The Samurai Bond:
Credit Supply and Economic Growth in Pre-War Japan

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While credit supply growth is associated with exacerbating financial crises, its impact on economic activity and development are unclear. Using bond payments to samurai in nineteenth century Japan as a quasi-natural experiment and exploiting regional variation, we find samurai population shares are positively associated with short run firm establishment, capital investment, and average firm capital. In the long run, initial samurai population share corresponds with per capita output growth and labor reallocation throughout the pre-war period conditional on early adoption of railways. Our results indicate the interaction of credit supply with productivity-enhancing technology provides persistent growth and structural change.

Keywords: credit supply, finance-led growth, market access, railways, structural change

JEL codes: E51, N15, O47

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How does the growth of credit supply affect financial and economic activity? In recent years, negative effects of credit supply growth have been implicated in the severity of the financial crisis of the past decade, namely through the accumulation of mortgage debt in the United States (Mian and Sufi 2009). Jordà et al. (2011) also highlight this relationship, using historical data to show that credit supply booms are associated with longer, deeper, and more persistent recessions. These studies offer a counterpoint to the existing literature on the positive relationship between finance and growth observed across countries and over time (e.g, Levine 2005).

However, the causal impact of credit supply on economic growth in both the short and the long run remains an open question due to the challenges of identification and data availability. We address these problems by using a historic quasi-natural experiment starting with a large credit supply shock. In 1876, the Japanese government involuntarily commuted the hereditary pensions of former samurai into government bonds.[1] The samurai represented about five percent of the population, and their pensions were collectively valued at 210 million yen, which was equivalent to nearly half of the country's national income in 1876 and six times total government revenue (Flath 2014, p. 33; Yamamura 1967, p. 204).[2]

To assess the effect of credit supply growth, we use the initial share of prefectural samurai population at the time of the pension commutation to proxy for differences in credit availability. Since the pension conversion was universal, compulsory, and resisted by the samurai themselves, this policy reform is plausibly exogenous to existing or anticipated local economic activity.[3] Our identification comes from the within-country variation in samurai population distribution, which remained fairly stable in most regions through the late nineteenth century. We hypothesize that, given the highly

[1] Samurai were a hereditary class of warriors in pre-modern Japan that were the de facto rulers during the Edo period (1603 to 1867). Their monopolies on political and military power were dissolved following the Meiji restoration in 1868; see the next section for more detail.

[2] There were earlier voluntary commutations of samurai pensions in 1873 and 1874, amounting to 36 million yen in cash and bonds and about one-third of eligible samurai took up the conversion. The 1876 commutation was valued at 174 million yen, paid only in government bonds, and applied to all remaining samurai liabilities.

[3] "The effect of [the 1876 pension commutation law] was instantaneous and manifested itself in an epidemic of samurai riots and lawless demonstrations against the government" (McLaren 1979, p. 562). This culminated in the unsuccessful 1877 Seinan rebellion led by dissatisfied samurai.

variable distribution of samurai between regions, this credit supply shock may account for subsequent differences in financial and industrial activity between regions. Furthermore, since the economy was in the process of industrializing and imperfectly integrated during the late nineteenth century, our analysis of local credit supply provides evidence of both the short run impact on local economies as well as potential persistence in the long run.

We test our hypothesis that variation in initial credit supply affects local economic activity by regressing various economic outcomes (per capita gross prefecture product growth, firm count and size, capital investment) on samurai population share both over time and at the time of the bond issuance. This allows us to include both prefecture and year fixed effects in our short run regressions while for the long run we control only for temporal variation. We report results using both the full sample of regions as well as the subset with stable samurai shares.

In the short run (1883-1890), we find that samurai share is positively associated with an increase in per capita firm numbers and investment levels, and in capital per firm. Lengthening the coverage to the turn of the century (1883-1898) reduces both the magnitude and statistical significance of samurai share on these outcomes, with per capita investment having a positive correlation. Results using all prefectures and those with stable samurai shares are comparable, with slightly larger coefficients on samurai share in the latter group.

We also expand our baseline regression model by adding time varying regional control variables. First, it could be argued that samurai population shares could be correlated with other variables that determine credit supply. For instance, Rajan and Ramcharan (2015) argue that the number of banks can proxy for the credit supply. Thus, we include number of banks per capita in our baseline regression. Second, we also include total population as a proxy for prefectural income since the latter are unavailable in annual series. Our main results are robust to including these variables.

The effect of samurai share varies by major industry group in both time periods. A one percent increase in samurai share corresponds with a 29 percent increase in firms per capita across all sectors, with the relationship by

sector percentages highest in the primary sector. This is followed by services and then the secondary sector, which may correspond to differences in initial average firm counts among the three sectors. The relative contribution shares remain the same over the longer period of 1883 to 1898. Other measures of industrial activity, including capital investment per capita and firm capitalization, also increased with samurai population share and varied by major sector.

Unlike these direct measures of industrial activity, increased local credit supply on its own does not directly translate into overall regional economic development in the short and long run. Only in the presence of productivity enhancing infrastructure, i.e., railway access, do regions experience higher output growth per capita and this effect is persistent for over six decades.

We show this by interacting initial samurai population share with railway access prior to the first wave of industrialization starting in the mid 1880s. In regions that were integrated earlier into the national market via railways, a one percent increase in samurai population share accounts for 56 percent of per capita output growth in the first decade following the credit supply shock. The average share declines to 31 percent on average to the eve of World War One, and ultimately to 10 percent for the whole period up to 1940. The impact varied by major sectors, with primary industries shrinking throughout the entire pre-war period while secondary sectors grew strongly in through the 1920s and tertiary sectors in subsequent decades.

The impact is slightly shorter lived but also observed in the reallocation of labor away from primary to secondary and, to a lesser extent, tertiary sectors. The results mirror those for per capita output growth and indicate long run structural change corresponding with Japan's transition as a modern economy. Our interpretation of the results is that the initial credit supply shock, coupled with growth-promoting investment opportunities and greater market access, had short and long run positive effects on local economic activity and structural change.

I. Background

While there is a well-established link between financial sector development and economic growth across countries and overtime (King and Levine 1993; Rajan and Zingales 1998), less clear is the role of credit supply on regions within a country over the long run.[4] Historically, periods of economic growth coincided with increased credit intensity, but the overhang of excess credit in turn magnified the severity of crises and delayed recovery through debt-deflation pressure on prices and swings in expectations (Jorda et al 2011; Schularick and Taylor 2012). Most of the literature has focused on macroeconomic aggregates or use modern data, leaving the within-country impact and its long run persistence unaddressed.

This paper exploits within-country differences in initial samurai population shares. This empirical strategy is similar to Mian and Sufi (2009) which compares ZIP codes in the U.S. to uncover the origins of the mortgage debt boom in the late 2000s. Similarly, Guiso et al. (2004) exploit regulation variations within Italy to analyze the effect of local financial development within an integrated financial system. Mian et al (2017) examine the impact of credit supply shocks in the United States for the modern period starting in the 1980s. In contrast to these papers, we analyze differences in credit supply across regions in a financially and physically fragmented economy and for a longer period of time. Therefore, it allows us to control for aggregate country shocks and investigate the effect of credit supply growth and its persistence.

Japan in the late nineteenth century provides a useful setting to examine the role of credit provision on local economic outcomes. Starting in the Meiji Period (1868-1912), the government implemented numerous reforms and invested in infrastructure and industrial enterprises to modernize the economy. By the turn of the century, Japanese manufacturing had reached the same share of output as the United States and continued to increase in value-added and capital intensity (Perkins and Tang 2017).

[4] The finance-led growth literature uses a variety of measures of financial development like credit availability, assets and liabilities, capital formation, and institutions to assess changes in income and industrial growth. The underlying rationale emphasizes the roles of transaction costs, capital allocation, and risk management in facilitating growth.

While its financial sector development, measured both intensively (e.g., financial assets, equities) and extensively (e.g., banks, informal intermediaries), is associated with its overall industrialization (Rousseau 1999; Tang 2013), a plausible causal trigger to its transition was a large exogenous shock to its credit supply. This shock was the 1876 involuntary conversion of hereditary samurai stipends (aka, *chitsuroku*) into government bonds (aka, *kinroku*) worth 173.9 million yen, which was motivated by the drain on public finances from samurai payments.[5] In the years leading up to the conversion, these payments accounted for one quarter to one third of all government expenditures in the 1870s (Beasley 1972).[6] The bond issuance would improve the central government's fiscal position while simultaneously provide a major source of investment capital for agricultural and industrial expansion (Harootunian 1960, McLaren 1979). The conversion was also sizeable relative to the existing supply of government bonds: before the issue of the 1876 *kinroku* bonds, public bonds totaled 51.5 million yen.[7] Table I provides the pension commutation scales into interest bearing bonds, which had a maturity of thirty years and minimum holding period of five years.[8]

[Table I]

There were some immediate consequences following the stipend conversion. First, interest payments by the government fell from 34.6 million yen before the 1868 Meiji restoration to 12.8 million yen after the 1876 stipend conversion. Second, the banking system expanded rapidly since chartered national banks were allowed to accept these commutation bonds as

[5] This conversion was preceded by a number of events that also affected the economic and social status of samurai. First, the 1868 Charter Oath effectively ended the professional monopolies of samurai warriors on military and government power (Bary 1964). This was followed by the creation of a conscript army in 1873 and the prohibition of sword carrying in 1876.

[6] A similar share covered government administration costs and the remainder was for military expenses.

[7] This figure includes the 16.6 million yen in public bonds for voluntary pension conversion between 1874 and 1876.

[8] Interest payments were made in May for each year of the commutation duration, except for the first year 1877, which was made in November. Adjustments were made for pension conversions near threshold limits to ensure lower income conversion payments did not exceed those at the next higher threshold. Interest would be paid between five and fourteen years, and redemption of all *kinroku* bonds was completed by 1906. See McLaren (1979, pp 562-566) and Tomita (2005, pp. 14-16) and Table I for details.

investment capital.[9] These banks increased from 6 in 1876 to 153 over the next three years, with samurai owning more than three times of their capital in these banks compared to all other classes combined (ibid, p. 205).[10] Their dominant position in bank ownership remained in place throughout the 1880s, which coincided with the start of modern economic growth and Japan's subsequent transition to an industrialized economy (Tang 2013; Rousseau 1999).[11]

The public finance and banking narratives, however, are incomplete in that the national budget remained precarious given military expenditures, high inflation and later deflation, and the small share of bonds (27 percent) invested in national banks (Tomita 2005).[12] The high inflation period immediately following the pension commutation may have also created uncertainty around the government's commitment to fulfill its bond obligations, motivating samurai to invest their bonds in enterprises or redeem them as soon as possible. Exacerbating these initial conditions was the lack of capital market integration in Japan, which persisted until the 1890s once the central bank was established and its branch network reduced interest rate spreads (Mitchener and Ohnuki 2007). Bonds were also not limited to bank capitalization: between 1876 and 1889, businesses owned by samurai also grew extensively and varied from small companies to joint-stock corporations (Harootunian 1960).

More importantly, since the samurai were unequally distributed across regions, their contribution to local economic activity via additional credit may account for the short and long run regional differences measured more broadly in industrial activity, income growth and labor allocation (Moriguchi and Saez 2008; Fukao et al 2015). In the period preceding World War Two, regional inequality rose significantly due largely to shifts away from primary to

[9] The 1876 National Bank and *Kinroku* Public Bond Instrument Issue Ordinances allowed national banks to be established with government bonds paying a (lower) four percent interest rate and the (higher) ratio of paid-in capital of government bonds to 80 percent (Tomita 2005). All bonds would be redeemed up to thirty years after issuance. To facilitate securitization and capital mobilization, stock exchanges were set up in Osaka and Tokyo in 1878.

[10] The 1879 breakdown of capital contribution was 76.0 percent samurai (including the *kazoku* nobility), 14.6 merchants, 3.5 farmers, and 5.7 others. For a list of major financial reforms in the late nineteenth century, see Tang (2013), table 1.

[11] The overall macroeconomic effect of the stipend conversion is disputed, however, with some studies alleging samurai incompetence in investment and management as well as an exaggerated influence of the national banks (Harootunian 1960; Yamamura 1974).

[12] Yamamura (1967) finds the samurai contribution to modern Japanese banking modest, and that commoners played a more important role when private and quasi-banks are included.

secondary production. Major metropolitan areas like Tokyo and Osaka experienced rapid industrialization, and more populated areas grew at the expense of smaller and more isolated ones following the expansion of the national railway system (ibid; Tang 2014). In the remaining sections, we analyze the extent by which regional differences in credit supply may have affected economic activity and whether these persisted over time.

II. Research Design

A. Data

To investigate the relationship between the local credit supply shock and later development, we use historic data that provide regional measures of output, industrial activity, market access, and demography. Collectively, these data span the period 1880 to 2005 and are disaggregated by the 47 regions (aka, prefectures) that comprise Japan. Samurai population series are available annually starting in 1880 and were collected by the Japanese government's Cabinet Bureau of Statistics (Japan Statistical Association 1962). These yearbooks also include industrial and demographic data like the number of firms, amount of capital investment, and total prefectural population. Output and labor force data by prefecture are available for a number of years in the pre-war period: 1874, 1890, 1909, 1926, and 1940 (Fukao et al 2015). These are also separable into the three major sectors of primary, secondary, and tertiary categories for the entire period of analysis by gross value added. Railway data are from a handbook of rail station construction, which provide both dates and location of all stations built starting in the 1870s (Chuo Shoin 1995; Tang 2014).

Regression estimates of samurai share over the years 1880 and 1898 indicate that 39 of the 47 had stable trends, as shown in Table II.[13] These shares underscore the relative immobility of samurai between regions during

[13] The eight prefectures with unstable trends in samurai population shares are Ehime, Fukui, Ishikawa, Iwate, Kagoshima, Kyoto, Osaka, and Tochigi. In Table II, samurai population shares in 1875 are extrapolated from 1880 to 1898 data, but are not used in the main regression results.

this period, despite efforts by the government to encourage migration. The investment activity of samurai was similarly localized, as illustrated by with a regional distribution of national banks and their consistently high ownership shares by samurai.[14] Table III provides a breakdown of samurai bank ownership in 1884.

[Tables II and III]

Industrial data from the same official source are disaggregated by three major sectors and include the number of firms as well as total capital invested, which allows calculation of average firm capital. We have annual data available by region between 1883 and 1898, which coincides with the onset of industrialization in Japan and allows analysis of short run effects from regional differences in credit (Perkins and Tang 2016). This period also encompasses the redemption period of nearly all *kinroku* bonds issued under the 1876 commutation law, which allows for a direct correspondence between bond redemption and industrial activity (Tomita 2005).[15]

As shown in Table IV, between 1885 and 1890 the average number of firms across all prefectures nearly trebled to 93.4 firms while average firm capitalization increased two-fold, from 25,200 to 36,000 nominal yen. The largest increase in firms occurred in manufacturing and allied industries, accounting for over half of total firms. Both secondary and tertiary sector firms increased their average capitalization, with the latter exceeding twice that of the former. These patterns are similar in the restricted sample of regions in the second panel of the table, which excludes the eight prefectures that have unstable samurai population shares during the 1880s and 1890s.

[14] Shizume and Tsurumi (2016) describe the evolution of the national banking system starting with the 1876 National Bank Act up to the creation of the central bank, the Bank of Japan, in 1882.

[15] Redemption of 7 percent interest, which represented 62 percent of the total bond issue, was completed in September 1891; 6 percent interest bearing bonds (14 percent) were all redeemed in April 1893; and 5 percent interest bearing bonds (18 percent) in April 1906. Special bonds bearing 10 percent interest (5 percent total bond value) were all redeemed by June 1886.

[Table IV]

Compared with either the full or restricted sample, there are notable differences between the top and bottom quartiles of prefectures based on samurai population share. Firm numbers grew faster in the top quartile albeit starting from a slightly lower average, with more of the growth in the tertiary sector. In particular, the average firm count in the top quartile surpassed the bottom quartile during this period and was more capitalized throughout the period. This is the first indication that credit supply may be associated with extensive manufacturing growth, which we will corroborate with regression analysis.

The tertiary sector also experienced significant extensive growth, and while the top quartile did not increase much in average capitalization, it remained well above the national and bottom quartile averages. This reflects a widening of the market, particularly in finance as non-national banking firms expanded during the 1880s and the economy recovered from the Matsukata deflation in the first half of the decade. Average firm capital rose less quickly in the secondary sector for the top quartile, but also stayed higher than in the bottom quartile over the period.

With regard to output and labor, measures by region are shown in Tables V and VI, respectively, and cover the years between 1874 and 1940. Throughout this period, Japan steadily increased its per capita income, with the shares of value from secondary and tertiary sectors growing at the expense of primary production. The period between 1874 and 1909 shows a near doubling of secondary sector value, which reached over a third of national output by 1940 largely due to a shift away from primary production. Labor shares also shifted away from primary production into the secondary and tertiary sectors, respectively doubling and trebling their proportion of the labor force by the end of the period. Similar patterns hold for both the full and restricted sample of regions.

[Tables V and VI]

In the quartile comparison, despite starting at comparable levels of income at the start of the period, the top quartile of prefectures gradually increases its lead in both total and per capita output for the next half century. By the end of the period, the top quartile has nearly twice the total output of the bottom quartile even as per capita income remains comparable. The two quartiles also differ in that the share of output from the tertiary sector is consistently larger albeit with smaller margins over time. For labor, there is a much more pronounced difference in levels and distribution between sectors. While the top quartile had a lower average labor force at the start of the period, the numbers doubled by 1940 and the share in tertiary industries was persistently higher throughout. We condition for time fixed effects in the regression analysis described in the next section to see whether these output differences are due to the samurai credit supply shock or idiosyncratic period influences.

B. Empirical Strategy

Our working assumption is that samurai population share is a proxy of credit supply growth. Therefore, to test whether credit supply growth had a short run effect on economic development, we consider the following equation,

$$(1) \qquad Y_{it} = \beta_0 + \beta_1 * SamuraiShare_{it} + \delta_i + \delta_t + e_{it},$$

where $SamuraiShare_{it}$ is the population share of samurai in prefecture i and year t and δ_i and δ_t are prefecture and year fixed effects, respectively.[16] Identification comes from the variation in samurai population share between regions, and the prefecture fixed effects capture unobserved and time-invariant differences. The year fixed effects account for idiosyncratic differences over time. The dependent variable, Y_{it}, is the economic outcome variable (i.e.,

[16] While the shares of samurai vary by prefecture and over time, for most prefectures the shares have stable trends during this period; see Table II.

number of firms per capita, capital per capita, average firm capitalization). We have yearly data at prefectural level from 1883 up to 1898. If $\beta_1 > 0$, it implies that credit supply growth has a positive short run effect on the outcomes.

To investigate the long run effect, we proceed in analogous way as in the above equation but use initial population samurai share. As before, our baseline specification restricts the sample to prefectures with a stable samurai population share, and we include year fixed effects to account for idiosyncratic temporal shocks. We omit prefecture fixed effects since our measure of initial credit supply shock does not vary over time by prefecture.[17]

We also utilize another exogenous shock in credit demand to analyze the differential short and long run effect of credit supply across prefectures. The shock is access to railways, measured as the number of railway stations per capita in the 1880s. As it has been argued in Tang (2014) and Yamazaki (2017), the adoption of railways across regions in late nineteenth century Japan was exogenous and had a positive effect on local development. Other studies on railway expansion in different countries and over time have generally found similar positive effects (e.g., Summerhill 2005; Atack et al 2008; Herranz-Loncan 2011; Donaldson, forthcoming). We extend that literature by testing the hypothesis that credit supply has a more positive effect on regional development if it goes hand in hand with local latent demand, particularly investment opportunities that are technology enhancing or improve market access. This conditional effect of the availability of long-run investment has anecdotal support in the historical record, with many samurai and entrepreneurs failing in their ventures due to the immaturity of the economy and non-viable investments (Harootunian 1960, p. 443).

The following is our reduced form linear regression model using prefectural data:

$$(2) \qquad \Delta GPPpc_{it} = \beta_0 + \beta_1 * ln(GPPpc_{it-1}) + \beta_2 * Samurai_{i0} + \beta_3 * Samurai_{i0} * Stations_{i1} + \delta_t + e_{it},$$

[17] A similar approach is used by Banerjee and Iyer (2005), which analyzes the effect of initial distribution of land ownership in colonial India on economic outcomes.

where $\Delta GPPpc_{it} = ln(GPPpc_{it}/GPPpc_{it-1})$, $GPPpc_{it}$ is gross prefecture product per capita in prefecture *i* and year *t,* $Samurai_{i0}$ is the samurai population share in 1880, $Stations_{i1}$ is the number of railway stations per capita in prefecture *i* in year 1885. The lag term for per capita output controls for possible income convergence over time between regions. We use railways in 1885 in our baseline specification because coincides with both the end of the Matsukata deflationary period, which promoted private investment and the start of the railway boom, but we also consider for robustness the number of stations per capita in 1880. As shown in Tang (2014), initial market conditions create path dependency and industrial agglomeration, so we anticipate a larger effect in areas that joined the national railway network and market earlier in the period. Per capita regional output from 1874 to 1940 is measured in constant 1934-36 yen (Fukao et al. 2015).

The main variable of interest is the interaction between initial samurai population share (aka, credit supply) and per capita railway stations (aka, credit demand). $\beta_2 > 0$ implies that the effect of credit supply on regional economic development is exacerbated if the prefecture has railways. We then compute the net effect of credit supply growth for the prefecture with the average number of railways. Finally, we run this regression for different time periods, from the short run (up to 1890, per the industrial activity regressions) through the long run (up to 1940) and intervening years, and in levels of income per capita. We expect that the effect of the credit supply shock on GPP growth per capita attenuates over time, varies by sector, and differs by early rail access.

$$(3) \quad \Delta LaborRatio_{12it} = \beta_0 + \beta_1 * LaborRatio_{12it-1} + \beta_2 * Samurai_{i0} + \beta_3 * Samurai_{i0} * Stations_{i1} + \delta_t + e_{it},$$

Our third model examines structural change between major sectors in the economy, using changes in the ratio of total laborers $LaborRatio_{12it}$ in each of the three sectors of primary, secondary, and tertiary to one of the other sectors. Labor force ratios are in natural logs. Included covariates, aside from the lagged labor force ratio term, are the same as in the previous model. The

lag term for labor force ratio is included to capture earlier reallocation. As with that model, we interpret a positive net effect from initial samurai share as facilitating the transition between the numerator sector relative to that in the denominator, and show results for the three possible combinations. These regressions are run for each subperiod up through the entire period between 1874 and 1940. Per existing literature (e.g., Fukao et al., 2015), we expect the samurai effect to facilitate movement away from the primary sector into the other two sectors.

III. Results

A. Short Run Industrial Activity

Results from our short run industry level regression analysis are given in Tables VII through IX, which have as dependent variables per capita firm counts, per capita investment capital, and average firm capital levels, respectively. We show both the results from the full panel of prefectures as well as those for our restricted sample of prefectures. We also separate the analysis into two periods of 1883-1890 and 1883-1898 to investigate the short run persistence of the samurai credit shock. Since samurai population share was largely stable during both decades, its contemporaneous relationship with the outcome measures is assumed to proxy for the credit supply shock in 1876.

Before showing the regression results, a concern regarding our exercise is that prefectures may already be different prior to the stipend conversion. To fully address this concern, we would need to have data from before the samurai pension commutation. Unfortunately, data on industrial capital or number of firms by prefecture prior to 1883 is not available. We can, however, regress per capita income in 1874 on samurai population share in 1880. Whether using the full sample of prefectures or the restricted set with stable population shares, neither coefficient on samurai population share is

statistically significant.[18] Therefore, we cannot reject the hypothesis that Japanese prefectures had the same income before the pension commutation.

As the regression results in Table VII show, samurai population share is positively associated with per capita firms in aggregate and by major sector. A one percent increase in samurai population corresponds with approximately 18 additional firms per one million residents between 1883 and 1890.[19] This is equivalent to 28.5 percent of the average total of per capita firms based on a period mean of 65 firms per million residents. For the longer period of 1883 to 1898, the average effect is lower, about 15 percent of average per capita firms out of a mean of 83 firms per million. In the restricted sample, extensive firm count is statistically significantly larger in the secondary sector relative to the primary sector in the 1880s, but then diminishes in the following decade. This is consistent with the decreasing share of output observed in the primary sector from Table VII.

Between sectors, the corresponding shares of average per capita firms is 76 percent (primary), 21 percent (secondary), and 28 percent (tertiary) in the 1883 to 1890 period across all prefectures and similar magnitudes in the restricted sample. In the longer period to 1898, the shares fall to 34 percent (primary), 14 percent (secondary), and 10 percent (tertiary). Qualitatively more pronounced is the relationship between samurai population share and tertiary sector firm numbers, which is statistically significant in the first period of analysis but not in the longer one extending to the late 1890s. This result is also supported by historical evidence on samurai bank ownership, which fell as private banking institutions rose in prominence (at the expense of national banks that were mainly owned by the samurai).

[Table VII]

For total capital investment, samurai population share is also contemporaneously correlated with increased investment in the first decade,

[18] For the full sample of prefectures, the estimated coefficient is -0.565; for the restricted sample of prefectures with stable population shares, the coefficient is 0.095. Neither is statistically significant to at least the 10 percent level.

[19] This is calculated by multiplying the samurai share coefficient by ten (or dividing the coefficient by 100 for whole number percentage points and then multiplying by 1000).

but not for the total period lasting until 1898. As shown in Table VIII, three quarters of the investment was in the tertiary sector, followed by manufacturing and allied industries, and about ten percent from primary production. Our interpretation of the continued growth in both the primary and secondary sectors during the 1890s, despite an insignificant relationship in the tertiary sector, is that the availability of investment capital in banking and finance earlier could sustain other areas of capital growth, i.e., a redistribution of financial credit to productive areas in the real economy. This point is corroborated in the average firm capital regressions in Table IX, where tertiary sector firm capital grew strongly in the 1880s while secondary sector firms through the 1890s, as well as in the long run analysis utilizing railway access as a proxy for credit demand.

[Tables VIII and IX]

B. Long Run Output Growth and Labor Reallocation

To generalize the economic effects to output as a whole as well as to differentiate between use of credit supply, we examine regional output growth over the short and long run and include the adoption of railways. Table X provides results for increasing periods starting with 1874 and each subsequent year of available data. Note that the first column, 1874 to 1890, corresponds to the first decade of industry level outcomes from the previous three tables and captures two-thirds of the total value of bonds redeemed. In the simple regression with only samurai population share in 1880 (results not shown), there is no statistically significant relationship with overall output growth over this period. Once the effect of railway access is included, however, the net samurai population share effect across all sectors is positive and represents 55.6 percent of per capita output growth in rail accessible prefectures between 1874 and 1890.[20] This effect is statistically significant and persists for the next

[20] This is calculated from an average natural log of per capita output growth (all sectors) of 0.121 in prefectures with rail access by 1885 between 1874 and 1890. Similarly, the means for subsequent periods are: 0.166 (1874-1909), 0.212 (1874-1925), 0.181 (1874-1935), and 0.186 (1874-1940). Means for per capita income growth are similar when using the full sample of prefectures regardless of rail access year.

four periods lasting until 1940, albeit declining in average share of growth to 9.8 percent over the six decades.[21]

[Table X]

Our regression analysis also decomposes the effect from the credit supply shock (i.e., samurai share in 1880) from the productivity shock (i.e., per capita rail stations in 1885) and their interaction. The results indicate that while rail access itself has a slightly negative effect across regions, which may be due to industrial agglomeration drawing (Tang 2014), this is offset in rail-accessible regions with higher shares of samurai. Both effects become insignificant in the very long run, by the 1930s.

When disaggregated by major sector, the decrease in output growth from primary production is more than compensated by that in both the secondary and tertiary sectors. The net samurai effect is statistically significant for the periods up to 1925 in the secondary sector, accounting for the bulk of the effect on total output growth per capita, while the effect becomes significant for the tertiary sector only as the period lengthens to the longer run, in the last three columns. We interpret these findings to be that the credit supply shock, coupled with rail access, varied in its real impact between the short and long runs. This evidence is consistent with the historical record of Japan and other countries, where the economy transitions from primary sector activity toward capital-intensive manufacturing and then subsequently into services.

Across all the specifications, credit supply on its own has a weakly negative or no effect on per capita output. Rail access, which allows for market access and agglomeration economies, has a mixed effect independently, but in interaction with credit supply is positive and statistically significant for the economy as a whole and in both the secondary and tertiary sectors. In other words, for areas with rail access, increased credit supply is associated with higher per capita output. This suggests the importance of productive uses

[21] The intervening per period growth contributions are 30.5 percent (1874-1909), 20.4 percent (1874-1925), and 14.0 percent (1874-1935). The results from using per capita output in levels are qualitatively similar in statistical significance and length of persistence.

for credit, e.g., infrastructure, on directly or indirectly promoting short run, and for the tertiary sector, long run economic growth.[22]

Similar results obtain when analyzing labor share ratios between each of the three major sectors, shown in Table XI. The net samurai effect inclusive of early rail access is positive and significant up through 1935 (columns 1 to 4) when comparing the secondary to primary sector. This can be interpreted as a relative increase in secondary labor force shares: between 1874 and 1890, a one percent increased in initial samurai population share corresponding to a 15.3 percent increase in the ratio of secondary sector laborers to those in the primary industries among early-access rail prefectures, rising to 16.5 percent for the period until 1935.[23] That most of these decades coincide with a fairly stable absolute size in the agricultural labor force underscores the rapid industrial transition in areas with increased credit and investment opportunities (Nakamura 1966, p. 143). The long-run effect lasts until 1940 in the comparison between the tertiary to primary sector labor force shares, although the former expanded at a slower rate than the secondary sector.[24]

[Table XI]

IV. Robustness

We check our results for robustness using a variety of alternative measures that could be masked by initial samurai share. For example, Rajan and Ramcharan (2015) analyze the effect of credit supply on the boom-bust of land prices in the United States in the 1920s. Their preferred measure of credit supply is the number of banks, i.e., financial intermediaries. Although our exercise and historical episode differ from theirs, it could be the case that the

[22] Since the data for the tertiary sector in 1874 are not disaggregated between transport and other services (including finance), we are unable to attribute the growth improvement to direct investment in transport infrastructure or to financial or retail services.

[23] The conditional means of sectoral labor ratio growth between secondary and primary sectors are 0.705 (1874-1890), 0.398 (1874-1909), 0.372 (1874-1925), 0.300 (1874-1935) and 0.280 (1874-1940).

[24] For tertiary to primary labor ratio growth, the conditional means are 0.359 (1874-1890), 0.298 (1874-1909), 0.340 (1874-1925), 0.296 (1874-1935), and 0.239 (1874-1940). For the tertiary to secondary comparison, the means for the respective periods are -0.347, -0.099, -0.032, -0.004, and -0.040.

effect we identify on credit supply is similarly driven by the number of banks. This is plausible, despite the relatively small share of commutation bonds invested in banks relative to the total value of the bond issuance, since earlier research indicates extensive growth of financial intermediation predicts modern industrial activity (Tang 2013). Thus, we control for this possible effect by including the number of banks per capita at the prefecture level in our baseline regression for the short run period. Banking data come from the database of banking establishments collected by the Japanese Bankers Association (2012).

Table XII reports the results of including banks per capita to the earlier regressions of firms per capita, capital per capita, and firm capitalization. The first column considers all prefectures and the second column those with stable samurai population shares. Across both samples and the three measures of industrial activity, samurai share is positive and statistically significant. In contrast, while usually positive the coefficient of banks per capita is not significant in any regression.

[Table XII]

A related concern is that demand factors could be driving our results. In order to address this concern, we replicate the same regressions with total population instead of per capita income. Ideally, we would prefer to use the latter as a demand measure but this variable is not available at the prefecture level on an annual basis. As Japan had not yet transitioned to modern economic growth until the late 1890s (Perkins and Tang 2017), total population may be a good proxy for demand (income) in this earlier period. The third and fourth columns of Table XII report the coefficients of adding total population to our baseline regressions. The coefficient on samurai share remains positive and statistically significant in all regressions. However, total population is not significant, which corroborates the per capita income regression results using benchmark years between 1874 and 1940.

For the long run results, we rely on the earliest available data for prefectures, which were collected starting in 1880. Since the samurai bond conversion took place in 1876, it may be useful to use pre-conversion samurai

shares. To have these, we use linear extrapolation to impute missing years as well as to extend these series back to the 1870s. Results for 1875 samurai population shares (not shown) are qualitatively consistent with those using the 1880 shares.

Finally, while the initial distribution of samurai across prefectures may vary, it is possible that this was not random or exogenous to economic activity. It may be the case that higher samurai shares may reflect differences in land productivity, with more fertile areas generating sufficient revenues to support a larger rentier class. We check for this by using prefectural latitude (Google Maps 2016) instead of initial samurai share as Japan was a largely agricultural economy until the end of the nineteenth century. This variable is also interacted with early rail access per the earlier specifications to assess the impact of exogenously determined climatic differences on per capita output growth. The estimates for this specification are shown in Table XIII for all sectors in each of the subperiods of analysis.

[Table XIII]

In the top panel, the net latitide effect is statistically insignificant for each of the subperiods. Once initial samurai population share and its interaction with early rail access are added to the specification, however, the net samurai effect remains positive and statistically significant for the periods extending up to 1940. These periods and magnitudes are similar to those without the latitude variables, and the net latitude effect remains statistically insignificant across all periods. We interpret these results as indicating an effect from the 1876 pension commutation and injection of credit as opposed to any underlying economic differences in the prefectures themselves.

V. Concluding Remarks

Studies on the impact of credit supply on economic growth usually emphasize the negative relationship with financial crises, neglecting to highlight potential short and long run benefits and heterogeneity between

regions within a country. Our analysis of an exogenous credit supply shock in late nineteenth century Japan indicates that there are persistent positive effects for the economy as a whole and by sector. In the short run, we find evidence of extensive growth in the secondary sector even if much of the credit supply accumulated in the tertiary. In the long run, the effect on output growth is also observed to be largest in early years and steadily decreases over the next five decades, but only in the presence of productivity-enhancing technology (i.e., early railway access). Long-run growth investment opportunities allowing greater market access would allow regions to take advantage of the additional credit supply made available from the samurai pension conversion.

Whether the effect would have persisted longer is unclear given the global economic depression in the 1930s and Japanese militarization before World War II. That said, the credit supply shock varied by sector and region, with most benefits accruing in tertiary industries and disproportionately in areas with early access to railways, which may also have spatial effects and agglomeration economies. The sectoral, temporal, and demand effects are visible both in per capita income growth as well as labor reallocation between sectors. These results are suggestive of the joint importance of credit supply and the opportunity to utilize it in ways that maintain growth over time and facilitate structural change.

Does the pre-war Japanese case generalize to other economic scenarios as well? Understandably, in the late nineteenth century the Japanese economy was fragmented and financially underdeveloped, which may account for the large observed effects. The exogenous credit supply shock was also extremely large in relative terms, which may be unrealistic to expect in a modern context. Nevertheless, the persistence of a positive impact for the entire pre-war period is remarkable given the rapidity of industrialization and market integration, and shows that initial conditions may play a strong role in continued and long run development. Our next steps would include identifying the channels through which the interaction of credit supply and demand had the most impact as well as whether there may be negative effects obscured at the current level of regional analysis, especially for within regional inequality and returns to labor.

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TABLE I—SAMURAI PENSION COMMUTATION SCALES, 1876

Original Annual Income Value (yen) [a]	Conversion Factor[b]	Bond Interest (%)[c]
70,000 yen or higher	5.0	5
60,000 to 70,000	5.25	5
50,000 to 60,000	5.5	5
40,000 to 50,000	5.75	5
30,000 to 40,000	6.0	5
20,000 to 30,000	6.25	5
10,000 to 20,000	6.5	5
7,000 to 10,000	6.75	5
5,000 to 7,000	7.0	5
2,000 to 5,000	7.25	5
1,000 to 2,000	7.5	5
900 to 1,000	7.75	6
800 to 900	8.0	6
700 to 800	8.25	6
600 to 700	8.5	6
500 to 600	8.75	6
450 to 500	9.0	6
400 to 450	9.25	6
350 to 400	9.5	6
300 to 350	9.75	6
250 to 300	10.0	6
200 to 250	10.25	6
150 to 200	10.5	6
100 to 150	11.0	6
75 to 100	11.5	7
50 to 75	12.0	7
40 to 50	12.5	7
30 to 40	13.0	7
25 to 30	13.5	7
Below 25	14.0	7

Source: McLaren (1979) and Tomita (2005). [a]For incomes in perpetuity. Non-hereditary life incomes receive the same interest rates but for half the duration. Non-hereditary fixed term incomes also receive the same interest rates but for shorter durations than hereditary incomes: above 10 years (40 percent); 8 to 10 years (35 percent); 6 to 8 years (30 percent); 4 to 6 years (25 percent); 3 to 4 years (20 percent); and 2 years (15 percent). [b]Scaling factor to convert annual income into total bond capitalization value; e.g., a 6,000 yen annual income would be converted into bonds worth 42,000 yen paying 5 percent interest per year. [c]Redemption of bonds bearing 7 percent interest was completed in 1891, 6 percent interest in 1893, and 5 percent interest in 1906. See text for more detail.

TABLE II—SAMURAI POPULATION SHARES BY PREFECTURE, 1875-1898

	1875[a]	1887	1898	% Annual Growth[b]
Japan	5.4	5.0	4.8	-0.027
Aichi	3.7	3.4	3.4	-0.018
Akita	6.0	5.2	4.5	-0.072
Aomori	6.7	5.9	5.7	-0.059
Chiba	1.9	1.6	1.4	-0.021
Ehime		3.8	4.0	
Fukui		4.1	5.1	
Fukuoka	7.3	6.7	6.0	-0.060
Fukushima	4.5	4.9	5.4	0.040
Gifu	1.8	1.7	1.6	-0.012
Gunma	3.4	3.0	2.6	-0.035
Hiroshima	2.9	2.3	2.2	-0.046
Hokkaido	5.5	11.1	8.9	0.332
Hyogo	3.0	2.7	2.6	-0.020
Ibaraki	3.4	3.1	3.2	-0.009
Ishikawa		6.6	5.7	
Iwate		2.0	2.5	
Kagawa	3.7		3.1	-0.030
Kagoshima		24.0	23.2	
Kanagawa	1.0	1.4	1.8	0.040
Kochi	8.2	7.1	6.2	-0.091
Kumamoto	9.3	7.6	6.6	-0.129
Kyoto		3.2	3.1	
Mie	2.7	2.4	2.5	-0.024
Miyagi	5.8	5.0	4.4	-0.063
Miyazaki	18.5	18.0	17.6	-0.031
Nagano	3.3	2.9	2.6	-0.033
Nagasaki	12.5	10.6	10.1	-0.122
Nara	5.2	4.5	3.7	-0.074
Niigata	2.4	2.0	1.8	-0.026
Oita	5.0	4.5	3.9	-0.049
Okayama	3.9	3.4	2.9	-0.047
Okinawa	26.3	27.4	29.2	0.138
Osaka		1.1	1.5	
Saga	16.9	15.4	14.1	-0.135
Saitama	1.2	1.2	0.9	-0.013
Shiga	2.9	2.4	2.2	-0.036
Shimane	3.8	3.0	2.7	-0.061
Shizuoka	4.1	3.0	2.1	-0.091
Tochigi		2.0	1.9	
Tokushima	6.2	5.8	5.1	-0.051
Tokyo	9.7	9.6	8.7	-0.049
Tottori	6.6	5.6	5.2	-0.077
Toyama	2.4	2.4	2.0	0.000
Wakayama	5.5	4.8	4.1	-0.067
Yamagata	8.6	7.5	6.5	-0.098
Yamaguchi	8.4	7.7	7.0	-0.059
Yamanashi	0.3	0.4	0.5	0.008

Source: Authors' calculations. [a]Based on linear extrapolation from 1880-1898 period. [b]Estimates of annual change use robust standard errors and are statistically significant at least to 5 percent except where missing. Kagawa prefecture is missing data for 1887.

TABLE III—DISTRIBUTION OF BANKING CAPITAL BY PREFECTURE, 1884

	National Bank Count[a]	National Bank Capital[b]	Samurai Ownership %	Other Banking Capital[b]
Japan	142	52,536	58.5	32,667
Aichi	4	670	40.0	913
Akita	1	100	31.6	0
Aomori	2	300	78.4	181
Chiba	2	215	73.7	275
Ehime	4	440	53.3	536
Fukui	4	430	91.2	282
Fukuoka	4	640	72.2	504
Fukushima	5	930	20.4	676
Gifu	5	760	30.6	580
Gunma	2	570	47.4	823
Hiroshima	2	440	50.5	0
Hokkaido	2	330	40.7	100
Hyogo	7	790	37.1	460
Ibaraki	4	420	76.4	416
Ishikawa	2	190	63.9	0
Iwate	2	150	64.9	20
Kagoshima	2	530	90.8	67
Kanagawa	4	3,100	27.0	2,124
Kochi	4	650	64.0	0
Kumamoto	3	265	96.9	100
Kyoto	4	400	38.4	330
Mie	4	350	65.8	0
Miyagi	1	250	42.4	32
Miyazaki	2	100	80.8	511
Nagano	4	760	34.9	2,786
Nagasaki	3	370	35.7	435
Niigata	5	1,300	15.8	3,238
Oita	3	340	73.1	584
Okayama	2	380	81.5	689
Okinawa	0	0	0	100
Osaka	11	2,590	12.7	1,642
Saga	2	390	94.1	795
Saitama	1	200	25.8	1,459
Shiga	3	500	17.7	210
Shimane	1	80	70.6	79
Shizuoka	3	750	17.7	3,661
Tochigi	1	300	27.3	314
Tokushima	1	260	76.3	636
Tokyo	16	28,046	73.2	3,983
Tottori	1	200	86.9	24
Toyama	1	300	21.1	744
Wakayama	1	200	74.1	117
Yamagata	4	590	37.5	174
Yamaguchi	2	680	89.9	0
Yamanashi	1	250	5.8	2,067

Source: Japan Statistical Association (1962) and authors' calculations. [a]Excludes branches. [b]In thousand nominal yen. Other capital includes private banks and quasi-banking institutions.

TABLE IV—INDUSTRIAL ACTIVITY BY PREFECTURE, 1885-1890

	1885			1890		
	Firms	Capital	Avg. Firm Capital	Firms	Capital	Avg. Firm Capital
All Prefectures						
All sectors	35.2	1,450.3	25.2	93.4	4,901.2	36.0
Primary	2.1	39.2	16.4	10.1	178.9	17.7
Secondary	14.0	291.1	17.2	49.7	1,685.4	26.8
Tertiary	19.1	1,120.0	39.7	33.6	3,037.3	60.7
Sample Prefectures[a]						
All sectors	34.9	1,497.7	23.7	90.3	4,942.8	35.7
Primary	2.2	30.8	14.6	10.7	185.7	15.9
Secondary	14.0	280.6	15.5	45.2	1,549.9	26.6
Tertiary	18.7	1,186.2	41.7	34.4	3,207.2	60.6
Top Quartile Prefectures[b]						
All sectors	30.3	3,805.1	43.8	93.8	12,360.1	54.7
Primary	1.4	34.8	22.2	8.3	450.3	26.1
Secondary	17.8	631.8	21.4	49.2	3,828.6	36.3
Tertiary	11.1	3,138.5	102.2	36.2	8,081.1	109.4
Bottom Quartile Prefectures[b]						
All sectors	34.9	759.9	19.5	92.9	2,503.1	31.1
Primary	2.2	10.3	6.9	8.8	72.5	17.5
Secondary	8.2	96.8	15.3	43.6	648.6	22.6
Tertiary	23.7	652.8	22.5	40.5	1,782.0	43.5

Source: Japan Statistical Association (1962) and authors' calculations. Capital values in thousand nominal yen. [a]Excludes eight prefectures with variable samurai population shares; see Table II. [b]Based on 1875 samurai shares.

TABLE V—PRE-WAR PREFECTURAL OUTPUT, 1874-1940

	1874	1890	1909	1925	1940
All Prefectures					
Gross Prefectural Product	84.0	113.2	175.4	311.8	519.9
Per capita income	113.2	127.8	152.8	214.5	285.5
Primary (%)	61.4	50.1	42.6	35.7	26.9
Secondary (%)	10.3	14.8	19.6	22.3	35.8
Tertiary (%)	28.3	35.1	37.8	42.0	37.3
Sample Prefectures[a]					
Gross Prefectural Product	78.7	107.4	170.6	298.8	499.5
Per capita income	109.3	122.1	149.0	208.9	280.5
Primary (%)	63.2	51.4	43.1	36.3	27.4
Secondary (%)	10.0	14.5	19.3	22.0	36.0
Tertiary (%)	26.8	34.1	37.5	41.7	36.6
Top Quartile Prefectures[b]					
Gross Prefectural Product	90.3	128.4	215.0	418.0	751.1
Per capita income	124.1	135.6	163.5	227.5	306.5
Primary (%)	58.6	47.5	41.1	34.7	26.6
Secondary (%)	8.6	13.7	18.3	20.0	33.7
Tertiary (%)	32.8	38.8	40.6	45.3	39.7
Bottom Quartile Prefectures[b]					
Gross Prefectural Product	83.1	106.1	155.0	235.9	403.3
Per capita income	99.8	117.0	146.4	198.9	284.5
Primary (%)	65.4	54.6	43.2	36.1	25.4
Secondary (%)	10.4	13.1	18.6	22.2	39.8
Tertiary (%)	24.2	32.3	38.2	41.6	34.8

Source: Fukao et al (2015), Economic and Social Research Institute (2017), Jorda et al (2017) and authors' calculations. Gross prefectural product in constant 1934-36 million yen and per capita income in constant 1934-36 thousand yen. [a]Excludes eight prefectures with variable samurai population shares; see Table II. [b]Based on 1875 samurai shares.

TABLE VI—PRE-WAR PREFECTURAL LABOR FORCE, 1874-1940

	1874	1890	1909	1925	1940
All Prefectures					
Labor force (thou)	462.7	495.0	495.7	579.1	708.0
Primary (%)	71.0	60.0	56.0	46.7	40.6
Secondary (%)	12.7	21.0	21.3	24.3	28.4
Tertiary (%)	16.3	19.0	22.7	29.0	31.0
Sample Prefectures[a]					
Labor force (thou)	461.5	499.8	500.7	577.8	703.5
Primary (%)	72.0	60.8	57.0	47.9	42.0
Secondary (%)	12.4	20.7	21.0	24.0	27.8
Tertiary (%)	15.6	18.5	22.0	28.1	30.2
Top Quartile Prefectures[b]					
Labor force (thou)	409.7	463.3	505.0	623.9	815.2
Primary (%)	65.6	54.4	49.4	37.8	30.0
Secondary (%)	13.6	22.2	23.5	26.7	32.5
Tertiary (%)	20.8	23.4	27.1	35.4	37.5
Bottom Quartile Prefectures[b]					
Labor force (thou)	567.0	568.1	521.3	557.4	650.1
Primary (%)	73.5	62.7	60.0	51.8	46.0
Secondary (%)	13.0	20.7	19.9	23.2	27.3
Tertiary (%)	13.5	16.6	20.1	24.9	26.7

Source: Fukao et al (2015) and authors' calculations. Gainfully occupied population numbers are based on the estimating procedure in Umemura et al (1988). [a]Excludes eight prefectures with variable samurai population shares; see Table II. [b]Based on 1875 samurai shares.

TABLE VII—FIRM COUNT REGRESSIONS, 1883-1898

	1883-1890		1883-1898	
DV: Firms per 1000 residents	All Prefectures	Sample Prefectures[a]	All Prefectures	Sample Prefectures[a]
All sectors				
Samurai share	1.837***	2.172***	1.267***	1.421***
	(0.372)	(0.250)	(0.463)	(0.416)
Observations	351	288	719	592
Prefectures	47	39	47	39
R-squared	0.484	0.513	0.418	0.418
F-statistic	30.58***	27.03***	16.01***	21.68***
Primary sector				
Samurai share	0.517***	0.542***	0.518**	0.565***
	(0.059)	(0.050)	(0.199)	(0.164)
Observations	306	251	674	555
Prefectures	47	39	47	39
R-squared	0.243	0.249	0.657	0.670
F-statistic	22.56***	43.08***	18.34***	23.98***
Secondary sector				
Samurai share	0.737***	0.911***	0.572**	0.722***
	(0.237)	(0.175)	(0.228)	(0.165)
Observations	351	288	719	592
Prefectures	47	39	47	39
R-squared	0.310	0.304	0.311	0.293
F-statistic	28.74***	32.93***	25.71***	35.67***
Tertiary sector				
Samurai share	0.596***	0.708***	0.283	0.233
	(0.156)	(0.127)	(0.178)	(0.219)
Observations	351	288	719	592
Prefectures	47	39	47	39
R-squared	0.223	0.226	0.194	0.196
F-statistic	16.43***	19.78***	14.13***	11.93***

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors in parentheses. All specifications include year and prefecture fixed effects. [a]Excludes eight prefectures with variable samurai population shares; see Table II.

TABLE VIII—CAPITAL INVESTMENT REGRESSIONS, 1883-1898

	1883-1890		1883-1898	
DV: Capital per 1000 residents	All Prefectures	Sample Prefectures[a]	All Prefectures	Sample Prefectures[a]
All sectors				
Samurai share	372.909***	403.429***	231.358*	237.517*
	(79.673)	(92.054)	(133.928)	(132.077)
Observations	351	288	719	592
Prefectures	47	39	47	39
R-squared	0.239	0.252	0.217	0.200
F-statistic	13.41***	56.07***	9.05***	17.90***
Primary sector				
Samurai share	18.271***	19.160***	19.829***	21.424***
	(6.447)	(6.896)	(6.045)	(6.446)
Observations	306	251	674	555
Prefectures	47	39	47	39
R-squared	0.122	0.126	0.169	0.166
F-statistic	2.38**	5.27***	19.59***	29.01***
Secondary sector				
Samurai share	65.861**	75.876**	72.139***	80.750***
	(31.017)	(35.092)	(24.141)	(25.673)
Observations	351	288	719	592
Prefectures	47	39	47	39
R-squared	0.169	0.172	0.156	0.163
F-statistic	10.60***	9.17***	34.85***	39.14***
Tertiary sector				
Samurai share	288.738***	308.454***	141.348	137.697
	(45.031)	(51.984)	(156.209)	(158.696)
Observations	351	288	719	592
Prefectures	47	39	47	39
R-squared	0.250	0.267	0.197	0.179
F-statistic	27.93***	109.99***	8.55***	13.46***

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors in parentheses. All specifications include year and prefecture fixed effects. Capital in nominal yen. [a]Excludes eight prefectures with variable samurai population shares; see Table II.

TABLE IX—FIRM CAPITAL REGRESSIONS, 1883-1898

	1883-1890		1883-1898	
DV: Capital per firm (thou yen)	All Prefectures	Sample Prefectures[a]	All Prefectures	Sample Prefectures[a]
All sectors				
Samurai share	492.533***	568.223***	201.237	141.484
	(160.307)	(144.174)	(621.577)	(686.414)
Observations	350	287	718	591
Prefectures	47	39	47	39
R-squared	0.042	0.045	0.252	0.238
F-statistic	6.43***	19.42***	14.77***	21.04***
Primary sector				
Samurai share	-457.083	-564.626	615.081	616.047
	(1215.267)	(136.100)	(895.093)	(1072.243)
Observations	257	214	590	488
Prefectures	46	38	46	38
R-squared	0.012	0.016	0.071	0.060
F-statistic	1.00	0.362	22.92***	24.64***
Secondary sector				
Samurai share	-33.239	-45.920	383.763***	340.278**
	(207.143)	(216.460)	(139.848)	(155.935)
Observations	344	282	712	586
Prefectures	47	39	47	39
R-squared	0.086	0.096	0.099	0.099
F-statistic	3.94***	3.17***	80.40***	99.53***
Tertiary sector				
Samurai share	1748.407**	1941.900***	1978.561	2252.904*
	(678.455)	(534.293)	(1363.091)	(1258.686)
Observations	340	279	708	583
Prefectures	47	39	47	39
R-squared	0.033	0.037	0.504	0.476
F-statistic	12.95***	29.75***	28.27***	30.38***

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors in parentheses. All specifications include year and prefecture fixed effects. Capital in nominal yen. [a]Excludes eight prefectures with variable samurai population shares; see Table II.

TABLE X—OUTPUT GROWTH REGRESSIONS, 1874-1940

DV: Δ ln(output per capita)	1874-1890	1874-1909	1874-1925	1874-1935	1874-1940
All sectors					
Lag ln(output per capita)	-0.433***	-0.367***	-0.321***	-0.210***	-0.171**
	(0.116)	(0.110)	(0.080)	(0.077)	(0.052)
Samurai share in 1880	-0.806	-0.503	-0.688*	-0.562*	-0.461
	(0.517)	(0.421)	(0.413)	(0.332)	(0.276)
Rail stations per million residents in 1885	-0.017***	-0.013***	-0.014***	-0.009***	-0.007**
	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)
Interaction of samurai share w/1885 rail access	0.734***	0.542***	0.489***	0.302**	0.221**
	(0.170)	(0.183)	(0.142)	(0.136)	(0.100)
Net samurai effect	6.735***	5.067**	4.333***	2.538*	1.814*
	(1.859)	(1.995)	(1.504)	(1.394)	(1.007)
R-squared	0.360	0.309	0.474	0.423	0.406
F-statistic	6.91***	6.74***	16.63***	19.82***	17.22***
Primary sector					
Lag ln(output per capita)	-2.542***	-2.284***	-1.578***	-1.159***	-0.849***
	(0.677)	(0.334)	(0.351)	(0.304)	(0.265)
Samurai share in 1880	-1.399	-0.688	-0.365	-0.053	0.066
	(1.442)	(0.840)	(0.570)	(0.443)	(0.366)
Rail stations per million residents in 1885	0.029**	0.029***	0.026***	0.022**	0.018**
	(0.014)	(0.011)	(0.009)	(0.009)	(0.008)
Interaction of samurai share w/1885 rail access	-1.559***	-1.319***	-1.077***	-0.872***	-0.675**
	(0.424)	(0.359)	(0.314)	(0.288)	(0.270)
Net samurai effect	-17.414***	-14.236***	-11.435***	-9.012***	-6.867**
	(4.029)	(3.691)	(3.220)	(2.949)	(2.754)
R-squared	0.507	0.498	0.352	0.395	0.329
F-statistic	18.52***	18.06***	7.33***	17.34***	15.35***
Secondary sector					
Lag ln(output per capita)	-1.174***	-0.881***	-0.755***	-0.580***	-0.544***
	(0.359)	(0.296)	(0.224)	(0.191)	(0.158)
Samurai share in 1880	-0.542	-1.882**	-1.514**	-1.420**	-1.197**
	(0.645)	(0.932)	(0.721)	(0.640)	(0.537)
Rail stations per million residents in 1885	-0.015	-0.031**	-0.019	-0.013	-0.011
	(0.012)	(0.015)	(0.014)	(0.012)	(0.009)
Interaction of samurai share w/1885 rail access	1.466***	1.352***	0.853***	0.566	0.462*
	(0.336)	(0.239)	(0.385)	(0.343)	(0.276)
Net samurai effect	14.521***	12.006***	7.252*	4.389	3.550
	(3.422)	(2.248)	(3.823)	(3.402)	(2.737)
R-squared	0.464	0.234	0.154	0.086	0.198
F-statistic	13.66***	7.18***	2.47**	1.77*	10.53***
Tertiary sector					
Lag ln(output per capita)	-0.666***	-0.851***	-1.114***	-1.024***	-0.987***
	(0.275)	(0.278)	(0.242)	(0.218)	(0.190)
Samurai share in 1880	-1.085**	-0.510	-0.713	-0.435	-0.318
	(0.399)	(0.635)	(0.641)	(0.512)	(0.414)
Rail stations per million residents in 1885	-0.008	-0.005	-0.013**	-0.012**	-0.010***
	(0.005)	(0.006)	(0.006)	(0.005)	(0.004)
Interaction of samurai share w/1885 rail access	0.315	0.247	0.427**	0.354**	0.293**
	(0.207)	(0.211)	(0.195)	(0.158)	(0.137)
Net samurai effect	2.153	2.028	3.672*	3.205**	2.690*
	(2.364)	(2.333)	(2.015)	(1.606)	(1.374)
R-squared	0.333	0.215	0.493	0.610	0.605
F-statistic	9.93***	5.49***	20.16***	47.89***	44.58***
Observations	37	74	111	148	185

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors in parentheses. All specifications include year fixed effects and exclude eight prefectures with variable samurai population shares; see Table II. Prefectures missing 1880 samurai population share use extrapolated values. Kagawa and Nara prefectures are missing population data in 1885 and thus omitted from the analysis. Gross prefectural product in 1934-36 constant million yen and per capita income in 1934-36 constant yen.

TABLE XI—LABOR SHARE GROWTH REGRESSIONS, 1874-1940

DV: Δ secondary/primary labor force	1874-1890	1874-1909	1874-1925	1874-1935	1874-1940
Lag labor force ratio	-0.539***	-0.389***	-0.232***	-0.108*	0.004
	(0.055)	(0.077)	(0.073)	(0.059)	(0.058)
Samurai share in 1880	-0.155	-0.387	-0.437	-0.355	-0.296
	(0.306)	(0.355)	(0.317)	(0.274)	(0.261)
Rail stations per million residents in 1885	-0.031***	-0.027**	-0.022**	-0.016**	-0.008
	(0.009)	(0.011)	(0.009)	(0.008)	(0.007)
Interaction of samurai share w/1885 rail access	1.066***	0.975***	0.757**	0.516*	0.266
	(0.289)	(0.370)	(0.316)	(0.263)	(0.253)
Net samurai effect	10.792***	9.633**	7.343**	4.945*	2.432
	(2.924)	(3.768)	(3.236)	(2.678)	(2.566)
R-squared	0.778	0.803	0.701	0.745	0.696
F-statistic	33.89***	65.61***	52.40***	51.65***	41.26***
DV: Δ tertiary/primary labor force					
Lag labor force ratio	-0.351***	-0.315***	-0.186***	-0.107**	-0.091**
	(0.047)	(0.065)	(0.064)	(0.051)	(0.039)
Samurai share in 1880	-1.268***	-1.214***	-1.335***	-1.064***	-0.881***
	(0.84)	(0.289)	(0.264)	(0.226)	(0.198)
Rail stations per million residents in 1885	-0.034***	-0.035***	-0.029***	-0.024***	-0.021***
	(0.006)	(0.0074)	(0.008)	(0.007)	(0.006)
Interaction of samurai share w/1885 rail access	1.176***	1.192***	0.965***	0.755***	0.654***
	(0.231)	(0.284)	(0.307)	(0.255)	(0.210)
Net samurai effect	10.809***	11.031***	8.576***	6.696**	5.835***
	(2.493)	(3.055)	(3.220)	(2.648)	(2.162)
R-squared	0.609	0.435	0.319	0.305	0.426
F-statistic	21.35***	16.75***	10.97***	10.43***	23.61***
DV: Δ tertiary/secondary labor force					
Lag labor force ratio	-0.414***	-0.383***	-0.348***	-0.316***	-0.344***
	(0.105)	(0.072)	(0.057)	(0.052)	(0.055)
Samurai share in 1880	-1.223	-0.801	-0.770**	-0.560*	-0.293
	(0.751)	(0.478)	(0.331)	(0.287)	(0.286)
Rail stations per million residents in 1885	-0.016***	-0.013**	-0.011**	-0.010***	-0.007
	(0.005)	(0.006)	(0.005)	(0.004)	(0.004)
Interaction of samurai share w/1885 rail access	0.688***	0.454**	0.425***	0.377***	0.269*
	(0.101)	(0.189)	(0.134)	(0.109)	(0.156)
Net samurai effect	5.848***	3.862*	3.599***	3.311***	2.478
	(1.005)	(1.944)	(1.373)	(1.099)	(1.594)
R-squared	0.574	0.814	0.798	0.785	0.719
F-statistic	25.37***	74.00***	67.03***	57.22***	48.57***
Observations	37	74	111	148	185

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors in parentheses. All specifications include year fixed effects and exclude eight prefectures with variable samurai population shares; see Table II. Prefectures missing 1880 samurai population share use extrapolated values. Kagawa and Nara prefectures are missing population data in 1885 and thus omitted from the analysis. Labor force per sector measured in levels, and the ratios are in natural logs; see text for details.

TABLE XII— INDUSTRIAL ACTIVITY ROBUSTNESS CHECKS, 1883-1890

	Financial intermediation		Market demand	
	All Prefectures	Sample Prefectures[a]	All Prefectures	Sample Prefectures[a]
DV: Firms per 1000 residents				
Samurai share	1.407***	1.838***	1.901***	1.986***
	(0.512)	(0.407)	(0.105)	(0.157)
Banks per 1000 residents	0.508	-0.543		
	(1.549)	(1.314)		
Population (mil)			-0.071	0.373
			(0.104)	(0.314)
Observations	252	215	351	288
Prefectures	47	39	47	39
R-squared	0.503	0.528	0.496	0.524
F-statistic	20.60***	28.42***	24.43***	55.56***
DV: Capital per 1000 residents				
Samurai share	454.409***	491.256***	373.019***	341.713***
	(234.741)	(75.583)	(75.583)	(52.500)
Banks per 1000 residents	285.546	252.483		
	(234.741)	(260.178)		
Population (mil)			-0.123	123.780
			(9.128)	(92.118)
Observations	252	215	351	288
Prefectures	47	39	47	39
R-squared	0.280	0.285	0.239	0.314
F-statistic	10.39***	28.26***	19.21***	32.74***
DV: Capital per firm (thou yen)				
Samurai share	930.831***	985.195***	481.141***	435.115***
	(189.239)	(188.679)	(153.959)	(100.368)
Banks per 1000 residents	1522.247	1721.947		
	(1443.072)	(1656.636)		
Population (mil)			12.766	267.486
			(14.411)	(191.097)
Observations	251	214	350	287
Prefectures	47	39	47	39
R-squared	0.057	0.061	0.042	0.051
F-statistic	11.09***	23.99***	6.64***	23.99***

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors in parentheses. All specifications include year and prefecture fixed effects. Capital measured in nominal yen. [a]Excludes eight prefectures with variable samurai population shares; see Table I.

TABLE XIII—OUTPUT GROWTH ROBUSTNESS CHECKS, 1874-1940

DV: Δ ln(output per capita)	1874-1890	1874-1909	1874-1925	1874-1935	1874-1940
All sectors					
Lag ln(output per capita)	-0.251*	-0.242	-0.204***	-0.130**	-0.117***
	(0.144)	(0.092)	(0.069)	(0.057)	(0.041)
Latitude	0.020**	0.004	0.007	0.001	0.001
	(0.008)	(0.009)	(0.009)	(0.007)	(0.006)
Rail stations per million residents in 1885	0.023	0.046	0.033	0.015	0.012
	(0.064)	(0.038)	(0.030)	(0.026)	(0.021)
Interaction of latitude w/1885 rail access	-0.001	-0.001	-0.001	-0.0003	-0.0003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.0005)
Net latitude effect	0.014	-0.007	-0.001	-0.003	-0.002
	(0.016)	(0.011)	(0.010)	(0.008)	(0.006)
R-squared	0.263	0.234	0.377	0.389	0.379
F-statistic	7.47***	4.43***	12.26***	16.30***	13.79***
All sectors					
Lag ln(output per capita)	-0.412***	-0.371*	-0.327***	-0.222***	-0.187***
	(0.116)	(0.109)	(0.081)	(0.075)	(0.052)
Samurai share in 1880	-0.426	-0.562	-0.783*	-0.939***	-0.792***
	(0.571)	(0.468)	(0.400)	(0.346)	(0.288)
Latitude	0.013	-0.003	-0.003	-0.011*	-0.010*
	(0.010)	(0.009)	(0.007)	(0.006)	(0.005)
Rail stations per million residents in 1885	-0.022	0.007	-0.008	-0.022	-0.018
	(0.051)	(0.038)	(0.028)	(0.026)	(0.021)
Interaction of samurai share w/1885 rail access	0.694***	0.528***	0.494***	0.352**	0.272**
	(0.182)	(0.187)	(0.149)	(0.138)	(0.106)
Interaction of latitude w/1885 rail access	0.0001	-0.0004	-0.0001	0.0003	0.0002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.0005)
Net samurai effect	6.707***	4.860**	4.296***	2.677*	2.007*
	(2.006)	(2.005)	(1.552)	(1.400)	(1.041)
Net latitude effect	0.014	-0.008	-0.005	-0.008	-0.007
	(0.013)	(0.010)	(0.008)	(0.007)	(0.006)
R-squared	0.388	0.317	0.453	0.439	0.419
F-statistic	10.00***	5.02***	12.49***	16.81***	14.82***
Observations	37	74	111	148	185

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors in parentheses. All specifications include year fixed effects and exclude eight prefectures with variable samurai population shares; see Table I. Prefectures missing 1880 samurai population share use extrapolated values. Kagawa and Nara prefectures are missing population data in 1885 and thus omitted from the analysis. Gross prefectural product in 1934-36 constant million yen and per capita income in 1934-36 constant yen.