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 long-run economic growth is unclear. Using bond payments to samurai in nineteenth century Japan as a quasi-natural experiment and exploiting regional variation, we find that bond payments are associated with persistent redistributive effects between both regions and sectors. Areas with early railway access and higher bond value per capita experienced faster income growth in the tertiary sector and slower growth in the primary, with analogous effects for sectoral labor shares. Our interpretation is that the interaction between credit supply and market access facilitated economic growth and structural transformation.

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 economic growth observed across countries and over time (e.g, Levine 2005).

However, the causal impact of credit supply on economic growth in the long run remains an open question due to the challenges of identification and data availability.[1] We address these problems by using a historic dataset (1874-1940) and a quasi-natural experiment starting with a large credit supply shock. In 1876, the Japanese government compulsorily replaced the hereditary stipends of former samurai with interest bearing government bonds.[2] The ex-samurai represented about five percent of the population and the replacement bonds 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, but also an annual loss to the ex-samurai of up to 75 percent of their original stipends (Flath 2014, p. 33; Yamamura 1967, p. 204).[3]

To assess the effect of this credit supply shock, we use bond values at the time of the stipends commutation to proxy for differences in credit availability between regions. Since the stipend conversion was universal, compulsory, and resisted by the samurai themselves, this policy reform is

[1] There exists a large economic development literature that investigates the microeconomic short-run effects of credit supply injections. For example, Banerjee and Duflo (2014) on firm investment or Burgess and Pande (2005) on poverty. The aim of our paper is on the long-run aggregate economic effects. In this sense, it is more related to the macro-finance literature in the tradition of the seminal paper of King and Levine (1993)

[2] 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.

[3] There were earlier voluntary commutations of samurai stipends 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. Income loss was proportionately greater the higher the original stipend value, with ex-samurai receiving a quarter of their earlier income if their stipend was valued greater than 70,000 yen while the poorest ex-samurai received nearly all their original stipend value from the bond interest payments; see Table I.

plausibly exogenous to existing or anticipated local economic activity.[4] Our identification comes from the within-country variation in regional per capita samurai bond values, which is due to the historic distribution of samurai that existed before the policy change.[5] We hypothesize that, given the high variation of per capita bond values between regions, this credit supply shock may account for subsequent differences in economic activity between those 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 persistent differences in the long run.[6]

We test our hypothesis that variation in initial credit supply affects local economic activity by regressing per capita income growth on per capita samurai bond value at the regional level between 1874 and 1940. Our dataset includes intervening benchmark years, which provide more systematic evidence of trends and persistence. To better identify the channels of transmission, we separately estimate the impact by major sector, include different bond coupon rates and banking capital measures, as well as examine possible correspondence in sectoral labor shares. In addition to controlling for initial level of income, our preferred specification includes time-varying control variables of population (market size), per capita student enrollment share (human capital), and low gradient land population density (urbanization). Our measure of market access and attendant demand is the early construction of rail stations by region, which is then interacted with bond value per capita.

Our results indicate that there are two main redistributive effects: between sectors and between regions. In the short run (1874-1890), we find that per capita samurai bond value is positively associated with growth in the tertiary

[4] "The effect of [the 1876 stipend 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.

[5] Formally, when we regress the log of bond value per capita in 1876 on observables in 1874 (per capita income, population, urbanization), none of the control variables is statistically significant. Furthermore, the pairwise correlation between regional per capita income in 1874 and regional per capita bond value in 1876 is statistically insignificant.

[6] See Banerjee and Iyer (2005) for a similar approach on regional differences affecting long run growth.

sector, which includes finance, retail, and other services.[7] This tertiary sector growth is amplified in the presence of early railway access, which also varied by region. Over the same period, the primary sector experienced a large decline in growth among regions with high bond values and railway access. In marginal terms, for rail accessible regions a 1 percent increase in per capita samurai bond value corresponded with nearly a 12 percent increase in per capita income growth for the tertiary sector and a 27 percent decrease for the primary sector. We interpret the significant effects of the interaction between bonds and railway access as showing how both credit supply and market access, as facilitated by productivity-enhancing infrastructure and investment opportunities, were needed to generate growth and to allow for reallocation between sectors.

Lengthening the coverage into the early twentieth century reduces the magnitude of the effect of samurai bond value on both the primary and tertiary sectors, although growth persists through the decades leading up to World War Two. In particular, a 1 percent increase in average per capita bond value is associated with a 9 percent decline in growth in the primary sector between 1874 and 1940. For the tertiary sector, growth would increase about 4 percent. All specifications for our regression model include regional control variables such as population, school enrollment, urbanization, and a lagged term of per capita income as well as year dummies.

Similar results obtain when using per capita banking capital instead of bond value and using sectoral labor share ratios as dependent variables. The negative effect on primary sector growth is more modest and less persistent when regressed on banking capital, and primary sector labor shares decline relative to tertiary employment. These findings indicate that the real economy, measured in output and labor, was significantly impacted by the initial credit supply shock, and when coupled with growth-promoting investment opportunities and greater market access had short and long run distributional effects on regional economic activity and overall structural change.

[7] The primary sector includes the agriculture, forestry, and fishery industries; the secondary sector includes mining, manufacturing, construction, and utilities; and the tertiary sector includes commercial services (e.g., retail, finance) and transport.

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.[8] 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 (Jordà 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 variation in credit supply via an historic public bond issuance. 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. We can thus 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 along with private sector entrepreneurs 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

[8] 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.

2017).[9] The tertiary sector also experienced dramatic growth as shown with the rise of general merchandising, shop-keeping, financial intermediation, and transport services (land and water).[10]

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 an earlier large exogenous shock to its credit supply. This shock was the 1876 conversion of hereditary samurai stipends (aka, *chitsuroku*) into government bonds (aka, *kinroku*) worth 173.9 million yen, motivated by the drain on public finances from samurai payments.[11] 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).[12] 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, with public bonds totaling 51.5 million yen at that time.[13] Table I provides the stipend commutation scales into interest bearing bonds, which had a maturity of thirty years and minimum holding period of five years.[14]

[9] The content of Japanese manufacturing at the time, however, was still relatively labor intensive and low value, as demonstrated by its export composition consisting mainly of textiles (Meissner and Tang, forthcoming).

[10] Makimura (2017) describes the activities of raw silk purveyors and the large amounts of merchandise they handled and sold for export in the Yokohama region during this period. This preceded Japan's textile manufacturing expansion from the turn of the century, when cotton textiles and woven fabrics were produced domestically and exported (Meissner and Tang, forthcoming).

[11] 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.

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

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

[14] 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 stipend 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.

[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 investment capital.[15] These banks increased from 6 in 1876 to 153 over the next three years, with samurai contributing three times more capital in these banks compared to all other classes combined (ibid, p. 205).[16] Their dominant position in bank ownership remained in place through the 1880s, which coincided with the start of modern economic growth and Japan's subsequent transition to an industrialized economy (Rousseau 1999; Tang 2013).[17]

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 samurai bonds (27 percent by value) invested in national banks (Tomita 2005).[18] The high inflation period immediately following the stipend 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 to 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 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

[15] 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.

[16] 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.

[17] 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).

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

1960). The pairwise correlation of per capita bonds in 1876 with per capita banking capital in 1884 is 0.75 and with per capita bank counts is 0.30.[19] By focusing on the role of banking, the contribution of the bond issue on tertiary sector growth that includes financial services would be obscured as well.

The premise of our identification strategy is since the ex-samurai and their bond payments 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 productivity (Moriguchi and Saez 2008; Fukao et al 2015). In the period preceding World War Two, regional inequality rose significantly due to shifts away from primary to secondary production, which did not decrease until after the war (Fukao and Paul 2017). 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 (Fukao et al 2017; 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 subsequent development, we use historic data that provide regional measures of output, employment, market access, and demography. Collectively, these data span the period between 1874 and 1940 and are disaggregated by the 47 regions (aka, prefectures) that comprise Japan. Output and labor force data by prefecture are available for a number of benchmark years in the pre-war period: 1874, 1890, 1909, 1925, 1935 and 1940 (Fukao et al 2015). These data are also

[19] At less than one percent statistical significance. The correlations increase when limited to only national banking measures: 0.80 for per capita national banking capital and 0.55 for per capital national bank counts by prefecture.

separable by region into the three major sectors of primary, secondary, and tertiary categories for the entire period. Data on bonds issued to samurai by region in 1876 were collected by the Japanese Ministry of Finance (Meiji Zaiseishi 1971). Railway data are from a handbook of rail station construction, which provide both dates and locations of all stations built starting in the 1870s (Chuo Shoin 1995; Tang 2014).

Average per capita bond values in nominal yen are shown in the last column in Table II. Extreme values include Tokyo (40.42 yen per capita) and Yamanashi (0.14 yen per capita), which can be attributed in part to the high share of wealthy samurai living in the former (who received 5 percent coupon bonds) and the lack of in the latter. Moreover, there are nine prefectures that did not exist at the time of the 1876 commutation, so no bond values for these regions are available, bringing the sample in the analysis down to 38 prefectures.[20] Table III shows the breakdown of chartered national banks, which received much of their paid-in capital from these samurai bonds. These bank counts and samurai ownership shares underscore the relative immobility of financial capital between regions during this period, despite efforts by the government to create a national system during this period.[21] The lack of integration in the short run demonstrated by the dispersion of capital may thus allow for localized economic impacts from the bond issuance, which were not fully redeemed until the first decade of the 1900s.[22]

[Tables II and III]

Prefectural output measures in per capita terms and by sector are shown in the top and third panels of Table IV, covering the years between 1874 and 1940. Throughout this period, Japan steadily increased its per capita income in real terms, with the shares of value from secondary and tertiary sectors growing

[20] The nine prefectures missing bond data are Fukui, Kagawa, Miyazaki, Nara, Okinawa, Saga, Tokyshima, Tottori, and Toyama.

[21] 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.

[22] Redemption of 7 percent coupon bonds, 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; see Tomita (2015). Special bonds bearing 10 percent interest (5 percent total bond value) were all redeemed by June 1886.

at the expense of primary production. The period between 1874 and 1909 shows a doubling of secondary sector value, which reached nearly one third of national output by 1940 largely due to a shift away from primary production. This is true for both all prefectures in the country and for those with available bond data. The second and bottom panels show a similar breakdown for employment, which also shifted away from primary production into the secondary and tertiary sectors, doubling their proportions of the labor force by the end of the period.

[Table IV]

B . *Theoretical Motivation*

How should the bond conversion of former samurai stipends affect the economic activity? Numerous anecdotes of former samurai (e.g., Yasuda Zenjiro of Yasuda Mutual Life Insurance, Iwasaki Yataro of Mitsubishi, and Fujioka Ichisuke of Tokyo Electric Light) illustrate their success in establishing new firms and investing in banks (Yamamura 1974, Tokyo Dento 1936). While there were nascent equity exchanges in Tokyo and Osaka, most firm capital formation was through network finance without necessarily using banks as intermediaries. At the same time, banking played a role in mobilizing financial capital and using the samurai bonds as collateral as intended with the National Banking Act of 1876 (Tomita 2015). In this section, we briefly summarize the theoretical channels through which financial development may affect the economy and how we can empirically test its effect.

Financial development is a loose word that is broadly used to describe different functions that financial systems provide. Levine (2005) emphasizes five functions: (i) produce information and improve capital allocation, (ii) monitor investment after providing finance, (iii) increase diversification and reduce uncertainty, (iv) mobilize and pool savings and (v) facilitate exchange of goods and services. Samurai bonds may have helped to improve Japanese financial institutions in more than one of the above categories, for example, by creating new assets in the economy to generate growth (Acemoglu and Zillibotti 1997). Moreover, the use of samurai bonds to capitalize chartered national

banks could be conducive to increasing the number of firms (Holmstrom and Tirole 1997). Finally, by helping to mobilize resources, samurai bonds may have helped to fund large projects that could not have been funded by individual investors (Bagehot 1873).

While it is beyond the scope of this paper to disentangle which specific channel the samurai bond conversion affected the economic development of Japan, we can empirically assess the effect of financial development (proxied by samurai bonds per capita) on subsequent economic activity. Similar to Mian et al (2007), we analyze how the economic growth of different regions within a country are affected by their initial level of financial development. The empirical framework follows the tradition of cross-country growth regressions to estimate the effect of financial development on economic growth, as employed by King and Levine (1993).[23] Our contributions are to use the provision of a financial instrument instead of changes in regulation, an identification strategy with a quasi-experimental setting for a plausible causal interpretation, and a long run data series that allows for analysis of both short run effects and potential long run persistence.[24]

Furthermore, given that we have sectoral disaggregation, we can study the differential effect of financial development across sectors and time. This follows the seminal work of Rajan and Zingales (1998), who show that the effect of financial development should depend on the characteristics of the industries. In particular, the effect of financial development should be larger in more financially dependent industries. We perform a similar exercise but within a country and at a higher level of aggregation. Consistent with their predictions, we should find that the effect of samurai bonds on economic activity is exacerbated in financial dependent sectors (like heavy industry and finance) and

[23] Although there exists a large literature which analyzes episodes of financial liberalization (e.g., Kaminski and Schmukler, 2008) we view the samurai bond event as an increase in credit supply, which affected the level of financial development of the country, more than a financial liberalization. There exist more papers which run similar cross-country financial development-economic growth regressions. For example, Loayza et al. (2006), which emphasize that financial intermediation may have a negative short-run effect but a positive in the long run. Similarly, Arcand et al. (2015) argue that too much financial development may have a negative effect on growth.

[24] There have been several papers which have related historical events with persistent long-run effects. For example, the seminal paper of Acemoglu et al (2001) emphasize that the type of institutions that Europeans adopted in the different colonies had long and persistent effects.

it should have a lower or negative effect on less financial dependent sectors as agriculture.

One additional contribution not found in the financial development literature is the effect of productivity-enhancing technology, for which we use railway access as our proxy. The positive effect of railways on economic development is well-established, and we extend this scholarship by testing the hypothesis that financial development has a more positive effect on regional development if it occurs simultaneously with local latent demand, particularly investment opportunities that improve access to technology or markets (Summerhill 2005; Atack et al 2008; Herranz-Loncan 2011; Donaldson 2018). This conditional effect of the availability of profitable investment opportunities 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 ventures (Harootunian 1960, p. 443). In the context of pre-war Japan, we argue that per capita railway stations serve as a reasonable proxy for local credit demand and potential growth. Furthermore, the placement of the railways throughout the 1880s was exogenous to the government's bond policy, dictated by geographical constraints on construction (Tang 2014, Yamazaki 2017). Thus, the intersection between the two effects of bond availability and railway access can be compared against regions that received just one or the other and highlight their relative importance to growth.

C. Empirical Strategy

Following our previous discussion, we consider the next growth regression to assess the effect of bond per capita on economic activity of Japan:

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

where $\Delta\, GPPpc_{it} = ln(GPPpc_{it}/GPPpc_{it-1})$, $GPPpc_{it}$ is gross prefecture product per capita in prefecture *i* and year *t*, $Bond_{i0}$ is the bond value per capita in 1876, and $Stations_{i1}$ is the number of railway stations per capita in

prefecture *i* in year 1885. To control for possible income convergence over time between regions we include a lag term for the previous period's per capita output. Our preferred specification also includes prefectural-level control variables of population (i.e., market size), per capita student enrollment share (i.e., human capital), and low gradient land population density (i.e., urbanization) in the current year. We use railways in 1885 in our baseline specification because that year 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 growth effect in areas that joined the national railway network and market earlier in the period. Both per capita bond value in 1876 and regional output from 1874 to 1940 are measured in constant 1934-36 yen (Fukao et al. 2015).

The main variable of interest is the interaction between 1876 per capita bond values (aka, credit supply) and 1885 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 railway access. We then compute the total effect of credit supply for the average prefecture with the average number of railway stations on income growth all in per capita and constant yen terms. Finally, we run this regression for different time periods, from the short run (1874 to 1890) through the long run (1874 to 1940) and intervening years.[25] Since our base year of 1874 precedes the bond issue, our model can identify the change in growth due to that shock. 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.

[25] The use of benchmark years ranging between five and nineteen years means that our analysis does not specifically control for subperiods of inflation and deflation. For example, the first period between 1874 and 1890 covers both the inflationary years immediately following the bond issue (1877-1881) and the subsequent deflationary period (aka, the Matsukata deflation between 1881 and 1885). Given that all values for bonds and output are adjusted to constant yen terms, our inclusion of year dummies, and we are agnostic as to the individuals holding the bonds at any given point in time, we do not consider periods of inflation or deflation problematic in the interpretation of our results.

We are also interested in the possible effect of credit supply shock on the structural transformation of Japan. In order to perform this complementary exercise, we run the following regression,

(2)

$$\Delta LaborRatio_{12it} = \beta_0 + \beta_1 * LaborRatio_{12it-1} + \beta_2 * Bond_{i0} + \beta_3 * Bond_{i0} * Stations_{i1} + \delta_t + e_{it},$$

where $\Delta LaborRatio_{12it}$ is the change in the ratio of the labor force for one sector over another for all three sectoral combinations. Included covariates are the same as in the previous model, with lag term for labor force ratio capturing earlier reallocation. As with our output model, we interpret a positive average total effect from per capita bond value 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 earlier scholarship (Fukao et al. 2015, Fukao and Paul 2017), we expect high values of bonds per capita to facilitate movement away from the primary sector into the other two sectors.

III. Results

A. Output Growth

To generalize the economic effects to output as a whole as well as to differentiate between use of credit supply, we examine regional per capita output growth over the short and long run and include the adoption of railways. Table V provides results for the first period 1874 to 1890, starting with individual control variables for per capita bond value and rail stations, and then adding their interaction term and additional prefectural controls. In other words, these specifications decompose the effect from the credit supply shock (i.e., bonds per capita in 1876) from the productivity shock (i.e., per capita rail stations in 1885) and their interaction. In the top panel, there is no statistically significant relationship between overall output growth and the included variables across most of the specifications as the F-statistic is not significant.

Only with the full complement of control variables in the last column is there a meaningful relationship, with per capita bond value negative and significant at the 10 percent level. However, taking account of the inclusion of per capita rail stations and their interaction (i.e., the average total effect), there is no overall joint significance.[26]

[Table V]

The remaining panels perform the same decomposition exercise for the three sectors of the economy. For the primary sector, bond value per capita by itself do not have any significant on primary income growth (column A). However, when interacted with railways stations (columns C and D), the coefficient is negative, indicating that given early access to railway stations, higher per capita bond value reduces primary income growth. When we repeat this exercise for the secondary sector, we do not find significant effects from either bonds or rail stations per capita. The bottom panel reports the coefficients for the regression on tertiary income growth. Note that we obtain the opposite results compared to those for primary income growth, which may account for the lack of an average total income growth effect. For each of the two sectors, the signs on the coefficients for railway access and its interaction with bonds are the same (negative-negative for primary, positive-positive for tertiary), suggesting a complementarity of credit demand and supply. These results also underscore the redistributive effects of the credit supply shock: given early access to railways, areas with higher bond value per capita experienced higher (lower) growth in tertiary (primary) income.

The full set of period regressions is shown in Table VI, starting with 1874 to 1890 and expanding to each subsequent year of available data (up to 1940).[27] There are four results that we would like to highlight. First, we do not observe any significant effect of the credit supply shock for aggregate output growth in any period. Second, we find a significant and persistent effect of the credit supply shock on the redistribution of income between regions and sectors.

[26] This is calculated from the average natural log of per capita bond value (all sectors) of -0.292 and the average per capita (thousand) station count of 0.0025 across prefectures.

[27] Note that the first column in this table is the same as column D in Table V.

The coefficient on the interaction between bond value and rail access is negative and significant in all specifications for primary income growth and positive and significant for tertiary income growth. Third, the redistributive effects are persistent but attenuate over time. This can be seen in both the magnitudes of the coefficients on the interaction of bonds and rail stations per capita as well as in the calculated average total effect. For the latter, the cumulative effect of bonds and railways is associated with a shrinking primary sector for the entire 1874 to 1940 period, while for the tertiary sector the total growth effect persists until 1925. Finally, and related to the previous point, the credit supply shock grows in importance over time relative to the separate railway effect for both the primary and tertiary sectors, and persists in significance longer in the latter. This indicates railways by themselves were not solely responsible for the redistribution of activity across regions in Japan and worked with the credit supply shock to generate long run impact.

[Table VI]

Before looking at the impact on labor shares, we first examine another more direct channel of finance, banking capital, on real output growth. In our theoretical discussion, we emphasized the development of financial institutions as the most likely mechanism through which bonds per capita could affect economic activity. According to this narrative, we should find similar results when using total banking capital per capita instead of bonds per capita in our regressions. That said, there are two limitations to this approach. First, total banking capital (85.2 million yen) represented less than half of all bonds value (173.8 million yen), and samurai ownership in national banking capital less than one sixth (30.7 million yen). Second, bank capital is already included in the tertiary sector. Therefore, we would expect that total bank capital had a negative effect on primary sector and a more muted (or insignificant) effect on tertiary sector growth.

[Table VII]

Table VII reports the coefficients on the same regressions as in Table VI but with total bank capital per capita in 1884 instead of bond value per capita in 1876. One parallel between the two measures of financial capital is that banking capital per capita also did not have any effect on overall growth across periods. Also, the quantitative effect of total bank capital on primary income growth is similar both in the marginal effect from the interaction term and in the average total effect. The main difference with the previous table is that since banking capital is already included in the tertiary sector, we fail to observe a positive effect on the tertiary sector growth. In any event, these results paint a picture consistent with the view that financial development was the transmission mechanism of the stipend commutation into the real economy.

As discussed earlier, there exist opposing views on the role of samurai on the industrialization process of Japan. Even though resolving this debate is outside the scope of this paper, we can contribute by analyzing the effect of bank capital owned by samurai. To do so, we use the share of national bank capital ownership by samurai to construct a samurai capital measure and use that instead of bonds per capita. The aforementioned pairwise correlation between per capita bond value and per capita national bank capital by prefecture is 0.80 at less than one percent statistical significance.[28] Using the samurai ownership share of national banks allows us to investigate whether prefectures dominated by banks owned by samurai exhibited different patterns from the other prefectures in real output growth.[29]

[Table VIII]

Table VIII reports the coefficients from this exercise, and the results from this table along with our bond per capita analysis are consistent with both sides of the samurai contribution debate. On the one hand, we can observe that prefectures with higher samurai bank capital did not experience higher overall

[28] See footnote 19.

[29] Jha, Mitchener, and Takashima (2015) employ a similar approach in assessing the contributions of samurai on the political economy of Meiji Japan.

growth in any of the subperiods. On the other hand, we do find that output in the secondary sector grew faster in prefectures with higher samurai bank capital, but only in the pre-WWI period. We do not find any significant effect on primary or tertiary sectors. As in our previous results, the positive effect of samurai bank capital also hinges on early access to railway stations and this effect was persistent up to 1909. These results suggest that industrial activity increased in prefectures where samurai managed to concentrate more resources in national banks and also had access to railways, but not in other sectors nor when total banking capital or the full value of bonds are considered.

Another related concern with our results is that the distribution of wealthy versus poor samurai among prefectures is uneven, with Tokyo as an extreme example (cf. Table II). This is due to the 5 percent coupon bonds, of which former samurai living in Tokyo received the 96 percent of the national total. Removing these bonds from the total bond value mitigates this bias (Tokyo's bond value share falls to 7 percent), so we repeat the same regression analysis in the earlier tables with the subset of higher coupon bonds.

[Table IX]

Table IX reports the coefficients of running our baseline specifications with higher coupon bond value per capita (i.e., excluding 5 percent bonds) instead of total bond value per capita. The coefficients are similar both qualitatively and quantitatively to our baseline specification in Table VI. We observe that as before the credit supply shock had a redistributive effect both between regions and sectors. That is, regions with more bonds per capita and access to railways experienced faster growth in tertiary output and slower growth in primary output.[30]

Two additional points should be clarified regarding interpretation of the results. The first is that the results may overstate the role of the credit supply shock, when in fact pre-existing differences between regions may be responsible for post-bond issue growth trends or the allocation of the bonds

[30] Regressions using samurai population share by prefecture (not shown) give qualitatively similar results with respect to redistribution between sectors and regions. Samurai population includes all family members and is divided by the resident population of the prefecture at the time.

themselves. While data limitations prevent us from performing a pre-trend analysis of regional activity since there is only one year of data (1874) before the stipend conversion, our pre-level analysis indicates that there were no statistically significant differences in regional per capita income given future per capita bond values, even after including observables in 1874 like population and urbanization. This is supported by a lack of statistical significance in the pairwise correlation of 1874 per capita income and 1876 per capita bond values, which suggests the regional differences observed in subsequent periods post-date the 1874 income data.

Similarly, whether one can attribute the sectoral growth effects to the credit supply shock as opposed to the introduction of the railways is not immediately obvious given the coefficients for the latter are typically large in magnitude and statistically significant. It is true that the individual contribution of per capita bond value is not statistically significant (or opposing in sign) in many specifications, but the interaction with per capita rail stations corresponds in sign and significance with rail access on its own. Moreover, the magnitude of the interaction term's coefficient increases relative to that for rail access, and in the tertiary sector remains significant when railways are no longer. Since the introduction of railways occurred nearly simultaneously as the credit supply shock, and the first two benchmark years (1874, 1890) effectively span both policy changes, our emphasis is on the joint significance of the two.

B. Structural Transformation

Several studies have emphasized the barriers to structural transformation as the reason why the Japanese economy started its industrialization process later than other economies (see, for example, Fukao and Paul 2017). Some specific limits to this structural transformation include legal constraints that limited urban emigration (Hayashi and Prescott 2008) or geographical constraints that determined the location of economic activity (Davis and Weinstein 2001).

In this section we analyze whether the shock to credit supply contributed to the structural transformation of the pre-war Japanese economy. There exists a large literature emphasizing the role of financial frictions on the allocation of

factors (e.g., Banerjee and Duflo 2014). Thus, we would expect that the credit supply shock facilitated the reallocation of labor from the primary to the secondary and tertiary sectors.

[Table X]

Table X reports the coefficients of running equation (2). It is the same model specification as the one used earlier for output growth but with the dependent variable measured as the change in the labor ratio between two sectors. The three panels show the results from the three combinations of primary, secondary, and tertiary sectors, and we interpret a positive sign on a coefficient as evidence that this variable contributed to structural transformation. For example, in the top panel comparing secondary to primary sector labor, the coefficient on the interaction term is positive and statistically significant. This implies that, given early access to railways, a higher bond value per capita is associated with the reallocation of workers from the primary to the secondary sector. Although the interaction is positive in all subperiods, it is only statistically significant between 1874 and 1890.

In the middle panel, the dependent variable is the change in the ratio between labor in the tertiary and primary sectors. The coefficient on the interaction term is positive and usually statistically significant. This positive coefficient indicates that the shock in credit supply was associated with a decline in the primary sector labor force relative to that in the tertiary sector, and this is fairly persistent over time even as it decreases in magnitude. The statistical significance of the reallocation between these sectors compared with the secondary sector is consistent with our findings on output growth.

Finally, in the bottom panel the dependent variable is the change in the ratio between labor in the tertiary and secondary sector. This variable does not have a direct implication for structural transformation but we include it for completeness. The coefficient on the interaction term is positive but not statistically significant in any of the subsamples. This result implies that the shock to credit supply did not have a significant effect on the reallocation of labor between the secondary and tertiary sector.

To conclude, the results presented in this section indicate that the shock to credit supply is associated with the structural transformation of the Japanese economy. Similar to the results on output growth, the effect of credit supply was dependent on early access to railways, which was in part driven by geographical constraints. In this sense, our findings are consistent with the findings of Davis and Weinstein (2001), which highlight the importance of location and path dependence.

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 a singular credit supply shock in late nineteenth century Japan indicates that there are persistent redistributive effects both between regions and between sectors. We find evidence that bond value per capita amplified the effects of early access to railways and generated faster output growth in the tertiary sector and slower growth in the primary sector. These effects were larger in the initial period (1874-1890) and attenuated over time up to 1940. We find analogous results for the reallocation of labor, with the interaction of bond value per capita and rail access conducive to the structural transformation of the economy, leading to a reallocation of labor from the primary to the tertiary sector. An important contribution of our work is to emphasize the complementarity between shocks to credit supply and the initial characteristics of the country, including latent demand and market access.

A number of extensions to our analysis are possible, including an examination of firm-level dynamics given the availability of investable credit. How firms behaved in a period of capital scarcity versus not may provide insight on which industries became dominant in the pre-war economy and whether bank or equity finance were relatively more important (e.g., Miwa and Ramseyer 2002). Another area of contemporary relevance is the role of wealth concentration in sectoral growth and investment. Our results using bond coupon disaggregation indicate that there were differences in how sectors performed,

with the capital-intensive secondary sector benefitting the most in regions with the highest concentration of wealthy ex-samurai. Given existing work on income inequality in pre-war Japan (Moriguchi and Saez 2008), regional disaggregation and sectoral analysis may further identify sources of inequality and their persistence.

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. That said, the unanticipated credit supply shock was also extremely large in relative terms, and thus it may be unrealistic to expect similar magnitudes in a modern context. Nevertheless, the persistence of impact for the entire pre-war period is remarkable given the rapidity of industrialization and market integration, and shows that initial conditions can play a strong role in continued and long run development.

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TABLE I—SAMURAI STIPEND 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 BOND DISTRIBUTION BY PREFECTURE

	5 percent	6 percent	7 percent	Total[b]	Per capita[c]
Japan[a]	31,412,405	25,003,741	108,242,785	173,844,631	5.68
Aichi	27,815	935,810	4,982,120	5,945,745	4.71
Akita	0	216,910	2,515,130	2,732,040	4.42
Aomori	0	68,840	1,602,315	1,671,155	3.41
Chiba	0	279,310	1,465,980	1,745,290	1.39
Ehime	15,570	683,025	4,108,920	4,807,515	5.90
Fukuoka	34,850	1,945,165	676,140	8,741,465	8.14
Fukushima	0	20,740	1,171,980	1,192,720	1.75
Gifu	19,480	402,755	1,650,485	2,072,720	2.69
Gunma	0	646,795	1,779,590	2,426,385	4.05
Hiroshima	26,470	327,050	1,820,130	2,173,650	1.73
Hokkaido	43,345	730	185,595	236,300	1.56
Hyogo	9,290	516,130	3,212,560	3,737,980	2.74
Ibaraki	0	113,151	2,025,530	2,138,681	3.01
Ishikawa	206,780	3,524,630	8,813,805	12,545,215	17.64
Iwate	0	30,975	914,820	945,795	1.30
Kagoshima	84,895	242,355	4,351,275	13,146,225	15.62
Kanagawa	0	44,645	967,670	1,012,315	1.44
Kochi	292,585	2,578,055	5,763,650	9,110,350	16.63
Kumamoto	14,295	2,310,420	3,560,705	5,885,420	5.93
Kyoto	0	464,115	1,934,690	2,398,805	2.62
Mie	9,060	424,075	1,403,505	1,836,640	2.27
Miyagi	0	5,470	1,273,330	1,278,800	2.58
Nagano	0	268,740	2,116,420	2,385,160	2.40
Nagasaki	247,160	1,905,985	5,863,435	8,016,580	11.57
Niigata	0	101,080	2,300,335	2,401,415	1.57
Oita	0	373,720	2,604,435	2,978,155	4.11
Okayama	0	216,920	2,758,210	2,975,130	3.25
Osaka	0	124,375	1,061,860	1,187,045	1.16
Saitama	0	356,200	965,590	1,321,790	1.91
Shiga	8,665	366,220	2,149,105	2,531,845	4.22
Shimane	42,930	1,208,645	3,841,395	5,092,970	8.14
Shizuoka	0	1,225	3,838,490	3,839,715	4.43
Tochigi	0	44,290	652,745	697,035	1.06
Tokyo	30,261,480	2,157,555	7,208,285	39,846,950	40.42
Wakayama	23,325	740,515	2,070,915	2,834,755	4.84
Yamagata	0	279,410	3,072,000	3,351,640	5.00
Yamaguchi	13,835	1,058,930	5,432,035	6,518,215	7.52
Yamanashi	0	12,150	42,295	54,445	0.14

Source:.Ministry of Finance (1904). [a]Includes 5 percent bonds valued at 30,575 yen distributed to the imperial household, which are not prefecture specific. Fukui, Kagawa, Miyazaki, Nara, Saga, Tokushima, Tottori, and Toyama prefectures did not exist (i.e., were part of other prefectures) at the time of the stipend commutation, and Okinawa was not formally incorporated into Japan until 1879, after the commutation. [b]Includes 1 percent bonds, which account for 9,185,700 yen (5.3 percent) of the total bonds distributed. [c]In nominal yen.

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—PRE-WAR PREFECTURAL OUTPUT AND LABOR, 1874-1940

	1874	1890	1909	1925	1940
All Prefectures					
Gross Prefectural Product	83,976	113,156	175,413	311,803	519,881
Per capita income	113.2	127.8	152.7	214.5	285.5
Primary (%)	48.5	42.4	40.6	30.8	21.3
Secondary (%)	7.1	11.0	15.0	19.4	32.3
Tertiary (%)	44.3	46.5	44.4	49.8	46.4
Labor force (thou)	470.4	500.0	499.6	586.4	717.8
Primary (%)	70.1	60.0	57.8	50.9	47.6
Secondary (%)	12.7	20.8	20.6	23.0	25.0
Tertiary (%)	17.1	19.2	21.6	26.1	27.4
Bond Prefectures[a]					
Gross Prefectural Product	91,211	125,076	198,592	357.5	601,687
Per capita income	113.9	131.0	157.8	221.5	292.394
Primary (%)	49.1	42.1	39.3	29.8	20.8
Secondary (%)	7.3	11.3	15.3	19.6	32.9
Tertiary (%)	43.6	46.6	45.4	50.6	46.3
Labor force (thou)	569.4	605.2	604.8	709.9	868.9
Primary (%)	70.9	60.3	57.4	50.3	46.9
Secondary (%)	12.7	20.8	20.8	23.3	25.5
Tertiary (%)	16.4	18.9	21.8	26.5	27.6

Source: Fukao et al (2015) and authors' calculations. Gross prefectural product and per capita income in thousand constant 1934-36 yen; see Fukao et al (2015). [a]Excludes prefectures that did not receive bond payments; see footnote in Table II.

TABLE V—BOND VALUE OUTPUT GROWTH REGRESSIONS, 1874-1890

DV: ΔLn(Output per capita)	A	B	C	D
All sectors				
Ln(1876 bond value per capita)	-0.048		-0.060*	-0.055*
	(0.029)		(0.035)	(0.029)
1885 rail stations per thou		0.036	2.628	-6.990
		(4.051)	(10.039)	(7.570)
Interaction of bond value and rail access			5.280	-0.980
			(7.846)	(5.848)
Average total effect	0.014	0.0001	0.017	0.0001
	(0.009)	(0.010)	(0.019)	(0.015)
R-squared	0.144	0.052	0.168	0.457
F-statistic	1.64	1.14	1.67	4.11***
Primary sector				
Ln(1876 bond value per capita)	-0.075		-0.035	0.012
	(0.064)		(0.039)	(0.036)
1885 rail stations per thou		-18.653***	-42.244***	-46.982***
		(5.542)	(10.350)	(7.486)
Interaction of bond value and rail access			-27.159***	-26.687***
			(9.719)	(7.192)
Average total effect	0.,022	-0.047***	-0.057***	-0.083***
	(0.019)	(0.014)	(0.020)	(0.015)
R-squared	0.191	0.289	0.556	0.763
F-statistic	7.14***	22.49***	6.89***	13.39***
Secondary sector				
Ln(1876 bond value per capita)	0.002		-0.004	-0.059
	(0.075)		(0.053)	(0.054)
1885 rail stations per thou		28.328**	34.195	15.025
		(10.888)	(24.718)	(25.534)
Interaction of bond value and rail access			6.282	-0.577
			(20.654)	(19.128)
Average total effect	-0.001	0.071**	0.078*	0.055
	(0.022)	(0.027)	(0.045)	(0.047)
R-squared	0.062	0.217	0.221	0.339
F-statistic	0.88	4.43**	1.89	3.13***
Tertiary sector				
Ln(1876 bond value per capita)	-0.080***		-0.109***	-0.102***
	(0.024)		(0.023)	(0.027)
1885 rail stations per thou		1.995	11.225***	11.084***
		(4.762)	(3.141)	(4.025)
Interaction of bond value and rail access			14.729***	11.679***
			(2.709)	(3.359)
Average total effect	0.023***	0.005	0.039***	0.041***
	(0.007)	(0.012)	(0.009)	(0.010)
R-squared	0.329	0.116	0.463	0.520
F-statistic	7.25***	3.15*	10.58***	8.84***
Observations	38	38	38	38

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors in parentheses. All specifications include year dummies and a lagged output growth variable and exclude the nine prefectures with missing bond data; see Table II. Column D includes time-varying control variables of population, per capita student enrollment share, and low gradient land population density; see text for details. Bond values and gross prefectural product per capita income in 1934-36 constant yen. Average total effect is the predicted effect for the prefecture with the average value of bonds per capita (column A); the average number of railways per capita (column B) and both of them (columns C and D). The average of ln(1876 bond value per capita) is -0.292, the average number of railways per capita (in thousands) is 0.0025.

TABLE VI—BOND VALUE OUTPUT GROWTH REGRESSIONS, ALL PERIODS

DV: ΔLn(Output per capita)	1874-1890	1874-1909	1874-1925	1874-1935	1874-1940
All sectors					
Ln(1876 bond value per capita)	-0.055*	-0.039*	-0.028*	-0.018	-0.014
	(0.029)	(0.0200	(0.015)	(0.017)	(0.013)
1885 rail stations per thou	-6.990	0.197	1.117	-2.189	-1.801
	(7.570)	(3.691)	(2.854)	(3.146)	(2.436)
Interaction of bond value and rail access	-0.980	3.241	4.607*	0.922	0.423
	(5.848)	(3.097)	(2.300)	(2.479)	(1.910)
Average total effect	0.0001	0.007	0.005	-0.002	-0.001
	(0.015)	(0.008)	(0.007)	(0.007)	(0.006)
R-squared	0.457	0.372	0.470	0.469	0.456
F-statistic	4.11***	8.38***	15.27***	19.84***	21.90***
Primary sector					
Ln(1876 bond value per capita)	0.012	0.030	0.031	0.037**	0.025
	(0.036)	(0.021)	(0.020)	(0.017)	(0.015)
1885 rail stations per thou	-46.982***	-29.154***	-19.212***	-15.697***	-9.365**
	(7.486)	(8.392)	(6.278)	(4.970)	(4.410)
Interaction of bond value and rail access	-26.687***	-20.817***	-15.084**	-13.634***	-9.086**
	(7.192)	(7.379)	(5.624)	(4.424)	(3.899)
Average total effect	-0.083***	-0.052***	-0.036***	-0.031***	-0.018**
	(0.015)	(0.013)	(0.009)	(0.008)	(0.007)
R-squared	0.763	0.577	0.456	0.459	0.380
F-statistic	13.39***	15.09***	14.94***	42.10***	22.22***
Secondary sector					
Ln(1876 bond value per capita)	-0.059	-0.034	-0.008	-0.011	-0.007
	(0.054)	(0.035)	(0.032)	(0.029)	(0.025)
1885 rail stations per thou	15.025	5.568	4.334	0.456	1.217
	(25.534)	(17.601)	(10.979)	(9.621)	(7.302)
Interaction of bond value and rail access	-0.577	3.054	2.352	1.360	1.116
	(19.128)	(12.073)	(8.318)	(7.304)	(5.634)
Average total effect	0.055	0.019	0.010	0.002	0.004
	(0.047)	(0.034)	(0.021)	(0.019)	(0.015)
R-squared	0.339	0.213	0.114	0.089	0.208
F-statistic	3.13***	3.27***	2.43**	1.40	9.80***
Tertiary sector					
Ln(1876 bond value per capita)	-0.102***	-0.075**	-0.056***	-0.039**	-0.027**
	(0.027)	(0.034)	(0.018)	(0.018)	(0.013)
1885 rail stations per thou	11.084***	9.906**	7.884**	3.019	1.541
	(4.025)	(4.449)	(3.142)	(2.918)	(2.410)
Interaction of bond value and rail access	11.679***	9.987**	11.638***	6.505***	4.551**
	(3.359)	(3.837)	(2.330)	(2.315)	(1.829)
Average total effect	0.041***	0.033***	0.020**	0.010	0.005
	(0.010)	(0.012)	(0.008)	(0.008)	(0.006)
R-squared	0.520	0.408	0.547	0.680	0.668
F-statistic	8.84***	10.99***	28.16***	80.47***	78.88***
Observations	38	76	114	152	190

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors in parentheses. All specifications include time-varying control variables of population, per capita student enrollment share, and low gradient land population density, year dummies, and a lagged output growth variable, and exclude the nine prefectures with missing bond data; see text for details and Table II. Bond values and gross prefectural product per capita income in 1934-36 constant yen. Average total effect is the predicted effect for the prefecture with the average value of bonds per capita and the average number of railways per capita. The average of ln(1876 bond value per capita) is -0.292, the average number of railways per capita (in thousands) is 0.0025.

TABLE VII—BANKING CAPITAL REGRESSIONS, ALL PERIODS

DV: ΔLn(Output per capita)	1874-1890	1874-1909	1874-1925	1874-1935	1874-1940
All sectors					
Ln(1884 banking capital per capita)	0.016	0.011	0.005	0.002	0.003
	(0.030	(0.019)	(0.012)	(0.013)	(0.011)
1885 rail stations per thou	-3.207	-3.056	-4.369***	-3.064**	-2.040*
	(3.592)	(2.054)	(1.424)	(1.204)	(1.028)
Interaction of banking capital and rail access	-2.447	2.339	3.771	1.012	0.372
	(5.908)	(3.280)	(3.234)	(2.893)	(2.433)
Average total effect	-0.009	-0.001	-0.003	-0.005	-0.004
	(0.012)	(0.006)	(0.005)	(0.005)	(0.004)
R-squared	0.366	0.339	0.457	0.463	0.452
F-statistic	3.37***	6.62***	11.96***	22.41***	21.89***
Primary sector					
Ln(1884 banking capital per capita)	-0.009	-0.024	-0.026	-0.027*	-0.020
	(0.031)	(0.018)	(0.016)	(0.015)	(0.014)
1885 rail stations per thou	-3.250	3.894	3.183	2.935	2.728
	(3.993)	(3.677)	(3.958)	(3.879)	(3.434)
Interaction of banking capital and rail access	-35.468***	-27.862***	-17.425**	-12.816*	-7.781
	(7.013)	(7.177)	(7.258)	(6.455)	(5.572)
Average total effect	-0.077***	-0.048***	-0.030***	-0.022***	-0.012**
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
R-squared	0.807	0.643	0.487	0.469	0.384
F-statistic	28.97***	20.24***	31.05***	31.02***	20.45***
Secondary sector					
Ln(1884 banking capital per capita)	0.025	0.018	0.029	0.019	0.020
	(0.068)	(0.045)	(0.029)	(0.025)	(0.021)
1885 rail stations per thou	10.992	-0.931	-1.223	-3.664	-2.331
	(18.222)	(8.225)	(4.584)	(3.850)	(2.839)
Interaction of banking capital and rail access	10.306	7.495	5.480	5.403	4.511
	(15.045)	(10.346)	(8.150)	(6.609)	(5.231)
Average total effect	0.052	0.015	0.013	0.005	0.007
	(0.041)	(0.027)	(0.017)	(0.014)	(0.011)
R-squared	0.339	0.218	0.128	0.097	0.216
F-statistic	7.14***	7.00***	4.29***	2.40**	10.60***
Tertiary sector					
Ln(1884 banking capital per capita)	0.047	0.029	0.010	0.002	-0.001
	(0.037)	(0.030)	(0.018)	(0.015)	(0.011)
1885 rail stations per thou	3.019	0.673	-5.148*	-4.056*	-3.438**
	(4.918)	(4.758)	(2.809)	(2.067)	(1.464)
Interaction of banking capital and rail access	-0.481	3.374	7.426*	4.241	3.185
	(7.259)	(5.275)	(4.320)	(3.324)	(2.759)
Average total effect	0.017*	0.014	0.003	-0.002	-0.003
	(0.009)	(0.010)	(0.008)	(0.006)	(0.005)
R-squared	0.346	0.334	0.513	0.668	0.660
F-statistic	3.08**	6.72***	12.23**	46.42***	41.49***
Observations	38	76	114	152	190

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors in parentheses. All specifications include time-varying control variables of population, per capita student enrollment share, and low gradient land population density, year dummies, and a lagged output growth variable, and exclude the nine prefectures with missing bond data; see text for details and Table II. Bank capital and gross prefectural product per capita income in 1934-36 constant yen. Average total effect is the predicted effect for the prefecture with the average value of banking capita per capita and the average number of railways per capita. The average of ln(1884 banking capital per capita) is 0.211, the average number of railways per capita (in thousands) is 0.0025.

TABLE VIII—SAMURAI BANK CAPITAL REGRESSIONS, ALL PERIODS

DV: ΔLn(Output per capita)	1874-1890	1874-1909	1874-1925	1874-1935	1874-1940
All sectors					
Ln(1884 samurai bank capital per capita)	-0.031	-0.008	-0.009	-0.003	0.0005
	(0.037)	(0.022)	(0.016)	(0.017)	(0.013)
1885 rail stations per thou	6.882	1.715	4.146	-0.548	-0.935
	(8.948)	(5.692)	(4.667)	(5.033)	(4.122)
Interaction of banking capital and rail access	5.112	1.614	3.108*	0.930	-.395
	(3.556)	(2.084)	(1.684)	(1.930)	(1.553)
Average total effect	0.067	0.017	0.015	0.002	-0.006
	(0.091)	(0.056)	(0.040)	(0.042)	(0.034)
R-squared	0.383	0.330	0.456	0.463	0.451
F-statistic	4.01***	8.01***	9.60***	18.15***	19.17***
Primary sector					
Ln(1884 samurai bank capital per capita)	-0.026	-0.023	-0.023	-0.020	-0.018
	(0.052)	(0.031)	(0.027)	(0.025)	(0.019)
1885 rail stations per thou	-50.226**	-32.050**	-14.019	-8.032	-0.855
	(20.359)	(13.944)	(10.680)	(9.588)	(7.227)
Interaction of banking capital and rail access	-13.048	-10.184	-3.845	-1.944	0.294
	(10.411)	(6.784)	(4.723)	(4.012)	(2.891)
Average total effect	0.006	0.028	0.041	0.040	0.041
	(0.124)	(0.078)	(0.069)	(0.064)	(0.048)
R-squared	0.720	0.560	0.418	0.416	0.356
F-statistic	14.11***	25.51***	17.15***	35.71***	27.77***
Secondary sector					
Ln(1884 samurai bank capital per capita)	-0.123	-0.090*	0.001	0.001	0.014
	(0.076)	(0.046)	(0.036)	(0.032)	(0.025)
1885 rail stations per thou	82.341***	42.770**	16.971	8.818	4.681
	(21.294)	(16.204)	(13.235)	(10.779)	(8.555)
Interaction of banking capital and rail access	30.779***	17.890***	6.894	4.389	2.070
	(8.072)	(5.670)	(4.675)	(3.767)	(2.989)
Average total effect	0.347*	0.234**	0.004	-0.004	-0.033
	(0.190)	(0.115)	(0.091)	(0.081)	(0.064)
R-squared	0.441	0.258	0.129	0.095	0.212
F-statistic	10.44***	8.31***	10.69***	4.04***	12.59***
Tertiary sector					
Ln(1884 samurai bank capital per capita)	0.001	0.015	-0.010	-0.004	-0.006
	(0.059)	(0.038)	(0.026)	(0.019)	(0.015)
1885 rail stations per thou	6.512	1.159	8.050	2.271	2.416
	(14.220)	(10.636)	(7.803)	(5.824)	(4.531)
Interaction of banking capital and rail access	1.148	-0.831	4.459	2.008	2.042
	(6.029)	(3.604)	(2.695)	(2.016)	(1.645)
Average total effect	0.008	-0.030	0.023	0.005	0.010
	(0.147)	(0.098)	(0.066)	(0.050)	(0.039)
R-squared	0.282	0.304	0.505	0.667	0.660
F-statistic	3.43***	9.74***	10.99***	44.87***	37.73***
Observations	38	76	114	152	190

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors in parentheses. All specifications include time-varying control variables of population, per capita student enrollment share, and low gradient land population density, year dummies, and a lagged output growth variable, and exclude the nine prefectures with missing bond data; see text for details and Table II. Samurai-owned national bank capital and gross prefectural product per capita income in 1934-36 constant yen. Average total effect is the predicted effect for the prefecture with the average value of samurai bank capital per capita and the average number of railways per capita. The average of ln(1884 samurai bank capital per capita) is -2.44, the average number of railways per capita (in thousands) is .0025.

TABLE IX—HIGH COUPON BOND VALUE REGRESSIONS, ALL PERIODS

DV: ΔLn(Output per capita)	1874-1890	1874-1909	1874-1925	1874-1935	1874-1940
All sectors					
Ln(1876 high coupon bond per capita)	-0.058*	-0.041*	-0.028*	-0.018	-0.014
	(0.030)	(0.021)	(0.015)	(0.0178)	(0.014)
1885 rail stations per thou	-13.383	-1.235	0.796	-2.421	-2.091
	(8.248)	(4.501)	(3.347)	(3.577)	(2.493)
Interaction of bond value and rail access	-6.260	1.695	3.815	0.642	0.149
	(5.931)	(3.506)	(2.476)	(2.472)	(1.669)
Average total effect	-0.002	0.007	0.004	-0.001	-0.001
	(0.015)	(0.008)	(0.007)	(0.008)	(0.006)
R-squared	0.486	0.377	0.469	0.469	0.456
F-statistic	4.47***	8.28***	18.07***	23.94***	24.19***
Primary sector					
Ln(1876 high coupon bond per capita)	0.014	0.031	0.031	0.037**	0.025
	(0.040)	(0.021)	(0.019)	(0.016)	(0.015)
1885 rail stations per thou	-52.139***	-29.955**	-21.085**	-18.340***	-12.163**
	(15.322)	(12.584)	(8.436)	(6.302)	(5.118)
Interaction of bond value and rail access	-26.394**	-18.802*	-14.877**	-14.348***	-10.515***
	(12.551)	(10.292)	(6.706)	(4.884)	(3.861)
Average total effect	-0.085***	-0.050***	-0.035***	-0.031***	-0.019**
	(0.020)	(0.015)	(0.011)	(0.008)	(0.007)
R-squared	0.703	0.537	0.442	0.456	0.382
F-statistic	10.15***	13.53***	15.20***	30.29***	21.52***
Secondary sector					
Ln(1876 high coupon bond per capita)	-0.060	-0.038	-0.010	-0.012	-0.009
	(0.054)	(0.035)	(0.032)	(0.029)	(0.025)
1885 rail stations per thou	-10.788	-4.222	0.196	-2.702	-0.0084
	(37.568)	(22.528)	(13.300)	(12.124)	(8.781)
Interaction of bond value and rail access	-21.460	-5.715	-1.589	-1.591	-0.877
	(26.702)	(16.021)	(9.904)	(8.935)	(6.449)
Average total effect	0.034	0.013	0.007	0.0004	0.002
	(0.053)	(0.033)	(0.021)	(0.019)	(0.014)
R-squared	0.375	0.221	0.114	0.089	0.208
F-statistic	5.37***	4.01***	1.97*	1.33	10.93***
Tertiary sector					
Ln(1876 high coupon bond per capita)	-0.102***	-0.075**	-0.056***	-0.038**	-0.027**
	(0.027)	(0.033)	(0.017)	(0.018)	(0.013)
1885 rail stations per thou	12.806***	12.654**	10.309***	4.718	2.466
	(4.670)	(4.837)	(3.338)	(2.841)	(2.421)
Interaction of bond value and rail access	12.088***	11.415***	12.458***	7.294***	4.866***
	(3.823)	(3.861)	(2.189)	(1.826)	(1.516)
Average total effect	0.044***	0.035***	0.021***	0.011	0.006
	(0.010)	(0.011)	(0.008)	(0.008)	(0.006)
R-squared	0.526	0.416	0.548	0.681	0.668
F-statistic	10.35***	12.33***	51.23***	82.09***	79.20***
Observations	38	76	114	152	190

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors in parentheses. All specifications include time-varying control variables of population, per capita student enrollment share, and low gradient land population density, year dummies, and a lagged output growth variable, and exclude the nine prefectures with missing bond data; see text for details and Table II. High coupon bond values (six percent or more) and gross prefectural product per capita income in 1934-36 constant yen; see Table I. Average total effect is the predicted effect for the prefecture with the average value of high coupon bonds per capita and the average number of railways per capita. The average of ln(1876 high coupon bond value per capita) is -0.34, the average number of railways per capita (in thousands) is .0025.

TABLE X—LABOR SHARE GROWTH REGRESSIONS BY BOND VALUE, ALL PERIODS

	1874-1890	1874-1909	1874-1925	1874-1935	1874-1940
DV: Δsecondary/primary labor force					
Ln(1876 bond value per capita)	-0.078	-0.089*	-0.068*	-0.051*	-0.051*
	(0.054)	(0.050)	(0.037)	(0.030	(0.028)
1885 rail stations per thou	76.371***	20.918	10.500	7.251	1.498
	(16.498)	(27.909)	(15.948)	(10.388)	(9.255)
Interaction of bond value and rail access	77.911***	21.798	15.464	12.271	5.721
	(15.187)	(25.586)	(14.137)	(8.984)	(7.964)
Average total effect	0.104***	0.048	0.024	0.016	0.011
	(0.021)	(0.036)	(0.024)	(0.018)	(0.016)
R-squared	0.611	0.738	0.706	0.726	0.716
F-statistic	15.03***	38.97***	46.93***	45.95***	43.47***
DV: Δtertiary/primary labor force					
Ln(1876 bond value per capita)	-0.171**	-0.161**	-0.136***	-0.110**	-0.087**
	(0.064)	(0.064)	(0.049)	(0.043)	(0.034)
1885 rail stations per thou	33.812***	11.771	3.680	9.652*	7.920*
	(10.019)	(18.302)	(11.968)	(5.344)	(4.249)
Interaction of bond value and rail access	35.973***	18.883	11.491	17.371***	15.229***
	(9.718)	(15.930)	(10.928)	(4.833)	(4.003)
Average total effect	0.084***	0.050*	0.033	0.032**	0.024**
	(0.021)	(0.028)	(0.021)	(0.015)	(0.012)
R-squared	0.462	0.439	0.413	0.407	0.483
F-statistic	9.68***	22.41***	33.60***	44.16***	50.73***
DV: Δtertiary/secondary labor force					
Ln(1876 bond value per capita)	-0.019	-0.030	-0.038*	-0.036*	-0.020
	(0.021)	(0.037)	(0.022	(0.018)	(0.014)
1885 rail stations per thou	5.442	1.772	3.435	2.989	2.340
	(5.611)	(4.600)	(4.009)	(3.796)	(4.420)
Interaction of bond value and rail access	0.479	4.079	3.484	3.729	3.377
	(5.097)	(5.001)	(3.499)	(3.172)	(3.609)
Average total effect	0.018*	0.007	0.015	0.013	0.007
	(0.010)	(0.012)	(0.009)	(0.008)	(0.008)
R-squared	0.612	0.779	0.743	0.725	0.676
F-statistic	8.56***	41.76***	121.70***	128.04***	113.42***
Observations	38	76	114	152	190

Significance: ***1 percent, **5 percent, *10 percent. Robust standard errors in parentheses. All specifications include time-varying control variables of population, per capita student enrollment share, and low gradient land population density, year dummies, and a lagged labor share ratio variable, and exclude the nine prefectures with missing bond data; see text for details and Table II. Bond values in 1934-36 constant yen. Average total effect is the predicted effect for the prefecture with the average value of bonds per capita and the average number of railways per capita. The average of ln(1876 bond value per capita) is -0.292, the average number of railways per capita (in thousands) is 0.0025.