical evidence suggests that the issuance of samurai bonds was conducive to the creation of a credit market, which enabled financial constrained entrepreneurs to obtain funds and establish firms. Given these assumptions, we test three hypotheses. First, the life expectancy of firms decreases with bank capital. Second, bank capital-abundant prefectures experience more firm entry. Lastly, bank capital-abundant prefectures have more firm exit. To identify exogenous differences in the availability of credit supply across prefectures, we instrument bank capital with samurai bonds.

Our empirical findings follow from the predictions in the theoretical literature on credit rationing, adverse selection, and external financing. In our sample, the lifespan of firms decreases with bank capital and this effect is amplified in the manufacturing sector. We also find that prefectures abundant with bank capital had increased firm exit and entry, with pronounced effects for manufacturing. Taken together, our results indicate that banking was plausibly the main channel through which samurai bonds affected the economy.

Our analysis also underscores an important impact of the 1876 samurai bond issuance, which is that it appears to have facilitated Japan's financial development. Channeled through the banking system that was adapted to utilize it, this credit injection increased firm dynamism by helping to fund some riskier firms that were relatively more fragile and thus shorter-lived, especially in the manufacturing sector. In turn, this large credit supply shock may have marked an inflection point for Japan's modernization by increasing aggregate savings to develop a financial system and generate entrepreneurial activity.

Whether this would have been possible without other reforms taking place in the country, such as the early land reform for fiscal taxation, the adoption of a modern commercial code for incorporation, and the creation of personal and corporate income taxes, is outside the scope of this paper but regional variation in bank capital makes the bond issuance a likely factor (e.g., Kramer, 1953; Onji and Tang, 2017). Moreover, the importance of state capacity to pursue and implement both fiscal and monetary policies may explain differences between the historical experiences of Japan and China or modern-day developing countries (e.g., Ma and Rubin, 2019). Large even by modern standards, the credit supply shock early in Japan's modernization may be instructive for economies seeking a similar industrial transition.

## Data availability

Data will be made available on request.

## CRediT authorship contribution statement

**John P. Tang:** Conceptualization, Investigation, Methodology, Writing – original draft, Writing – review & editing, Data curation. **Sergi Basco:** Conceptualization, Investigation, Methodology, Writing – original draft, Writing – review & editing, Data curation.

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## Appendix A: Additional regression tables

**Table A1**
Pseudo-IV results for lifespan, all sectors.

| DV: Firm lifespan in years | OLS | | Poisson | |
|---|---|---|---|---|
| Bank capital p.c. | -2.668*** | -3.017*** | -0.145*** | -0.156*** |
| | (0.571) | (0.533) | (0.031) | (0.022) |
| Prefectural income p.c. | | 22.499*** | | 1.118*** |
| | | (6.857) | | (0.287) |
| Population | | 6.089** | | 0.279** |
| | | (2.583) | | (0.112) |
| Urbanization | | 1.684* | | 0.076** |
| | | (0.954) | | (0.038) |
| R-squared | 0.137 | 0.166 | | |
| Pseudo R-squared | | | 0.104 | 0.126 |
| F-statistic | 21.82 | 12.57 | | |
| Wald statistic | | | 6281.01 | 91876.75 |
| Observations | 440 | 440 | 440 | 440 |

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors clustered by prefectures in parentheses. Bank capital and samurai bond values are in nominal yen, which we transform with an inverse hyperbolic sine function because the value of bonds per capita was zero before 1876. All specifications include sector and period fixed effects.

[49] Appendix B provides some suggestive evidence that firms in the capital abundant period were technologically more innovative and thus riskier.

**Table A2**
Poisson results for lifespan by bank capital, all sectors.

| DV: Firm lifespan in years | All bank capital | | National bank capital | |
|---|---|---|---|---|
| | | *OLS* | | |
| Bank capital p.c. | -0.062** | -0.089** | -0.047* | -0.089*** |
| | (0.029) | (0.045) | (0.026) | (0.034) |
| Prefectural income p.c. | | 1.563** | | 1.672*** |
| | | (0.667) | | (0.634) |
| Population | | 0.412** | | 0.429** |
| | | (0.169) | | (0.172) |
| Urbanization | | 0.082 | | 0.085 |
| | | (0.055) | | (0.054) |
| Pseudo R-squared | 0.094 | 0.126 | 0.092 | 0.127 |
| Wald statistic | 201.69 | 243.98 | 211.30 | 258.19 |
| Observations | 270 | 270 | 270 | 270 |
| | | *IV* | | |
| Bank capital p.c. | -0.135* | -0.175*** | -0.121* | -0.155*** |
| | (0.076) | (0.051) | (0.067) | (0.043) |
| Prefectural income p.c. | | 2.386*** | | 2.380*** |
| | | (0.542) | | (0.537) |
| Population | | 0.349** | | 0.392** |
| | | (0.178) | | (0.177) |
| Urbanization | | 0.055 | | 0.067 |
| | | (0.052) | | (0.051) |
| Observations | 270 | 270 | 270 | 270 |
| Samurai bond value p.c. | 0.420** | 0.275*** | 0.564*** | 0.356*** |
| | (0.087) | (0.024) | (0.127) | (0.032) |
| First-stage Wald statistic | 243.07 | 4130.28 | 987.03 | 6298.47 |

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors clustered by prefectures in parentheses. Bank capital and samurai bond values are in nominal yen, which we transform with an inverse hyperbolic sine function because the value of bonds per capita was zero before 1876. All specifications include sector and period fixed effects.

**Table A3**
OLS results for lifespan by bank capital, excluding outliers.

| DV: Firm lifespan in years | All bank capital | | National bank capital | |
|---|---|---|---|---|
| | *Excluding top 1 percent outlier firms* | | | |
| Bank capital p.c. | -1.962* | -2.776** | -1.763* | -2.465** |
| | (1.081) | (1.317) | (0.965) | (1.155) |
| Prefectural income p.c. | | 42.649** | | 42.579** |
| | | (17.188) | | (17.163) |
| Population | | 6.059 | | 6.596 |
| | | (4.350) | | (4.307) |
| Urbanization | | 1.669 | | 1.857 |
| | | (1.458) | | (1.431) |
| Observations | 267 | 267 | 267 | 267 |
| Samurai bond value p.c. | 0.931*** | 0.727*** | 1.035*** | 0.819*** |
| | (0.199) | (0.082) | (0.215) | (0.084) |
| First-stage F-statistic | 21.79 | 79.03 | 23.23 | 95.97 |
| | *Excluding top 0.5 percent outlier firms* | | | |
| Bank capital p.c. | -1.915** | -2.592** | -1.721** | -2.300** |
| | (0.903) | (1.114) | (0.807) | (0.976) |
| Prefectural income p.c. | | 36.745** | | 36.640** |
| | | (13.903) | | (13.977) |
| Population | | 6.732 | | 7.238* |
| | | (4.063) | | (4.045) |
| Urbanization | | 1.587 | | 1.762 |
| | | (1.427) | | (1.403) |
| Observations | 268 | 268 | 268 | 268 |
| Samurai bond value p.c. | 0.929*** | 0.724*** | 1.034*** | 0.817*** |
| | (0.203) | (0.084) | (0.219) | (0.086) |
| First-stage F-statistic | 20.89 | 73.55 | 22.30 | 89.57 |

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors clustered by prefectures in parentheses. Bank capital and samurai bond values are in nominal yen, which we transform with an inverse hyperbolic sine function because the value of bonds per capita was zero before 1876. All specifications include sector and period fixed effects.

**Table A4**
Lifespan by bank capital, excluding financial firms.

| DV: Firm lifespan in years | All bank capital | | National bank capital | |
|---|---|---|---|---|
| | | *OLS* | | |
| Bank capital p.c. | -1.288* | -1.392* | -1.177** | -1.299** |
| | (0.657) | (0.812) | (0.573) | (0.634) |
| Prefectural income p.c. | | 20.240** | | 20.532** |
| | | (9.367) | | (8.521) |
| Population | | 9.624** | | 9.478** |
| | | (4.491) | | (4.364) |
| Urbanization | | 2.099* | | 2.154** |
| | | (1.116) | | (1.031) |
| R-squared | 0.110 | 0.144 | 0.110 | 0.143 |
| F-statistic | 3.85 | 7.69 | 4.23 | 8.41 |
| Observations | 164 | 164 | 164 | 164 |
| | | *IV* | | |
| Bank capital p.c. | -1.741** | -1.699*** | -1.588*** | -1.529*** |
| | (0.638) | (0.579) | (0.570) | (0.511) |
| Prefectural income p.c. | | 23.262** | | 22.999** |
| | | (9.333) | | (9.282) |
| Population | | 9.351** | | 9.232** |
| | | (4.196) | | (4.094) |
| Urbanization | | 1.961* | | 2.053* |
| | | (1.053) | | (1.016) |
| F-statistic | 7.43 | 6.57 | 7.76 | 6.91 |
| Observations | 164 | 164 | 164 | 164 |
| Samurai bond value p.c. | 0.926*** | 0.752*** | 1.014*** | 0.836*** |
| | (0.195) | (0.071) | (0.205) | (0.075) |
| First-stage F-statistic | 22.52 | 111.99 | 24.53 | 125.65 |
| Cragg-Donald Weak Instrument test | 236.063 | 264.896 | 275.837 | 350.707 |

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors clustered by prefectures in parentheses. Bank capital and samurai bond values are in nominal yen, which we transform with an inverse hyperbolic sine function because the value of bonds per capita was zero before 1876. All specifications include year and sector fixed effects.

**Table A5**
Firm entry by bank capital, excluding financial firms.

| DV: Number of entries per prefecture and period | All bank capital | | National bank capital | |
|---|---|---|---|---|
| | | *Poisson* | | |
| Bank capital p.c. | 0.548*** | 0.090* | 0.546*** | 0.101* |
| | (0.064) | (0.051) | (0.048) | (0.053) |
| Prefectural income p.c. | | 11.084*** | | 10.838*** |
| | | (1.320) | | (1.467) |
| Population | | 0.821** | | 0.827** |
| | | (0.374) | | (0.369) |
| Urbanization | | -0.223*** | | -0.224*** |
| | | (0.056) | | (0.056) |
| Pseudo R-squared | 0.281 | 0.412 | 0.296 | 0.413 |
| Wald statistic | 244.07 | 697.85 | 550.11 | 1038.22 |
| Observations | 153 | 153 | 153 | 153 |
| | | *IV Poisson* | | |
| Bank capital p.c. | 0.468* | 0.062** | 0.409* | 0.056** |
| | (0.241) | (0.027) | (0.216) | (0.024) |
| Prefectural income p.c. | | 11.361*** | | 11.356*** |
| | | (0.968) | | (0.962) |
| Population | | 0.811** | | 0.809** |
| | | (0.364) | | (0.362) |
| Urbanization | | -0.234*** | | -0.240*** |
| | | (0.057) | | (0.056) |
| Observations | 153 | 153 | 153 | 153 |
| Samurai bond value p.c. | 0.471*** | 0.274*** | 0.624*** | 0.356*** |
| | (0.133) | (0.049) | (0.154) | (0.051) |
| First-stage Wald statistic | 107.70 | 755.53 | 338.34 | 848.11 |

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors clustered by prefectures in parentheses. Bank capital and samurai bond values are in nominal yen, which we transform with an inverse hyperbolic sine function because the value of bonds per capita was zero before 1876. All specifications include sector and period fixed effects.

**Table A6**
Firm exit by banking capital, excluding finance firms.

| DV: Number of exits | All bank capital | | National bank capital | |
|---|---|---|---|---|
| | | *Poisson* | | |
| Bank capital p.c. | 0.968*** | 0.540*** | 0.924*** | 0.516*** |
| | (0.126) | (0.127) | (0.090) | (0.097) |
| Prefectural income p.c. | | 11.161*** | | 10.587*** |
| | | (2.206) | | (2.329) |
| Population | | 1.471* | | 1.482* |
| | | (0.797) | | (0.806) |
| Urbanization | | -0.053 | | -0.097 |
| | | (0.195) | | (0.186) |
| Pseudo R-squared | 0.488 | 0.570 | 0.504 | 0.570 |
| Wald statistic | 6352.09 | 8055.65 | 6851.22 | 7682.67 |
| Observations | 153 | 153 | 153 | 153 |
| | | *IV Poisson* | | |
| Bank capital p.c. | 2.350*** | 1.747*** | 1.862*** | 1.427*** |
| | (0.315) | (0.178) | (0.250) | (0.145) |
| Prefectural income p.c. | | 6.242*** | | 5.057** |
| | | (1.990) | | (2.041) |
| Population | | 1.871** | | 1.979*** |
| | | (0.752) | | (0.753) |
| Urbanization | | 0.186 | | 0.080 |
| | | (0.206) | | (0.197) |
| Observations | 153 | 153 | 153 | 153 |
| Samurai bond value p.c. | 0.155*** | 0.101*** | 0.195*** | 0.124*** |
| | (0.021) | (0.008) | (0.027) | (0.007) |
| First-stage Wald statistic | 162.88 | 661.96 | 282.41 | 1673.76 |

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors clustered by prefectures in parentheses. Bank capital and samurai bond values are in nominal yen, which we transform with an inverse hyperbolic sine function because the value of bonds per capita was zero before 1876. Poisson and IV Poisson MLE are right truncated at the maximum number of incumbents; see text for details.

## Appendix B: Assessing firm risk profile

An indirect approach to identifying firm risk profile could be through differences in the technology used by new firms across sectors. Following Tang (2011), firm risk may be roughly proxied by the relative newness of the technology used in each industry compared to production methods already in the market. The earlier empirical analysis in the paper controls for major industry type (i.e., primary, secondary, tertiary), which is not precise enough to compare technologies in related, but different sectors within a major industry. However, the genealogical firm data provide enough information to assign industry classification codes up to the four-digit level. If firms using a newer technology are more likely to be established during periods of increased credit availability, this would corroborate the mechanism that banks with additional capital are willing to lend to riskier firms at the margin.

We assign industry codes to firms using the 1987 Japanese Standard Industrial Classification (JSIC) system based on the industry identified in the firm's original name. For example, the Kurihara Ine Cotton Textile company, established in 1879, would be assigned the JSIC three-digit code of 144: Woven Fabric Mill. Using the nested hierarchical nature of industry classification codes, if Kurihara Ine is the first firm in the 144 category under the two-digit 14 industry (Textile Mill, Unfinished Fabric) in Tokyo and other woven fabric firms (e.g., Morita Filature in the three-digit industry 141: Silk Reeling Factory) are already producing locally, we code Kurihara Ine as using new technology. If industry information is unavailable, we use information in the genealogical annotations or search historical records for the type of products produced by the firm at the time of establishment. For our baseline, we consider all industries with firms established before 1876 (pre-samurai bond issue) in our sample as pre-existing technologies.

**Table B1**
New industry establishment results.

| | 1870-1880 | 1870-1885 | 1870-1890 |
|---|---|---|---|
| Pearson's correlation | | | |
| *BondIssue* \| *NewJSIC3* | 0.733*** | 0.579*** | 0.499*** |
| | (0.000) | (0.000) | (0.000) |
| Observations | 47 | 63 | 78 |
| OLS regression DV: *NewJSIC3* | | | |
| *BondIssue* | 0.615*** | 0.615*** | 0.615*** |
| | (0.085) | (0.138) | (0.121) |
| Adjusted R-squared | 0.526 | 0.352 | 0.264 |
| F-statistic | 52.09 | 17.85 | 10.22 |
| Observations | 47 | 63 | 78 |

Significance: ***1 percent, **5 percent, *10 percent. Both Sidak and Bonferroni standard error corrections to the correlation analysis do not change the results. Standard errors for the OLS regression model are in parentheses.

Within our sample of 440 firms, we were able to assign 322 with three-digit JSIC codes.[50] Since our comparison is between industries, not firms, we exclude firms that are simultaneously in the same three-digit industry, prefecture, and five-year subperiod, which leaves up to one three-digit industry per subperiod and prefecture. For these remaining observations, we generate a dummy variable *NewJSIC3* coded as either 0 for a pre-existing industry or 1 for a new industry. This leaves 78 three-digit industries spread across 11 prefectures. A second dummy variable, *BondIssue*, is coded as 0 for the years before 1876 (pre-bond) or as 1 for the years 1876 (post-bond) and after to indicate relative credit availability. Note that neither variable is indexed by prefecture, year, or industry group given the small number of observations.

As shown in column 1 of Table B1, the pairwise correlation coefficient for new industry appearance (*NewJSIC3*) and the issue of samurai bonds (*BondIssue*) in the years 1870 to 1880 is 0.733 at less than 1 percent statistical significance. When the following five-year subperiod (column 2) and all subperiods in the sample (column 3) are included, the coefficient decreases to 0.579 and 0.499, respectively, and is also at less than 1 percent significance.

Using an OLS model that regresses *NewJSIC3* on *BondIssue* with fixed effects for each of the subperiods, the results are qualitatively similar to those from the correlation analysis. This suggests that new technologies as proxied by industry codes are associated with firm establishment when credit was more widely available, which is consistent with our assumption that the bond issue allowed banks to lend to firms with riskier investment profiles.

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[50] At a lower level of industry disaggregation (i.e., two-digit codes), there is no variation between subindustries while at higher levels (i.e., four-digit codes) many more firms cannot be identified by industry. As in the analysis of firm dynamics in the main text, we also exclude the five prefectures of Hokkaido, Kagawa, Miyazaki, Nara, and Okinawa.

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