COMPARATIVE ANALYSIS OF INDUSTRIAL AGGLOMERATIONS IN THE CHŪBU REGION DURING THE MEIJI PERIOD. A QUANTITATIVE EXAMINATION THROUGH NETWORK AND STATISTICAL ANALYSES

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Abstract. *This study seeks to elucidate the developmental disparities between Hamamatsu City and Yokkaichi City—both regional industrial centres and clusters that prospered during the Meiji period—by comparing the structural and statistical characteristics of their entrepreneurial networks.*

The significance of this research lies in its comparative examination of the divergent developmental trajectories of individual cities within Japan's industrial clusters, employing historical data and network analysis methodologies. As Robinson (2014) highlights, a central challenge in inter-city comparative studies is the effective "tracking and visualising of the diverse connections between cities," and this study seeks to address this challenge directly. Specifically, by focusing on Japanese industrial cities that evolved organically, rather than planned industrial districts as examined in Lewis's (2004) study of Chicago, this research aims to elucidate the heterogeneous patterns of urban industrial development.

Keywords*: Culture, Leadership, Japan, Networks, Influence, Communication.*

A salient feature of Japan during the Meiji period was the marked increase in manufacturing labour productivity from the 1890s to the 1900s, driven by the expansion of the railway network and the diffusion of new technologies. Although regional disparities widened, industrialisation simultaneously extended to peripheral areas (Settsu et al. 2016). Within this broader process of nationwide industrialisation, regional cities also exhibited notable progress in industrial agglomeration. Furthermore, prior research has observed that the foundations of Japan's four major industrial zones—Keihin, Hanshin, Chukyo, and Kitakyushu—which later became the nation's principal industrial centres in the early twentieth century, were already discernible during the Meiji industrial revolution (Yamazaki 1999; Ishii 1997).

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Regarding industrial agglomeration, Porter (1998) identifies it as a catalyst for regional economic development, accelerating growth through the promotion of knowledge sharing and technological innovation arising from both cooperation and competition among firms. In theoretical terms, several mechanisms underlying industrial agglomeration have been delineated. For example, MAR (Marshall-Arrow-Romer) externalities underscore the significance of learning effects and knowledge spillovers resulting from industry-specific specialisation, while Jacobs-type externalities propose that the concentration of diverse industries fosters technological innovation and economic expansion. Nevertheless, empirical industrial clusters seldom conform precisely to a single theoretical model, as individual cities often demonstrate unique configurations and developmental paths. To address this complexity, it is imperative to undertake comparative analyses of clusters with different formative processes and to explicitly identify their distinguishing features. Consequently, this study undertakes a comparative examination of two industrial clusters—Hamamatsu City and Yokkaichi City—with the aim of elucidating the differential trajectories of their development.

1. LITERATURE REVIEW

Prior research reveals two key issues: firstly, existing studies have largely confined themselves to comparisons at the metropolitan or prefectural level, failing to adequately elucidate differences in development trajectories between cities; secondly, analyses integrating statistical characteristics with network structures have scarcely been attempted. In contrast, this study focuses on regional cities. By combining structural analysis of entrepreneurial networks with comparative examination of statistical characteristics, it aims to empirically elucidate the divergent developmental trajectories of industrial clusters.

Drawing on case studies in network analysis, Suzuki et al. (2009) constructed a network of Meiji-period entrepreneurs using company director directories. Nonetheless, their analysis remained predominantly tabular and did not extend to quantitative measurement. In contrast, Watahiki et al. (2023) applied centrality analysis and heatmap visualisation to Niigata Prefecture, revealing that regional development is shaped more profoundly by human networks than by geographical conditions. Accordingly, this study concentrates on human networks to examine the representation of developmental disparities.

Furthermore, Brandt et al. (2009) visualised collaborative relationships between research institutions and businesses in the Hanover metropolitan area of northern Germany. However, their analysis was confined to network construction and visualisation, with limited integration of statistical perspectives. Additionally, the study covered a broad geographical area of approximately 18,600 km², which impeded a detailed understanding of the region's internal structures. Comparative studies in Japan include Higaki and Watabiki (2019), who examined Niigata Prefecture (approximately 12,584 km²) and Hyogo Prefecture (approximately 8,400 km²), as well as Ito and Watabiki (2023), who compared Gunma Prefecture (approximately 6,362 km²) and Tochigi Prefecture (approximately 6,408 km²). Nevertheless, these studies have not sufficiently explored the industrial structures or developmental processes of regional cities within the respective prefectures.

2. SUBJECT OF ANALYSIS

2.1. Subject Regions

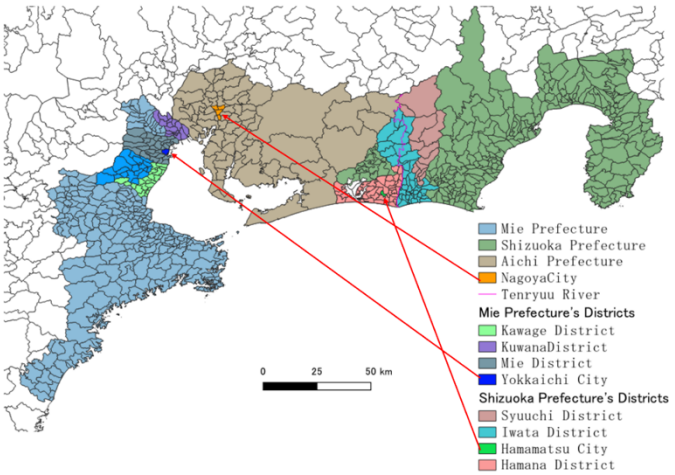
The subject regions of this study, Hamamatsu City and Yokkaichi City, are regional municipalities that do not serve as prefectural capitals. Both are situated within the Chūkyō economic sphere and, although influenced by the distributional, economic, and cultural domain centred on Nagoya City, they have pursued distinct paths of industrial development since the late Meiji period (Yamaguchi 2015). The locations of the respective prefectures and their principal cities are presented in Figure 1. The map shown in Figure 1 was prepared by the author using Japanese data from 1920, which was selected because it exhibits no spatial discrepancies relative to the study period, approximately 1910.

Hamamatsu City implemented its municipal system in 1911 and underwent rapid industrial development during the latter half of the Meiji period, particularly following the Russo-Japanese War. This development is well-documented in the History of Shizuoka Prefecture. Of particular significance was the expansion of the textile and musical instrument industries. The Enshū region's long-established tradition of cotton weaving, combined with its abundant labour force and the technical ingenuity of its craftsmen, fostered a distinctive industrial cluster unique to the area. Within the musical instrument sector, the founding of Yamaha marked a significant milestone, as it evolved into a globally recognized enterprise. While initially catering primarily to local residents and the domestic market, the industries in Hamamatsu also pioneered new demand. By 1912, the city had the highest number of companies and capital investment in the prefecture. Thus, Hamamatsu forged its own industrial cluster centered on domestic markets, establishing itself as the economic hub of Shizuoka Prefecture. Today, Hamamatsu is recognized as one of Japan’s ordinance-designated cities, reflecting its sustained industrial and economic importance.

Meanwhile, Yokkaichi City implemented its municipal system in 1897 and developed by capitalizing on its strategic location as a port town. In 1899, it was designated as the first official port to open in Ise Bay, cementing its status as a significant port city. This strategic port facilitated the import and export of diverse industries, including spinning, silk reeling, fishing nets, and ceramics, both domestically and internationally through Yokkaichi Port. Consequently, Yokkaichi evolved into an international industrial city primarily oriented toward overseas markets. Notably, despite not being the prefectural capital of Mie Prefecture or serving as an administrative center, Yokkaichi successfully established an export-driven industrial structure.

Thus, while Hamamatsu City developed predominantly as an industrial city focused on meeting domestic demand, Yokkaichi City pursued an external demand-oriented industrial model, serving overseas markets via its port. A defining characteristic of both cities lies in their ability to build customer bases finely attuned to their geographic contexts and industrial features, resulting in divergent developmental pathways.

Figure 1. Location of Hamamatsu City and Yokkaichi City

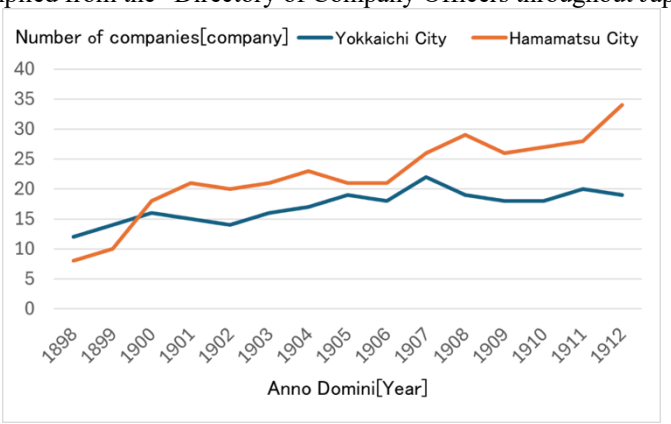


Source: authors' own preparations based on data collected from participatory research

Graph 1 illustrates the trend in the number of companies in Hamamatsu and Yokkaichi Cities from 1898 to 1912. In 1898, Hamamatsu had 8 companies compared to Yokkaichi's 12. However, by 1912, Hamamatsu experienced significant growth, reaching 34 companies, while Yokkaichi, after peaking in 1907, saw a decline to 19 companies. It is important to note that during the Meiji period, joint-stock companies were equivalent to modern listed companies, and obtaining corporate legal status indicated a certain level of capital strength and scale.

This data reveals that though both cities developed industrial clusters, their trajectories diverged over time. Hamamatsu exhibited sustained growth in company numbers, reflecting its domestic market orientation, while Yokkaichi showed a rise and subsequent decline, likely linked to its export-oriented structure and port-based economy. This study will analyze this divergence further through network analysis, integrating metrics such as company numbers, population, and industrial shipments to provide a comprehensive understanding of their industrial development patterns.

Graph 1. Changes in the Number of Companies in Hamamatsu City and Yokkaichi City (Compiled from the "Directory of Company Officers throughout Japan")



Source: authors' own preparations based on data collected from participatory research

2.2. Periods Analysed

The periods analyzed in this study are 1902, 1907, and 1912, which correspond closely to the timeframe around the Russo-Japanese War (1904–1905) and the broader industrial revolution in Japan. These years represent significant moments in the industrial development of both Hamamatsu City and Yokkaichi City, reflecting nationwide economic shifts.

In 1902, the increased loan amounts exceeding deposits at several Hamamatsu banks signal a heightened demand for industrial funding, marking the beginning of an industrial expansion phase. By 1907, Yokkaichi City reached the peak in its number of companies, marking a critical juncture where the industrial trajectories of Hamamatsu and Yokkaichi began to diverge. Hamamatsu continued to experience growth in company numbers, especially in textiles and musical instruments, while Yokkaichi started to decline after its peak in 1907. By 1912, the transition from Meiji-era industrialization to the Taisho period became clear, with Hamamatsu demonstrating continued industrial growth and Yokkaichi entering a period of contraction. This divergence highlights the differing sustainable growth capacities of the two cities, with 1912 serving as a definitive year to confirm these distinct developmental paths.

3. ANALYTICAL METHODS

3.1. Data

3.1.1. Data Sources

This study analyzed data on companies located in Shizuoka and Mie Prefectures using the Meiji-period publication Directory of Company Officers throughout Japan (hereafter referred to as the Officers Directory), complemented by the Statistical Book, which comprises government-published statistics from the Meiji period. These sources were employed to investigate regional development and the industrial structure during this transformative era. Additionally, data on Hamamatsu City prior to its formal establishment in 1911 were compiled by the author using records for Hamamatsu-machi, the predecessor administrative unit of Hamamatsu City.

The Officers Directory is a comprehensive resource listing company names, affiliated officers, locations of both officers and companies, capital amounts, and other relevant details organized by prefecture. This makes it an invaluable tool for understanding corporate activities and industrial dynamics in modern Japan.

The Statistical Yearbook was compiled by the statistical departments of each prefecture and published by the prefectural offices. It provided data on population, industrial output value, and other key indicators of the regional economy during the Meiji period. The Yearbook serves as an essential resource for understanding the economic context underpinning corporate activities at that time. This study utilized the Statistical Yearbook specifically for the target years of 1902, 1907, and 1912 to analyze regional industrial development and economic characteristics more comprehensively.

3.1.2. Data Correction

The Register of Officers contains inherent errors and omissions, with some records lacking essential information such as company names or locations. To maintain the integrity and reliability of the analysis, this study deliberately excluded incomplete data that posed difficulties for accurate assessment, such as entries missing confirmed company names or location details.

Additionally, name variations posed a challenge, as the same individual's name could appear in multiple forms due to differences in kanji characters—whether old-style or

new-style—or homophones written with different kanji. To address this, the Director Directory was converted into CSV format, allowing systematic comparison. Names with a Levenshtein distance of one were extracted and examined; where it was determined they referred to the same person, kanji spellings were standardized. This verification process involved consulting the directors' addresses and cross-referencing with other biographical sources such as the Personnel Directory and Japanese Who's Who to ensure consistent identification.

3.2. Network Analysis

To visualise the entrepreneurial networks examined in this study, a network was constructed to represent the relationships between companies and their directors, based on data obtained from the "Company Directors Register". Specifically, an undirected bipartite graph was generated, in which companies and their associated directors were defined as "nodes", and the connections between them were defined as "edges".

3.2.1. Betweenness Centrality

Betweenness Centrality is a network analysis metric that measures the frequency with which a node lies on the shortest path between other nodes within a network. More precisely, a node with high betweenness centrality significally influences the flow of information and resources throughout the network by mediating interactions among multiple nodes. Consequently, individuals or organisations with high betweenness centrality values function as bridges linking different communities, thereby occupying positions as structural intermediaries within the network. If g_{jk} is the number of paths passing through element i among the shortest paths between elements j and k, then g_{jk} of element i is expressed by elements in Equation (1).

$$C_B(n_i) = \sum_{j=1, i \neq j}^{n} \frac{g_{jk}(n_i)}{g_{jk}} \qquad \ldots (1)$$

3.3. Scatter Diagram

This study employed network indicators alongside various statistical data to conduct comparative analyses of industrial structures both across regions and within specific industries. Population density and industrial shipment values were sourced from the "Statistical Yearbook," while the number of companies was obtained from the "Company Directory" to serve as key indicators. Additionally, the number of edges, derived from network analysis, was utilised as a network metric.

To visualize relationships among these indicators and elucidate regional characteristics and divergences, the data were represented through scatter plots.

For each scatter plot, regression lines were fitted separately by prefecture to assess correlations between indicators, with the coefficient of determination (R^2) reported as a measure of model fit. The regression line delineates the linear relationship between paired variables, while its slope quantifies the magnitude of influence exerted by one variable upon the other. The coefficient of determination, ranging from 0 to 1, indicates explanatory power, with values approaching 1 signifying that the regression line closely approximates the data distribution. Thus, elevated R^2 values denote strong variable associations, whereas lower values imply the involvement of additional unmodeled factors. The coefficient of determination R^2 is defined by Equation (2).

$$R^2 = 1 - \frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{\sum_{i=1}^{n}(y_i - \bar{y})^2} \quad \text{... (2)}$$

Furthermore, the regression line equation depicted in each figure (e.g., $y = ax + b$) quantifies the responsiveness of the vertical-axis variable to changes along the horizontal axis. The coefficient a, representing the slope, denotes both the strength and direction of the linear relationship between the variables. Larger absolute values of a indicate greater responsiveness of dependent indicators to increments in company counts. The intercept b signifies the baseline value of the dependent variable when company counts equal zero.

Thus, joint examination of the slope (a) and coefficient of determination (R^2) enables quantitative assessment of correlation strengths and region-specific structural characteristics.

4. RESULTS

4.4. Centrality Analysis

This study constructed entrepreneurial networks for Shizuoka and Mie Prefectures utilizing a database derived from the "Director's Register." Tables 1 through 3 present the centrality metrics calculated from the entrepreneurial networks of both prefectures for the years 1902, 1907, and 1912, respectively.

4.4.1. Year 1902

To elucidate the characteristics of the entrepreneurial networks in Hamamatsu City and Yokkaichi City in 1902, Table 1 presents the results identifying the top individuals by betweenness centrality.

Table 1. Top 5 individuals by betweenness centrality among executives in both cities in 1902

Executive	Company	Betweenness Centrality	Area	Remarks
Kuki Monshichi	Yokkaichi Bank,Co., Ltd.	0.0534	Yokkaichi	Large Taxpayer, Member of the House of Representatives
Yoshida Tsunekichi	Yokkaichi Bank,Co., Ltd.	0.0106	Yokkaichi	Executive Board Member of the Yokkaichi Chamber of Commerce and Industry
Mizutani Goroku	Yokkaichi Bank,Co., Ltd.	0.0094	Yokkaichi	Member of the Mie Prefectural Assembly
Kuki Sotaro	Yokkaichi Bank,Co., Ltd.	0.00437	Yokkaichi	The 5th Chairman of the Yokkaichi City Council
Okawa Magojiro	Yokkaichi Dentou Co., Ltd.	0.00152	Yokkaichi	Member of the Town Assembly
Tashiro Eisaku	The 138th Bank,Co., Ltd.	0.0261	Hamamatsu	Mayor of Futamata Town
Nakamura Tokichi	The 35th Bank, Co., Ltd.	0.0209	Hamamatsu	Mayor of Hamamatsu Town
Uchida Tadashi	The 35th Bank, Co., Ltd.	0.0182	Hamamatsu	Mayor of Hamamatsu Town
Kimura Kotaro	Totoumi Tyochiku Bank, Co., Ltd.	0.00604	Hamamatsu	Council Member of the Hamamatsu Chamber of Commerce and Industry
Imaizumi Shobei	Yoshikawa Bank, Co., Ltd.	0.00526	Hamamatsu	Founding Member of the Hamamatsu Chamber of Commerce

Source: authors' own preparations based on collected and analyzed data

In Yokkaichi City, Kuki Monnichi of Yokkaichi Bank exhibited exceptionally high betweenness centrality, underscoring his pivotal position within the regional financial network. Kuki Monnichi served concurrently as a director of Yokkaichi Bank Co., Ltd. and Mie Spinning Co., Ltd., and was active as a Diet member during the Taisho period. Moreover, given Yokkaichi City's limited banking infrastructure with only one institution, his influence was particularly pronounced. While other directors maintained betweenness centrality values around 0.01, this suggests a concentration of mediating functions among select industrialists.

In contrast, Hamamatsu City featured multiple bank directors—including Tashiro Eisaku of Hyakujusan-hachi Bank Co., Ltd., Nakamura Tokichi of Sanjugo Bank Co., Ltd., and Uchida Tadashi—with comparably high centrality measures, indicative of a distributed intermediary role. Nakamura Tokichi, notably, held directorships at several banks, including the 35 Bank and Hamamatsu Savings Bank Co., Ltd., as well as at Nippon Gakki Co., Ltd., reflecting substantial engagement across both finance and regional industry. A shared characteristic across both cities was the prominence of bank directors as central network nodes.

4.4.2. Year 1907

Table 2 presents the results identifying the leading individuals based on betweenness centrality, which were analyzed to elucidate the structural characteristics of entrepreneurial networks in Hamamatsu City and Yokkaichi City in 1907.

Table 2. Top five individuals ranked by betweenness centrality among executives in both cities in 1907

Executive	Company	Betweenness Centrality	Area	Remarks
Inaba Koutarou	Ise Bay Onibune Co., Ltd.	0.0271	Yokkaichi	The 6th Vice Chairman of the Yokkaichi City Council
Yamanaka Genzaburou	Yokkaichi Bank,Co., Ltd.	0.0241	Yokkaichi	The 5th Vice Chairman of the Yokkaichi City Council
Kuki Sotaro	Yokkaichi Bank,Co., Ltd.	0.00437	Yokkaichi	The 5th Chairman of the Yokkaichi City Council
Hayami Kanzou	Yokkaichi Printing Co., Ltd.	0.019	Yokkaichi	Industrialist
Kuki Monshichi	Yokkaichi Bank,Co., Ltd.	0.0534	Yokkaichi	Large Taxpayer, Member of the House of Representatives
Nakamura Tokichi	The 35th Bank, Co., Ltd.	0.0209	Hamamatsu	Mayor of Hamamatsu Town
Miyamoto Jinshichi	Hamamatsu Dentou Co., Ltd.	0.0413	Hamamatsu	Council Member of the Hamamatsu Chamber of Commerce and Industry
Yamaha Torakusu	Hamamatsu Dentou Co., Ltd.	0.0389	Hamamatsu	Council Member of the Hamamatsu Chamber of Commerce and Industry
Uchida Tadashi	The 35th Bank, Co., Ltd.	0.0182	Hamamatsu	Mayor of Hamamatsu Town
Tsurumi Shinpei	Hamamatsu Shinyo Bank,Co, Ltd.	0.0253	Hamamatsu	The First Mayor of Hamamatsu City

Source: authors' own preparations based on collected and analyzed data

In Yokkaichi City, Kotaro Inaba of Yokkaichi Bank Ltd. exhibited high betweenness centrality, whereas Monosaburo Kuki, who had occupied the top position in 1902, declined to fifth place. Inaba Kōtarō served as a director of Ise Bay Onsen Co., Ltd. and Narunaga Co.,

Ltd., and later held the position of Vice-Chairman of the City Council. These results suggest that, compared with 1902, the proportion of bank executives declined, while directors from a broader range of industries increasingly fulfilled intermediary functions within the network.

In contrast, in Hamamatsu City, Nakamura Tōkichi, who ranked second in 1902, recorded the highest centrality in 1907. Moreover, non-banking directors such as Torakusu Yamamoto and Jinichi Miyamoto also occupied prominent positions, revealing a distinguishing feature of a more dispersed intermediary structure, not confined to the banking sector. Torakusu Yamamoto, notably, served as a director for multiple manufacturing enterprises—including Nippon Gakki Co., Ltd., Hamamatsu Denko Co., Ltd., and Nippon Katazome Co., Ltd.—demonstrating extensive involvement across the regional industrial domain. Miyamoto Jinshichi, through firms such as Teikoku Seibo Co., Ltd., represented the light industry sector and exerted significant influence on the local economy. Similar to Yokkaichi City, this trend indicates a reduction in the proportion of bank-affiliated directors compared with 1902 and a corresponding expansion in the intermediary roles of directors from more diverse industrial backgrounds.

4.4.3. Year 1912

To elucidate the characteristics of entrepreneurial networks in Hamamatsu City and Yokkaichi City in 1912, Table 3 presents the results identifying the leading individuals based on mediating centrality.

Table 3. Top five individuals ranked by mediating centrality among executives in both cities in 1912

Executive	Company	Betweenness Centrality	Area	Remarks
Hirano Daishichi	Ise Railway Co., Ltd.	0.205	Yokkaichi	The 19th Chairman of the Yokkaichi City Council
Kuki Sotaro	Yokkaichi Bank,Co., Ltd.	0.00437	Yokkaichi	The 5th Chairman of the Yokkaichi City Council
Hirota Kyujiro	Yokkaichi Bank,Co., Ltd.	0.0318	Yokkaichi	Council Member of the Yokkaichi Town Federation
Kuki Monjurou	Yokkaichi Rice Exchange Co., Ltd.	0.0261	Yokkaichi	Industrialist
Yamanaka Densiro	Yokkaichi Warehouse Co., Ltd.	0.0248	Yokkaichi	Large Taxpayer
Nakamura Tokichi	The 35th Bank, Co., Ltd.	0.0209	Hamamatsu	Mayor of Hamamatsu Town
Uchida Tadashi	The 35th Bank, Co., Ltd.	0.0182	Hamamatsu	Mayor of Hamamatsu Town
Kimura Kotaro	Totoumi Tyochiku Bank, Co., Ltd.	0.00604	Hamamatsu	Council Member of the Hamamatsu Chamber of Commerce and Industry
Yamaha Torakusu	Hamamatsu Dentou Co., Ltd.	0.0389	Hamamatsu	Council Member of the Hamamatsu Chamber of Commerce and Industry
Inagaki Sadasuke	Nakano Town Bank,Co., Ltd.	0.00428	Hamamatsu	Industrialist

In Yokkaichi City, Daishichi Hirano of the Ise Railway exhibited high centrality. He served as a director of Yokkaichi Railway Co., Ltd. and Toyo Suisan Co., Ltd., and subsequently held the position of Chairman of the City Council. A notable feature, compared with 1907, is the further decline in both the number of bank-affiliated executives and the proportion of such individuals among the top five.

In contrast, in Hamamatsu City, Nakamura Tōkichi, who held the highest centrality in 1907, maintained this position in 1912. The composition of top executives remained largely consistent, with bank directors continuing to occupy central positions. However, a significant shift is observed: Jinichi Miyamoto, who had ranked highly in 1907, disappeared from the 1912 list, while Teisuke Inagaki of Nakanocho Bank Co., Ltd. newly entered at fifth place. In other words, relative to 1907, Hamamatsu City experienced the disappearance of executives from manufacturing backgrounds and a concomitant rise in the prominence of banking figures.

4.4.4. Summary

The analysis presented above identifies a shared structural feature in both cities: executives serving in a larger number of companies exhibited higher intermediary centrality. This pattern indicates that individuals occupying bridging positions between different firms functioned as facilitators of information and resource flows across the entire network. Industrialists such as Nakamura Tōkichi, who operated across both banking and manufacturing sectors, served as pivotal nodes connecting diverse segments of the regional economy.

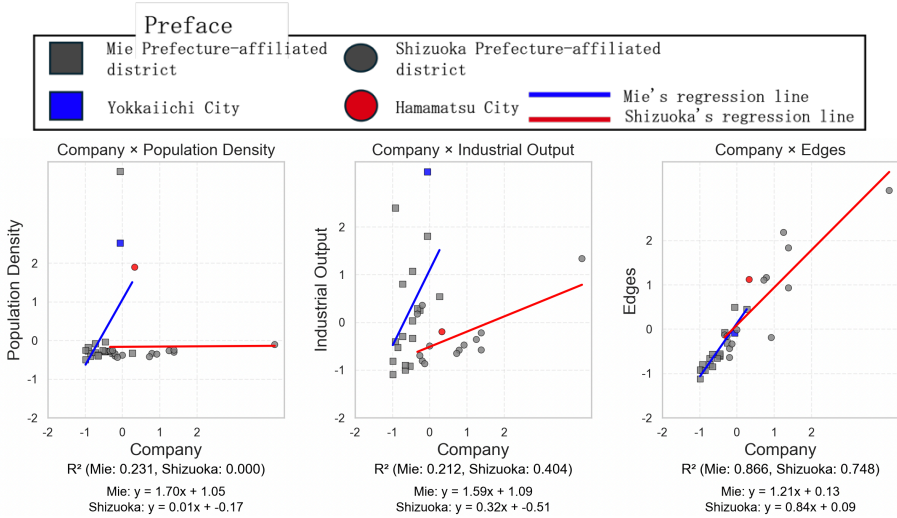
Moreover, the prevalence of directors concurrently holding positions within financial institutions represents another salient characteristic common to both regions. Representative figures include Kuki Monnichi and Inaba Kōtarō in Yokkaichi City, and Tashiro Eisaku and Nakamura Tōkichi in Hamamatsu City. Each utilized their foundation in the financial sector to engage with enterprises in other industries, thereby reinforcing their role as mediators within the regional business network. The financial sector, by virtue of its capital provision function, occupied a central position in the regional economic structure. The concurrent directorships held by bank executives across multiple firms further strengthened the interdependence between financial and industrial networks.

Accordingly, in both Yokkaichi and Hamamatsu, concurrently appointed directors—particularly bank executives—played a crucial mediating role that connected heterogeneous enterprises and contributed significantly to the development of the regional economy.

4.5. Scatter Diagram

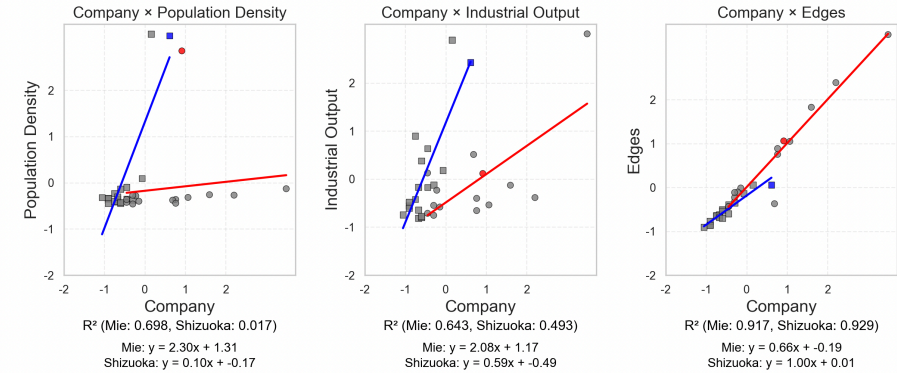
This study constructed scatter plots by standardizing data based on the number of edges derived from network analysis, the number of companies obtained from the *Directory of Directors*, and socio-economic data (population density and industrial shipment values) from the *Statistical Book*. Figures 5, 6, and 7 respectively illustrate the relationships among these variables for the counties and cities within both prefectures in 1902, 1907, and 1912. In each plot, the horizontal axis represents the "Number of Companies," while the vertical axis corresponds to "Population Density," "Industrial Shipment Value," or "Number of Edges." The relationships among variables are presented using regression lines, differentiated by prefecture.

Figure 5. Scatter plot for both prefecture in 1902



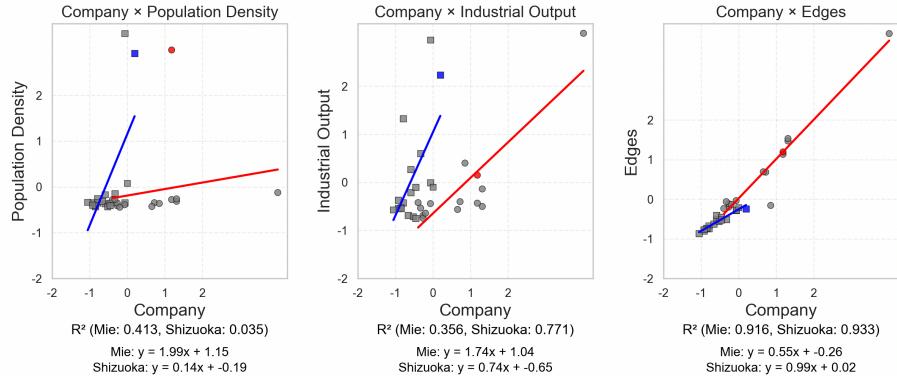
Source: authors' own preparations based on collected and analyzed data

Figure 6.: Scatter plot for both prefectures in 1907



Source: authors' own preparations based on collected and analyzed data

Figure 7. Scatter plot for both prefectures in 1912



Source: authors' own preparations based on collected and analyzed data

By comparing the scatter plots presented in Figures 5–7, distinct shifts in the relative positioning of Hamamatsu City and Yokkaichi City across economic and network indicators between 1902 and 1912 become evident. In 1902 (Figure 5), Hamamatsu City surpassed Yokkaichi City in both the number of companies and network density (measured by edges). Conversely, Yokkaichi City exceeded Hamamatsu in population density and achieved the highest industrial shipment value among districts in both Mie and Shizuoka Prefectures. This elevated industrial output stemmed not from a greater number of companies or broader corporate connectivity, but from concentrated production within a limited set of firms. Consequently, Hamamatsu developed an industrial structure characterized by numerous enterprises and extensive inter-firm networks, whereas Yokkaichi exhibited a production model reliant on fewer, larger-scale companies.

This pattern persisted fundamentally unchanged through 1907 (Figure 6). Although both cities recorded increases in company counts, network density, population density, and industrial shipments, Hamamatsu retained its advantage in corporate quantity and network breadth. Yokkaichi, meanwhile, maintained leadership in population density and industrial shipments, again attaining the highest prefectural value as in 1902. By 1912 (Figure 7), Hamamatsu further expanded its company count, network density, and population density, ultimately surpassing Yokkaichi in the latter metric. In contrast, Yokkaichi displayed declining trends in companies and edges, with industrial shipments contracting from 1907 (Meiji 40) onward. These dynamics suggest Yokkaichi may have attained its developmental peak between 1902 and 1907, followed by decelerated growth. Hamamatsu, starting from a position of relative disadvantage in 1902, demonstrated sustained expansion across all indicators from 1907, propelled by intensified corporate formation and executive network growth.

Furthermore, examining the overall trends in both prefectures reveals that in Mie Prefecture, from 1902 through 1912, increases in population density and industrial shipments contributed to the rise in the number of companies. The slopes of the regression equations (1902: population density 1.70, industrial shipments 1.59; 1912: population density 1.99, industrial shipments 1.74) were consistently high, indicating that population and industrial production responded sensitively to the increase in the number of companies. Particularly in 1907, the coefficients of determination (R^2) were high at 0.698 for population density and 0.643 for industrial shipments, suggesting that population concentration and expanded industrial activity strongly promoted new company formation and business expansion.

However, by 1912, the coefficients of determination for the number of companies relative to population density and industrial shipments had declined to 0.413 and 0.356 respectively, indicating that these indicators alone could no longer fully explain fluctuations in the number of companies. This suggests that factors such as population concentration and industrial scale expansion alone cannot fully account for the situation in Mie Prefecture during this period.

In contrast, throughout Shizuoka Prefecture from 1902 to 1912, the correlation with population density remained consistently weak (slope: 0.01 in 1902, 0.10 in 1907, 0.14 in 1912), suggesting that the development of entrepreneurial networks, rather than population concentration, tended to drive regional industrialisation. Particularly in the relationship between “number of companies × industrial shipments” and “number of companies × number of edges”, the coefficient of determination (R^2) increased over the time series (industrial shipments: 0.404→0.493→0.771; number of edges: 0.748→0.929→0.933), while the slope also progressively increased (industrial

shipments: 0.32→0.59→0.74; number of edges: 0.84→1.00→0.99). This clearly demonstrates that in Shizuoka Prefecture, the increase in the number of companies was linked to an increase in the number of edges between companies, leading to growth in industrial shipments through the expansion of the network structure.

Synthesising these results, Mie Prefecture, including Yokkaichi City, developed as a region based on urban agglomeration and a limited company structure. Conversely, Shizuoka Prefecture, including Hamamatsu City, developed as a network-driven region through the expansion of company numbers and networks. In other words, while both regions expanded their corporate activities during the same period, clear differences existed in the underlying factors driving their development.

5. ANALYSIS

The network analysis and scatter plot results presented in this study confirm that Hamamatsu City and Yokkaichi City pursued divergent developmental trajectories between 1902 and 1912. Hamamatsu sustained growth in both company counts and network density (edges), ultimately surpassing Yokkaichi in population density. In contrast, Yokkaichi maintained elevated industrial shipment values through 1912 but exhibited decelerated growth after 1907. This divergence appears substantially influenced by contemporaneous external conditions within the Japanese economy. The present chapter examines the underlying factors contributing to this developmental disparity.

5.1. The Number of Banks

The proliferation of banks in Hamamatsu City provided institutional infrastructure that facilitated the formation and expansion of diverse local industries. Conversely, the relative scarcity of banking institutions in Yokkaichi City constituted a structural constraint impeding its developmental momentum.

Table 4. Changes in the Number of Banks in Both Cities

	Year 1902	Year 1907	Year 1912
Hamamatsu	11	12	18
Yokkaichi	1	1	1

This disparity manifests clearly in the network structure as well. Table 4 reveals that Hamamatsu City experienced an increase in the number of banks between 1902 and 1912, thereby enhancing their capacity to facilitate inter-firm capital flows. In contrast, Yokkaichi City maintained only a single banking institution throughout this period, constraining the availability of funds for local industries.

Moreover, as Section 5.2 demonstrates, the concentration of high-intermediary centrality among executives declined progressively in Yokkaichi City. This pattern likely reflects the limited opportunities for expansion into new brokerage roles offered by the solitary local bank, resulting in a diffusion of intermediary functions across executives from other sectors.

During this period, both national and private banks operated with relatively modest deposit bases—particularly private deposits—yet extended loans aggressively to industry. When lending funds proved insufficient, banks frequently supplemented them with their own capital, exhibiting what Ōtsuka (1984) characterizes as a pronounced “lending

company-like character." Consequently, banks fulfilled an indispensable function in providing capital for emerging industries.

Given these dynamics, the multiplicity of banks in Hamamatsu City constituted a critical institutional foundation that enabled industrial diversification and sustained growth. Conversely, the paucity of banking institutions in Yokkaichi City restricted financing channels, ultimately emerging as a structural impediment to regional development.

5.2. Timber Supply

Timber provides a crucial lens for examining the factors enabling Hamamatsu City's sustained development and those contributing to Yokkaichi City's progressive growth deceleration.

As Yamaguchi (2011) observes, during Japan's modern industrialization, timber served as energy, construction material, and raw input for both emerging and traditional industries, underscoring its indispensable role in industrial expansion.

Following the Russo-Japanese War (1904), Yokkaichi City experienced expanded timber demand[1]. In response, Taishō-period initiatives promoted bamboo cultivation and artificial afforestation. This development, conversely, reveals that during the Meiji era, Yokkaichi lacked a timber supply infrastructure adequate to meet rising demand.

Hamamatsu City, by contrast, harnessed timber from the adjacent Tenryū River basin to cultivate industries such as musical instruments and textiles[2]. Thus, Tenryū basin resources constituted a foundational element supporting Hamamatsu's industrial trajectory. Moreover, Tsuchiya (2020) documents the planting of approximately 3 million cedar and cypress saplings in this basin between 1886 and 1900, evidencing the prior establishment of a robust supply base.

The Shizuoka Prefecture districts bordering the Tenryū River—Shūchi, Iwata, and Hamana (see Figure 1)—served as primary timber suppliers to Hamamatsu City. Comparing forested areas between these Tenryū basin districts and those adjacent to Yokkaichi City elucidates regional disparities in supply capacity. Table 4 presents 1902 forested area data for Yokkaichi's surrounding counties (Mie, Kuwana, Kawage, and Suzuka) alongside those in the Tenryū River basin counties.

Table 4. Comparison of Forest Area in the Yokkaichi Area and the Tenryū River Basin

Area (District)	**Forest Area (km²)**
Mie District	73.587
Kuwana District	19.085
Kawage District	32.678
Suzuka District	119.213
Syuuchi District	578.437
Iwata District	180.31
Hamana District	84.371

[1] Yokkaichi City History, Vol. 18: General History, Modern Era, Yokkaichi City, 2000, pp. 402-403

[2] Shizuoka Prefecture History: General History Volume 5, Modern and Contemporary Period I, Shizuoka Prefecture, 1996, pp. 602-603

As Table 4 indicates, the aggregate forested area across districts surrounding Yokkaichi City (Kuwana, Mie, Kawage, Suzuka) totals approximately 245 km², whereas that within the Tenryū River basin districts (Shūchi, Iwata, Hamana) reaches approximately 843 km². Thus, the Hamamatsu region possessed over three times the forest resources of the Yokkaichi vicinity.

This disparity underscores the divergent timber supply capacities between the two regions. Hamamatsu City benefited from a stable supply infrastructure supported by the Tenryū basin's abundant forest resources, while Yokkaichi City—confronted with resource scarcity—struggled to satisfy escalating timber demand. Accordingly, the presence or absence of a robust timber supply base emerges as a key factor contributing to the divergent industrial trajectories observed in the two cities.

6. CONCLUSION

This study conducted a comparative analysis of entrepreneurial networks in Hamamatsu City and Yokkaichi City through centrality measures and statistical indicators. The findings confirm distinct developmental divergences between the two cities. In Hamamatsu City, the proliferation of banks enabled their directors to mediate across industries via concurrent directorships, sustaining the emergence of highly centralized actors and demonstrating both the stability and scalability of the network structure. Conversely, Yokkaichi City's limited banking presence resulted in a progressive decline in directors bridging financial and industrial sectors, yielding an increasingly unstable network configuration.

Moreover, scatter plot analysis reveals that Hamamatsu City sustained growth across company counts, network density (edges), and population density, whereas Yokkaichi City—despite a transient advantage in industrial shipment values—exhibited contractions in companies and edges, evidencing unsustainable development. These patterns indicate that Hamamatsu City's industrial trajectory rested on the complementary foundations of Tenryū River basin timber resources and multiple banking institutions, while Yokkaichi City's growth decelerated amid forest resource scarcity and financial underdevelopment.

The foregoing analysis demonstrates that regional developmental divergences were determined not merely by variations in company counts or population size, but substantially by the abundance and sustainability of "bridging actors"—such as mediating executives—and complementary financial and resource infrastructures. Specifically, Hamamatsu City, where bridging actors operated robustly, enhanced network cohesion and achieved sustained growth, whereas Yokkaichi City, constrained by limited such actors, experienced developmental deceleration.

This divergence demonstrably shaped the subsequent industrial trajectories of both cities. Post-World War II, Yokkaichi City developed a major industrial complex under national and prefectural auspices, evolving into a heavy chemical industry hub centered on energy and petrochemicals. In contrast, Hamamatsu City leveraged its Meiji-era industrial and human networks, fostering post-war collaboration among small and medium-sized enterprises in musical instruments, motorcycles, and transport equipment. Firms such as Yamaha, Suzuki, and Kawai Musical Instruments, in particular, benefited from accumulated local craftsmanship and inter-firm connectivity, propelling the city toward recognition as a national industrial center.

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