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Capital Market Integration with Multiple Convergence Clubs: The Case of Prewar Japan^{*}

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Abstract

This paper examines capital market integration in prewar Japan, using a methodology that allows for multiple equilibria in convergence. Specifically, we apply the method of log t regression and the club convergence test proposed by Phillips and Sul (2007) to examine the convergence of prefectural loan rates and detect the convergence clubs that followed heterogeneous transition paths. Whereas prefectural loan rates were converging towards two equilibria from 1888–1900, all the prefectural loan rates converged towards a unique equilibrium from 1901–1926. From 1927, however, the prefectural loan rates diverged again, and four different convergence clubs emerged. Restrictive regulation imposed by the Bank Law of 1928 reduced competition in local markets, increased barriers to interregional capital mobility, and, thereby, reversed capital market integration.

Keywords: capital market integration, bank loan, loan rates, banking market structure

JEL classification: G21, N25

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1. Introduction

Integrating regionally fragmented capital markets into a unified national capital market has significant implications for subsequent economic development. A unified national capital market facilitates capital flows across regions, which in turn enables capital to be allocated to more productive projects and improves resource allocation in the economy.

If capital market integration proceeds, interregional interest rate difference declines by arbitrage, and regional interest rates converge towards a unique equilibrium in the long run¹. Based on this idea, many studies have assessed the integration of capital market by examining the overtime evolution of interregional interest rate differences.

For the United States of America, Davis (1965) found that the interest rates were substantially different across regions just after the Civil War, but since then the difference decreased until World War I. Davis argued that the decline in the interest rate difference across regions was driven by the westward spread of the commercial paper market, which reduced barriers to capital mobility. Motivated by Davis (1965), subsequent studies examined the reasons for differences and convergence of regional interest rates. Sylla (1969) suggested that higher minimum capital requirements, set for national banks by the National Banking Act of 1864, restricted new entries of banks and gave rise to interregional interest rate differences, and that the Gold Standard Act of 1900, which decreased the minimum capital requirements for national banks, lowered the barriers to entry and resulted in the convergence of regional interest rates. Meanwhile, James (1976a, 1976b) found that the local monopoly power of banks was the most significant factor that accounted for the differences in regional interest rates. He argued that lower capital requirements, more liberal regulation, and the states' laws of general banking that encouraged foundation of state banks rather than national banks, increased competition in the banking industry, and this, in turn, brought about the

¹ As summarized by Sushka and Barrett (1984), integration of capital markets (i.e., formation of a national capital market) implies the following: (1) capital mobility across regions, (2) reduction or elimination of barriers to entry into capital markets, and (3) the narrowing of interest rate differentials among different areas.

convergence of regional interest rates. On the other hand, Sushka and Barrett (1984) argued that the decline in regional interest rate differences was caused by an increase in the sensitivity of firms to interest rates and the availability of alternative sources of finance, including the stock market.

In the context of Japan, Yamamura (1970) and Lewis and Yamamura (1971) showed that the Japanese capital market was integrated nationwide by around 1905, using the data of prefectural loan rates and deposit rates from 1889–1925. Grossman and Imai (2008), using data from 1889–1938, found that distance to the financial centers and the extent of bank competition had significant effects on the interest rate in each prefecture, but that these effects diminished over time as transportation and communication networks improved. They also pointed out the possibility that restrictive regulations raising barriers to new entries of banks would delay the integration of capital market. Mitchener and Ohnuki (2009), using prefectural loan rates from 1884–1925, showed that growth of the telegraph networks, growth of commercial branch banking networks, and development of the Bank of Japan's branches played a significant role in forming an integrated national capital market².

These studies of the Japanese capital market agreed on the general conclusion that a nationwide integration of capital market progressed from 1890–1925. This conclusion is supported by two basic observations. First, the dispersion in interregional loan rates sharply declined in this period. Second, the effects of local factors, including transaction costs and the extent of banking market competition on regional loan rates, decreased over time throughout this period. Whereas these local factors should have a significant effect on regional loan rates under the situation where capital markets are segmented by region, their effects should vanish by interest rate arbitrage once the capital market is integrated.

We share these general conclusion and observations, but we consider that limitations remain in these prior studies. First, they assume that regional capital markets converged to a unique national market. It is to be tested, however, whether regional capital markets converged to a unique national

² Ohnuki (2007) examined prefectural loan rates from 1889–1925, indicating the possibility that expansion of the Bank of Japan's branches and correspondent networks promoted capital market integration in Japan.

market, because it is potentially possible that regional capital markets converged to multiple markets, what we call “convergence clubs”. Hence, it is necessary to conduct a statistical convergence test that allows for multiple convergence clubs. In addition, as Lewis and Yamamura (1971) pointed out, capital market integration is not a simultaneous process that took place in all regions at the same speed, but the processes are heterogeneous and uneven across regions. Hence, it is necessary to explicitly consider this heterogeneity and unevenness of convergence.

Based on this idea, we conduct a strict statistical convergence test on whether regional capital markets in Japan converged to a unique national market or to multiple convergence clubs. Specifically, we apply the log t regression and club convergence test proposed by Phillips and Sul (2007), which is an asymptotic statistical convergence test for panel variables, allowing for multiplicity of clusters converging to different equilibria.

The remainder of the paper is organized as follows. Section 2 overviews the transition of banking market structure in prewar Japan. Section 3 explains the empirical method of log t regression and club convergence test proposed by Phillips and Sul (2007). Section 4 describes our main dataset of prefectural loan rates in prewar Japan. Section 5 shows the empirical results of the log t regression and club convergence test. Section 6 concludes.

2. Structure of the banking market in prewar Japan

As many prior studies have pointed out, changes in the market structure and regulation for the banking industry played a significant role in the evolution of the national capital market (Sylla, 1969; James, 1976a, 1976b; Grossman and Imai, 2008). The Japanese banking industry experienced dramatic changes in the period before World War II. Figure 1 illustrates the change over time in the number of private banks by type in the prewar period. The modern banking industry in Japan began with the foundation of national banks following the National Bank Act of 1872. National banks were private banks that were privileged to issue bank notes. At first few national banks were established because of the obligation of convertibility of bank notes into gold and a high reserve ratio. Given that,

the government revised the National Bank Act in 1876 to suspend convertibility and lower the reserve ratio. Consequently, the number of national banks increased sharply to be 153, the upper limit prescribed by the Act, in 1879. The function of national banks to issue bank notes was substituted by the Bank of Japan, founded in 1882 as the central bank. Accordingly, national banks were reorganized into ordinary banks, which did not issue bank notes.

The number of ordinary banks increased from the 1880s and surged in the 1890s after the enactment of the Bank Act in 1893. Because the Bank Act did not impose any minimum capital requirement, numerous small ordinary banks were established³. At the same time, the number of savings banks also increased. Savings banks, according to the Savings Bank Act of 1893, were the banks that specialized in collecting small individual savings and lending to small businesses. By the revision of the Savings Bank Act in 1895, restrictions on fund application and reserve were relaxed, which resulted in sharp an increase of the number of savings banks.

The total number of private banks, including ordinary and savings banks, reached a peak of 2,308 in 1901, after that decreasing gradually. This trend shift reflects the change in government policy. After the bank panic of 1901, government authorities recognized that having too many small banks was harmful to the stability of the banking system⁴. In this regard, in 1901, the government imposed a minimum capital requirement of 500,000 yen to newly incorporated banks⁵. Thereafter, the minimum capital requirement was successively raised, which caused a gradual decline in the number of ordinary banks along with the policy of promoting bank consolidations⁶⁷.

³ Other reasons for the rapid increase in the number of ordinary banks in 1893 are the influence of the establishment booms of companies after the Sino-Japanese War and the conversion of pseudo banking companies to ordinary banks by enforcement of the Bank Act (Okazaki, 2002).

⁴ A financial crisis occurred in 1901—50 banks were closed, and most of them were small banks with capital less than 250,000 yen (Goto, 1973).

⁵ This requirement was for banks to be incorporated. For non-incorporated banks, the minimum capital requirement was 250,000 yen.

⁶ In 1911, the notification by the secretary of the Ministry of Finance raised the minimum capital requirement to 1 million yen or more for banks in areas with a population of more than 100,000, and requested local governments to promote the consolidation of small local banks. Also, in 1923, the Ministry of Finance announced guidelines to prohibit the establishment of new banks and branches in principle and encourage bank consolidations. Based on this guideline, in 1924, the notification by the secretary of the Ministry of Finance again requested local governments to promote the consolidation of local banks.

⁷ Okazaki (2002) and Okazaki and Sawada (2007) show that bank exits during the 1900s were mainly

During World War I, the Japanese economy enjoyed a huge boom, but after the collapse of the boom in 1920, it faced prolonged economic stagnation and financial crises. The Bank Law enacted in 1928 to cope with the financial crises led to an epoch in the history of financial regulation and the financial system in Japan. By this Law, ordinary banks were obliged to have corporate forms, and on them was imposed the minimum capital requirement of one million yen. When the Law was enacted, 807 out of a total of 1,420 ordinary banks did not meet the minimum capital requirement. Furthermore, the government did not allow those banks to increase capital, forcing their merger with other banks or exit, which resulted in a sharp decline in the number of banks (Figure 1).

Referring to the history of the banking industry and the financial regulations outlined above, and following Grossman and Imai (2008), we divide the prewar history of the Japanese banking industry into three subperiods. The first subperiod is from 1873–1900, when the number of banks rapidly increased due to the absence of any minimum capital requirements. The second subperiod is from 1901–1926, when the number of banks reached a peak and remained almost flat or slightly decreased due to the gradual increase in minimum capital requirements. Finally, the third subperiod is from 1927–1945, when the number of banks sharply declined due to a further rise in the minimum capital requirements under the Bank Law of 1928.

3. Empirical methodology

In this paper, we employ the panel data model named log t regression and club convergence test, proposed by Phillips and Sul (2007). The model is a nonlinear time varying factor model to test the heterogeneous convergence of panel variables. This has several valuable features. First, it accommodates the behavior of heterogeneous agents by implementing a time varying factor loading coefficient. Second, the model does not rely on any particular assumptions concerning trend stationarity or stochastic nonstationarity. Third, because the model relies on a test for the asymptotic

caused by failure or dissolution, and since the late 1920s, bank exits via consolidation were rapidly increasing.

convergence in long run equilibrium, it is applicable to micro panels with a relatively short time period. Fourth, it is able to detect club convergence clusters, each of which converges to different points of equilibria or steady states. In the next subsection, we briefly explain this method of log t regression and club convergence test.

3.1 Time varying factor representation

Panel variable X_{it} can be generally decomposed as

$$X_{it} = g_{it} + a_{it}, \quad (1)$$

where g_{it} represents systematic components, including permanent common components, and a_{it} represents transitory components. To separate the common components from the idiosyncratic components in the panel variable, equation (1) is further transformed as

$$X_{it} = \left(\frac{g_{it} + a_{it}}{\mu_t} \right) \mu_t = \delta_{it} \mu_t \quad \text{for all } i \text{ and } t, \quad (2)$$

where δ_{it} is a time varying idiosyncratic element and μ_t is a single common component.

Specifically, the focus of our interest here is the evolution over time of δ_{it} . The time varying factor representation of equation (2) is fully flexible and applicable to various micro and macroeconomic models.

When equation (2) is applied to actual panel data, the number of observations is usually less than the number of unknowns in the model. Therefore, it is impossible to estimate the loading coefficient δ_{it} directly without imposing some structure on δ_{it} and μ_t . To address this problem, Phillips and Sul (2007) remove the common factor μ_t by scaling

$$h_{it} = \frac{X_{it}}{\frac{1}{N} \sum_{i=1}^N X_{it}} = \frac{\delta_{it}}{\frac{1}{N} \sum_{i=1}^N \delta_{it}}, \quad (3)$$

where h_{it} is the relative transition parameter, which measures the loading coefficient δ_{it} in relation to the panel average at time t . As is obvious, the cross-sectional mean of h_{it} is unity by definition. Like δ_{it} , the relative transition parameter h_{it} still traces out a transition path for economy i . Here our analytical focus is placed on the time evolution of h_{it} to test the convergence of X_{it} .

Another practical point to note is that as the focus of our interests is the long run behavior of X_{it} , we need to remove business cycle components from X_{it} . Concerning this point, Phillips and Sul (2007) recommend using the Hodrick and Prescott smoothing filter to remove business cycle components and extract long run trend components from X_{it} . Using the trend estimate $\hat{\theta}_{it}$ extracted from X_{it} , the relative transition parameter is redefined as follows.

$$\hat{h}_{it} = \frac{\hat{\theta}_{it}}{\frac{1}{N} \sum_{i=1}^N \hat{\theta}_{it}} \quad (4)$$

In the analysis below, we use \hat{h}_{it} as the relative transition parameter.

3.2 The log t regression

Relative long run convergence exists among X_{it} , if the loading coefficient δ_{it} converges to δ for all i as $t \rightarrow \infty$. In this case, the relative transition parameters h_{it} converge to unity and the cross-sectional variance of h_{it} converges to zero in the long run as follows.

$$H_t = \frac{1}{N} \sum_{i=1}^N (h_{it} - 1)^2 \rightarrow 0 \quad \text{if} \quad \lim_{t \rightarrow \infty} \delta_{it} = \delta \quad \text{for all } i \quad (5)$$

Phillips and Sul (2007) use this property to test the null hypothesis of convergence. To design a statistical test of convergence, they first model the time varying behavior of δ_{it} in general semiparametric form such as:

$$\delta_{it} = \delta_i + \frac{\sigma_i \xi_{it}}{L(t)t^\alpha}, \quad t \geq 1, \quad \sigma_i > 0, \quad \text{for all } i, \quad (6)$$

where δ_i is fixed, ξ_{it} is iid $(0, 1)$ across i but weakly dependent over t , and $L(t)$ is a slowly varying function for which $L(t) \rightarrow \infty$ as $t \rightarrow \infty$.

From equation (6), Phillips and Sul (2007) show the cross-sectional variance H_t has the limiting form

$$H_t \sim \frac{A}{L(t)^2 t^{2\alpha}} \quad \text{as } t \rightarrow \infty \quad (7)$$

for some constant $A > 0$. Setting $L(t) = \log t$, this formulation leads to the following log t

regression model:

$$\log\left(\frac{H_1}{H_t}\right) - 2\log L(t) = a + b\log t + u_t$$

$$\text{for } t = [rT], [rT + 1], \dots, T \text{ with } r > 0 \quad (8)$$

In this regression $L(t) = \log(t + 1)$ and $b = 2\alpha$, where α is the parameter in H_0 . The data for this regression start at $t = [rT]$, the integer part of rT for some fraction $r > 0$ where T is the number of time periods. Phillips and Sul (2007) recommend $r = 0.3$ based on the results of Monte Carlo experiments⁸. In conducting the regression (8), the convergence test proceeds as a one-sided t -test of $\alpha \geq 0$ using the estimate of b and a heteroscedasticity and autocorrelation consistent standard error. The null hypothesis of convergence is rejected at 5% level if the t -statistics $t_b < 1.65$.

3.3 Club convergence test and clustering

Rejection of the null hypothesis of convergence does not necessarily mean that there is no convergence in the subgroups of the panel variables. For example, there may be a case where multiple clusters converge to different equilibria, and also that where both convergent and divergent clusters coexist. To detect such possibility of convergence clusters, Phillips and Sul (2007) proposed the following empirical clustering algorithm.

Step 1: Order individuals according to the value of observations in the last period of panel.

Step 2: Select the first k highest individuals in the panel to form the subgroup G_k for some $N > k \geq 2$, run the log t regression and calculate the convergence test statistic $t_b(k)$ for each k . Choose the core group size k^* by maximizing $t_b(k)$ over k under the condition $\min\{t_b(k)\} > -1.65$. These first k^* highest individuals form the core group G_{k^*} .

Step 3: Add each remaining individual one by one to the core group G_{k^*} and run the log t test again. Include each individual in the core group G_{k^*} if the t -statistic $t_b > c$, where c is some chosen

⁸ In the club convergence test in Section 5, we also set $r = 0.3$.

critical value⁹.

Step 4: Form a second group from all the remaining individuals that the sieve condition fails in Step 3.

Run the log t test for this group and see if this group satisfies the convergence test $t_b > -1.65$. If so, conclude that this group forms another convergence club. If not, repeat Step 1 through Step 3 to see if this group can itself be subdivided into multiple convergence clubs¹⁰.

4. Data

Our primary data are the prefectural interest rates on loans in Japan from 1888–1936¹¹. The data were originally recorded in *Ginko-kyoku Nenpo* (Annual Report of the Banking Bureau) edited by the Banking Bureau of the Ministry of Finance and were recently compiled and publicized by the Bank of Japan. These data provide the highest and lowest values of loan rates in each prefecture on a monthly or semiannual basis. The loan rates recorded are for loans from 500 yen to 10,000 yen with a maturity of 90 days or less¹². As in the previous study, we calculate the prefectural loan rates by taking the average of the highest and lowest values for each prefecture. In order to match the time scale of the variables from other databases, we convert the data to an annual basis¹³.

Panel (a) and (b) of Figure 2 show the time-series of prefectural loan rates and their cross-sectional dispersion, respectively. As shown in Panel (a), prefectural loan rates are highly volatile and heterogeneous across prefectures. And as Panel (b) indicates, the cross-sectional

⁹ Higher critical value c implies less risk of including a wrong member of the convergence club. Specifically, when T is small, Phillips and Sul (2009) recommends setting the sieve criterion c to zero to ensure that it is highly conservative. Based on this, we set $c = 0$ in the club convergence test in Section 5.

¹⁰ Phillips and Sul (2009) recommends conducting a club merging step in addition to the above steps 1 to 4 to avoid excessive detection of the number of convergence clubs. In accordance with Phillips and Sul (2009) and Schurbus, Haupt, and Meier (2016), we conduct a club merging step as follows. First, run the log t regression for all pairs of subsequent initial clubs. If the test cannot reject the null hypothesis of convergence, then merge them to form a final convergence club.

¹¹ Although this data is originally from the period 1887–1940, because (1) there were many missing values before 1887 and (2) after 1937 the Second Sino-Japanese War occurred and financial control policies were set by the Japanese government, we set our sample period from 1888–1936.

¹² See Yamamura (1970).

¹³ In our sample, seven observations of prefectural loan rates are missing (Okinawa in 1891, 1892, 1893, 1894, 1925, 1926, and Tottori in 1897). We supplement these missing values with linear interpolation. As described in Section 3.1, log t regression and club convergence test use only the long run trend components extracted by the Hodrick and Prescott smoothing filter, so the influence of this treatment on the results is considered to be minor.

dispersion of prefectural loan rates gradually declined until 1920, which is consistent with the conclusions of prior studies that Japanese capital market integration had progressed during this period (Yamamura, 1970; Grossman and Imai, 2008; Mitchener and Ohnuki, 2009). It is notable, however, that the cross-sectional dispersion went up again from the late 1920s (Panel (b)). Although this fact had not been the focus of prior studies, this is an important fact suggesting that the trend of capital market integration was reversed in this period.

Panels (a) and (b) of Figure 3 indicate the time-series of the relative transition parameters of each prefecture defined by equation (4) and its cross-sectional dispersion. In Panel (a) of Figure 3, we can see that the relative transition parameters of each prefecture converged towards the mean value of unity until 1920, but they diverged from unity again from the late 1920s. In addition, it can be seen in Panel (b) of Figure 3 that while the cross-sectional dispersion in the relative transition parameters gradually decreased until the early 1920s, it increased again from the late 1920s. These facts are consistent with the observation from Figure 2 that the trend of the capital market integration was reversed in the late 1920s.

5. Empirical results

5.1 Results for the entire sample period, 1888–1936

We now apply the log t regression and club convergence test to the prefectural loan rates¹⁴. Table 1 reports the results of the log t regression using the specification of equation (8) for the entire sample period of 1888–1936. Each column reports the point estimate of the parameter b , HAC standard error, and t -value, respectively. The point estimate of b is -0.35 and t -value is -2.45 , so that the null hypothesis of convergence is rejected at the 5% level. Thus, in the entire sample period of 1888–1936, there is no evidence that loan rates of all prefectures converged towards a unique equilibrium.

¹⁴ Rughoo and Sarantis (2012, 2014), Matousek, Rughoo, Sarantis, and Assaf (2015) apply the log t regression and club convergence test to the analysis of the integration process of the banking sector in the European Union. They conduct convergence tests and detect convergence clubs by using series, including loan rates, deposit rates, and banking efficiency of each European Union member country.

As discussed above, however, rejection of convergence does not necessarily deny the existence of convergence in subgroups of the panel. For example, there may be cases where prefectures fall into a number of clusters that converge on different equilibria, or cases where converging and diverging prefectural clusters coexist. In order to detect such possibilities, we conduct the club convergence and clustering test described in Section 3.3. Panels (a1) and (a2) of Figure 4 report the results. Figure 4 (a1) indicates that there were two different convergence clubs in this period. Club 1 consists of almost all prefectures, including Tokyo and Osaka, whereas Club 2 consists of the remaining local prefectures. Figure 4 (a2) illustrates the time path of relative transition parameters for each club. In Figure 4 (a2), the parameter of Club 1 has been around a mean value of unity throughout the entire period, while that of Club 2 has been at a slightly lower level than the average and declined sharply since the late 1920s. In summary, the two convergence clubs followed different transition paths and finally converged to different equilibria.

5.2 Results for the subsample periods

As we have just seen in Section 5.1, there is no evidence that the loan rates of all the prefectures converged on a unique equilibrium in the entire sample period of 1888–1936. Instead, there were two different convergence clubs, and each club converged on a different equilibrium. These results suggest that the integration of the Japanese capital market was not nationwide in this period. However, as discussed in Section 2, because regulations and the market structure of the banking industry changed dramatically during this period, we need to explicitly take these changes into account in our analyses. Based on this idea, we divide the sample period into three subperiods, according to the changes in regulations and the banking market structure, and conduct the log t test and club convergence test for each subperiod.

Following the discussion in Section 2, we divide the subperiods into 1888–1900, 1901–1926, and 1927–1936, respectively. The first subperiod, 1888–1900, corresponds to the period when the number of banks sharply increased as a result of the surge of new entries. The second subperiod,

1901–1926, corresponds to the period when the number of banks reached a peak and remained almost flat or slightly decreased due to the gradual increase in the minimum capital requirements for ordinary banks. The third subperiod, 1927–1936, corresponds to the period when the number of banks sharply declined due to the further rise of the minimum capital requirements under the Bank Law of 1928 and the policy of promoting bank consolidations.

Table 2 shows the results of the log t test for each subperiod. For the subperiod of 1888–1900, the null hypothesis of convergence is rejected at the 5% level, indicating that nationwide capital market integration was not achieved. For the subperiod of 1901–1926, however, the null hypothesis is no longer rejected, indicating that there was a progression toward the nationwide integration of capital markets. Finally, for the subperiod of 1927–1936, the null hypothesis of convergence is rejected, suggesting that the Japanese capital market was once again segmented.

Next, we conduct the club convergence test for each subperiod. Panels (a1) to (c2) in Figure 5 show the results. From 1888–1900, there are two convergence clubs: Club 1 consists of prefectures in rural areas and Club 2 consists of prefectures in the metropolitan area including Tokyo and Osaka (Figure 5 (a1)). From the relative transition parameters, we can see that the two clubs converged towards different equilibria (Figure 5 (a2)). On the other hand, from 1901–1926, all prefectures were included in one club. In other words, all prefectures converged toward a unique equilibrium (Figure 5 (b1) (b2)). From 1927–1936, the feature of convergence changed again, and we can identify four convergence clubs (Figure 5 (c1)). Also, in this period, the two prefectures, Nara and Niigata, did not belong to any convergence clubs. In addition, there are no outstanding clubs that contain many prefectures, and the prefectures within each club are not geographically clustered but rather dispersed. As for the relative transition parameters, the four clubs converged on different equilibria, with the equilibrium loan rate being highest for Club 1 and decreasing for Clubs 2, 3, and 4 (Figure 5 (c2)).

Our findings can be summarized as follows. First, from 1888–1900, prefectural loan rates converged on two equilibria. That is, unlike the understanding of prior literature, regional capital markets in Japan were not on a path to a unified national capital market (Yamamura, 1970; Mitchener

and Ohnuki, 2009). Second, loan rates of all the prefectures converged on a unique equilibrium from 1901–1926, indicating that nationwide capital market integration progressed. In this period, as shown in Figure 1, the number of banks reached a peak and remained almost flat or slightly decreased, suggesting that the banking market structure was kept highly competitive. It is known that interregional interest rate differentials decline as the banking market becomes more competitive and variation in the monopoly power of local banks becomes smaller (Sylla, 1969; Yamamura, 1970; James, 1976b), which is consistent with our results.

Second, prefectural loan rates diverged to different equilibria from 1927–1936, implying that capital markets segmented again in Japan. It is striking that capital markets, once headed for consolidation, subsequently segmented again, which had not been found in prior literature. As indicated in Figure 1, from 1927–1936, the number of banks declined sharply due to the tightening of bank capital requirements of the Bank Law of 1928, which implies that the local banking markets became less competitive. Grossman and Imai (2008) speculate that the tightening of regulations since the 1900s may have reduced interbank competition and prevented the integration of the Japanese capital market, although they did not test this conjecture rigorously. We investigate this in the next section.

5.3 Exploring the reasons for market re-segmentation after 1927

As we saw in the previous section, the Japanese capital market was integrated from 1901–1926, but then segmented again from 1927–1936. Given the sharp decline in the number of banks from 1927–1936 caused by tightening regulations by the Bank Law of 1928, the re-segmentation of the capital market is likely to be related to this change. We hypothesize that the sharp decline in the number of banks during this period triggered the re-segmentation of capital markets through the following two channels: (a) by reducing the degree of competition in local banking markets and (b) by increasing the barriers to interregional capital mobility by elimination of interregional branch banking networks.

As the number of banks decreased sharply, the local banking markets became less

competitive and local banks regained monopoly power. This increased the degree of monopoly power possessed by local banks again and, consequently, widened the differentials in loan rates across regions. The sharp decline in the number of banks and their branches will also eliminate a number of interregional branch banking networks and impede smooth capital mobility and arbitrage across regions. As a result, this increased the interregional differences in financial transaction costs, which resulted in widening the interregional differentials in loan rates.

In order to test these hypotheses, we examine the determinants of the four convergence clubs (Club 1 to 4) from 1927–1936 that converged on different equilibria, which we have identified in the previous section. If this divergence was triggered through the two channels stated above, the two local factors, i.e., the degree of banking market competition and transaction costs in each prefecture, would have significant power in explaining the emergence of the four convergence clubs.

The determinants of the four convergence clubs are estimated as follows. Figure 5 (c2) indicates that the equilibrium loan rates were highest for Club 1, and went down in order, Clubs 2, 3, and 4. That is, the levels of equilibrium loan rates of Club 1 to Club 4 have a clear order. Therefore, in estimating the determinants of Clubs 1 to 4, it is necessary to use the ordered probit model.

The ordinal variable y_i for each prefecture i is defined as follows so that the equilibrium loan rates of each club are in ascending order from low to high.

$$\left\{ \begin{array}{ll} y_i = 1 & \Leftrightarrow i \in \text{Club4} \\ y_i = 2 & \Leftrightarrow i \in \text{Club3} \\ y_i = 3 & \Leftrightarrow i \in \text{Club2} \\ y_i = 4 & \Leftrightarrow i \in \text{Club1} \end{array} \right. \quad (9)$$

Assuming that the dependent variable y_i is related to the continuous latent variable y_i^* , we can write the model such as:

$$y_i^* = X_i\beta + u_i, \quad (10)$$

where X_i is a vector of independent variables and u_i is the error term. Latent variable y_i^* is unobservable by definition, but has the following relationships with dependent variable y_i .

$$\begin{cases} y_i = 1 & \Leftrightarrow -\infty < y_i^* \leq \kappa_1 \\ y_i = 2 & \Leftrightarrow \kappa_1 < y_i^* \leq \kappa_2 \\ y_i = 3 & \Leftrightarrow \kappa_2 < y_i^* \leq \kappa_3 \\ y_i = 4 & \Leftrightarrow \kappa_3 < y_i^* \leq \infty \end{cases} \quad (11)$$

In this model, we estimate the coefficient β in equation (10) together with the cut points κ_1 , κ_2 , and κ_3 in equation (11).

The vector of independent variables X_i includes the proxies for various local factors. Because we are primarily interested in how the initial conditions of these proxies and their changes over time affect the subsequent formation of convergence clubs, we use both of the initial values (i.e., values of 1927) and the changes during this period (i.e., changes from 1927–1936) for each proxy. The key variables of interest are the proxies for the degree of banking market competition and transaction costs in each prefecture, as stated above. As a proxy for the degree of banking market competition, we use the number of head offices and branches of banks in each prefecture in 1927 and their changes from 1927–1936. And, as a proxy for the transaction costs, we use the distance to the financial center in 1927, which is the minimum distance of each prefecture from Tokyo or Osaka, whichever is closer. As other control variables, the vector of independent variables X_i also includes the proxies for the loan demand and economic scale in each prefecture. As a proxy for loan demand, the loan to deposit ratio in each prefecture in 1927 and their changes from 1927–1936 are used. And, as proxy for economic scale, we use the gross prefectural product in 1925 and their changes from 1925–1935.

The number of head offices and branches of banks in each prefecture were obtained from *Ginko Soran* (Handbook of Banks) and the loan and deposit amounts in each prefecture were obtained from *Nihon Teikoku Tokei Nenkan* (Japan Empire Statistical Yearbook). For the distance between prefectures, we used the database of the Geospatial Information Authority of Japan. For the gross prefectural product, we used the *Gross Prefectural Product Database in Prewar Japan* constructed by Yuan et al. (2009)¹⁵. The summary statistics for these variables are reported in Table 3.

¹⁵ In this database, we used the estimated values of prefectural gross value added based on regional prices.

The results of the ordered probit estimation and the marginal effects for each outcome are reported in Tables 4 and 5. First, looking at the estimated results in Table 4, the Wald Chi-Square test statistic is 22.7 and the null hypothesis that the estimated coefficients are jointly equal to zero is rejected at the 1% level. The pseudo R^2 of the estimation model is 0.2. We can see that most of the proxies have significant effects on the formation of convergence clubs.

For the key variables of interest, the number of head offices and branches of banks in 1927 is negative and statistically significant, indicating that prefectures with a small number of bank branches in 1927, that is, prefectures with a monopolistic or less competitive banking market in the initial state, were more likely to belong to high-loan rate clubs. The changes in the number of head offices and branches of banks from 1927–1936 are also negative and statistically significant, indicating that prefectures that experienced a larger decline in the number of bank branches from 1927–1936, that is, prefectures where the degree of banking market competition declined significantly, are more likely to belong to high-loan rate clubs. These results are consistent with the hypothesis that the sharp decline in the number of banks in this period, reduced competition in local banking markets and widened interregional variation in the monopoly power of local banks, which resulted in interregional differentials in loan rates. The distance to the financial center, a proxy for transaction costs, is positive and statistically significant. This suggests that prefectures that were distant from the financial centers and have high transaction costs are more likely to belong to the high-loan rate clubs. This result is consistent with the hypothesis that the sharp decline in the number of banks during this period increased barriers to interregional capital mobility through the elimination of the interregional branch banking networks and widened the interregional differences in transaction costs and the resulting interregional differentials in loan rates. For other control variables, the loan to deposit ratio in 1927 and their changes from 1927–1936, and the changes in gross prefectural product from 1925–1935 are statistically significant and all have the expected signs.

In addition, because the estimated values of this database are recorded at intervals of 10 to 20 years, we used the estimated values of 1925 and 1935 as the values of 1927 and 1936, respectively.

Next, we look at the marginal effects for each outcome in Table 5 to evaluate whether the above results are not only statistically significant but also economically significant. In Table 5, a decrease of one standard deviation (112.75) of the number of head offices and branches of banks in 1927 increases the probability of belonging to Club 1 (Club 2) by 18.4%pt (9.9%pt), while decreasing the probability of belonging to Club 4 (Club 3) by 16.8%pt (11.4%pt). For the changes in the number of head offices and branches of banks from 1927–1936, a decrease of one standard deviation (47.22) of this variable increases the probability of belonging to Club 1 (Club 2) by 17.1%pt (9.2%pt) while reducing the probability of belonging to Club 4 (Club 3) by 15.6%pt (10.6%pt). Increasing the distance to the financial center by one standard deviation (242.12) increases the probability of belonging to Club 1 (Club 2) by 11.9%pt (6.4%pt) while reducing the probability of belonging to Club 4 (Club 3) by 10.9%pt (7.4%pt). Taken together, it can be seen that the proxies for the degree of banking market competition and transaction costs are economically significant.

In summary, the results of this section are strongly consistent with our hypotheses. That is, the tightening of regulation by the Bank Law of 1928 and the subsequent sharp decline in the number of banks reduced competition in local banking markets and raised barriers to interregional capital mobility through elimination of the interregional branch banking networks. This widened interregional variations in the degree of bank competition and in transaction costs, and, consequently, widened the interregional differences in loan rates again. That is, we can conclude that the Bank Law of 1928 and regulations based on the Law impeded capital market integration and segmented the capital markets again.

6. Conclusion

This paper examined capital market integration in prewar Japan, using a methodology that allows for multiple equilibria in convergence. Specifically, we apply the method of log t regression and club convergence test proposed by Phillips and Sul (2007) to test the convergence of prefectural loan rates and detect the convergence clubs that followed heterogeneous transition paths. The major

findings are as follows. First, from 1888–1900, prefectural loan rates converged on two equilibria. That is, prefectural capital markets were not converging on a unique national capital market in this period. Second, from 1901–1926, loan rates of all the prefectures did converge on a unique equilibrium. That is, a unique national capital market was emerging in this period. Third, however, from 1927–1936, the prefectural loan rates diverged again, and converged on four different equilibria. Fourth, re-segmentation of the capital market after 1927 was triggered by the Bank Law of 1928. Strengthened regulation created by the Bank Law caused a sharp decline in the number of banks, which reduced competition in local banking markets and raised barriers to interregional capital mobility. This, in turn, increased interregional variation in the degree of bank competition and transaction costs, which resulted in the divergence of loan rates. We can conclude that the restrictive regulatory regime of the Bank Law of 1928 reversed the process of capital market integration and led to re-segmentation of the capital market.

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Figure 1: Number of banks, 1873-1945

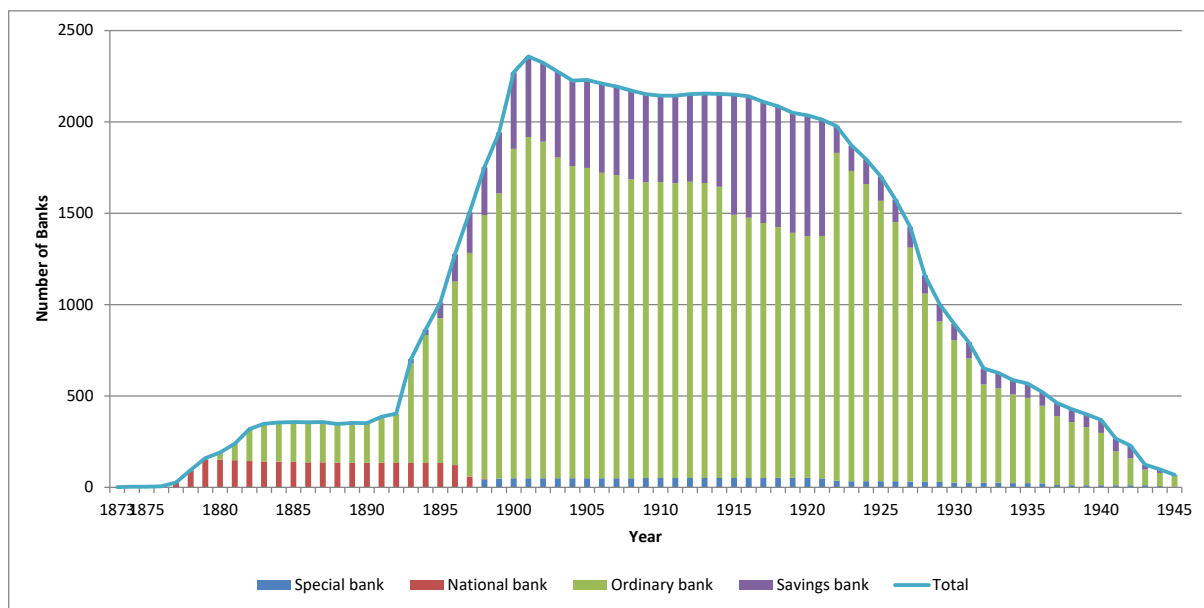
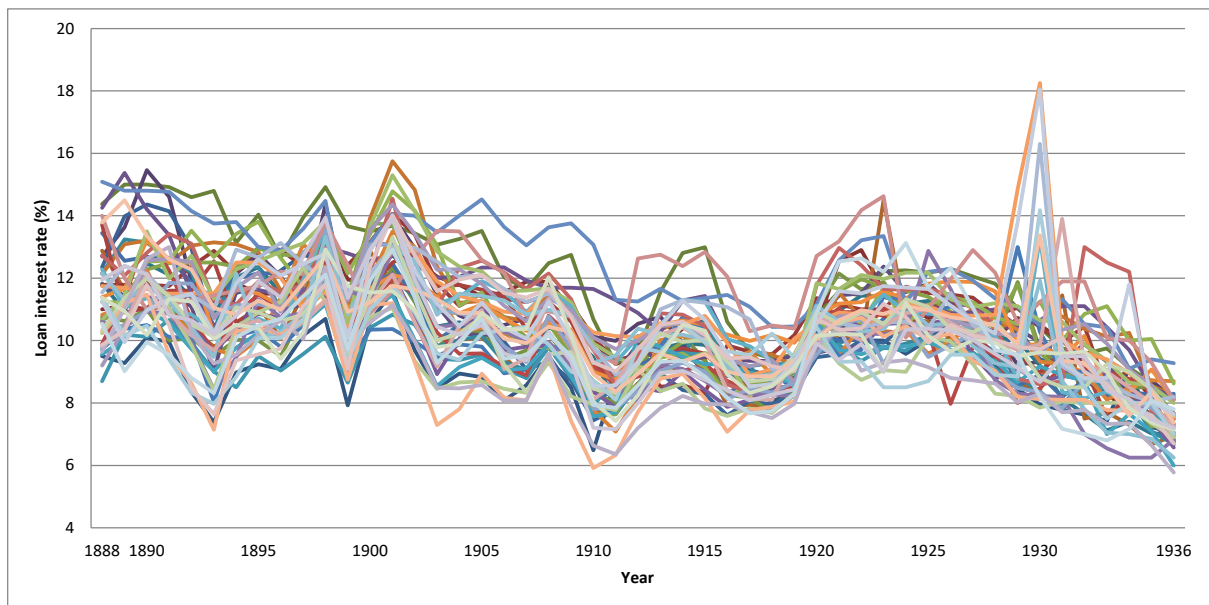


Figure2: Raw data of loan rates

(a) Loan rates by prefecture, 1888-1936



(b) Cross-sectional dispersion in loan rates, 1888-1936

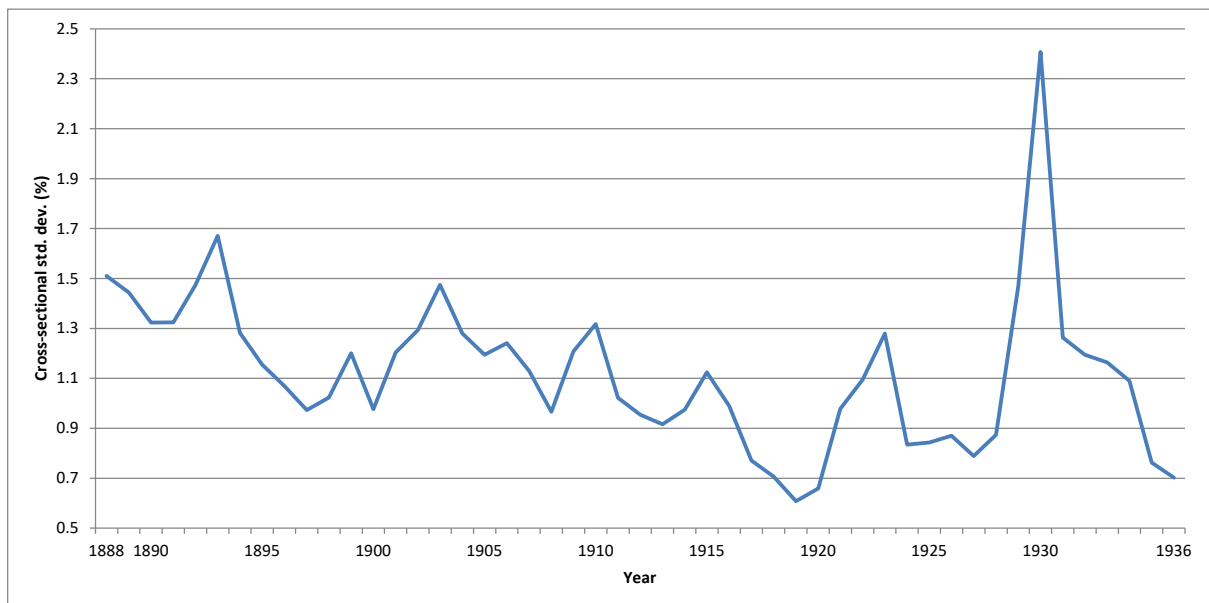
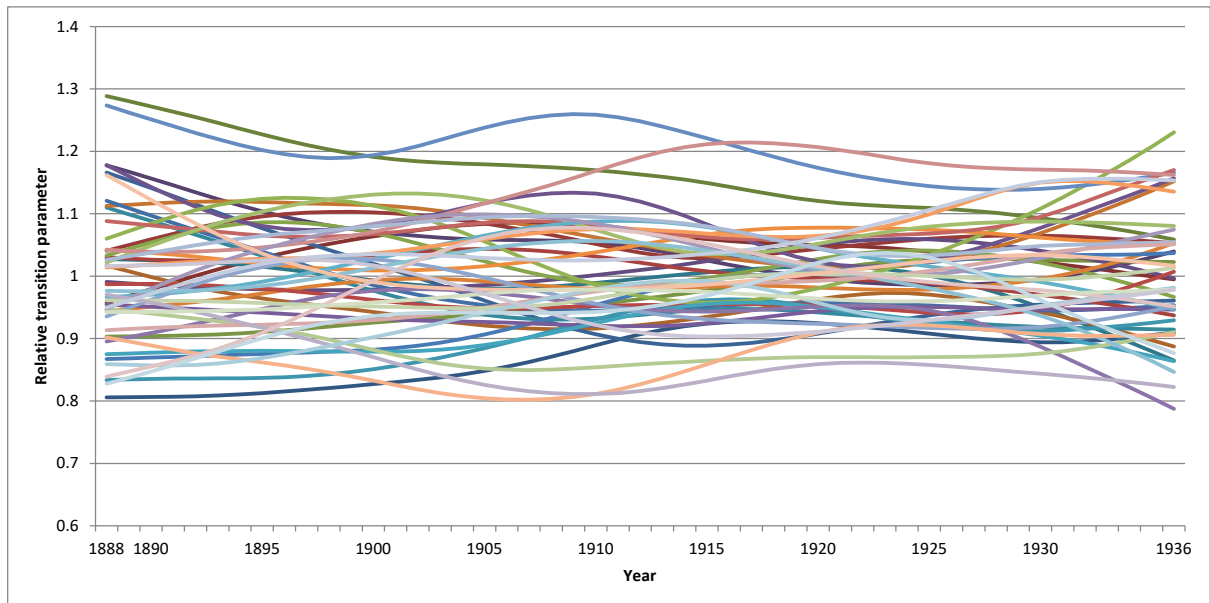


Figure3: Relative transition parameters

(a) Relative transition parameters by prefecture, 1888-1936



(b) Cross-sectional dispersion in relative transition parameters, 1888-1936

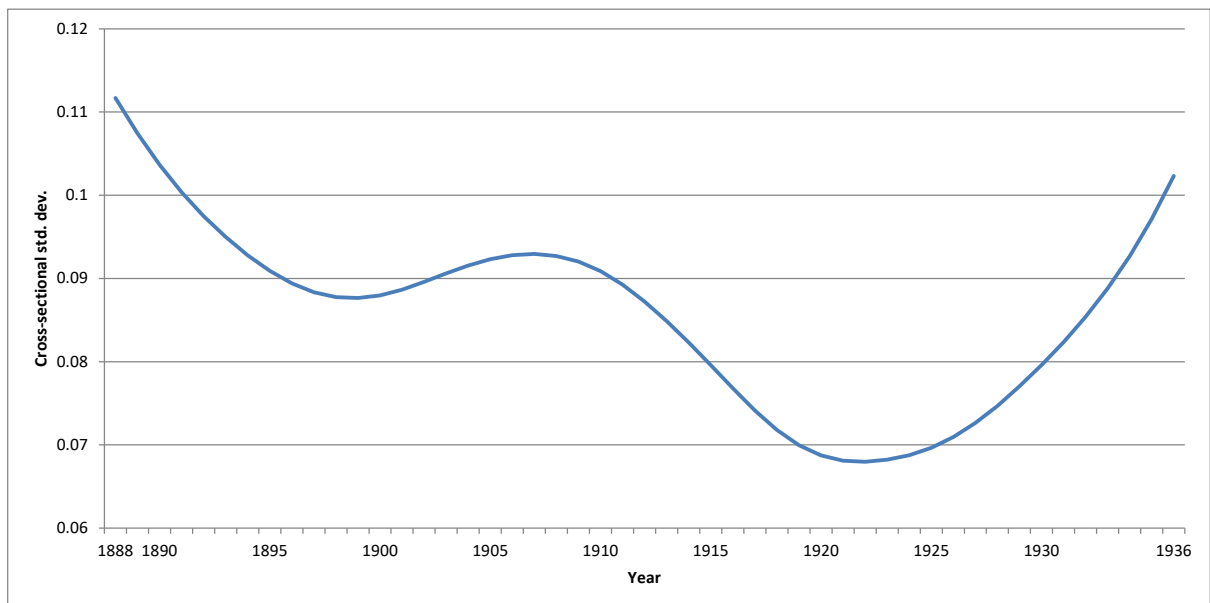
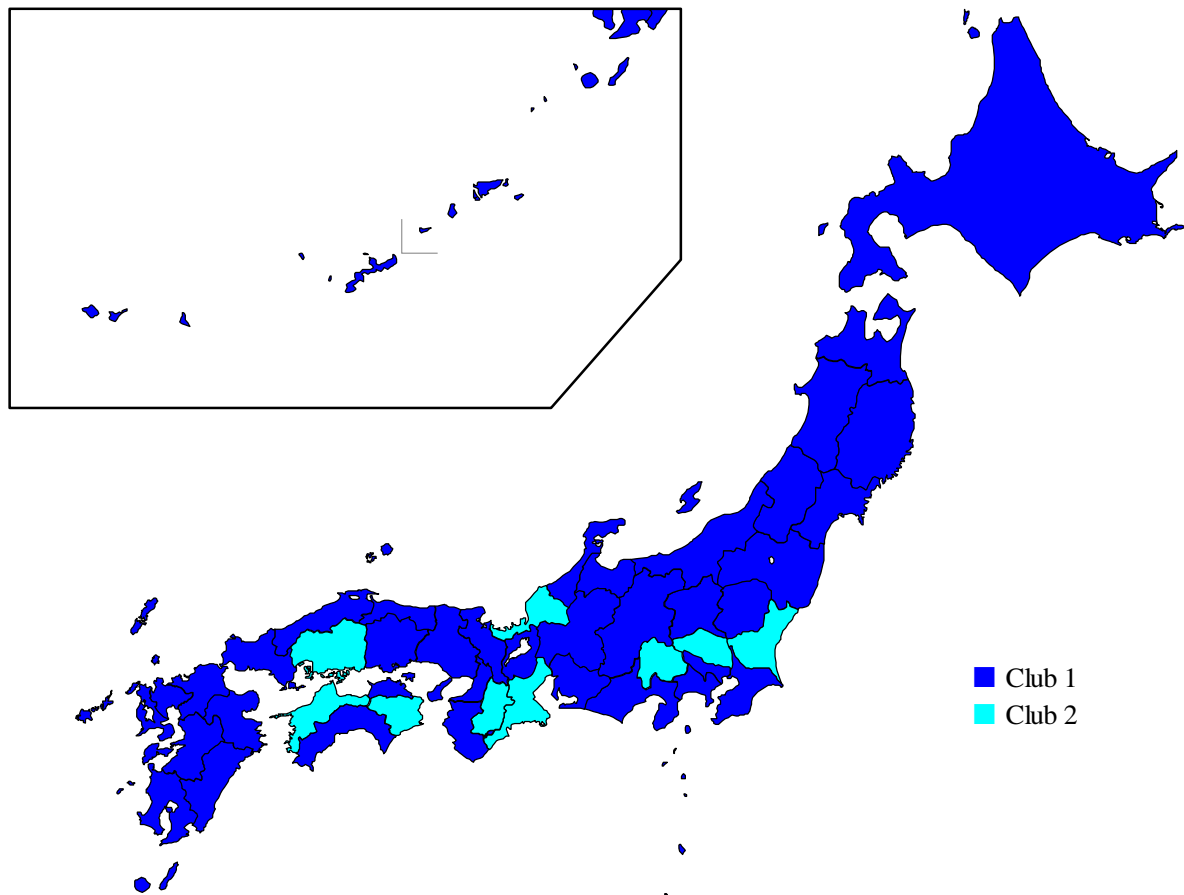


Figure4: Club convergence test for the entire sample period 1888-1936

(a1) Convergence clubs, 1888-1936



Club 1: (38)	Aichi Akita Aomori Chiba Fukuoka Fukushima Gifu Gunma Hokkaido Hyogo Ishikawa Iwate Kagawa Kagoshima Kanagawa Kochi Kumamoto Kyoto Miyagi Miyazaki Nagano Nagasaki Niigata Oita Okayama Okinawa Osaka Saga Shiga Shimane Shizuoka Tochigi Tokyo Tottori Toyama Wakayama Yamagata Yamaguchi
Club 2: (9)	Ehime Fukui Hiroshima Ibaraki Mie Nara Saitama Tokushima Yamanashi

(a2) Relative transition parameters by club, 1888-1936

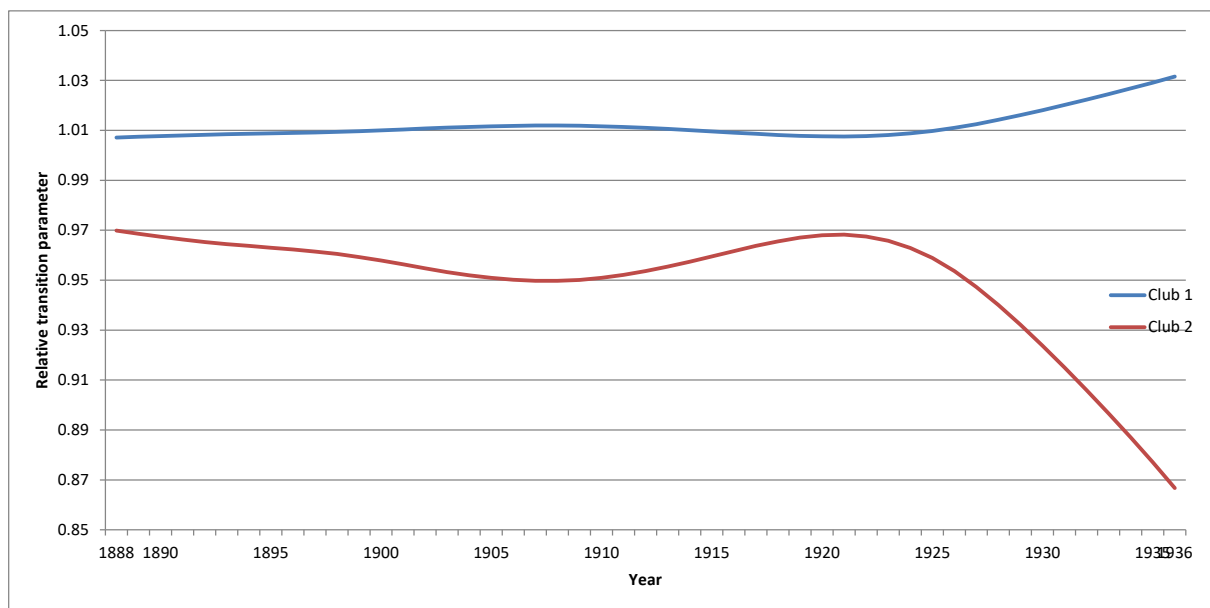
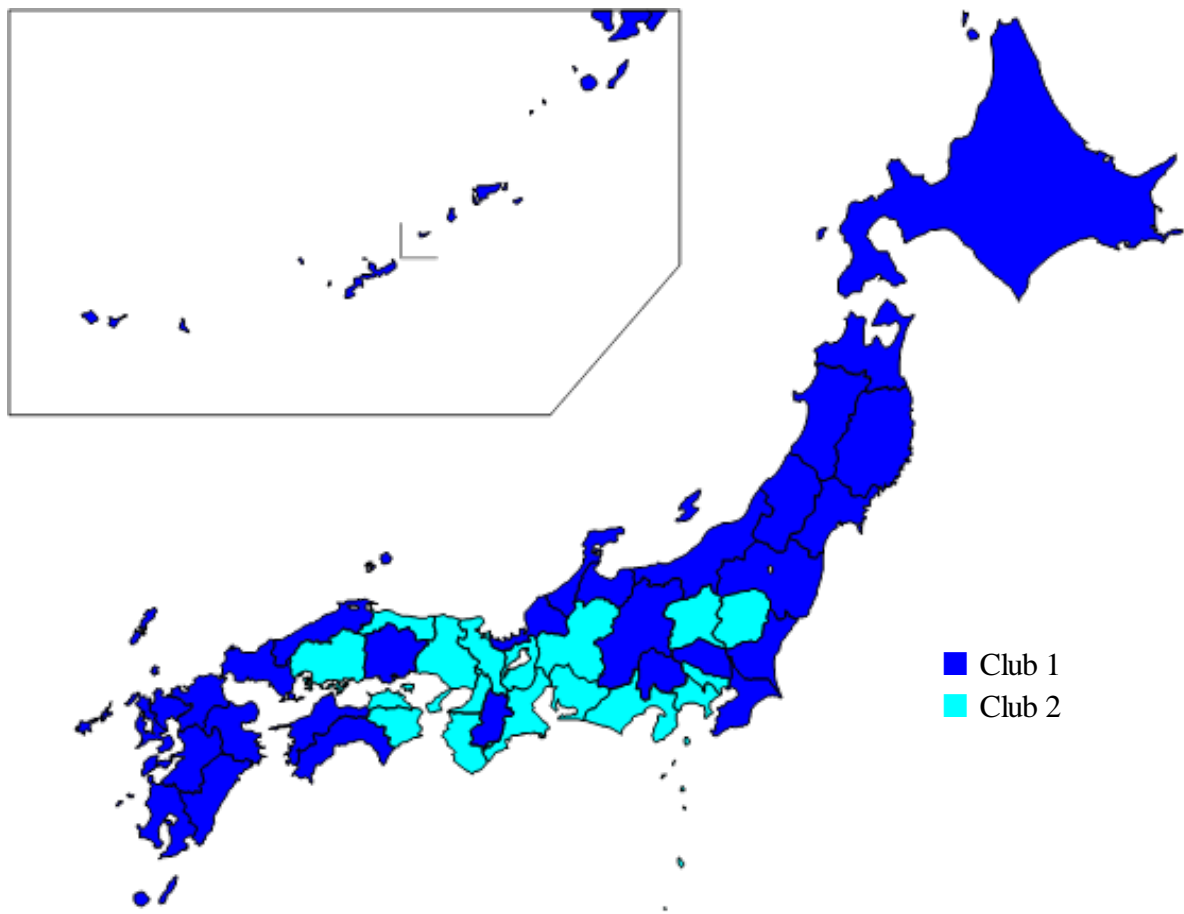


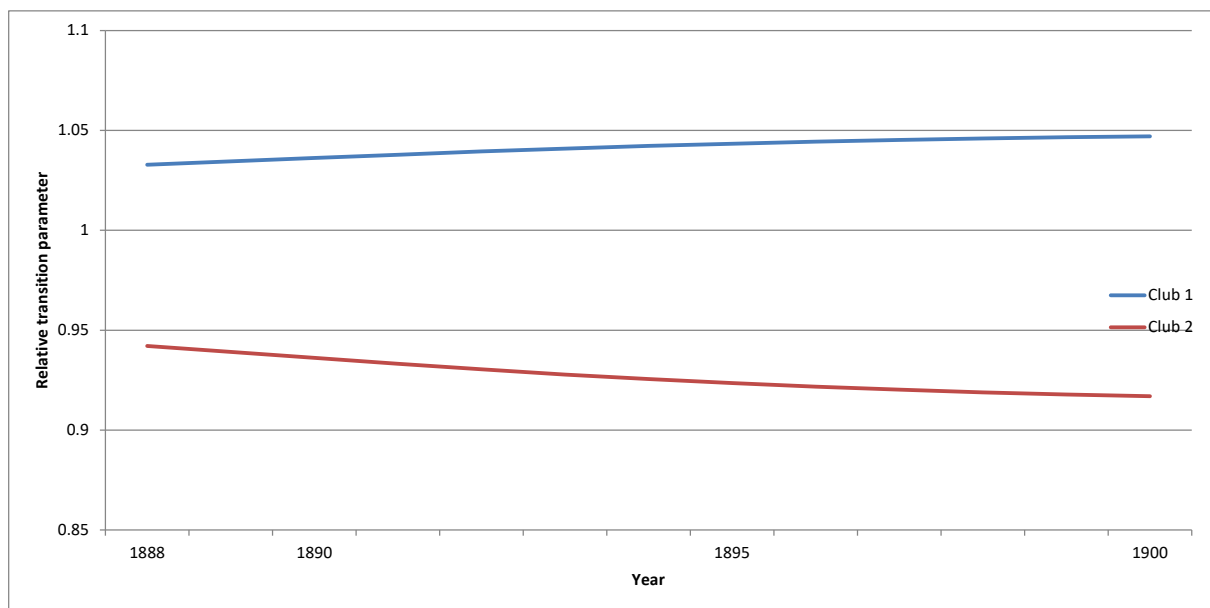
Figure5: Club convergence test for the subperiods

(a1) Convergence clubs, 1888-1900

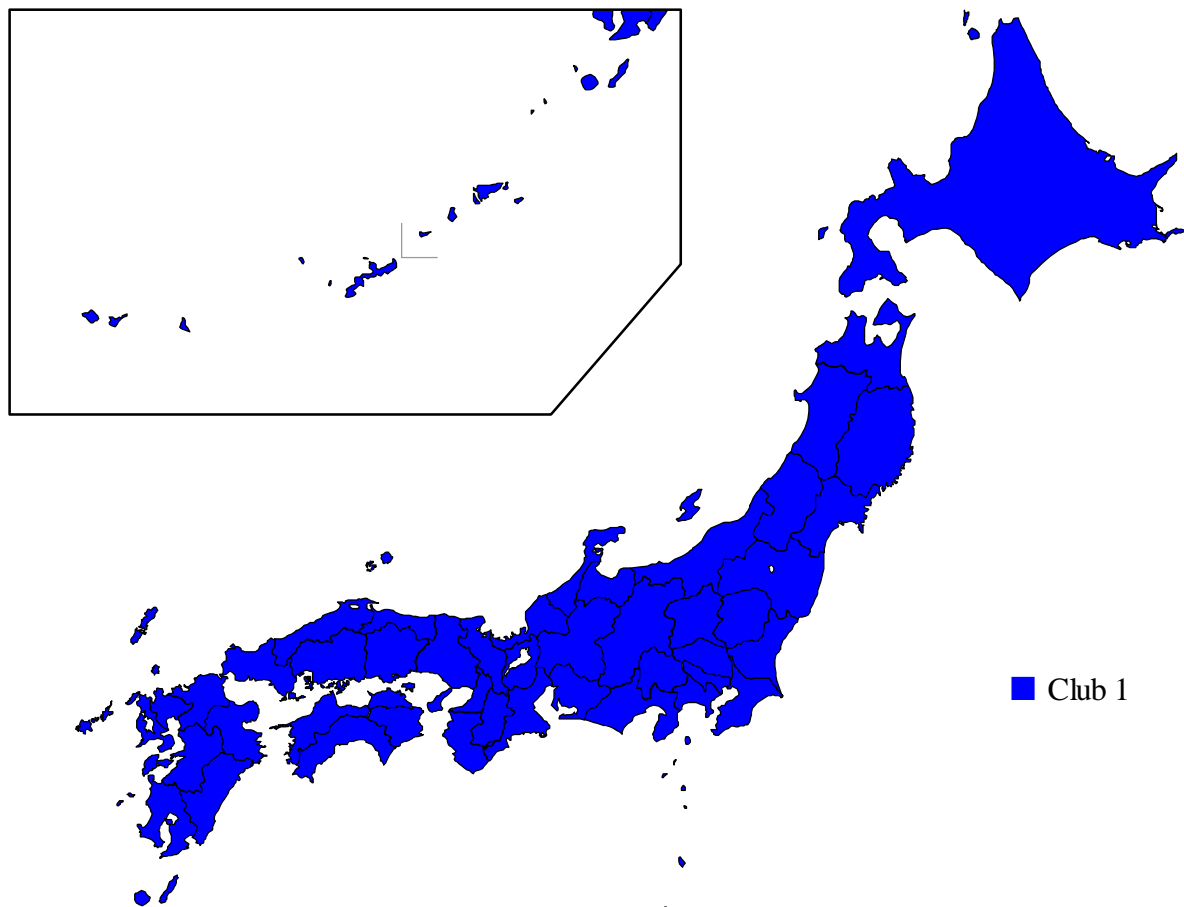


Club 1: (30)	Akita Aomori Chiba Ehime Fukui Fukuoka Fukushima Hokkaido Ibaraki Ishikawa Iwate Kagoshima Kochi Kumamoto Miyagi Miyazaki Nagano Nagasaki Nara Niigata Oita Okayama Okinawa Saga Saitama Shimane Toyama Yamagata Yamaguchi Yamanashi
Club 2: (17)	Aichi Gifu Gunma Hiroshima Hyogo Kagawa Kanagawa Kyoto Mie Osaka Shiga Shizuoka Tochigi Tokushima Tokyo Tottori Wakayama

(a2) Relative transition parameters by club, 1888-1900

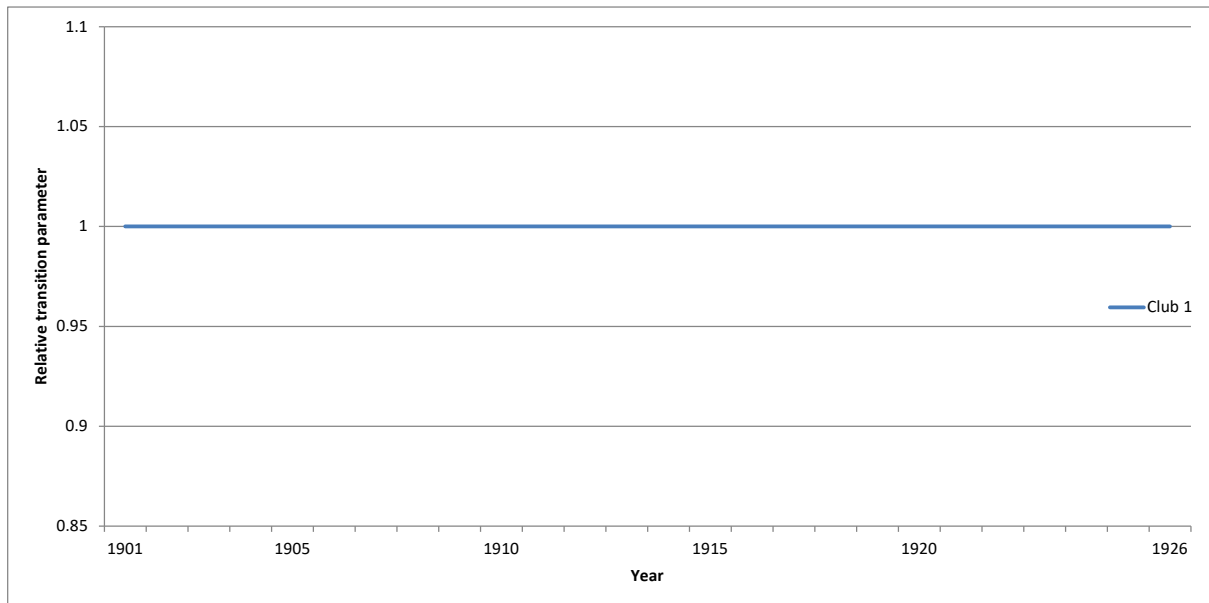


(b1) Convergence clubs, 1901-1926

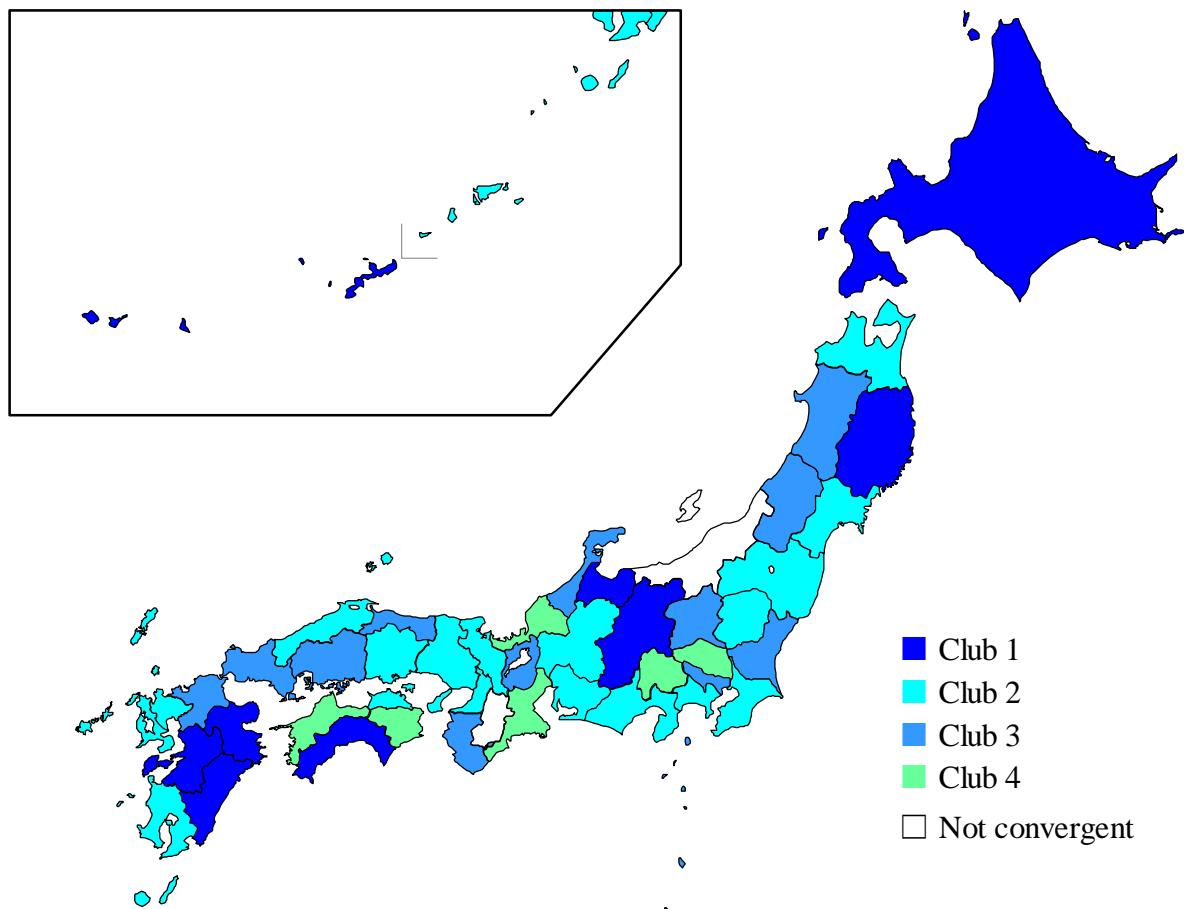


Club 1: (47)	Aichi Akita Aomori Chiba Ehime Fukui Fukuoka Fukushima Gifu Gunma Hiroshima Hokkaido Hyogo Ibaraki Ishikawa Iwate Kagawa Kagoshima Kanagawa Kochi Kumamoto Kyoto Mie Miyagi Miyazaki Nagano Nagasaki Nara Niigata Oita Okayama Okinawa Osaka Saga Saitama Shiga Shimane Shizuoka Tochigi Tokushima Tokyo Tottori Toyama Wakayama Yamagata Yamaguchi Yamanashi
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(b2) Relative transition parameters by club, 1901-1926



(c1) Convergence clubs, 1927-1936



Club 1: (9)	Hokkaido Iwate Kochi Kumamoto Miyazaki Nagano Oita Okinawa Toyama
Club 2: (18)	Aichi Aomori Chiba Fukushima Gifu Hyogo Kagawa Kagoshima Kanagawa Kyoto Miyagi Nagasaki Okayama Osaka Saga Shimane Shizuoka Tochigi
Club 3: (12)	Akita Fukuoka Gunma Hiroshima Ibaraki Ishikawa Shiga Tokyo Tottori Wakayama Yamagata Yamaguchi
Club 4: (6)	Ehime Fukui Mie Saitama Tokushima Yamanashi
Not convergent: (2)	Nara Niigata

(c2) Relative transition parameters by club, 1927-1936

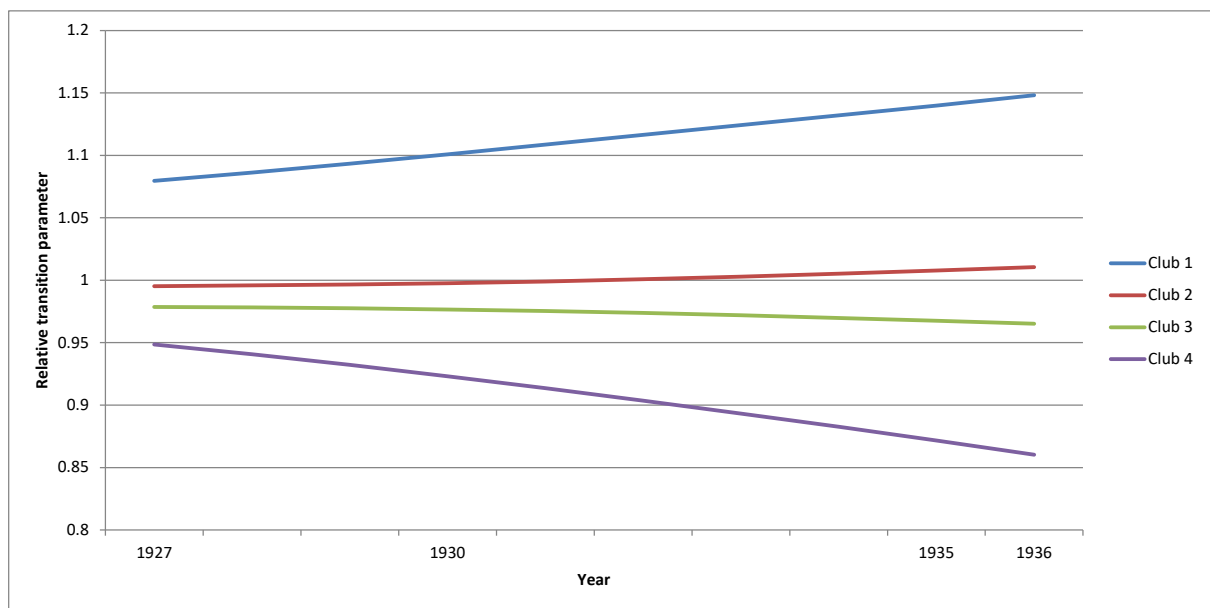


Table 1: Log t regression for the entire sample period 1888-1936

Sample Period	b	Std. Err.	t-Stat
1888-1936	-0.349	0.142	-2.448

Notes:

- 1) $b = 2\alpha$ is the coefficient of $\log t$ in equation (8).
- 2) Autocorrelation and heteroscedasticity robust standard error is reported.
- 3) The null hypothesis of convergence is rejected at 5% level if the t-statistics $t_b < 1.65$.

Table 2: Log t regression for the subperiods

Sample Period	b	Std. Err.	t-Stat
1888-1900	-0.524	0.022	-23.937
1901-1926	0.107	0.071	1.509
1927-1936	-1.323	0.056	-23.571

Notes:

- 1) $b = 2\alpha$ are the coefficients of $\log t$ in equation (8).
- 2) Autocorrelation and heteroscedasticity robust standard errors are reported.
- 3) The null hypothesis of convergence is rejected at 5% level if the t-statistics $t_b < 1.65$.

Table 3: Summary statistics for the ordered probit estimation

	Mean Std. dev.
Number of head office and branches of banks 1927	156.378 (112.752)
△Number of head office and branches of banks 1927-1936	-58.356 (47.222)
Distance to the financial center 1927 (km)	262.264 (242.122)
Loan to deposit ratio 1927	0.839 (0.246)
△Loan to deposit ratio 1927-1936	-0.332 (0.176)
Gross prefectural product 1925 (logarithmic value)	12.597 (0.669)
△Gross prefectural product 1925-1935	-0.055 (0.184)
Number of observations	45

Table 4: Results for the ordered probit estimation

	1927-1936
Number of head office and branches of banks 1927	-0.009 ** (0.004)
△Number of head office and branches of banks 1927-1936	-0.019 *** (0.007)
Distance to the financial center 1927 (km)	0.003 ** (0.001)
Loan to deposit ratio 1927	4.622 *** (1.531)
△Loan to deposit ratio 1927-1936	4.179 ** (1.803)
Gross prefectural product 1925	0.321 (0.458)
△Gross prefectural product 1925-1935	2.081 ** (1.083)
cut1	
Constant	5.375 (5.504)
cut2	
Constant	6.472 (5.528)
cut3	
Constant	8.004 (5.579)
Number of observations	45
Wald χ^2	22.66 ***
Pseudo R ²	0.205

Notes:

1) Heteroskedasticity robust standard errors are shown in parentheses.

2) ***, **, * indicate statistical significance at the 1, 5, and 10% level, respectively.

Table 5: Marginal effects for the ordered probit estimation

	1927-1936			
	← Lower	Equilibrium loan rate		Higher →
	$y_i=1$	$y_i=2$	$y_i=3$	$y_i=4$
	Club 4	Club 3	Club 2	Club 1
Number of head office and branches 1927	0.0015 ** (0.0008)	0.0010 ** (0.0005)	-0.0009 * (0.0005)	-0.0016 ** (0.0007)
△Number of head office and branches 1927-1936	0.0033 ** (0.0014)	0.0022 *** (0.0008)	-0.0019 * (0.0010)	-0.0036 *** (0.0010)
Distance to financial center 1927	-0.0005 ** (0.0002)	-0.0003 *** (0.0001)	0.0003 ** (0.0001)	0.0005 *** (0.0002)
Loan to deposit ratio 1927	-0.7938 *** (0.2745)	-0.5389 ** (0.2356)	0.4656 ** (0.1983)	0.8671 *** (0.2955)
△Loan to deposit ratio 1927-1936	-0.7177 ** (0.3474)	-0.4872 ** (0.2288)	0.4210 * (0.2305)	0.7840 ** (0.3287)
ln Gross prefectural product 1925	-0.0552 (0.0798)	-0.0374 (0.0526)	0.0324 (0.0475)	0.0603 (0.0846)
△ln Gross prefectural product 1925-1935	-0.3574 * (0.1953)	-0.2426 * (0.1294)	0.2096 * (0.1152)	0.3904 * (0.2041)
N	6	12	18	9

Notes:

- 1) Average marginal effects are reported.
- 2) Heteroskedasticity robust standard errors are shown in parentheses.
- 3) ***, **, * indicate statistical significance at the 1, 5, and 10% level, respectively.