Consumption Smoothing in Metropolis: Evidence from Working-class Households in Prewar Tokyo

Kota Ogasawara*

Tokyo Institute of Technology
(Institute of Science Tokyo)

September 4, 2024

Abstract

I analyzed the risk-coping strategies among factory worker households in early 20th-century Tokyo. I digitized and analyzed a unique daily longitudinal household budget survey to determine how consumption was impacted by idiosyncratic shocks. I found that while the households were so vulnerable that the shocks impacted their consumption levels, the estimated income elasticity for food consumption was relatively low in the short run. The event-study analysis using adverse health shock confirms the robustness of the results. The result of mechanism analysis suggests that credit purchases with local retailers smoothed short-run food consumption. Despite the potential loss of profit, retailers in a competitive situation allowed consumers to trade on credit. This shows the roles of informal credit institutions in mitigating vulnerability among urban worker households.

Keywords: Consumption smoothing; credit institution; urban local community; measurement error; risk-coping strategy; risk-sharing

JEL Codes: E21; N35

*Department of Industrial Engineering and Economics, School of Engineering, Tokyo Institute of Technology (Institute of Science Tokyo), 2-12-1, Ookayama, Meguro-ku, Tokyo 152-8552, Japan (E-mail: ogasawara.k.ab@m.titech.ac.jp).

I wish to thank Janet Hunter, Masayuki Tanimoto, Naofumi Nakamura, Yasuyuki Sawada, and the seminar participants at the University of Tokyo and Meiji University for their helpful comments. I am thankful to the Ohara Institute for Social Research for providing access to the archives of the Tsukishima Survey and Gonda Yasunosuke. I am grateful to the Center for International Research on the Japanese Economy (CIRJE) at the University of Tokyo for granting me the opportunity to be a short-term visitor in 2024. There are no conflicts of interest to declare. All remaining errors are my own.

1 Introduction

Economic theory illustrates the mechanism behind the smoothing of consumption in complete markets (Arrow and Debreu 1954). Additionally, a series of empirical studies have tested the smoothness of consumption among households in various economies under systematic empirical specification. Evidence shows that markets in contemporary developing countries are often imperfect.[1] The households are vulnerable to risk, and idiosyncratic shocks impact the levels of their consumption because shocks are not fully insured in the markets. Therefore, consumption smoothing is an essential mechanism for mitigating poverty, especially in developing economies.[2]

Credit institutions in local society can mitigate idiosyncratic income shocks, especially when the availability of formal financial institutions is limited. Udry (1994) showed that state-contingent loans among relatives and neighbors could partially insure against idiosyncratic shocks on rural households in northern Nigeria. A detailed field survey revealed that asymmetric information was no longer important in those private credit contracts (Udry 1990). Fafchamps and Lund (2003) also presented evidence that the households in the rural Philippines used informal networks with relatives and friends as a risk-mitigation strategy for idiosyncratic shocks. Related studies consider risk-sharing among households with similar cultural and institutional backgrounds. Grimard (1997) showed that insurance among households in the same ethnic group could partially mitigate idiosyncratic shocks in the multiethnic economy of Côte d'Ivoire. Munshi and Rosenzweig (2016) presented the importance of rural insurance networks among workers in the same caste in the context of spatial wage inequality in India. The evidence suggests that the availability of informal credit institutions relates to the stability of consumption in rural economies.

This study assesses risk-coping behavior in informal credit transactions in the urban community in early twentieth-century Tokyo. I digitized and analyzed a unique daily longitudinal budget survey on factory worker households conducted in a representative manufacturing area. I found that the full insurance hypothesis is strongly rejected for overall consumption expenditure, meaning that the factory worker households in the historical metropolis suffered certain consumption losses when they faced idiosyncratic adverse income shocks. However, expenses on indispensable consumption categories were partially smoothed in the short run. Credit purchases in local retailers played an important role in mitigating adverse idiosyncratic shocks, whereas the other risk-mitigation strategies were impractical. Credit purchases did not require an explicit contract and thus often led to a loss in sales for the retailers. However, to remain competitive, retailers allowed credit

[1]The early representative literature includes, for example, Townsend (1994), Townsend (1995), and Ravallion and Chaudhuri (1997). Morduch (1999), Townsend (1995), and Dercon (2004) provide reviews of the earlier studies. Attanasio and Pistaferri (2016) and Meyer and Sullivan (2023) provide recent discussions.

[2]Smoothness of consumption is also an important factor in human capital formation. For example, Foster (1995) investigates the shock of the 1988 floods in Bangladesh and shows that children's growth patterns are influenced by the inefficiency of the credit markets. Rose (1999) investigates the relationship between consumption smoothing and excess losses of girls, revealing that the favorable rainfall events in early life increased the survival probabilities of girls in rural India. Gertler and Gruber (2002) also shows that consumption smoothing against health shocks is imperfect in Indonesia.

transactions for their customers to remain regular customers. This shows that informal credit institutions in urban local communities functioned as informal insurance networks in rural economies.

The first contribution of this study is to offer a case study of a metropolis in a developing economy. Urbanization is now a worldwide phenomenon. Moreover, the proportions of urban population in many developing countries, especially in East Asia, are reaching a similar level to the developed countries (Henderson and Turner 2020). This requires a deeper understanding of consumption behavior among urban working households in the economic development process. However, risk-mitigation strategies among urban worker households have been understudied.[3] Although several studies considered consumption smoothing among urban households in postwar Bangkok and prewar Osaka, the risk-mitigation mechanisms, particularly via credit institutions, are not fully evaluated.[4] This study considers a set of homogeneous households in a representative manufacturing area in prewar Tokyo, which provides a valuable empirical setting for testing risk-sharing strategies in the historical metropolis.[5] My findings show that informal credit institutions in the local urban community could mitigate vulnerability among households similar to rural developing economies (Fafchamps and Lund 2003; Udry 1994).

The second contribution is to add analytical perspectives to economic history studies. First, studies of how working-class households overcame their economic hardships during the late 19th to the early 20th century have focused primarily on Britain. The weight of evidence supports the roles of historical financial institutions and labor supply adjustments in compensating for income loss in working-class households.[6] However, there is little evidence of how those risk-coping strategies smoothed their consumption. Similarly, previous studies have used cross-sectional variations in income to estimate the elasticities of the temporary income sources.[7] The estimated elasticity is, therefore, potentially disturbed by household-specific unobservable confounding factors such as preference and learning ability. As risk-mitigation is a concept in the dynamic behavior of a specific household, the estimator derived from within variations of the units is more suitable for

[3]Extant studies have focused particularly on the rural economies (e.g., Gertler and Gruber 2002; Ravallion and Chaudhuri 1997; Townsend 1994). Recent field experimental studies also focus on village economies (Comola and Prina 2023; Macours et al. 2022).

[4]See Townsend (1995) and Ogasawara (2024), respectively. Osaka was middle scale city of approximately half the size of Tokyo City circa 1920 (Online Appendix Table A.1). (Aguila et al. 2017; Skoufias and Quisumbing 2005) also provided case studies on middle-sized contemporary economies. However, they did not consider the roles of local credit institutions.

[5]Focusing on a sample that shares similar occupational and regional characteristics systematically mitigates bias in estimating income elasticity under the standard risk-sharing regressions due to the heterogeneity in the risk preferences (Mazzocco and Saini 2012; Schulhofer-Wohl 2011).

[6]Horrell and Oxley (2000) highlight the important role of labor supply adjustments among family members to manage the income losses of the head in working-class households in late 19th-century Britain. Scott and Walker (2012) also found that interwar British working-class households had access to various institutions such as clothing clubs, hire-purchase, contractual savings, and insurance. The households with less earnings were likely to use credit-based institutions like clubs and hire-purchase, whereas those with higher incomes could use savings institutions. Kiesling (1996) and Boyer (1997) focused on the risk-mitigation strategies among the cotton workers households in Lancashire during the recession caused by the Civil War.

[7]For example, Horrell and Oxley (2000) and James and Suto (2011) consider the deviations of actual earnings from the predicted earnings as the shocks. Scott and Walker (2012) employed the cross-sectional

evaluating the roles of risk-mitigation strategies. This study implements a stylized econometric method for the panel dataset to offer comparable estimates for future studies. Second, this study adds micro-level evidence on consumer strategies during industrialization. Francks (2009) provides a comprehensive view of the long-run consumption history in Japan from the Edo era to the twentieth century.[8] This study employs an alternative analytical view by focusing on short-run consumption strategies. An examination of how, and the extent to which, the local society could ensure household consumption provides valuable insights into consumption history literature. Third, several financial historical studies provide supply-side (lender-side) evidence on the functions of the micro-financial institutions for the workers (O'Connell and Reid 2005). This study is the first to document the function of informal credit transactions by local retailers in the context of consumption smoothing. Munshi and Rosenzweig (2016) linked spatial wage inequality and men's mobility in India with the availability of risk-mitigation networks among workers in the same caste. From this perspective, lower barriers of local credit institutions may motivate rural workers to urbanize, which may partially explain why Tokyo grew so fast circa WWI. This hypothesis requires testing in future research.

2 Historical Background

2.1 Japanese Economy *circa* the First World War

Between 1885 and 1915, the Japanese real GNP grew annually by 2.6%, whereas the population increased by 1.1%.[9] Soon after the outbreak of WWI, exports from European countries declined. Japan increased exports to the Asian market on behalf of those European countries and exported munitions and foodstuffs to the European Allies, leading to a current account surplus. The import substitution expanded the domestic market and led to a rise in the machinery, metal, and chemical sectors. A worldwide shortage of ships also stimulated the development of shipbuilding, which proliferated. The development of the shipbuilding industry further stimulated demand for the machinery and steel industries. Through this process of heavy and chemical industrialization, the total number of enterprises increased.[10] Figure 1 shows that the GNP growth from 1915–19 was 11.5% in

variations in the pooled cross-sectional sample to analyze the smoothness of expenditure (deviation from mean expenditure). An exceptional study is Saaritsa (2011), which shows the estimated elasticity of temporary income from a fixed effect one-way error component model using a panel household budget survey in 1928 Helsinki.

[8]Several business history studies analyze the relationship between consumption and production. A representative work is Gordon (2013), which investigated the expansion of the sewing machine from many perspectives, including production, distribution, and gender social norms in Japan. However, these studies have not focused on the households' risk-mitigation strategies. Some studies investigated the relationships between household chores and consumption strategies in interwar households (Tanimoto 2011, 2012).

[9]Faster economic than population growth implies that modern economic growth had started in this period as defined by Simon Kuznets (Miyamoto 2008, pp. 60; 64). In 1915, the percentage of the employed population in the primary, secondary, and tertiary industries were 63%, 20%, and 18%, respectively. Based on domestic genuine production, these industries accounted for just under 30%, over 30%, and approximately 40%, respectively.

[10]Descriptions about the process of heavy chemical industrialization are based on Nakamura (1971, p. 128), Nakamura and Odaka (1989, p. 10), and Sawai and Tanimoto (2016, p. 250). Year-on-year growth

nominal terms (4.4% in real terms), the highest growth throughout the 1910s and 1920s.

This rapid industrialization impacted the Japanese economy in many ways. Due to export-led economic growth, large inflows of gold increased domestic currency balances, causing prices to soar. Although wages began to rise *circa* 1916 as a response to rising prices and labor demand due to the increased number of firms, wage increases failed to keep pace with soaring prices. By the end of the war, the number of labor disputes grew sharply, and the labor movement flourished. Furthermore, the rise of business accelerated urbanization as the rural population moved to cities in search of job opportunities. The share of large cities (with a population of $50,000$ or more) as a percentage of the total population was less than 10% in 1889 but increased to nearly 16% in 1920 (Online Appendix Figure A.1). The growth rate was exceptionally high during WWI, indicating that structural changes through the war accelerated the rise of the urban population. Urbanization has increased public investment in large cities, especially in construction investment in social capital such as roads and water supply systems.[11]

Exports in the 1920s were lower because of the appreciation of the yen against the real exchange rate due to the accumulation of domestic and foreign currencies during WWI. As the current account deficit was settled through the disbursement of foreign currencies owned by the government and the Bank of Japan, there was no reduction in the domestic money supply despite the sizeable current account deficit. This resulted in the domestic prices (especially prices of non-tradable goods) remaining high. The first half of the 1920s saw a temporary decline in industrial investment as the capital investment boom of the WWI period came to a halt under declining demand.[12]

As described, there was a short-term business cycle characterized by the boom caused by WWI and the subsequent recession. However, as a whole, Japan achieved a high economic growth rate relative to other countries in the early 20th century. As shown in Figure 1, the growth rates of personal consumption expenditure were particularly high during and immediately after WWI, with average growth rates reaching 112% in 1915–19 and 118% in 1920–24. This was a high level by international standards.[13] This highlights the importance of revealing the consumption behavior of urban households to understand the mechanisms underpinning the rapid Japanese economic growth in this period.

2.2 Tsukishima: A Representative Manufacturing Area

The population in Tokyo City has been growing since the end of the 19th century, and industrialization due to WWI spurred its growth. Tokyo City's population share increased

in the number of incorporated firms was 17.8%, 22.3%, and 13.5% in 1918, 1919, and 1920, respectively. These are the top three of the 34 years from after the Russo-Japanese War to 1940 (Nakamura and Odaka 1989, p. 22).

[11]Descriptions of the export-led growths, urbanization, and investments are from Nakamura and Odaka (1989, pp. 21–23) and Nakamura (1971, pp. 142; 147).

[12]Conversely, construction investment by the private sector, including electric power and private railways, increased (Nakamura 1971, p. 145). Descriptions about the post-war economy in this paragraph are from Sawai and Tanimoto (2016, pp. 253–254).

[13]Total consumption as a percentage of the GNP remained above 80%. Although this level is not apparent among other countries (Kuznets 1962), the growth rate of real personal consumption per capita was relatively high: from 1875 to 1939, the average growth rate of personal consumption was 1.36%,

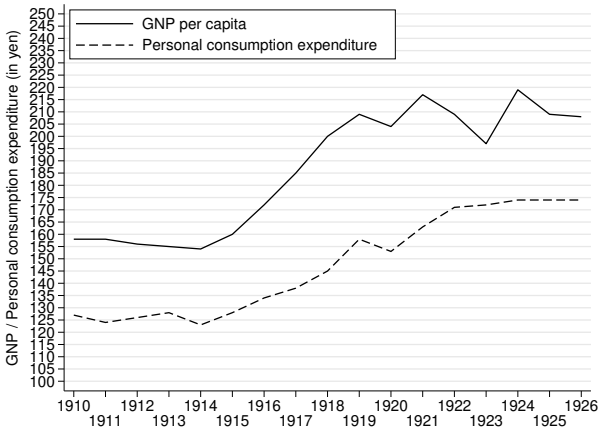


Figure 1: Gross National Product per Capita and Personal Consumption Expenditure (in yen)

Note: This figure shows the gross national product per capita (solid line) and personal consumption expenditure (dashed line) between 1910 and 1926. The prices are deflated using the CPI in 1934–1935 price.
Source: Created by the author using Ohkawa et. al. (1974, p. 237).

from 2.5% in 1889 to approximately 4% by 1920.[14] Throughout the 1910s, the percentage of industrial and commercial workers increased in Tokyo City, building the city as a gigantic commercial and industrial place (Tanimoto 2002, p. 8). Column 1 of Panel A in Table 1 shows that nearly half of the male workers in Tokyo worked in the industrial sector as of 1920.

The subject of this paper is Tsukishima, an industrial area located southeast of Kyobashi Ward in Tokyo (Figure 2).[15] Column (2) of Panel A in Table 1 shows that Kyobashi had an industrial composition like that of Tokyo City in 1920. Column (3) confirms that Tsukishima is a representative industrial area in the city; approximately 68% of male workers were employed in the manufacturing sector. In the same year, there were 214 factories on this island, and approximately 80% of them belonged to the machinery and related sectors (Department of Health, Ministry of the Interior 1923a, pp 385–389).[16] Figure 3 shows the spatial distribution of factories in Tsukishima as of June 30, 1918. Tsukishima had many machine factories and shipyards, and the workers' residences were clustered there.[17] The focus of this study is the consumption behavior of these worker

and the rates never became negative except during the Russo-Japanese War period. Descriptions on the personal consumption expenditure are from Nakamura (1971, pp. 2–5; 27; 30–31).

[14]In 1920, there were more than 10,000 municipalities in Japan, suggesting how large Tokyo was. There was a difference of about 1 million between Tokyo and Osaka, the second-largest city by population. Online Appendix Figure A.1 summarizes the trends in the number of people in the top five cities between 1889 and 1920.

[15]The base of the island was reclaimed during the Edo and Meiji periods from a delta at the mouth of the Sumida River. Online Appendix A.3 summarizes the development history of Tsukishima in detail.

[16]According to the census of 1920, the number of workers in the metal and machinery equipment manufacturing industry (27.1%) was the highest compared to other industries in the entire city of Tokyo. The same tendency was observed in Kyobashi Ward (35.5%). Although similar statistics are not available for Tsukishima, this supports the evidence that Kyobashi was not an area with a unique industrial pattern (Statistics Bureau of the Cabinet 1929c, pp. 85–86; 108–109)).

[17]For example, a representative shipbuilding plant was located on Ishikawajima, an island in the north

Figure 2: Administrative Wards in Tokyo City

Notes: The name in each lattice indicates the administrative ward in Tokyo. The gray ward indicates the Kyobashi Ward and an island in the Kyobashi Ward indicates Tsukishima. The border surrounded by Asakusa, Honjyo, Nihonbashi, and Fukagawa wards includes the Sumida River. The borders of each ward are based on the administrative districts in 1920. Geographical coordinate system is based on JGD2000/(B, L).
Source: Created by the author using the official shapefile (Ministry of Land, Infrastructure, Transport and Tourism, database).

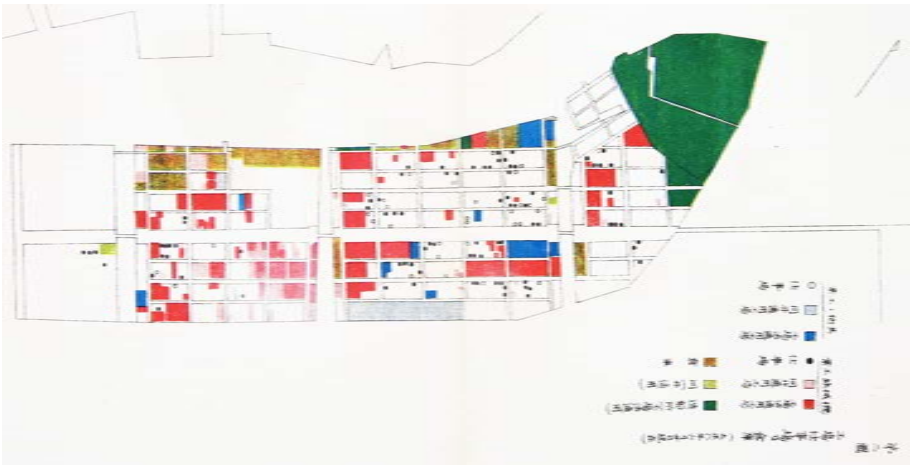


Figure 3: Factories in Tsukishima

Notes: Blocks in green and light green indicate the shipyards. Blocks in red and pink indicate the factories in the machinery sector. Blocks in blue and light blue indicate the factories in the other manufacturing sectors. Blocks in brown are the warehouses. Small circles colored in black and white show the workplaces in the machinery and other manufacturing sectors, respectively.
Source: Department of Health, Ministry of the Interior 1923c, second map. The tone was adjusted by the author using Adobe Photoshop 24.7.0.

households in the industrial sector.

Panel B in Table 1 summarizes the population and occupational statistics from the census to examine the characteristics of working-class households in Tsukishima. First, the average household size in Tsukishima is 4.3—similar to but slightly smaller than the values in Tokyo City (4.6) and Kyobashi Ward (4.7). The percentage of the married male population is 40%, which is similar to the range of the figures for Tokyo (38%) and Kyobashi (36%). The average age of men in Tsukishima is 25.1, slightly lower than the figures for Tokyo and Kyobashi. While the sex ratio by age group in Tsukishima shows a similar trend to that of Tokyo and Kyobashi, the ratios for the 14–19 and 20–29 age bins are higher than those. Overall, these statistics reflect the fact that Tsukishima was a typical industrial area and many young male workers were employed there. The slightly smaller household size in Tsukishima can be attributed to the relatively large number of young factory worker households. The percentage of married men in Tsukishima suggests that a certain proportion of the households in their early 20s might have been couples before they started raising children.

Finally, I provide a brief overview of the lives of the factory workers' households in Tsukishima. Factories and workers' residences were scattered throughout the island. The factory workers lived in similar tenements and used the commercial stores and restaurants in the central lot.[18] There were two postal offices, 13 pawnshops, and five moneylenders, which were scattered throughout the island (Online Appendix Figure A.2). The main routes to the mainland were the wooden Aioi Bridge (*Aioi bashi*) and three ferries (*watashi bune*). The average *daily* total number of people using the ferries in 1918 was reported to be 53,318, accounting for more than twice as many people as the Tsukishima population.[19] These descriptions illustrate Tsukishima as a busy machine manufacturing area during industrialization.

2.3 Risk-coping Institutions

Working-class households were exposed to several risks that led to losses of income at that time. Generally, social insurance, such as health, accident, and unemployment insurance,

of Tsukishima (Figure 3). Ships were strongly influenced by the import substitution that was underway at the beginning of the 20th century, and domestic production of ships progressed (Section 2.1). The production of a hydraulic 80-ton hardened crane by Ishikawajima Shipyard in 1917 is an example of the domestic output of a product that had previously relied on imports (Nakamura and Odaka 1989, pp. 10; 32).

[18]Tsukishima is composed of Ishikawajima island at the northern end, the adjacent Tsukudajima and Shin-tsukudajima islands, and the rectangular Lots 1–3 in the south (Online Appendix Figure A.3). Specifically, factories and worker residences were scattered throughout Shin-tsukudajima and Lots 1 and 2, whereas Lot 3, a relatively new reclaimed site completed in 1913, was undeveloped. Online Appendix A.4 summarizes the housing in Tsukishima in detail using a housing survey. There were 209, 109, 74, and 120 stores selling daily necessities, clothing, tools, and food, drink, and entertainment, respectively. Regarding medical personnel, there were eight doctors, four dentists, eight obstetricians, and 14 drug stores. There were also ten bathhouses (Department of Health, Ministry of the Interior 1923a, pp. 41–47).

[19]See Department of Health, Ministry of the Interior (1923a, p. 30). The number of people and households in Tsukishima at the end of December 1918 was reported to be 24,399 and 5,562, respectively (National Police Agency 1920a, pp. 50–51). Online Appendix Figure A.3 shows the routes of the ferries.

Table 1: Industrial and Family Structures in Tsukishima

Panel A: Industrial structure

Name of survey	(1) 1920 Population census	(2) 1920 Population census	(3) 1920 Population census
Survey area	Tokyo City	Kyobashi Ward	Tsukishima
Survey subject	Complete survey	Complete survey	Complete survey
Survey month and year	October 1920	October 1920	October 1920
Agriculture	1.0	0.6	0.4
Fisheries	0.1	0.3	0.8
Mining	0.4	0.4	0.8
Manufacturing	44.5	45.2	67.7
Commerce	32.4	34.0	16.9
Transport	7.6	10.2	6.1
Public service and professions	11.3	10.2	4.6
Housework	0.3	0.1	0.2
Other industry	2.4	2.0	2.5

Panel B: Demographic structure

Name of survey	(1) 1920 Population census	(2) 1920 Population census	(3) 1920 Population census
Survey area	Tokyo City	Kyobashi Ward	Tsukishima
Survey subject	Complete survey	Complete survey	Complete survey
Survey month and year	October 1920	October 1920	October 1920
Average household size (in person)	4.6	4.7	4.3
Share of married males (%)	38	36	40
Sex ratio (males/females)	1.2	1.2	1.3
0–13 years	1.1	1.1	1.1
14–19 years	1.5	1.7	2.2
20–29 years	1.3	1.4	1.6
30–39 years	1.2	1.2	1.3
40–49 years	1.2	1.2	1.3
50–59 years	1.1	1.1	1.2
60+	0.8	0.8	0.9
Average age of males	25.3	25.3	25.1

Notes:

Panel A: This panel summarizes the industrial structures based on the occupations of male workers measured in the 1920 population census. Each share is calculated as the number of males who worked as regular workers in each sector divided by the total number of male workers (in percentage). All the figures do not include the number of unemployed (*mugyō sha*) males.

Panel B: The average household size is the number of people divided by the number of households. The share of married males is the number of married males living with/without spouses divided by the total number of males (in percentage). The average age of males is calculated using the tables for population by age group reported in the census. As the tables are open-ended, the class for over 60 years old is rounded as 64.5 following the range of the former category (i.e., 50–59). All the figures in this panel do not include a small number of quasi-households (*jyun setai*), which include the person, such as the students in dormitories and the patients in hospitals.

The figures for Tsukishima listed in column 3 of both panels are based on the total sum of statistics of all the blocks (*chōme*) in Tsukishima (i.e., from *Tsukudajima* to *Tsukishima dōri jyūni chōme*).

Sources: Columns 1 and 2 of Panel A use the Statistics Bureau of the Cabinet (1929c, pp. 18–19). Columns 1 and 2 of Panel B use the Statistics Bureau of the Cabinet (1929c, pp. 38–43); Tokyo City Office (1922b, pp. 2–3; 42–46). Column 3 of Panel A uses the Tokyo City Office (1922c, pp. 42–47). Column 3 of Panel B uses the Tokyo City Office (1922a, pp. 26–31); Tokyo City Office (1922b, pp. 2–3; 42–46).

can mitigate idiosyncratic income shocks on workers.[20] However, comprehensive social insurance systems did not exist in the early 1920s in Japan. The previous health insurance was enacted in 1927, and unemployment insurance was not established throughout the prewar period. Additionally, the Factory Act enacted in 1916 did not specify compensation for the sickness of workers. Therefore, they had no public support for their illness, injuries, and unemployment. Instead, they might have used private financial institutions to manage idiosyncratic risks.

Several financial institutions were available for working-class households. A representative savings institution was the postal savings (*yūbin chokin*). In Tokyo City, approximately 1.4 million people had postal savings accounts, covering approximately 67% of the citizens in 1920 (Online Appendix Table A.2). The average savings amount per capita in Kyobashi Ward was 44.5 yen (Tokyo City Office 1921, pp. 892–893), which was less than one month's earnings for the skilled-factory workers (Section 3.2). Savings bank (*chochiku ginkō*) was another famous savings institution among the working class in the 1910s (Ito and Saito 2019, pp. 79–81). The number of people with savings accounts was approximately 1.4 million, accounting for approximately 58% of total people in Tokyo (Online Appendix Table A.2). However, 84.8% of all the depositors were commercial and miscellaneous workers, and the manufacturing sector shared only 11.5% in Kyobashi Ward (Online Appendix Table A.3). This reflects the fact that savings banks were institutions designed for lower-income workers rather than factory workers (Tokyo Institute for Municipal Research 1925b, p. 81). This is consistent with the fact that Tsukishima did not have any savings bank branches, while there were two postal offices (Section 2.2). Although another savings institution was the mutual loan association (*mujin*), it was used among small business owners and merchants for running their businesses (Online Appendix A.2).[21]

There were also few lending institutions. Credit purchases (*kakegai*) with retailers were the most popular institution. Although systematic statistics of credit purchases are unavailable, the THBS households often used credit purchases in various retailers for rice, fish, vegetables, firewood, and charcoal.[22] I will describe this institution in detail in

[20]Gertler and Gruber (2002) shows the impact of illness on consumption-smoothing behavior in the early 1990s in Indonesia and argues for the importance of public compensation for illness. Kantor and Fishback (1996) show that the installation of workers' compensation reduced the precautionary savings in the interwar US. Gruber (1997) provides evidence that unemployment insurance smooths individual consumption as was the case in the US from 1968–1987.

[21]Ordinary banks in prewar Japan provided large loans to businesses (Teranishi 2011). There was no bank in Tsukishima, as workers did not borrow money from banks to make ends meet. The official report states that "a commercial bank is not necessary in a laboring area such as Tsukishima, and even for large entrepreneurs such as factory owners, there is no particular need to establish a bank for their business transactions; transactions with banks in other areas are sufficient" (Department of Health, Ministry of the Interior 1923a, p. 48).

[22]Cooperative societies were also available for worker households to buy daily commodities, although they were not lending institutions. There were 26 cooperative societies in Tokyo prefecture in 1924, of which 23 were organized by the citizens and workers (Central Federation of Industrial Associations 1925, p. 57–59). However, while the two largest societies had approximately 4,000 members, the others were generally small societies with less than 100 members. This figure accounts for only a few percentage of the workers in the city, given that the number of male workers was more than 768 thousand. In fact, the THBS households rarely used the cooperatives.

Section 5. The pawnshop (*shichiya*) was another lending institution. The accessibility was higher than for the other lending institutions.[23] There were 13 pawnshops in Tsukishima, more than twice the number of moneylenders (Section 2.2). However, the primary users of the pawnshops were the low-income working-class households rather than the factory workers (Tokyo City Social Affairs Bureau 1921, p. 9). According to the statistics on the pawnshop users in Tokyo prefecture in 1923, the most representative users were the day laborers and workers classified as "miscellaneous," accounting for 63.4% of all users. By contrast, those for agriculture, commerce, and manufacturing sectors were only 1.7, 19.5, and 15.6%, respectively (Tokyo Institute for Municipal Research 1926, p. 25). The inexpensive articles pawned suggest that the pawnshops were only used to dealing with very short-run loans for necessities. Among the pawnshops of Kyobashi, for example, the average amount per case was 7.8 yen, which accounts for 12% of the monthly disposable income of the THBS households (Panel A of Table 3). Thus, the pawnshop was a small lending institution for low-income working-class households who needed credit. Indeed, lenders did not need to screen the borrower's credit, and the borrowers did not worry about incurring heavy debt as the main articles pawned were inexpensive clothes (Shibuya et al. 1982). Additionally, the interest rates were regulated by the Pawnbroker Regulation Act of 1895, and the average redemption rate was substantially high under the lower interest rates.[24]

Other lending institutions were money lenders (*kinsen kashitsuke gyō*) and credit unions (*shinyō kumiai*). Generally, moneylenders were used by business owners with very high interest rates (Shibuya 2000, pp. 184; 248). Similarly, the coverage of the credit unions was substantially low, possibly a few percentage points of the male workers in the manufacturing sector (Online Appendix A.2).

Informal gifts might have been another type of risk-mitigation institution, although systematic statistics are not available. A household survey on the 185 factory-worker households in Tokyo suggests that the share of average monthly gifts in total income was approximately 3% in November 1922 (Social Affairs Division 1925, pp. 58–59). While this means that the gifts comprised a few percentage points of the monthly income, it is unclear whether these informal income transfers functioned as mutual aid.

Finally, life insurance was not designed to compensate for temporary income losses. Generally, life insurance companies provided death insurance, meaning that temporary income reductions were not covered. Moreover, they did not target the working class as customers (Usami 1984, pp. 87–88). Although postal life insurance (*kani seimei hoken*) operated by the government started in 1916, it only provided life and endowment insurance. Thus, it never covered illness or unemployment (Usami 1984, pp. 102–107). [25]

To summarize, while there were several lending institutions, few were available to the factory workers. Postal savings might have been the best available device for them. Credit

[23]The number of pawnshops in Tokyo was 1,334 and 1,261 in 1918 and 1919, respectively. The total number of cases was 8,226,883 and 7,573,406 each year. These figures are more than three times greater than the entire population in Tokyo City.

[24]The average redemption rate was approximately 94% in 1920 among 88 pawnshops in Kyobashi (401,222 cases/427,265 cases) (Tokyo City Office 1922b, pp. 888–889).

[25]There were also several employment agencies that introduced jobs to low-income job-seekers in Tokyo. However, many of them were unscrupulous, and not commonly used at that time (Machida 2016).

purchase was the most plausible device regarding lending institutions. While pawnshops were accessible, they might not have provided sufficient money as the articles pawned were usually inexpensive. The factory workers in Tsukishima might have combined these devices to manage idiosyncratic income shocks.

3 Data

3.1 Tsukishima Household Budget Survey

The Tsukishima Survey was the first urban social survey conducted in Japan by the Ministry of Home Affairs *circa* 1919. The purpose was to investigate the status of the lives of urban worker households amid the rapid industrialization throughout WWI. It was designed as a field survey consisting of multiple survey items, including the budget survey (hereinafter THBS).[26] The Ministry of Home Affairs published a few official reports on the Tsukishima Survey in 1921, which contained some aggregated information on the target households. However, household-level budget information is required to analyze consumption-smoothing strategies.

Fortunately, the household budget book (*kinsendeiri hikaechō*) gathered in the THBS is preserved in the archives of the Ohara Institute of Social Research (hereafter, OISR).[27] These budget books were transferred to the OISR by Iwasaburo Takano, who was responsible for the Tsukishima Survey as a member of the 7th Section of the Health and Hygiene Research Committee of the Ministry of Home Affairs and became the first director of the OISR.[28]

I corrected and digitized all forty THBS budget books for the factory worker households that were included in the official report.[29] During the study period, each household recorded their income and expenses daily in a budget book. Notably, a survey office was set up in Tsukishima, where a few surveyors lived and were closely connected with the survey households. Furthermore, weekly administrative meetings were held to discuss the progress of the survey (Miyoshi 1980, p. 38). This confirms that the information in these budget books is reliable and that the THBS budget dataset ensures a quality that enables quantitative analysis.[30]

[26]The THBS was the first household survey in Japan to use the budget book method and is considered the prototype for subsequent household surveys in Japan (Sekiya 1970, p. 43). Online Appendix B.1 summarizes detailed information about the Tsukishima Survey.

[27]The author was permitted to access those unreleased materials related to the Tsukishima Survey by the OISR: Archives of the Tsukishima Survey (THBS, unreleased). The official reports of the survey published in 1921 by the Ministry of Home Affairs are included in the archives of Gonda Yasunosuke at the OISR and are available to the public (The OISR, Archives of Gonda Yasunosuke (7-2; 7-3; 7-4)).

[28]Iwasaburo Takano was a professor at Tokyo Imperial University and a specialist in social statistics and social policy. He emphasized gathering statistics about workers through social surveys and is known as a researcher who significantly contributed to the formation of social survey methodology in Japan. His contribution to the Tsukishima Survey is summarized in detail in the Online Appendix B.1.

[29]The archives of the OISR also preserve several other household budget books of factory worker households. However, these budget books contain poor record-keeping. Therefore, I do not use these incomplete books in this study. The characteristics of the remaining household budget books are summarized in detail in the Online Appendix B.5.

[30]Online Appendix B.1 provides finder details on how the Tsukishima Survey was conducted carefully

3.2 Sample Characteristics

Analytical Sample

The estimation strategy used for testing consumption-smoothing and risk-coping strategies requires panel structures for aggregate income and expenditure (Section 4). I use the semi-monthly series for baseline analysis, given that the head's income was paid twice monthly.[31] Among the 40 THBS households, there are five cross-sectional units in our semi-monthly data. I excluded these five cross-sectional units, leaving 35 households. Next, I removed a household with incomplete income information. Finally, I excluded a household for which no information on payments to the credit purchases was recorded. Consequently, my THBS sample for the semi-monthly series included 33 households with panel structures from January 12 to November 11, 1919.[32]

Before assessing the representatives of the THBS sample, I tested the potential selection bias due to attrition of the units. The panel units with shorter (longer) time-series observations might have different preferences on the consumption than those with longer (shorter) time-series observations. In other words, the households with shorter panels should have similar family size characteristics to those with more extended panels. To test this potential issue, I regressed an indicator variable for the shorter panel units on the family size variables. Online Appendix Table B.2 summarizes the results. All the estimated coefficients on the covariates were close to zero and statistically insignificant, and the Wald statistics support the null results. This is robust to using different thresholds such as first quantile, median, and third quantile. This supports the evidence that the household's preference was less likely to be correlated with a lack of balance.

Representativeness

Next, I assess the representativeness of the THBS sample in Tsukishima using the manufacturing and population censuses.

Panel A of Table 2 summarizes the share of male workers in the manufacturing industry by sector. Statistics of the National Police Agency (hereafter SNPA) covering factories with more than or equal to 15 workers show that approximately 90% of male workers were engaged in the machinery sector in 1919 (Column 1). Column 2 summarizes the statistics in the manufacturing census conducted in the Tsukishima Factory Survey. The proportion of machine factories is 85% in larger factories and 92% in smaller factories, indicating that most of the male workers worked in the machinery sector.[33] In Column 3, I confirm that the THBS heads' occupations show a similar proportion: 94% worked in the machinery sector. In fact, the report states that "It is not too much to say that most of

as a social survey project of Takano.

[31] Section 3.3 provides details on the definitions of aggregate income and expenditure.

[32] I also used the adjusted monthly panel dataset for sub-analysis in Section 4. Following the same trimming steps, my adjusted monthly panel dataset included 26 households for the same period. Note that several units have only three semi-month cells, for example, less than two adjusted months. These units have a panel structure in the semi-monthly panel dataset, but not in the adjusted monthly panel. Online Appendix B.3 summarizes the finer details of the original data structure and trimming.

[33] I have confirmed that the paternal occupational statistics for the primary school students in Tsukishima provide materially similar results (Online Appendix A.5).

Table 2: Assessing Representativeness: Tsukishima Household Budget Survey

Panel A: Manufacturing sector

Name of survey	(1) 1919 Statistics of National Police Agency	(2) 1920 Tsukishima Factory Survey		(3) The THBS
Survey area	Tsukishima	Tsukishima		Tsukishima
Survey month and year	December 1919	November 1920		1919
Survey subject	All factories with	All factories with # of		33 households
	# of workers ≥ 15	workers ≥ 15	workers < 15	
Textile	0.2	2.9	0.0	0
Machinery	87.4	85.3	91.8	93.9
Chemical	1.1	5.9	5.5	0
Food	1.2	1.5	0.0	3.0
Miscellaneous	10.2	4.4	2.7	3.0
Observations	7,647 workers	68 factories	146 factories	33 heads

Panel B: Family structure

Name of survey	(1) 1920 Population Census	(2) 1919 Statistics of National Police Agency	(3) The THBS
Survey area	Tsukishima	Tsukishima	Tsukishima
Survey month and year	October 1920	December 1919	1919
Survey subject	Complete survey	Complete survey	33 households
Average household size	4.3	4.3	4.3
Sex ratio	1.3	1.2	1.2
Household size (% share)			
1	6.0	–	0
2	16.7 (18.7)	–	15.2
3–5	50.8 (57.1)	–	57.6
6–8	21.5 (24.2)	–	27.3
9+	4.9	–	0
Pearson χ^2 statistic p-value	–	–	0.948

Panel C: Monthly earnings

Name of survey	(1) The THBS	(2) Manufacturing Census
Survey area	Tsukishima	Tokyo City
Survey/equivalent year	1919	1919
Survey subject	THBS heads (Ave. age: 33.2)	Male factory workers in machinery factories (Age range: 30-40)
Average monthly earnings	59.1 (median = 56.2) 95%CI [53.7, 64.5]	56.0

Notes: **Panel A**: Column 1 shows the share of factory workers to the total factory workers in each sector (in percentage). The number of factory workers includes female and male factory workers in the 68 factories, with 15 workers and more. Column 2 indicates the share of factories to the total number of factories in each sector by factory size (in percentage). Column 3 summarizes the manufacturing sectors for the heads of the THBS. Columns 2 and 3 use the classification definition in the Statistics of the National Police Agency (column 1). Following this definition, several "woodworking" factories measured in the Tsukishima Factory Survey are included in the machinery sector in column 2, as it consists of shipbuilding and wooden pattern factories. The report also supports that the wooden patterns are used in the casting process and shall be included in the machinery sector (Department of Health, Ministry of the Interior 1923a, pp. 388–389).
Panel B: The first and second rows in columns 1 and 2 show the average household size and sex ratio measured in the 1920 Population Census and Statistics of the National Police Agency of 1919, respectively. The fourth to eighth rows in columns 1 and 3 show household size distributions in the census and the THBS sample, respectively. The figures in parentheses in Column (1) are the percentage share for family size bins between 2 and 8 people. The ninth row in column 3 shows the p-value from the Pearson χ^2 test for the equality of the household size distributions between 2 and 8 people. The share in each household size bin measured in the census is used as the theoretical probability in calculating the test statistic (Online Appendix B.5).
Panel C: Column 1 lists the average monthly earnings of the THBS heads calculated using the adjusted monthly panel dataset. Of the 33 THBS households, information from 26 households for which adjusted monthly income can be traced back is used in this panel to follow the unit in the manufacturing census. Comparison based on the average semi-monthly income from all 33 households shows a similar result. Gaussian-based 95% confidence interval (CI) using bootstrap standard error is reported in the brackets. Column 2 shows the average monthly wage of the male factory workers in the skilled age range (30–40 years old) in machinery factories in Tokyo City. This figure is calculated using the average monthly wage and average monthly ancillary wage measured in the manufacturing censuses. All the wage statistics are deflated using the CPI for cities provided by Ohkawa et al. (1967, p. 255). Online Appendix B.6 summarizes the finer details of the process of this wage estimation.
Sources: Panel A: Column 1 uses the National Police Agency (1920b, p. 236). Column 2 uses the Department of Health, Ministry of the Interior (1923a, p. 385–386). Column 3 uses the Department of Health, Ministry of the Interior (1923a, p. 154). Panel B: Column 1 uses the Tokyo City Office (1922a, pp. 26–31; 262–283); Tokyo City Office (1922b, pp. 2–3; 42–46). Column 2 uses the National Police Agency (1920b, p. 53). The figures in column 3 are calculated by the author using the THBS dataset. Panel C: Column 1 uses the THBS dataset. Column 2 uses the Tokyo City Statistics Division (1926a, pp. 16; 244–245); Tokyo City Office (1921, pp. 726–757).

the industry in Tsukishima is machinery manufacturing. Therefore, to describe the labor situation in Tsukishima, it is sufficient to describe its machinery industry" (Department of Health, Ministry of the Interior 1923a, p. 389). Figure 3 illustrating a number of machinery factories supports this statement. As for the other sectors, the THBS includes a few heads who worked in food and miscellaneous sectors, and the proportions are similar to those listed in Column 2.

Panel B of Table 2 summarizes the family structure. The average household sizes are identical in the Population Census (Column 1), SNPA (Column 2), and THBS (Column 3). The sex ratio is also similar across the surveys (1.2–1.3). The number of people in the THBS households ranges from 2 to 8, meaning the THBS sample does not include single or very large households.[34] In other words, the THBS mainly focuses on the consumption behavior in couples and households with a few children. For this household size range, the Pearson χ^2 test does not reject the null of equality to the household size distribution measured in the census (p-value = 0.948), meaning that the THBS sample reasonably approximates the distribution of family households in Tsukishima. Online Appendix B.5 illustrates the household size distributions in finer detail. This confirms the validity of the statement in the report that the THBS households can be "regarded as representative of the family form in Tsukishima" (Department of Health, Ministry of the Interior 1923a, p. 145).

The official report of the Tsukishima Survey suggests that approximately nine out of ten factory workers in the skilled-age range were classified as skilled workers. Approximately six of those skilled workers were employed in the middle- to large-scale factories, and three worked in small-scale factories.[35] Given this, the THBS was designed to investigate the budgets in skilled workers' households.[36] The average THBS head's age is 33, which is indeed in the skilled workers' representative age range in the machinery factories (Kitazawa 1924).[37] Column 1 of Panel C in Table 2 indicates that the average monthly earning of the THBS heads is 59 yen (median = 56 yen). In Column 2, I calculated the average monthly earning of male machinery factory workers in the skilled-age range using the manufacturing censuses, which shows similar monthly earnings (56 yen).[38] This provides evidence that the monthly earnings of the THBS heads and skilled workers'

[34]Those family households with 2–8 people cover most of the households in Tsukishima because the share of single and very large (9+ people) households was approximately 10% (Column 1 of Panel B).

[35]Online Appendix A.5 summarizes this point in detail using the complete survey of the primary school students in the 4th to 6th grades in Tsukishima.

[36]Shortly, Iwasaburo Takano, a survey director, regarded that the skilled workers in the modern industrial sector constituted the core of the labor force, labor movement, and citizens. The finer details in the background of this survey design are summarized in Online Appendix B.1.

[37]Specific occupations are not available for most heads because they are usually listed as "factory workers" in the occupation section. However, sub-categories available for some heads indicate that they were the typical skilled workers in machinery factories such as lathe operators and finishers. Online Appendix A.6 summarizes the work in the machinery factories in Tsukishima.

[38]Shortly, this figure is calculated using the average daily wage of male factory workers aged 30–40 and average annual working days measured in the manufacturing censuses. Online Appendix B.6 provides the finer details of the calculation steps. The average wages for the male factory workers had an inverted-U-shaped distribution with respect to age, taking the greatest figure in the 30s (Online Appendix Figure B.7). This is a similar life-cycle pattern to the factory workers observed in late 19th century England (Horrell and Oxley 2000, p. 42).

households in Tsukishima were materially similar. To summarize, this evidence indicates that the THBS sample is useful for inferring the mean tendency of those households.

3.3 Aggregation

Measurement Error

It is necessary to summarize the daily budget information into a more extended time range because households need a set of time to smooth their consumption given a realized amount of income. To explore a reasonable method of aggregation, I first overviewed the daily time series on the total income and expenditure. Figure 4a shows that the head's income was paid twice monthly: the semi-monthly wages were paid on the middle (14–16th) and last day (30th or 31st).[39] Importantly, Figure 4a indicates that the households expensed most of their income on the payday and spent the rest of the payment little by little until the next payday. In other words, the expenditure never clearly increased just before the paydays. This means that the households made their consumption decisions (schedules until the next payday) based on the income they obtained. Note that calendar (semi-)monthly aggregation cannot reflect this household behavior because calendar (semi-)month does not place the payday at the beginning of its cell.[40] Another source of measurement error is the shift of the payday: the payday for the latter half of a month was sometimes set on the first date of the following month. Although this shift did not occur frequently, the calendar month cell might contain substantial interference from the shift as it leads to the cells including more (three paydays) and fewer (one payday) payments than normal. Nelson (1994) suggests that this sort of mismatching in the timing of income and expenditure induces type II errors when testing consumption smoothing.

Adjustment

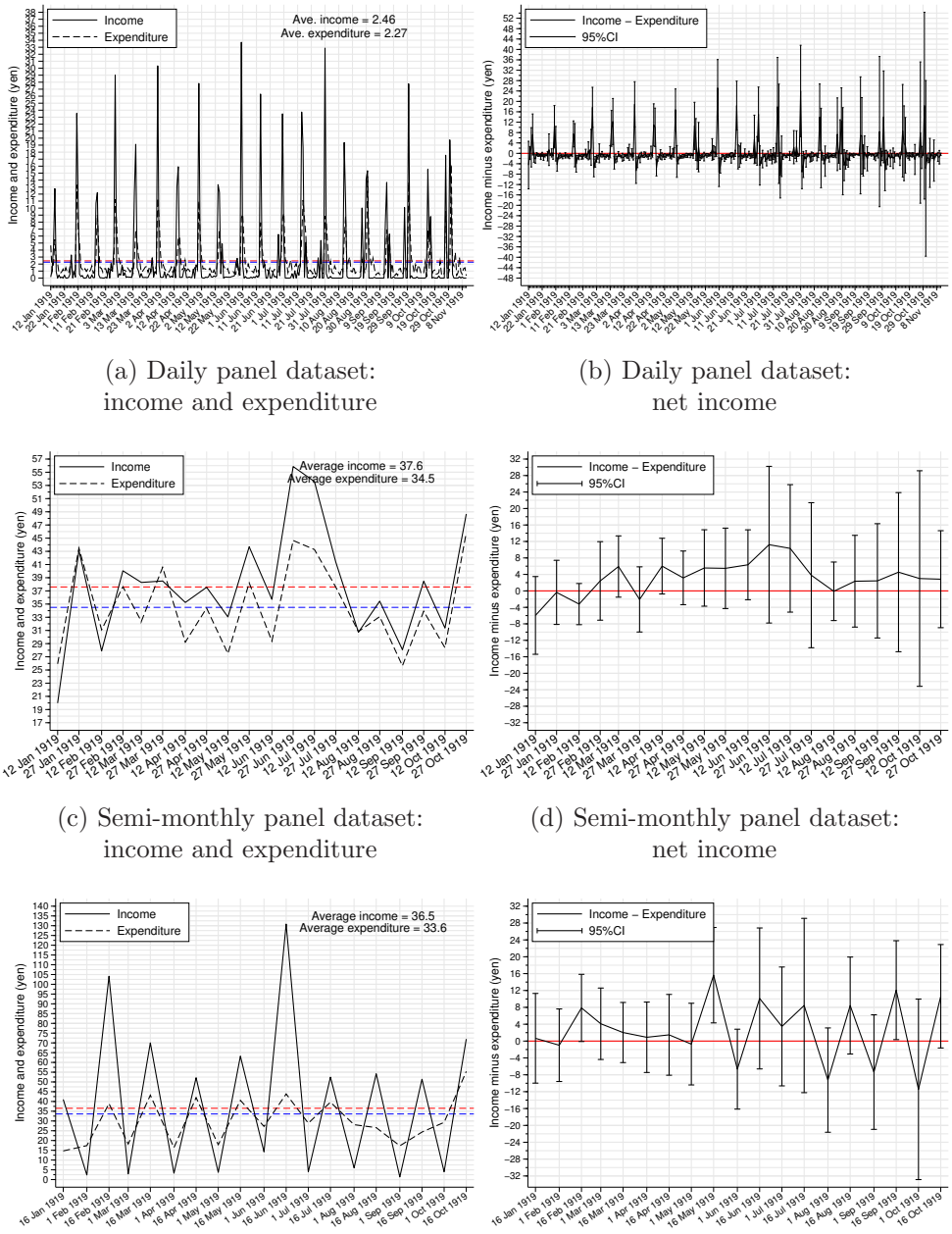
To manage the mismatch, I aggregated the daily observations between the 12th and 26th for the first half and those between the 27th and 11th of the next month for the second half.[41] This range is based on the fact that paydays in the second half of a month measured in the THBS dataset ranged from 27th to 31st.[42] Figure 4c shows the

[39]The head's income was the dominant method for earnings because the breadwinner households were typical at that time (Panel B in Table 3).

[40]For example, a calendar semi-month cell in January, for example, the cell from 1st to 14th, starts on the 1st but its payday is set for the 14th. Accordingly, this assumes that the aggregate consumption in this semi-month cell is based on the earnings at the end of its cell. This is clearly an unrealistic assumption.

[41]This means that the number of days included in a semi-month ranges from 13 (i.e., in February) to 16 (e.g., January). Note that this heterogeneity in the number of days over different semi-months is a cross-sectional constant. Thus, these differences are entirely captured using the semi-month fixed effects in the regression.

[42]Note that I do not use the definition of semi-month starting from the 2nd (to the 16th) in each month because this method of stratification places the payday at the end of each semi-month cell. Online Appendix B.7 provides the evidence that while the definition using 2nd in each month as the threshold provides an improved series in income, the expenditure cannot chase the income correctly because the expenses measured under this definition are based on the income in the previous semi-month cell. My preferred definition was using the 12th of each month as this threshold offers a clean series of income and expenditure.



(a) Daily panel dataset: income and expenditure

(b) Daily panel dataset: net income

(c) Semi-monthly panel dataset: income and expenditure

(d) Semi-monthly panel dataset: net income

(e) Unadj. semi-monthly panel dataset: income and expenditure

(f) Unadj. semi-monthly panel dataset: net income

Figure 4: Relationships between Average Income and Expenditure by Different Time-series Frequencies

Notes: Figure 4a, 4c, and 4e illustrate the time-series plots of the average daily, semi-monthly, and unadjusted semi-monthly income and expenditure, respectively. Figure 4b, 4d, and 4f illustrate the time-series plots of the average daily, semi-monthly, and unadjusted semi-monthly net income (i.e., income minus expenditure). Figures 4a and 4b show the daily data between January 12 and November 11, 1919. Figures 4c and 4d show the semi-monthly series calculated using the daily data between January 12 and November 11, 1919. The (adjusted) semi-monthly series defines the 12–26th for the first and 27–11th for the second half. Figures 4e and 4f show the unadjusted semi-monthly series calculated using the daily data between January 15 and October 31, 1919. The unadjusted semi-monthly series uses the 15th of each month as a threshold.
Source: Created by the author using the THBS sample.

time-series plots of the income and expenditure from this adjusted semi-monthly panel dataset, whereas Figure 4e illustrates the unadjusted (calender) semi-monthly series using the 15th of each month as the threshold of the semi-month. Clearly, Figure 4e provides very rough measures of income and expenditure due to the measurement errors from the maladjustment of paydays. The most significant improvement in Figure 4c is that the expenditure can chase the income in each month, reflecting the households' consumption strategies based on their income measured in the approximate exact timing. Given the improvements in both income and expenditure measures, the net income series shows a much smoother trend in Figure 4d, which is unavailable under the unadjusted series (Figure 4f). In Section 4.1, I will demonstrate how these measurement errors in the unadjusted dataset attenuate the estimates.

3.4 Data Description

Variables

The THBS budget book has two primary sections: expenditure and income. I digitized records in each category following the categorization used in the official report. Panel A of Table 3 lists the 11 subcategories for expenditures: food, housing, utilities, furniture, clothes, education, medical, entertainment, transportation, gifts, and miscellaneous. These are used to test the smoothness of the consumptions in each subcategory. To test the roles of risk-coping strategies, I considered five net income categories—savings, insurance, borrowing, credit purchase, and gifts. Net variables are defined as the income minus expenditure in each category; for example, net savings refers to the difference between the withdrawal amount and deposits to savings. I also considered the sales of miscellaneous goods and labor earnings from the family members (except for the head) to test the contribution of the sales of small assets and intrahousehold labor-supply adjustments. Panel B of Table 3 summarizes these variables.[43]

Alterations in family size may shift the household's preferences (Jappelli and Pistaferri 2017).[44] Fortunately, the archives of the Tsukishima Survey include a set of sheets documenting the changes in the composition of the THBS households (*Kazoku idō hyō*).[45] I found that the size of households was stable over time: one household experienced changes in the number of family members due to the birth of a son during the sample periods. This supports the evidence that the preference shifts rarely occurred among the THBS households. Although family size was included in all regressions, to be conservative, it had little effect on the results.[46] Panel C of Table 3 shows the summary statistics on the

[43]Online Appendix B.9 presents the results for the panel unit root tests. The null hypothesis of unit roots in all the panels is rejected at the conventional level for all these variables.

[44]In village economies, landholding and asset stocks such as livestock and grain may also be correlated with the household's risk-coping strategies (e.g., Udry 1994, 1995). As this study analyzes urban factory workers' households, the roles of these assets can be discarded.

[45]The Ohara Institute for Social Research, Archives of the Tsukishima Survey (THBS, unreleased).

[46]The family size variable was omitted in several regressions due to the multicollinearity in the fixed-effects models given its small within variations. Although the number of family members in different age bins is available from the THBS, those family composition variables are also time-constant and were absorbed by the household fixed effect.

Table 3: Summary Statistics

Panel A: Variables for testing consumption smoothing (in yen)

	Semi-monthly Panel Dataset				Adj. Monthly Panel Dataset			
	Level		Log		Level		Log	
	Mean	Obs.	Mean	Obs.	Mean	Obs.	Mean	Obs.
Total expenditure	34.5	289	3.4	289	69.3	124	4.2	124
Food	10.9	289	2.3	270	21.5	124	3.0	115
Housing	2.7	289	1.6	134	5.8	124	1.8	105
Utilities	1.2	289	-0.1	232	2.3	124	0.6	111
Furniture	0.4	289	-1.6	177	0.8	124	-1.1	99
Clothes	2.8	289	0.3	248	5.8	124	1.2	113
Education	1.3	289	-0.0	245	2.6	124	0.6	111
Medical	1.7	289	0.2	269	3.3	124	0.9	115
Entertainment	1.3	289	-0.2	255	2.6	124	0.5	114
Transportation	0.4	289	-1.3	195	0.9	124	-0.7	98
Gifts	3.1	289	0.5	243	6.3	124	1.3	114
Miscellaneous	0.5	289	-1.3	222	1.0	124	-0.7	111
Disposable income	37.6	289	3.5	278	76.8	124	4.2	123

Panel B: Variables for testing risk-coping mechanisms (in yen)

	Semi-monthly Panel Dataset			Adj. Monthly Panel Dataset		
	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	Obs.
Panel B-1: Savings, insurance, borrowing, and gifts						
Net savings	-0.01	3.97	289	0.08	5.78	124
Net insurance	-0.03	6.67	289	0.26	10.15	124
Net borrowing	0.31	5.03	289	1.16	7.63	124
Net credit purchase	-2.47	11.33	289	-5.05	20.92	124
Net gifts	-2.04	6.11	289	-3.83	9.82	124
Panel B-2: Labor supply adjustments & sales of miscellaneous assets						
Other family member's earning	3.74	6.11	289	8.21	16.44	124
Sales of miscellaneous assets	0.02	0.12	289	0.06	0.17	124
Panel B-3: Income variable						
Head's earnings	29.43	18.11	289	59.2	29.9	124

Panel C: Family size (people)

	Semi-monthly panel dataset				
	Mean	Std. dev.	Min	Max	Obs.
Number of family members	4.3	1.6	2.0	8.0	289

Panel D: Health shocks

	Semi-monthly panel dataset				
	Mean	Std. dev.	Min	Max	Obs.
Number of days with illness (head)	0.1	0.8	0	11	254
Number of days with illness (other family members)	0.2	1.7	0	16	254

Notes:
Panel A: This panel shows the summary statistics of the variables used to test the consumption smoothing for the 33- and 26-panel units in the semi-monthly and adjusted monthly panel datasets, respectively. Disposable income is the total income minus tax payments.
Panel B: This panel shows the summary statistics of the variables used to test the risk-coping strategies for the 33- and 26-panel units in the semi-monthly and adjusted monthly panel datasets, respectively. Each net income variable is defined as the difference between income and expenses. "Net savings" refers to the difference between the amount withdrawn and the total deposits. "Net insurance" refers to the amount received from insurance minus the expenses paid for insurance. "Net borrowing" refers to the amount of borrowing minus the debt payments. "Net credit purchase" refers to the amount of credit purchases minus credit redeemed. "Net gifts" refers to the total received amounts, including both pecuniary and non-pecuniary gifts, minus the payments for gifts. "Other family member's earnings" refers to the total income earned by all family members except for the head of the household. "Sales of miscellaneous assets" includes the sale of miscellaneous goods such as old newspapers and empty bottles.
Panel C: The summary statistics of the family size variable for the 33-panel units in the semi-monthly panel dataset are listed. The statistics for the adjusted monthly panel dataset are not reported because they are materially similar.
Panel D: The summary statistics of the number of days with illness for family members among the 33-panel units in the semi-monthly panel dataset are listed. As those are lagged variables, the initial period is omitted in all the units. Accordingly, a household with two semi-month observations is excluded.
Source: Created by the author from the THBS sample.

family size variable.

Trend

Next, I illustrate the time-series figures of the THBS dataset to overview the trend in income and expenditure. Figure 4c shows a weak increasing trend in the average income, which is consistent with the overall macroeconomic trend in nominal income during this period. This trend in earnings was, however, offset by steep inflation caused by expansions after the war (Section 2.1). In Figure 4d, the deviation of expenditure from income in January captures the expenses on the goods for the New Year events. The gaps in June to the first half of July may reflect the payments of bonuses. The peaks in March may reflect the preparation for the new fiscal and academic year from April, suggesting a higher proportion of temporary income from withdrawals and loans. These show that the budget data from the THBS households can capture a substantial aspect of the macroeconomic trends.

Idiosyncratic Shocks

Online Appendix Figure B.11 illustrates the residuals from the regression in the first difference in semi-monthly income on the first difference in aggregate semi-monthly income.[47] While the residuals satisfy the zero-average property, they occasionally take large negative and positive values, suggesting that the workers experienced idiosyncratic income shocks in some cells. Regardless of favorable or adverse shocks, these cells that deviated from the mean tendency help investigate how those households coped with the idiosyncratic shocks. Despite this, it is useful to consider illness as it is the least predictable shock (Gertler and Gruber 2002). Fortunately, the illness among the THBS families is documented systematically and thus, available for analysis. As explained in Section 2.3, neither a comprehensive health insurance system nor compensation for illness from the factories was available. Moreover, the sanitary conditions in the cities were low, leading to higher mortality rates.[48] The official report mentioned that the workers in the machinery factories in Tsukishima faced the risk of diseases under severe sanitary conditions (Department of Health, Ministry of the Interior 1923a, p. 14). Although unemployment might be another shock, the THBS heads rarely changed their occupation during the survey period as they were skilled workers who were less likely to move to other jobs.[49] Panel D of Table 3 shows the summary statistics on the health shock variables.

[47] Let n_t be the number of households in semi-month t in the year 1919. For household i in semi-month t cell, the residual is then defined as $\Delta\hat{v}_{i,t} = \Delta Income_{i,t} - \hat{\alpha}\Delta\overline{Income}_{.,t}$, where $\overline{Income}_{.,t} = \sum_{i=1}^{n_t} \frac{Income_{i,t}}{n_t}$ and $\hat{\alpha}$ is the estimated coefficient.

[48] See Schneider and Ogasawara (2018) for the overviews on the sanitary conditions in interwar Japan.

[49] Another possibility is that the THBS heads who changed their jobs might have been omitted from the survey. However, I confirmed that the households with longer and shorter time-series observations had similar family characteristics (Online Appendix B.3). Thus, this omission does not lead to selection bias in terms of the potential vulnerabilities to the idiosyncratic risk. Moreover, the number of dismissals at the Tsukishima factories would be small. In fact, the average monthly dismissal rate (i.e., the number of dismissals/workers) from June 1919 to May 1920 at the one factory available from the official report of the Tsukishima Survey was only 1.5% (Department of Health, Ministry of the Interior 1923a, p. 415).

Risk Preferences

The different attitudes toward risks among households with different occupations and regions may lead to bias in the standard risk-sharing regressions (Mazzocco and Saini 2012; Schulhofer-Wohl 2011). In contrast, this study investigates consumption-smoothing strategies among homogeneous households — skilled factory workers' households in the machinery manufacturing sector in Tsukishima. To assess the homogeneity of the risk preference among THBS households, I tested whether the earnings of the heads who worked in a few specific factories or sectors showed different responses to the aggregate shocks, following Schulhofer-Wohl (2011). Specifically, I consider the case that the heads who worked in large-scale or governmental factories might have had different risk preferences because those workers might have had lower risk tolerance than those who worked in smaller enterprises. I confirmed that the sensitivities to the aggregate shocks are statistically similar.[50] This result is unchanged if I assume that the heads who worked in the smithing factory or in the non-machinery manufacturing sectors had different risk preferences.[51] This shows that it is plausible to assume that the THBS households shared similar risk preferences, conditional on the household fixed effects.

4 Empirical Analysis

4.1 Consumption Smoothing

Estimation Strategy

I consider a linear fixed-effects model to test consumption smoothing.[52] Online Appendix C.1 provides the conceptual framework and the derivation of my empirical specification. For household i in time t, the reduced form equation is characterized as follows:

$$\log c_{i,t} = \gamma \log y_{i,t} + \delta x_{i,t} + \mu_i + \phi_t + u_{i,t}, \tag{1}$$

where $c_{i,t}$ is consumption, $y_{i,t}$ is disposable income, $x_{i,t}$ is the family size control, μ_i is the household fixed effect, ϕ_t is the semi-month fixed effect, and $u_{i,t}$ is a random error term. The household fixed effect captures the time-constant unobservable factors such as permanent income and consumption preference. The time-fixed effect effectively removes

[50] Online Appendix B.10 summarizes the finer details of the analysis. In short, the heads' earnings are regressed on the aggregate consumption, its interaction term with respect to the indicator variable for the large-scale and governmental factories, family size variable, and household fixed effects. The results are unchanged if I trim a few semi-months with a smaller number of cross-sectional observations.

[51] The skilled workers in the smithing sector could be business owners (Online Appendix A.6). Similarly, the workers in the non-machinery manufacturing sectors in Tsukishima—a representative machinery production area—could have a different, presumably higher, risk tolerance.

[52] Another empirical specification used to test consumption smoothing is the first-difference model, including the aggregate consumption to capture macroeconomic shocks in the economy (Mace 1991). This alternative model requires the interpretation of the estimated coefficient on the aggregate measure of consumption. However, the THBS households do not include entire households in the target economy—Tsukishima. This may disturb the interpretation of the coefficient on aggregate consumption. To be conservative, therefore, I use the two-way fixed-effects model to control for macroeconomic shocks (Cochrane 1991; Ravallion and Chaudhuri 1997).

the unobservable macroeconomic shocks and trends described in Section 3.4. The estimate of γ shows income elasticity, ranging from zero for perfect insurance to one for the absence of insurance.[53] The cluster-robust variance-covariance matrix estimator is used to manage heteroskedasticity and serial dependency (Arellano 1987).

Results

Table 4: Results of Estimating Income Elasticities

	(1) Semi-monthly Panels			(2) Adj. Monthly Panels			(3) Unadj. Monthly Panels		
	Disposable income		Obs.	Disposable income		Obs.	Disposable income		Obs.
	Coef.	Std. error		Coef.	Std. error		Coef.	Std. error	
Total consumption	0.358	[0.033]***	278	0.433	[0.059]***	123	0.261	[0.054]***	141
Food	0.136	[0.030]***	259	0.293	[0.066]***	114	0.100	[0.072]	132
Housing	0.099	[0.415]	134	0.013	[0.084]	105	-0.263	[0.167]	124
Utilities	-0.003	[0.138]	223	0.343	[0.236]	110	0.197	[0.334]	130
Furniture	0.426	[0.223]*	169	-0.114	[0.706]	98	0.250	[0.339]	112
Clothes	0.378	[0.190]*	238	0.347	[0.424]	112	0.806	[0.262]***	132
Education	0.101	[0.051]*	236	0.162	[0.128]	110	0.069	[0.146]	128
Medical expenses	0.039	[0.066]	258	0.194	[0.120]	114	-0.128	[0.094]	132
Entertainment expenses	0.307	[0.084]***	250	0.716	[0.181]***	113	0.194	[0.153]	132
Transportation	0.278	[0.110]**	187	0.605	[0.264]**	97	0.362	[0.291]	115
Gifts	0.523	[0.106]***	234	0.469	[0.197]**	113	0.622	[0.306]*	130
Miscellaneous	-0.076	[0.147]	214	0.522	[0.252]**	110	0.246	[0.267]	126

***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in brackets are clustered at the household level.
Notes: This table shows the results of Equation 1. The regressions of the 11 measures of log-transformed consumption on log-transformed disposable income, the family size control, household-fixed effect, and time-fixed effect are listed. Columns 1, 2, and 3 show the results for the semi-monthly, adjusted monthly, and unadjusted monthly panel datasets, respectively. The estimated coefficients on log-transformed disposable income are listed in the columns named "Coef.".

Column (1) of Table 4 presents the results from the semi-monthly panel dataset. In the total consumption, the estimated coefficient is 0.358. This means that a one percentage point decrease in disposable income decreases the total expenditure by 0.36 percentage point, suggesting that the factory worker households could not thoroughly smooth their consumption. An important finding is that the estimate for food categories is smaller (0.136) but highly statistically significant. This implies that while the households tended to reduce their food expenses when they faced adverse income shocks, they might have had some means to manage those shocks to smooth food consumption. The estimates for the entertainment and transportation expenses (0.307 and 0.278) are also highly statistically significant. This may be understandable because those expenses include family travel and

[53]This is comparable to the estimate from the same conceptual framework: this comparability is important in the consumption-smoothing literature. Note that relevant previous studies have not integrated the recent theoretical discussion on the fixed effect model with two-way error components under the difference-in-differences (TWFE-DID) setting yet. In fact, the bias-corrected estimator for the TWFE-DID model with continuous treatment for multiple periods is underdeveloped (see de Chaisemartin and D'Haultfœuille (2023) for a comprehensive review).

theatergoing.[54] Similarly, the estimate for gifts shows a large amount (0.523), reflecting that the expenses on the others were optional. The results for the other subcategories are statistically insignificant or unclear. The estimates for furniture and clothes are weakly statistically significant. Although not conclusive, this may reflect that both categories were luxury categories. The estimate for the education category is small but also weakly statistically significant (0.101). This may be because it includes an allowance for children, which could be easily decreased.[55]

I present the results for the adjusted monthly panel dataset in Column (2) to see whether the income elasticities changed over a longer span. Not surprisingly, the adjusted monthly series yields greater estimates than the semi-monthly series. The estimate for total consumption was 0.433, which is approximately 1.2 times greater than that from the semi-monthly series. One potential explanation for this difference is that the available sources of temporary income might have been limited, and those sources were not useful for compensating for adverse income shocks that lasted for at least one month. The most noticeable example is the food category, which comprised the largest portion of the expenditure (Panel A of Table 3). The estimate is 0.293, more than twice the estimate for the semi-monthly series (0.136). This implies that the households' food expenditures were likely to be insured for a few weeks but not over one month. I will investigate the mechanism underlying this behavior in the following subsections, and credit purchases may be used to smooth food consumption in the short run. Similarly, the expenses for entertainment and transportation were much more sensitive (0.716 and 0.605) to the shocks in the adjusted monthly series. The estimate for gifts is slightly smaller but in a similar range. In short, while the household could compensate for their income losses for a few weeks, they could not do so for several weeks, presumably because of borrowing constraints and/or a limited amount of liquidity assets. The expenses on those unnecessary categories might particularly be cut in response to relatively persistent shocks.

In contrast, a few subcategories were not sensitive to the idiosyncratic shocks over different time-series frequencies. For example, the estimates for the housing, utilities, and medical categories are not statistically significant in both semi-monthly and adjusted monthly series. This may reflect the fact that the rent and utility payments were relatively fixed.[56] The medical expenses included the fee for bathing (*yuya*). People took baths every few days at that time, which was less likely to be cut, although hairdressing for women (*kamiyui*) in the same category was likely to be cut. The estimates for the furniture, clothes, and education categories are statistically insignificant in the adjusted monthly series. While this could partly be the efficiency issue under a smaller sample size, those

[54]The workers could walk to the factories in Tsukishima, so the costs of commuting were not usually documented in the budget books.

[55]Toyotaro Miyoshi served as a research assistant at the Tsukishima Survey while he was a student at the Tokyo Imperial University. He left important retrospectives on the survey in his works (Online Appendix B.1). According to his book, since there were no nurseries, children in these working-class households regularly received a small allowance to play outside while their parents were working (Miyoshi 1989, pp. 383–384; 386; 387).

[56]For example, rent payment was usually fixed and paid once per month. Online Appendix C.2 shows that the housing category should be analyzed based on the adjusted monthly series rather than the semi-monthly series.

expenses may be sensitive to unexpected shocks in consumption, such as unanticipated losses of household goods, clothes, and stationery, including writing paper.[57] This may systematically attenuate the estimates for the specific categories in the adjusted monthly series.[58]

Finally, I assess the validity of the aggregation method used in this study. Adjusting the aggregate data to account for the timing of paydays reveals more transparent relationships between income and expenditure than the unadjusted data (Section 3.3). To demonstrate this mechanism, I listed the estimates from the unadjusted monthly panel dataset in Column (3). The estimate for total consumption is 0.26, which is much lower than the estimate for the adjusted series (0.43). In addition, most subcategories show systematically smaller estimates than those from the adjusted data listed in Column (2). For example, the estimate for the food category is now 0.10 and statistically insignificant. This means that measurement errors in the unadjusted aggregation lead to strong attenuation bias, which results in false negatives (i.e., false rejections of the null of full risk-sharing hypothesis) in most of the consumption categories. I, therefore, specified a generating process of systematic measurement errors in the aggregate survey data, which has attracted attention in the macroeconomics literature (Cochrane 1991; Dynarski et al. 1997; Gervais and Klein 2010; Nelson 1994). Moreover, several subcategories select values close to one or large negative values, which are no longer economically interpretable.[59] This means that the miss-assignment of paydays in the unadjusted data may cause critical statistical inference issues in a few subcategories.

4.2 Risk-coping Mechanisms

The preceding results show that the skilled workers' households in Tsukishima were less likely to smooth their consumption. The estimated elasticities, however, became smaller when I focused on the semi-monthly frequency. Specifically, food expenditure was likely to be insured within at least half a month. The workers might have coped with their shorter-run shocks relatively well but could not manage longer-run shocks. In this section, I test the mechanisms behind their smoothing behavior using several variables in the risk-coping

[57] An alternative explanation for the clothes category relates to seasonality. The workers had bought their work clothes for the new season (e.g., the OISR, Archives of the Tsukishima Survey (THBS #40, March 31, 1919)). As those clothes were necessary items, those seasonal expenses may attenuate the estimate.

[58] Generally, the panels with short-run time bins were more likely to be influenced by unexpected consumption shocks, which attenuated income elasticity (Nelson 1994). If this mechanism worked, subcategories that were sensitive (insensitive) to unexpected consumption shocks should be more (less) attenuated. In my result, however, the estimates for the adjusted monthly panels are greater than those for the semi-monthly panels in a large part of subcategories, suggesting that households faced more difficulties with smoothing their consumption in the long run.

[59] For example, the estimate for housing was negative. The households paid a fixed rent amount monthly. Given that the rent payday was fixed, the shifts in wage paydays might create cells with less income with a fixed amount of rent. In the case of seasonal consumption categories, the shifts may coincide with the timing of seasonal spending. The THBS households tended to purchase work clothes in March to prepare for the start of the new fiscal year in April. They also spent more on clothing in June, likely to buy summer clothes. The shift of paydays to these months may have created a strong but false positive correlation.

strategies.

Estimation Strategy

To test the roles of risk-coping strategies, I employed the empirical specification suggested by Fafchamps and Lund (2003). For household i at time t, the specification is characterized as follows:

$$r_{i,t} = \kappa \tilde{y}_{i,t} + \eta x_{i,t} + \nu_i + \zeta_t + \epsilon_{i,t}, \tag{2}$$

where $\tilde{y}_{i,t}$ is head's earning, $x_{i,t}$ is the family size control, ν_i is the household fixed effect, ζ_t is the time fixed effect, and $\epsilon_{i,t}$ is a random error term. Online Appendix C.1 summarizes the derivation of this specification. I used the head's income instead of the disposable income in Equation 2 to avoid the potential endogeneity.[60] Regarding $r_{i,t}$, I considered several variables to overview various risk-coping strategies. These included the net income on savings, insurance, borrowing, credit purchases, and gifts. Each net variable was defined as the difference between income and expenses. The estimates of κ were therefore expected to be negative since net income becomes negative in good times but positive in unfavorable times. I also considered the earnings of the family members (except for the head) and the sales of miscellaneous goods because both intra-household labor supply adjustments and asset sales might alleviate idiosyncratic shocks as alternative risk-mitigation strategies (Blundell et al. 2016; Udry 1995).[61] The estimated coefficients for the sales and labor supply adjustment variables may be negative, reflecting additional earnings when the head's income is reduced.

Results

Table 5 presents the results. Columns (1) and (2) summarize the results for the semi-monthly and adjusted monthly panel datasets, respectively. Panel A shows the results for the net income variables, whereas Panel B shows those for the labor supply adjustments and sales of small assets.

The estimated coefficient for the net savings is negative and statistically significant in Column (1). The estimate suggests that a one-yen decrease (increase) in the head's earnings increases (decreases) the net income from savings by 0.043 yen. The estimate from the adjusted monthly series is similar (0.035), albeit statistically insignificant (Column (2)). This is consistent with the historical fact that many workers had savings accounts

[60] For instance, the household's total income is the outcome of the intra-household responses to the shocks, such as the labor-supply adjustments. I confirmed that the results were largely unchanged if I used the disposable income as the idiosyncratic income shock variable instead of the head's income (not reported). This is consistent with the fact that the labor-supply adjustments did not occur among the THBS households (Table 5). Despite this, I preferred to use the conservative setting to manage potential biases and to set a comparable setting to the structural equation used in Section 4.3. See Asdrubali et al. (2020) for a recent study using the head's income as the shock variable in testing the full risk-sharing.

[61] Rosenzweig and Stark (1989) show that marriage cum migration in South Indian villages contributed to reducing the variability of household food consumption. Since the THBS focused on the households living in Tsukishima throughout the sample period, I did not need to address the ex-ante risk-mitigation strategy through migration.

Table 5: Results of Testing the Risk-coping Mechanisms

	(1) Semi-monthly Panels			(2) Adj. Monthly Panels		
	Head's earning		Obs.	Head's earning		Obs.
	Coef.	Std. error		Coef.	Std. error	
Panel A: Savings, insurance, borrowing, and gifts (yen)						
Net savings	-0.043	[0.018]**	289	-0.035	[0.028]	124
Net insurance	0.001	[0.013]	289	0.002	[0.033]	124
Net borrowing	-0.021	[0.027]	289	-0.027	[0.017]	124
Net credit purchase	-0.128	[0.039]***	289	-0.011	[0.042]	124
Net gifts	-0.052	[0.019]**	289	-0.006	[0.029]	124
Panel B: Labor supply adjustments & sales of miscellaneous assets (yen)						
Other member's earnings	0.001	[0.010]	289	0.036	[0.033]	124
Sales of miscellaneous assets	-0.000	[0.000]	289	0.000	[0.001]	124

***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in brackets are clustered at the household level.

Notes:

This table shows the results of equation 2. The family size control, household fixed effects, and time-fixed effects are included in all the regressions. Columns 1 and 2 show the estimates for the semi-monthly and adjusted monthly panel datasets, respectively. The estimated coefficients on the head's earnings are listed in the "Coef." columns.

Panel A: Each net income variable is defined as the difference between income and expenses. "Net savings" refers to the difference between the amount withdrawn and the total deposits. "Net insurance" refers to the amount received from insurance minus the expenses paid for insurance. "Net borrowing" refers to the amount of borrowing minus the debt payments. "Net credit purchase" refers to the amount of credit purchases minus credit redeemed. "Net gifts" refers to the total received amounts, including both pecuniary and non-pecuniary gifts, minus the payments for gifts.

Panel B: "Other member's earnings" refers to the total income earned by all family members except for the head of the household. "Sales of miscellaneous assets" includes the sale of daily miscellaneous goods such as newspapers and empty bottles. All dependent variables are in yen.

in postal savings and savings banks at that time (Section 2.3). However, the estimated magnitude was small, suggesting that the withdrawals from savings did not compensate for the earnings losses.

The estimates for the insurance category are close to zero and statistically insignificant in both columns. The budget books indicate that the primary source in this category was the mutual loan associations (*mujin*). As explained in Section 2.2, these associations' rules were unsuitable for compensating for the idiosyncratic shocks. For example, a THBS household won a lottery and received 100 yen in a monthly cell, which is independent of the worker's earnings.[62]

For the net borrowing category, the estimated coefficients are close to zero and statistically insignificant in both columns. Section 2.2 shows that pawnshops were a popular lending institution for low-income households. Although THBS households occasionally used pawnshops, this was not frequent.[63] This is understandable because skilled factory

[62]The OISR, Archives of the Tsukishima Survey (THBS #5, May 17, 1919). The bidding rule may be used to support a specific member in the association if members have a common belief in the aid. However, most of the income from *mujin* measured in the budget books was less than one yen, which is not the case on average.

[63]The OISR, Archives of the Tsukishima Survey (THBS #2; 19; 22).

workers were not classified as low-income working class at that time.

The estimated coefficient for net income from credit purchases is negative and strongly statistically significant in Column (1). The estimate suggests that a one-yen decrease (increase) in the head's earnings increases (decreases) the net income from credit purchases by 0.13 yen. This magnitude is the largest in all the categories. According to the THBS budget books, the credit purchases were mainly used to buy rice, fish, vegetables, and fuels (firewood and charcoal). As rice—a staple food—is usually an expensive item, credit purchases might have played an important role among these households. In addition, credit purchase was occasionally used for the call doctor and pharmacy. This is consistent with my baseline result for medical expenses in the semi-monthly series (Column (1) in Table 4). While these results suggest that credit purchase was the primary risk-mitigation strategy, Column (2) shows that credit was no longer effective in the long term. This is reasonable because borrowers could make monthly or semi-monthly payments but did not borrow for more than a month (Section 5). Given the estimated magnitude (0.13), however, it is noteworthy that the credit could only partially compensate for the idiosyncratic shocks.

The estimates for the gifts category are negative and statistically significant in Column (1). The budget books show that the gifts included seasonal gifts, celebration money, and return gifts. Among them, the return gifts can be regarded as mutual aid from personal networks, which may be reflected in this result. According to an official report of Tokyo, however, the share of average monthly gifts in total income was approximately 3% (Social Affairs Division 1925, pp. 58-59). In my adjusted monthly panels, this share is calculated to be approximately 4%. In this light, while the gifts comprised a few percentage points of the monthly income, they may not have provided sufficient aid for the households facing economic hardship. In fact, the estimate is no longer statistically significant in the adjusted monthly series (Column (2)).

Finally, Panel B tests the roles of the intra-household labor supply adjustment and sales of miscellaneous assets. The estimated coefficients in both columns of the first row are close to zero and statistically insignificant. Miyoshi (1989, pp. 383–386) documented that the wives regularly engaged in side jobs rather than working temporarily to compensate for the income loss. In fact, although sewing was the most popular side job among THBS wives, their earnings were too small to replace the lost income from their breadwinning husbands.[64] In the second row, I show that selling miscellaneous assets such as newspapers, bottles, and clocks was not an effective risk-mitigation strategy.

To summarize, the evidence suggests that credit purchases mitigated idiosyncratic shocks. The results also indicate that the savings institutions and personal networks might have been used as risk-coping institutions among the workers. However, these were available for the short term —at most half a month. The estimated magnitudes indicate that the workers could only partially compensate for the temporary losses of income by using these institutions. This supports the findings on partial risk-sharing in Section 4.1. Overall, the results are aligned with the descriptives from the historical documents on the financial institutions available in Tokyo City (Section 2.3). An interesting finding—which is not explicitly described in the historical sources—is that the credit purchases in the

[64]The OISR, Archives of the Tsukishima Survey (THBS#1, January 13, 1919).

local society and the informal gifts from personal networks might have provided some aid to the factory workers.

4.3 Event-Study Analysis: Response to Adverse Health Shocks

The foregoing analyses used the within variations in the earnings to estimate income elasticity, meaning that the identification depends both on the adverse and favorable idiosyncratic shocks. While it is useful to illustrate the overall responses of the households to the shocks, it does not reveal the pathways behind the risk-coping strategies. Next, I focus on temporary illness of household heads that could cause temporary income losses.

Estimation Strategy

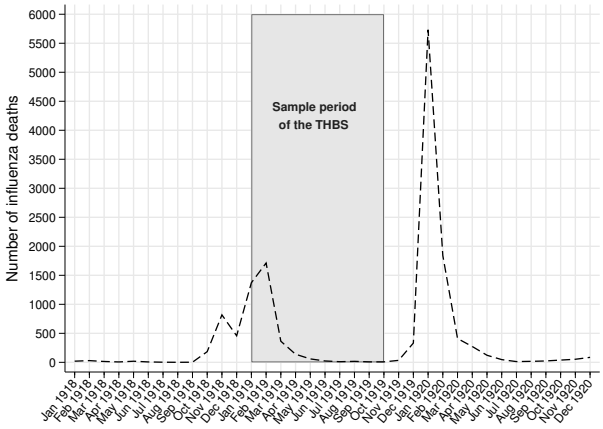


Figure 5: Number of Influenza Deaths in Tokyo between 1918 and 1920

Notes: This figure shows the time-series plots of the monthly death counts from influenza (*ryūkōsei kanbō*) in Tokyo prefecture between January 1918 and December 1920. The death statistics used in this figure were collected based on the comprehensive registration system.
Source: Created by the author using the 1918, 1919, and 1920 editions of the Statistics of Causes of Deaths of the Empire Japan (Statistics Bureau of the Cabinet 1921; 1922; 1923).

I began my analysis by testing whether the illness of the head impacted the earnings. To do so, I decided the exact timing and duration of illnesses of the family members using the *Kazoku idō hyō* (Section 3.4). Figure 5 shows the number of monthly deaths from influenza (*ryūkōsei kanbō*) in Tokyo between 1918 and 1920. There appears to have been a moderate spike in early 1919, which is partially captured in the THBS period. In fact, a few THBS budget books indicate that the family members contracted influenza during this period. Five households experienced the illness during the sample period, and illness affecting the heads was concentrated between February and May 1919, when influenza exposure was most prevalent.[65] In addition, the average duration for the heads is 5.8 days (Std. Dev. = 3.6), which is consistent with the fact that Type A influenza caused fever for less than six days (Uyeki et al. 2022). Therefore, it is plausible that influenza was responsible for illnesses during this period, providing a quasi-experimental

[65]Among four cells with health shocks on the heads, two are observed in February, during the peak of the epidemics (Figure 5), and the others are in March and May.

setting for analyzing to what extent the adverse idiosyncratic shock of illness influences the households' consumption strategies.

Earnings in a semi-month are based on the work done during the previous semi-month. This means that the head's earnings were influenced by the number of illness days in the previous semi-month cell. Table 6 presents the results from the regression of the head's earnings on the number of illness days in the previous semi-monthly cell. While the instantaneous health shock has little impact on the head's earnings (Column 1), the lagged health shock has a statistically significant effect on their earnings (Column 2). This result is unchanged if I include both variables in the same regression in Column 3, supporting the evidence that the health shocks in the previous cell reduced the earnings of the head. The estimate in Column (2) suggests that a one-day increase in illness decreases the head's semi-monthly income by approximately 2.4 yen. Notably, this is close to the average daily wage rate of skilled factory workers (Online Appendix B.6). This reflects the reductions in their salary due to absence: Miyoshi (1989, pp. 383; 388) highlighted that income was reduced due to absence when the head was infected with a disease. Finally, Column (4) adds the health shocks of the other family members into the specification of Column (3). The estimated coefficients on these placebo variables are statistically insignificant, supporting the robustness of the result in Column (3). These results confirm that the head who suffered illness lost earnings.[66]

Following the evidence, I characterize Equation 1 as a structural consumption-smoothing equation by using the first-stage reduced form equation as follows:

$$\log y_{i,t} = \beta h_{i,t-1} + \psi x_{i,t} + \varpi_i + \tau_t + e_{i,t}, \tag{3}$$

where $h_{i,t-1}$ is the number of days of the head's illness in the previous semi-month cell, ϖ_i is the household fixed effect, τ_t is the semi-month fixed effect, and $e_{i,t}$ is a random error term. For the risk-sharing mechanisms analysis under equation 2, the log-transformed disposable income in equation 3 ($y_{i,t}$) is replaced with the head's earnings ($\tilde{y}_{i,t}$). The health shock variable is plausibly exogenous because the illnesses were from the influenza epidemics, as explained above.[67] In addition, there is a correlation between the health shock variable and the head's earnings at a statistically valid level (Table 6). Both support the evidence that the exogeneity of the instrument and relevance condition hold under this just-identified system.

Results: To What Extent do Illnesses Affect Consumption?

I first consider a reduced-form specification using the head's illness as the exposure variable in equation 1 following Cochrane (1991). Column (1) in Table 7 shows the results. Overall, the coefficients on the exposure variable are negative, supporting evidence that

[66]Given that the average number of illness days was approximately 2.0, the temporary health shock losses were more than five yen in that month, accounting for approximately 10% of the average monthly income. Although this is a rough estimate and the losses depend on the severity of the shocks, my result shows that the household income responded to the adverse health shock of illness among the factory workers' households.

[67]As noted in Section 2.3, the factories did not offer compensation for sick leave because the Factory Act did not specify benefits for workers' illness (Study Group of the Factory Act 1916). Even in the

Table 6: Results of Testing the Impacts of Adverse Health Shocks on the Head's Earning

	Dependent Variable: Semi-monthly Earnings of the Head			
	(1)	(2)	(3)	(4)
Health shocks on:				
The head [level]	−0.061		−0.972	−1.319∗
	[0.679]		[0.699]	[0.666]
The head [lag]		−2.371***	−2.868***	−2.994***
		[0.644]	[0.734]	[0.765]
The others [level]				0.889
				[1.275]
The others [lag]				3.675
				[3.312]
Observations	287	254	254	254

***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in brackets are clustered at the household level.

Notes: This table shows the results from the regressions of the head's earnings on the health shock variables using the semi-monthly panel dataset. A household with two semi-month observations is excluded from the sample in all the regressions because the lagged health shock variables are included. The family size variable, household fixed effects, and time-fixed effects are included in all the regressions. "Health shocks on the head" refers to the number of days that the head suffered illness. "Health shocks on the others" refers to the number of days that family members, excluding the head, were ill. "[level]" indicates the variable of the head's earnings in the same semi-month cell. "[lag]" indicates the lagged variable (i.e., the shocks measured in the previous semi-month cell). Although the correlation coefficient between the level and lag of the health shock variables for the other family members is substantially high (Pearson's coefficient = 0.99), including either of the two variables does not change the finding on the negligible impacts of the health shocks on the other family members.

adverse health shocks on the heads reduce consumption levels. Next, I explicitly model the structure underlying the relationship between the health shocks and earnings using the reduced-form equation of (3). If the negative impacts of the health shocks on consumption were derived from the income losses, the results from the structural estimation approach correspond to those in Column (1). The estimates from the structural equation are listed in Column (2) of Table 7. As shown, the results are congruent with the reduced-form results in Column (1). Importantly, the estimates are systematically larger than those reported in Table 4. The estimates for total and food consumption categories are 0.543 and 0.355, respectively, whereas the baseline estimates are 0.358 and 0.136. While this result partly reflects the bias reduction under the instrumental variable estimation, it is also noteworthy that this system is designed to reduce the bias by specifying the channel from adverse (instead of favorable) income shocks. For example, expenses on the allowance for children could be easily cut during unfavorable times but may not respond to favorable shocks. Similarly, the expenses for furniture are likely to be cut, but the households might not buy those frequently, meaning that there are no sufficient cases for reacting to rare health shock events.[68] This may partly be reflected in the smaller value

largest factory in Tsukishima, the Ishikawajima Shipyard, any descriptions of the influenza epidemics are documented in the company's history (Arai 1930). In fact, Miyoshi (1989) documented the issue that the head's disease directly caused income loss due to the absence at that time.

[68] In other words, furniture may have only been purchased when the households had extra income.

of the first-stage F-statistics in the furniture subcategory.[69] A similar interpretation can be applied to the transportation category because family travel was not a frequent event and thus, unlikely to coincide with the timing of illness. By contrast, the entertainment expenses were still likely to be cut in case of illness, which might reflect the curtailment of tobacco, theater-going, and the allowance for heads. This may be another explanation for the difference in the results from my baseline results in Table 4.

While the estimates for the clothes and gifts categories now exceed one, the null of equality to the population mean of one is not statistically rejected for both cases. Although the large estimates may be partly due to the operation under the instrument based on rare health shock events, the findings are materially like my baseline results—both categories are sensitive to the shocks as are those of the dispensable categories.

Table 7: Results of Estimating Income Elasticities:
Smoothing Consumption against Adverse Health Shocks

	Semi-monthly Panel Dataset						
	(1) Reduced-form approach			(2) Instrumental variable approach			
	Head's illness		Obs.	Disposable income		Obs.	First-stage
	Coef.	Std. error		Coef.	Std. error		F-statistics
Total consumption	-0.118	[0.015]***	254	0.543	[0.076]***	245	17.6
Food	-0.075	[0.017]***	236	0.355	[0.075]***	227	18.4
Housing	-0.017	[0.070]	126	0.118	[0.477]	126	7.6
Utilities	-0.051	[0.066]	199	0.201	[0.331]	192	12.4
Furniture	-0.157	[0.106]	156	0.761	[0.801]	150	6.2
Clothes	-0.339	[0.050]***	219	1.233	[0.222]***	211	65.4
Education	-0.097	[0.024]***	216	0.462	[0.101]***	209	18.9
Medical expenses	-0.002	[0.028]	236	-0.001	[0.142]	227	18.4
Entertainment expenses	-0.094	[0.055]*	227	0.427	[0.501]**	218	20.2
Transportation	-0.100	[0.094]	170	0.436	[0.510]	162	20.5
Gifts	-0.325	[0.093]***	212	1.567	[0.797]*	204	17.8
Miscellaneous	-0.075	[0.027]***	195	0.343	[0.101]***	189	17.3

***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in brackets are clustered at the household level.

Notes:

Column 1 shows the results of Equation 1, in which the log-transformed disposable income is replaced with the head's illness (i.e., the number of days with illness in the previous semi-month cell). The dependent variables are the 11 measures of log-transformed consumption, and all the regressions include the family size control, household-fixed effects, and time-fixed effects. The estimated coefficient on the health shock variable is listed in the sub-column named "Coef.".

Column 2 shows the results of equation 1, in which the log-transformed disposable income is regarded as the endogenous variable. The head's illness is an instrumental variable (i.e., excluded exogenous regressor) for the first-stage reduced-form equation (3). The estimated coefficient of the disposable income is listed in the sub-column named "Coef.". The first-stage F-statistics on the health shock variable are listed in the final column.

[69]Note that the logarithmic transformation leaves the cells with expenses on the furniture. Thus, the reduced-form equation captures the relationship between the health shocks and earnings in the cells with any expenses on furniture. While the first-stage F-statitics is 35.7 in the linear-linear model, the second-stage result is robust against the functional form assumption. This may reflect the asymptotic theoretical advantage in the panel data model under nearly weak instruments case (Baltagi et al. 2012; Cai et al.

Results: How did the Households Compensate for Losses from illness?

I tested the risk-coping strategies for mitigating adverse health shocks in Table 8. Column 1 lists the reduced-form results in the same manner as Table 5. The estimated coefficients on the net income variables are positive in most cases, indicating the households' compensating strategies against the shocks. The estimate for the credit purchase category is weakly statistically significant, with the largest magnitude. It suggests that the one-day increase in the head's illness increased the net credit purchases by 1.29 yen, which accounts for approximately half of their average daily wages (1.29/2.56). Column 2 presents the estimates from the structural equation using the head's earnings as the endogenous variable. A similar but clearer result is obtained—the estimate for the credit purchase category is approximately four times greater than that reported in Column (1) of Table 5. It indicates that a one yen decrease in the head's earnings increases the net income from credit purchases by 0.55 yen. This magnitude is consistent with the direct effect of the health shocks on the net credit purchase estimated in Column (1) of Table 8.[70] The estimates for the savings and gifts categories are still negative but now statistically insignificant, supporting the evidence that credit purchase is the primary risk-mitigation strategy for dealing with health shocks. Since withdrawing and receiving gifts to use the money at the retailers takes more time (steps), the households likely prefer to use credit purchases.

Overall, the event-study analysis using adverse health shocks confirms the baseline findings and provides a sharper illustration of consumption-smoothing strategies in the case of adverse idiosyncratic shock events. My results show that the unique available response to idiosyncratic income shocks among the THBS households was to use credit purchases. The available compensation via credit purchases accounts for approximately half of their temporary income losses, which partially contributes to smoothing their food consumption in the short term.

5 Credit System in Local Economy

The foregoing results enlighten the roles of credit institutions among skilled workers' households during industrialization. As the credit for purchases was provided by local retailers, this suggests the importance of the relationships between the workers and retailers. To the best of my knowledge, however, there is little historical research on credit purchases in prewar Japan. Hence, the details of this credit institution are not yet clear.

The information on the credit purchases is personal, as in the case of state-contingent loans in the rural credit market (Udry 1994) and thus, not well documented. Therefore, systematic information on credit purchases is unavailable. Fortunately, however, I found that some official survey reports documented information on this credit institution. A survey report on retailers in 1930 (hereafter 1930 Survey Report) revealed that credit purchase was a popular payment method in transactions with consumers.[71] In fact,

2012; Staiger and Stock 1997). The same argument is applicable to the housing category.

[70] This means that $2.56 \times 0.55 = 1.4$ yen, which is close to 1.3 yen in Column (1).

[71] This survey was conducted in February and March 1930 by Tokyo City and covered 3,892 small and medium enterprises (Tokyo City Office 1932a, p. 1). Those included retailers as well as wholesale and

Table 8: Results of Testing the Risk-coping Mechanisms:
Adverse Health Shock as the Idiosyncratic Shock

	Semi-monthly Panels					
	(1) Reduced-form approach			(2) Instrumental variable approach		
	Head's illness		Obs.	Head's earning		Obs.
	Coef.	Std. error		Coef.	Std. error	
Panel A: Savings, insurance, borrowing, and gifts (yen)						
Net savings	0.397	[0.318]	254	-0.167	[0.117]	254
Net insurance	-0.168	[0.204]	254	0.071	[0.100]	254
Net borrowing	0.116	[0.261]	254	-0.049	[0.103]	254
Net credit purchase	1.294	[0.674]*	254	-0.546	[0.203]***	254
Net gifts	0.181	[0.177]	254	-0.077	[0.090]	254
Panel B: Labor supply adjustments & sales of miscellaneous assets (yen)						
Other member's earnings	0.001	[0.081]	254	-0.001	[0.034]	254
Sales of miscellaneous assets	0.002	[0.002]	254	-0.001	[0.001]	254

***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in brackets are clustered at the household level.
Notes:
Column 1 shows the results of equation 2, in which the head's earning is replaced with the head's illness (i.e., the number of days with illness in the previous semi-month cell). The family size control, household fixed effects, and time-fixed effects are included in all the regressions. The estimated coefficients on the head's illness are listed in the sub-column named "Coef.".
Column 2 shows the results of equation 2, in which the head's earning is treated as the endogenous variable. The head's illness is an instrumental variable (i.e., excluded exogenous regressor) in the first-stage reduced-form equation. The first-stage result is identical to the result listed in Column (2) of Table 6 with the first-stage F-statistics of 13.6. The estimated coefficients on the head's earnings are listed in the sub-column named "Coef.".
Panel A: Each net income variable is defined as the difference between income and expenses. "Net savings" refers to the difference between the amount withdrawn and the total deposits. "Net insurance" refers to the amount received from insurance minus the expenses paid for insurance. "Net borrowing" refers to the amount of borrowing minus the debt payments. "Net credit purchase" refers to the amount of credit purchases minus credit redeemed. "Net gifts" refers to the total received amounts, including both pecuniary and non-pecuniary gifts, minus the payments for gifts.
Panel B: "Other member's earnings" refers to the total income earned by all family members except for the head of the household. "Sales of miscellaneous assets" includes the sale of daily miscellaneous goods such as newspapers and empty bottles. All dependent variables are in yen.

99%(155/157) of grain retailers, 81%(35/43) of fish retailers, 78%(64/82) of greengrocers, and 94%(45/48) of fuel retailers used credit purchases for their selling method (Tokyo City Office 1932b, pp. 260; 263). A survey of retailers in 1935 published by the Tokyo City Chamber of Commerce and Industry provides more detailed information. Table 9 summarizes the information on the retailers' sales measured in this survey.[72] First, many annual sales were from their regular customers, most of whom were from the non-upper classes.

other small businesses. The number of respondents varied depending on the question items. The number of respondents in the statistical table on the payment methods was 2,654, of which 1,197 were retailers (Tokyo City Office 1932b, p. 273). To the best of my knowledge, this is the most comprehensive survey of the retailers in Tokyo circa 1930.

[72]This survey covered 939 retailers, and its report was edited on December 31, 1935. I digitized the statistics for all the retailers selling the representative items (rice, fish, fruit and vegetables, and fuels). The survey instrument included detailed questions regarding sales and purchases (Tokyo City Chamber of Commerce and Industry 1937, pp. legend, questionnaire). Online Appendix Table C.1 decomposes the statistics listed in Table 9 by scale of businesses. I confirm that the main findings are materially similar.

Table 9: Customers, Sales Methods, and Competitiveness in the Retailers in Tokyo City

Selling Item	Number of stores reported	Share of sales for regular customer (%)	Social Class of the Regular Customer (%)			Sales Method (%)			Number of competitors reported
			Upper	Middle	Other	Cash	Credit purchase	Monthly installment	
White Rice	101	73.1	16	45.7	38.2	26.9	71.5	1.7	8.5
Fish	59	64.6	6.8	57.6	35.6	43.9	56.1	0	5.0
Greengrocer	66	45.4	9.4	40.4	50.2	65.8	34.2	0	6.2
Firewood and charcoal	100	51.1	15.7	50.9	33.4	20.4	78.4	1.3	8.6

Notes: This table summarizes the statistics on the sales in the 326 retailers selling white rice, fish, fruit and vegetables, and firewood and charcoal in Tokyo surveyed in 1935. The number of stores reported the share of regular customers (column 2) is 90, 56, 61, and 93 in the white rice, fish, greengrocer, and fuel categories, respectively. The "share of sales for regular customers" is defined as the percentage of sales for regular customers in the annual sales. The definition of the social classes ("Upper"; "Middle"; "Other") is not defined in the report. The share of sales method is based on the percentage of sales using each method in the annual sales. The number of competitors indicates the number of peers within a three-*cho*, approximately 327 meters, radius. The department stores and retail markets are not included in this survey.
Source: Tokyo City Chamber of Commerce and Industry 1937, pp. legend; 20–21; questionnaire.

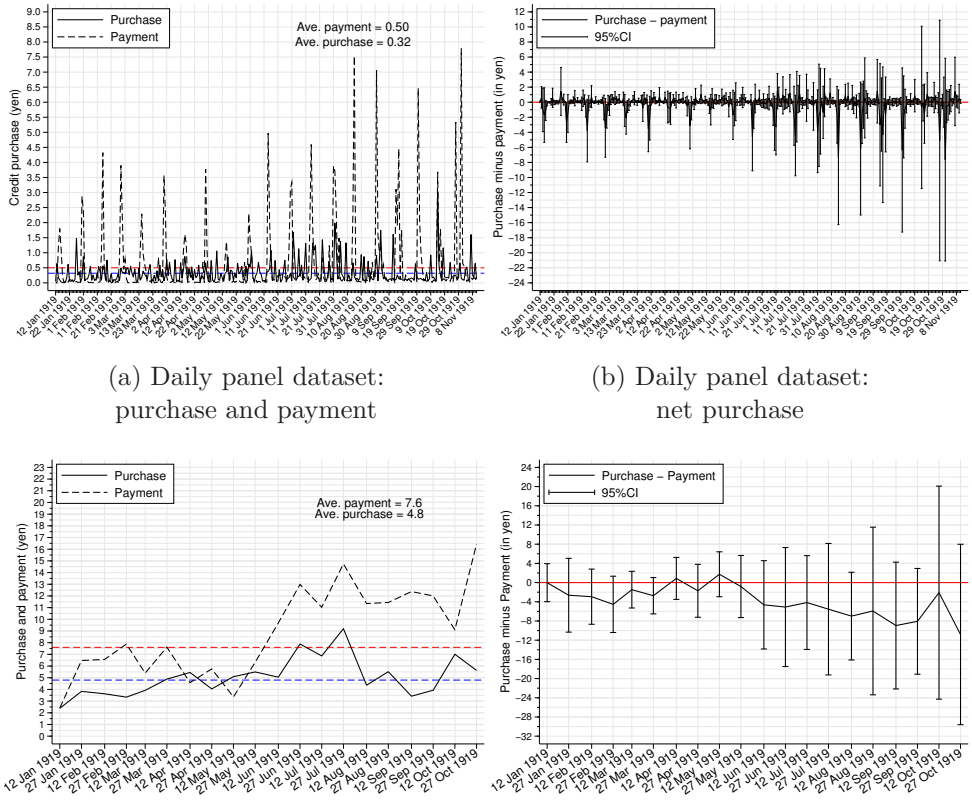
For example, 73% of annual sales of rice retailers were from their regular customers, and more than 80% of them were from non-upper classes, including factory workers. Second, credit purchase was a popular sales method, especially among rice and fuel retailers—more than 70% of the sales were conducted with credit in both shops.[73] Although cash was also used among greengrocers, 34% of the sales were settled using credit. This suggests that credit purchase was a popular payment method and that regular customers settled a large part of it.[74] Although these statistics are from the mid-1930s, this confirms the possibility that the retailers were engaged in credit transactions with long-term relationships with their regular customers.[75] The final column of this table further provides suggestive evidence for this. The survey asked retailers whether the sales area was competitive or not, and if yes, they were asked to report the number of competitors within a three-*cho* (approximately 330 meters) radius. As shown, rice and fuel stores have two to three more competitors than the retailers selling fish, fruit, and vegetables. Given the relatively high utilization of credit in rice and fuel retailers, they may have responded to competition by allowing their customers to trade on credit.

Next, I examined the credit purchases included in the THBS dataset. Most THBS households (29/33) used any credit purchases during their sample period, confirming that credit purchase was a common practice among factory workers. Figure 6a illustrates the average daily credit purchases and payments. Generally, there is a peak per semi-month in payments, which reflects the practice of making the payments for the credit

[73]These figures are systematically lower than those from the 1930 Survey Report. Given that both surveys show a systematic tendency toward credit purchases, this may be due to the differences in the samples, the definition of the retailers in each category, and the definition of the credit purchase itself.

[74]The 1930 Survey reveals that the retailers also commonly used credit purchases to buy their source goods from wholesalers (Tokyo City Office 1932a, pp. 154–157). This means that credit purchase was a familiar payment method for retailers as well as consumers.

[75]A textbook for retailers published in 1924 explains the psychology behind this long-term relationship—credit purchase was provided for the convenience of the customer's budget but also for the "vanity" (status) of being regular customers (Shimizu 1924, pp. 115–116).



(a) Daily panel dataset: purchase and payment

(b) Daily panel dataset: net purchase

(c) Semi-monthly panel dataset: purchase and payment

(d) Semi-monthly panel dataset: net purchase

Figure 6: Relationships between Average Credit Purchases and Payments by Different Time-series Frequencies

Notes: Figure 6a, and 6c illustrate the time-series plots of the average daily and semi-monthly credit purchase and payment, respectively. The blue and red dashed lines indicate the average credit purchases and payments, respectively. Figure 6b and 6d illustrate the time-series plots of the average daily and semi-monthly credit purchase minus payment. The red solid line highlights the zero value. Figures 6a and 6b show the daily data between January 12 and November 11, 1919. Figures 6c and 6d show the semi-monthly series calculated using the daily data between January and November 11, 1919. All figures are based on the 29 THBS households that used any credit purchases.
Source: Created by the author using the THBS sample.

purchase on or soon after their paydays. The purchase series shows a similar tendency but with lower spikes and larger variance. This indicates that the households first purchased goods for a certain amount on or soon after their paydays, and then used purchased perishable foods such as fish, fruit, and vegetables when they needed them. Figure 6b illustrating the net purchase confirms this behavior: the households used the credit on a daily basis and redeemed it near paydays. Figure 6c shows that the payment slightly exceeded purchase, suggesting that many households could approximately repay their loans. Although the difference between payment and purchase is relatively obvious after August 1919, Figure 6d indicates that this difference is not statistically significant in all the semi-months.[76] Thus, this is not a systematic trend but may be due to the smaller available number of households in the later sample period (Online Appendix Figure B.4).

I then analyzed whether the volatility of earnings restricted credit purchases. Since credit of worker was unobservable, I used the volatility of earnings as a proxy of credit risk in the following empirical specification:

$$I(\overline{CP}_i = 0) = \varkappa_0 + \varkappa_1 CV_i + \bar{\mathbf{x}}_i'\chi + v_i, \tag{4}$$

where $I(\cdot)$ is an indicator function, $\overline{CP}$ is the (unit-)average credit purchases, CV is the coefficient of variation for head's earnings, $\bar{\mathbf{x}}$ is a vector of the (unit-)average family composition variables, and v is a random error term. All variables are calculated using the semi-monthly series.[77] In this cross-sectional model, I include a set of family composition variables to control for unobservable preferences because the household-fixed effect cannot be modeled as an error component. If retailers allowed households to use credit purchases regardless of the variability of earnings, the estimate of $\varkappa_1$ becomes close to zero. By contrast, if retailers did not allow households with high-income volatility to trade on credit, the estimate should be positive and reasonably large.

Column (1) of Table 10 presents the result for Equation 4. The estimated coefficient is close to zero and statistically insignificant. A potential concern may be the correlations between the volatility of earnings and the head's age and earnings level. Column (2) shows the result from the extended model, including the head's age and earnings in the controls, which shows the robustness of the baseline estimate in Column (1). Another potential issue is the functional form assumption in the linear probability model. Column (3) then lists an alternative non-linear model, including the full set of control variables used in Column (2). It confirms that the estimate is not statistically significantly different from zero. Next, I changed the threshold for the dependent indicator variable to consider a wider range of households including the households with less than the first quartile of the average credit purchases. Columns (4)–(6) summarize the results in the same column layouts as Columns (1)–(3), confirming that the estimates are still close to zero in all the specifications. Finally, the last row in this table shows that the null of the joint zero slope hypothesis is strongly rejected in all the regressions. Overall, there is no apparent trend

[76]Strictly, payment can include accrued liabilities that should have been paid prior to the previous period. It is, therefore, reasonable that the average payment is greater than the average purchase in most semi-month cells.

[77]For example, the coefficient of variation for household i is defined as $CV_i = \{\sum_t^{T_i}(\tilde{y}_{i,t} - \bar{\tilde{y}}_{i,\cdot})/(T_i - 1)\}^{\frac{1}{2}}/\bar{\tilde{y}}_{i,\cdot}$, where T_i indicates the number of time-series observations, and $\bar{\tilde{y}}_{i,\cdot}$ indicates the time-series

Table 10: Volatility of Earnings and Use of Credit Purchases

	Dependent Variable: Indicator Variable for					
	Non-CP Users			Non-CP + Low-CP Users		
	(1)	(2)	(3)	(4)	(5)	(6)
CV of Head's Earnings	0.003	−0.002	−0.027	0.019	0.008	−0.005
	[0.012]	[0.014]	[0.050]	[0.013]	[0.017]	[0.049]
Sample mean of the DV	0.12	0.12	0.12	0.24	0.24	0.24
Model	LPM	LPM	Probit	LPM	LPM	Probit
Number of THBS households	33	33	33	33	33	33
Family Size	Yes	Yes	Yes	Yes	Yes	Yes
Children aged 6–12 (%)	Yes	Yes	Yes	Yes	Yes	Yes
Children aged 13–16 (%)	Yes	Yes	Yes	Yes	Yes	Yes
Adults aged 17+ (%)	Yes	Yes	Yes	Yes	Yes	Yes
Head's age	No	Yes	Yes	No	Yes	Yes
Head's earnings	No	Yes	Yes	No	Yes	Yes
Zero slope (p-value)	0.467	0.718	0.336	0.515	0.519	0.451

***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors are reported in brackets.

Notes: The dependent variable in Columns (1)–(3) is the indicator variable for the households who did not use any credit purchases during the sample period (non-CP users). The dependent variable in Columns (4)–(6) is the indicator variable for the non-CP users and households less than the first quartile in the sample average of credit purchases. Columns (1)–(2) and (4)–(5) use the linear probability model (LPM), whereas Columns (3) and (6) use the Probit model. "CV of Head's Earnings" indicates the coefficient of variations in the head's semi-monthly earnings. The sample mean of the CV is 5.76 (Std. Dev. = 5.72). All the regressions include the family composition variables: average family size, share of children aged 6–12, share of children aged 13–16, and share of adults aged 17+ (share of children aged 0–5 is used as a reference group). The average head's age and average head's earnings are added to the control variables in Columns 3 and 6. F-statistics p-values for the null of the zero-slope hypothesis are reported in Columns (1)–(2) and (4)–(5). χ^2-statistics p-values for the null of the zero-slope hypothesis are listed in Columns (3) and (6). The standard errors for the LPM are based on the HC2 estimator proposed by Horn et al. (1975).

in the characteristics of households that use credit for their purchases. This suggests that retailers may not have considered the volatility of earnings when providing credit to factory workers. This is consistent with the retailers' motivation to secure their local customers discussed earlier, and with the fact that factory workers commonly used credit for purchases.[78]

The results so far indicate that retailers were generous in considering the earnings volatility risk. This, in turn, implies that retailers may factor risk into retail prices or by charging interest on their loans. Unfortunately, there are no systematic statistics on the interest charged on credit purchases. It may be possible to reverse calculate the risk premiums by differencing payments and purchases. This reverse calculation technique requires information on both the price and type of retailers. However, budget books usually document price-by-item information but not price-by-*retailer* information. This is problematic because the same items were often sold in different types of retailers: for example, eggs were frequently sold in greengrocers (*yaoya*) but sometimes also in general stores (*aramonoya*). Fortunately, I found a specific month in a budget book that has documented the price-by-retailer information.[79] According to this budget book, the reimbursements were made semi-monthly, as seen in Figure 6b. They bought various goods in greengrocers, fish stores, and general stores between February 1 and February 14, 1919, and paid exactly the same amounts on the 15th.[80] In the latter half of February, the household paid the same amounts to greengrocers and general stores on the 28th, but paid less to the fish stores. As the budget book for March does not have information on the type of retailers, it is difficult to determine exactly how the reimbursement shortfall was managed. However, this case suggests that the risk premiums may have been included in the retail prices but not in the form of interest.

Finally, I assessed the losses suffered by retailers for credit purchases. According to the 1930 Survey Report, almost all the retailers suffered losses for credit purchases. For example, 99% of rice and 97% of fuel retailers lost their sales. This means that credit purchase was inherently a loss-making sales method for the retailers. As systematic statistics are unavailable to clarify the percentage of total profits corresponding to these losses, it is impossible to assess how severe these losses were for the retailers. However, an important fact is that these losses were usually capped at 5% of total sales. For example, the available statistics suggest that 87% of rice and 65% of fuel retailers suffered losses amounting to 5% of sales. This supports the evidence that while the retailers could not avoid losses in credit sales, they might have set prices that anticipated predicted losses to some extent. This seems to be a plausible sales strategy for retailers to manage adverse selection issues under imperfect consumer information. Online Appendix C.4 summarizes the statistics on the losses in credit purchases available from the 1930 Survey Report in detail.

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average of the head's income.

[78]Despite this, low-income households might have had more difficulty using credit for purchases. A famous essay drawn by a primary school student in the 1930s depicts an example of a rice retailer who refused to buy rice under credit purchase (Toyoda 1969, pp. 346–355).

[79]The OISR, Archives of the Tsukishima Survey (THBS #4, February 1919).

[80]The repayment period in credit purchases among retailers and wholesalers (footnote 74) was often set at approximately one month (Tokyo City Office 1932, pp. 157-159). Therefore, customers likely made repayments at semi-monthly or monthly intervals.

To summarize, the available documents show that retailers competed with other retailers in the same sales area. Under this circumstance, they provided regular consumers with the opportunity to trade on credit without interest for at least one month. The 1930 Survey Report indeed stated that "intense competition among competitors has led to a high frequency of credit purchases" (Tokyo City Office 1932b, p. 415). This accessibility to credit purchases could help workers manage consumption after unexpected individual setbacks in the short term.[81]

6 Conclusion

This study investigates the consumption-smoothing strategies used by working-class households in prewar Tokyo. I digitized the daily longitudinal budget survey on factory worker households conducted in Tsukishima in 1919. I carefully assessed the potential measurement error due to the miss-assignments of paydays and proposed a way to avoid the assignment errors. The estimated elasticity for total consumption indicates that the factory worker households suffered certain consumption losses when they faced idiosyncratic income shocks.

The estimated elasticity for total expenditure (0.43) is in a similar range to those in rural economies in developing countries. According to Ravallion and Chaudhuri (1997), the elasticity for the rural households in Indian villages between 1975 and 1984 was approximately 0.5. As for the urban households, the estimated elasticity was 0.4 for Bangkok between 1975 and 1990, which had a similar GDP per capita to 1920 Japan (Townsend 1995). Since my estimate is from a specific occupation, skilled factory workers, we need to be careful when making comparisons with these estimates based on urban samples which include a variety of occupations. Nevertheless, the factory workers in the historical metropolis of Japan circa WWI were vulnerable to idiosyncratic income shocks.

A recent study found an income elasticity of 0.39 for factory workers' households in Osaka city circa 1920 (Ogasawara 2024). My estimate from the adjusted monthly panels is slightly larger than this estimate. If taken literally, this implies that the Tsukishima factory workers were slightly more vulnerable than those in Osaka. This indicates that higher levels of urbanization do not necessarily correspond to a greater availability of risk-mitigation institutions. Therefore, inter-city and cross-national comparisons of income elasticities and analysis of the institutional characteristics behind consumption are subjects for future work.

Despite the vulnerability, the results from mechanism analyses show that credit purchases were commonly used among workers and played a role in mitigating adverse idiosyncratic shocks in several consumption subcategories, particularly food. My findings offer a new historical view of the interdependence between consumers and local retailers. As researchers build an understanding of local credit institutions we can comprehend

[81] Another potential explanation for the popularity of credit purchases might be theft. However, the number of thefts in 100 people in 1919 was 0.5 in Tsukishima, which is close to or even slightly lower than the city average of 1.3 (National Police Agency 1920b, pp 53–54; 244–245). In fact, Tsukishima Police Department does not mention that Tsukshima was an area with a particularly high rate of theft (Tsukishima Police Department 1976, pp. 244–245). Therefore, the crime channel is not relevant to explain the use of credit purchases.

regional consumption behavior and may understand how living standards improved in prewar Japan.

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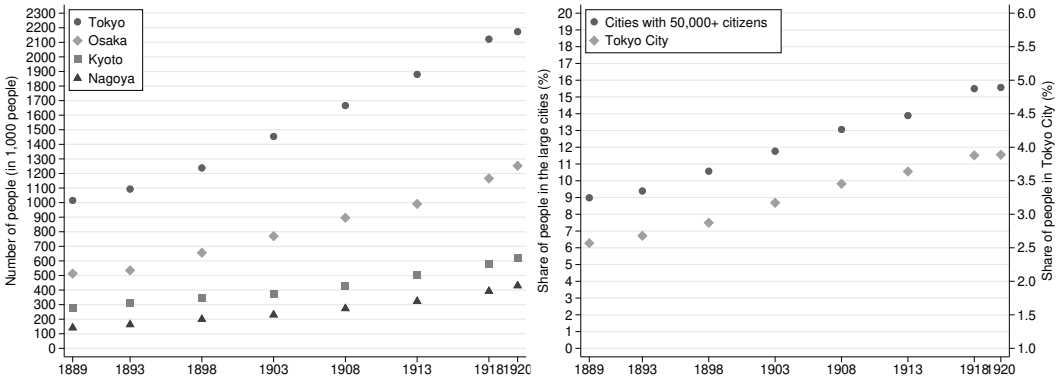
Appendices

Appendix A Background Appendix

A.1 Development of the Cities



(a) Number of people in the large cities (b) Share of people in the large cities (%)

Figure A.1: Development of the Large Cities in Japan

Notes: This figure illustrates the development of large cities in Japan between 1889 and 1920. Figure A.1 shows the number of people in Tokyo, Osaka, Kyoto, and Nagoya cities. Figure A.1b shows the share of people in Tokyo City (diamond) and the cities with more than 50,000 people (circle) in total population in Japan.

Sources: Umemura et al. (1983, pp. 303–305); Umemura et al. (1988, pp. 166; 168).

Figure A.1 illustrates the developments of the large cities in Japan between 1889 and 1920. Table A.1 summarizes the scales, industrial structures, infrastructures, and meteorological features of the large cities.

A.2 Financial Institutions in the Cities

Several financial institutions were available for working-class households in the cities *circa* 1920.

A representative savings institution was the postal savings (*yūbin chokin*). Postal savings was initially designed as a small savings institution for low-income households, and the share of postal savings to total savings was approximately 10% in the 1910s (Tanaka 2018, p. 29). However, the number of postal savings accounts per total population in the early 1910s exceeded 20% (Tanaka 2018, p. 33). James and Suto (2011) indeed show that the saving rate in prewar Japan was higher than that of the US. As shown in Panel A of Table A.2, approximately 1.4 million people had accounts in Tokyo in 1920. This covers approximately 67% of the entire population in Tokyo City and the average savings amount per capita was 64.5 yen. In Kyobashi Ward, the average figure for the postal savings accounts was 44.5 yen at the end of 1919 (Tokyo City Office 1921, pp. 892–893). This amount was less than the average monthly earnings of the skilled-factory workers (Section 3.2). Unfortunately, the statistics on postal savings by depositors' occupation are unavailable.[82] However, this implies that, while a large proportion of the workers might

[82]There are some statistics for the whole of Japan. According to the Postal Savings Bureau (1924,

Table A.1: City Characteristics:
Tokyo, Osaka, Kyoto, and Nagoya

	Name of cities			
	Tokyo	Osaka	Kyoto	Nagoya
Panel A: Population and Workers				
Population	2,173,201	1,252,983	591,323	429,997
Male workers	768,633	476,229	189,922	138,275
Panel B: Industrial Structure (% share in male workers)				
Agriculture	1.0	0.8	2.2	1.8
Fisheries	0.1	0.1	0.0	0.4
Mining	0.4	0.3	0.2	0.2
Manufacturing	44.5	45.6	49.0	45.8
Commerce	32.4	34.0	32.3	29.6
Transport	7.6	10.6	5.5	8.0
Public service and professions	11.3	6.7	9.0	11.3
Housework	0.3	1.8	0.1	0.0
Other industry	2.4	0.1	1.5	2.8
Panel C: Local Infrastructures				
Number of electrical lights per people in 1921	0.9	0.8	0.9	0.9
Accessibility to modern water supply (%)	78.9	80.5	46.5	39.4
Panel D: Meteorological Features				
January 1918 – December 1923				
Average daily temperature	14.1	15.4	14.1	14.6
Average daily precipitation	4.7	3.9	4.6	4.8
February – April only				
Average daily temperature	8.0	8.8	7.8	8.3
Average daily precipitation	4.2	3.4	4.1	4.3

Notes:
Panel A: The number of people and male workers measured in the Population Census conducted in October 1920 are listed.
Panel B: Occupations are classified based on the industrial classification of the 1920 Population Census. Unemployed people are not included in the calculation.
Panel C: The number of electrical lights measured at the end of 1921 is divided by the number of people in the 1920 Population Census. The number of houses accessible to water supply measured at the end of September 1920 is divided by the number of total households measured in the 1920 Population Census (%).
Panel D: The average daily temperature and precipitation between January 1, 1918, and December 31, 1923, and between February 1, 1920, and April 30, 1920 are listed.
Sources: The number of people in 1920 is from the 1920 Population Census (Statistics Bureau of the Cabinet 1928, pp. 186; 214; 222; 225). The number of male workers and their industrial structures are from the Statistics Bureau of the Cabinet (1929a, pp. 20–21; 26–29). The number of houses accessible to the water supply is from the Water Works Association (1922, pp. 69–70). The total number of households is from the 1920 Population Census (Statistics Bureau of the Cabinet 1928, pp. 186; 214; 222; 225). The number of electrical lights is from the Ministry of Posts and Telecommunications (1922, p. 558) The daily temperature and precipitation are from the Japan Meteorological Agency (database).

have had accounts, postal savings may not have provided sufficient temporary income.

Savings bank (*chochiku ginkō*) was another popular savings institution for working-class households in the 1910s (Ito and Saito 2019, pp 79–81). Panel A of Table A.2 shows that the number of people who had savings accounts was approximately 1.46 million, accounting for approximately 67.3% of the total people in Tokyo City at that time. Although this figure is similar to the postal savings, the workers in the manufacturing industry were less likely to rely on the savings banks than the workers in the other industrial sectors. Table A.3 summarizes the number of depositors and the amounts of deposits in savings banks by occupation in Tokyo City (Panel A) and Kyobashi Ward (Panel B). In Kyobashi, the commerce and miscellaneous sectors shared approximately 84.8% of all the depositors, whereas the manufacturing sector had only 11.5%. This is unchanged if I use the amounts of deposits to calculate the shares. The Tokyo Institute for Municipal Research confirmed that savings banks were designed as financial institutions for low-income households (Tokyo Institute for Municipal Research 1925b, p. 81). Thus, skilled factory worker households—like the THBS households—were less likely to use the savings banks. This is consistent with the fact that Tsukishima did not have any savings bank branches, while there were two postal offices.[83]

Mutual loan association (*mujin*) was another type of savings institution. The members of this association paid a fixed amount of money several times, and each member withdrew the total amount of payments each time under specific rules. The lotteries or bidding system decided which members could withdraw money each time. This means that the workers could not use this institution to manage acute adverse income shocks.[84] Instead, these were used by small business owners and merchants to generate money. A report suggests that the workers in the manufacturing sector shared only 10% of all the mutual loan associations in Tokyo City (Tokyo City Office 1935, p. 25). Moreover, the Tokyo Chamber of Commerce stated that the mutual loan association was used for business and rarely for household consumption (Tokyo Chamber of Commerce 1918, p. 121).

Cooperative societies were also available for worker households. Cooperative societies in Tokyo used credit as their payment method—households could buy goods in advance and pay at the end of the month or twice (in the middle and at the end of) a month. The commodity prices were similar to or slightly lower than those in the retailers (Central Federation of Industrial Associations 1925, pp. 18–19). However, the cooperatives covered a small proportion of citizens. There were 26 cooperative societies in Tokyo prefecture in 1924, and 23 of them were organized by the citizens and workers (Central Federation of Industrial Associations 1925, p. 57–59). Among these 23 cooperatives, two were large societies with approximately 4,000 members, and the others were small societies with less than 100 members. Given that the number of male workers was more than 768 thousand

p. 72), the share of depositors in the manufacturing sector was 4.8% (the share based on the deposit amount was 5.5%).

[83]There were 123 savings banks in Tokyo City in 1922, and ten of them were in Kyobashi Ward (Tokyo Institute for Municipal Research 1925, p. 76). However, Tsukishima—a representative manufacturing area—did not have savings banks at that time.

[84]This is the most representative mutual loan system called *tsūjyō* (i.e., common) *mujin*. There was a different type called *sueoki chokin* (or *tsumitate kai*) from which people could receive their stakes with interests after a fixed amount had been accumulated for a certain period (Tokyo Legislative Research Association 1915, pp. 3–4). However, these were also not flexible for compensating for income shocks.

(Table A.1), these account for only a few percentage points of the total workers in the city. In fact, the THBS households rarely used the cooperatives.

An alternative borrowing institution was credit purchase in retailers. The details of the credit purchase are little documented, and the systematic statistics on credit purchases are also unavailable. I surmise that this was because the information on the transactions was personal. Despite this, a few available documents show that credit purchases were used in various retailers at that time (Section 5). The THBS households frequently used credit for purchases in various retailers for rice, fish, vegetables, alcohol, firewood, charcoal, and medicines.

Pawnshops were the most popular lending institution among low-income working-class households. Lenders did not need to screen the borrower's credit, and the borrowers did not worry about incurring heavy debt as the primary articles pawned were inexpensive clothes (Shibuya et al. 1982). In addition, the interest rates were regulated by the Pawnbroker Regulation Act of 1895. Thus, the average redemption rate was substantially high under the lower interest rates. Among 88 pawnshops in Kyobashi, the average redemption rate was approximately 94% (401, 222 cases/427, 265 cases) in 1920 (Tokyo City Office 1922b, pp. 888–889). The number of pawnshops in Tokyo was 1, 334 and 1, 261 in 1918 and 1919, respectively. The total number of cases was 8, 226, 883 and 7, 573, 406 each year. These figures were more than three times greater than the entire population in Tokyo City. This means that pawnshops were more accessible to workers than other institutions. As described in the main text, there were 13 pawnshops in Tsukishima, whereas there were five moneylenders.

However, the inexpensive articles pawned meant that pawnshops were available only for short-run necessities. Among the pawnshops of Kyobashi, for example, the average amount per case was 7.8 yen, which was approximately 10% of the monthly earnings of the THBS households. While the pawnshop was a popular lending institution, it could not offer enough temporary income for relatively large idiosyncratic shocks. According to the statistics on the pawnshop users in Tokyo prefecture in 1923, the share of users in the agriculture, commerce, and manufacturing sectors was 1.7%, 19.5%, and 15.6%, respectively. In turn, the most representative users were the day laborers and workers classified as "miscellaneous," accounting for 63.4% (Tokyo Institute for Municipal Research 1926, p. 25). In fact, the Tokyo City Office stated that the pawnshops were mainly used among low-income (poor) working-class households (Tokyo City Social Affairs Bureau 1921, p. 9). This indicates the evidence that the primary pawnshop users were not the skilled-worker households like the THBS households.

Another lending institution was the money lenders (*kinsen kashitsuke gyō*). Generally, business owners used money lenders. The interest rates of the money lenders were very high compared with those in the pawnshops (Shibuya 2000, pp. 184; 248). Tokyo Institute for Municipal Research was indeed concerned about the increasing number of unscrupulous companies arrested by the National Police Agency (Tokyo Institute for Municipal Research 1925b, pp. 106–108). Given this fact, while there were two money lenders in Tsukishima, they were less likely to be used by the factory worker households.

Credit union (*shinyō kumiai*) was another institution available for working-class households. In Tokyo City, there were 215 unions in 1923. According to the survey of the 184 unions among them, however, the number of union members in the manufacturing sector

was only 5,662 (Tokyo Institute for Municipal Research 1925c, p. 20). This accounts for only a few percentage points of the male workers in the manufacturing sector in Tokyo measured in the population census of 1920 (Online Appendix Table A.1).

Table A.2: Financial Institutions in Tokyo, Osaka, Kyoto, and Nagoya Cities in 1920

	Name of cities			
	Tokyo	Osaka	Kyoto	Nagoya
Panel A: Savings Institutions				
Postal saving				
Number of depositors	1,462,604	725,642	305,927	172,183
Population percentage (%)	67.3	57.9	51.74	40.04
Total amounts (yen)	94,330,789	34,742,000	12,036,439	9,540,725
Amount per people (yen)	64.50	47.88	39.34	55.41
Savings bank				
Number of depositors	1,461,389	1,648,090	663,831	482,960
Population percentage (%)	67.25	131.53	112.26	112.32
Total amounts (yen)	48,682,260	50,674,000	28,495,407	24,014,781
Amount per people (yen)	33.31	30.75	42.93	49.72
Panel B: Pawnshop				
Number of retailers	1,253	867	441	412†
Number of units lent	6,042,501	2,027,690	1,251,283	319,609
Amount of loans (yen)	38,667,993	3,785,186	4,424,357	2,983,250
Amount per loan (yen)	6.40	1.87	3.54	9.33

Notes:
1. Panel A: The statistics on postal savings were measured at the end of March 1921. The statistics on savings banks were measured at the end of 1920.
2. Panel B: Pawnshops in Tokyo, Osaka, and Kyoto were measured in 1920. Those for Nagoya (suggested in †) were measured in 1923 because the statistics in the former years are unavailable.
Sources: Panel A: Tokyo City Office (1923, pp. 969; 977); Osaka City Office (1922, pp. 6(61); 6(67)); Kyoto Prefecture (1922, p. 257); Kyoto City Office (1926, pp. 188); Nagoya City Office (1922, pp. 286; 290). Panel B: Tokyo City Office (1923, pp. 888–889); Osaka City Office (1922, pp. 6(68)–(69)); Kyoto City Office (1922, p. 191); Tokyo City Statistics Division (1926b, p. 12).

A.3 Development of Tsukishima

Tsukishima (transliterated as "moon island") is a reclaimed land on a sandbar of the Sumida River. Ishikawajima and Tsukudajima islands at the northern end of Tsukishima (Figure A.3) are the starting point of its history. The following description in this section is based on Chūō Ward (1994, pp. 122–124).

Ishikawajima was built in 1626 by a boatman, Hachizaemon Ishikawa, who received a fief from the Shogunate. In 1790, the Ishikawajima Prison (*ninsoku yoseba*) was built on Ishikawajima. This was a facility for the reintegration of minor offenders and those without lodgings. After Matthew Perry arrived in Japan in 1853, the Shogunate ordered the Mito Clan to build a shipyard on Ishikawajima. A month later, a groundbreaking ceremony was held for a Western-style wooden sailing ship delivered to the Shogunate in 1856. In 1866, the Ishikawajima Beacon was built on the west bank of the Ishikawajima Prison

Table A.3: Deposits in the Savings Banks in Tokyo City by Occupations

	Occupations				
	Agriculture	Commerce	Manufacturing	Miscellaneous	Total
Pane A: Entire Tokyo City					
Number of depositors	76,210	550,784	166,498	619,963	1,413,455
Amount of deposits	2,002,124	19,112,713	6,663,091	19,809,591	47,587,519
Number of depositors (%)	5.4	39.0	11.8	43.9	100.0
Amount of deposits (%)	4.2	40.2	14.0	41.6	100.0
Pane B: Kyobahi Ward					
Number of depositors	3,809	34,665	11,664	51,481	101,619
Amount of deposits	130,781	1218,081	450,805	1,696,086	3,495,753
Number of depositors (%)	3.7	34.1	11.5	50.7	100.0
Amount of deposits (%)	3.7	34.8	12.9	48.5	100.0

Notes: This table summarizes the number of depositors and the total deposits in the savings banks by occupation. In the document, the miscellaneous category is not clearly defined but named as "Miscellaneous (*zatsu gyō*)." These statistics were measured on December 31, 1919. Panel A and B list the statistics for Tokyo City and Kyobashi Word, respectively.
Source: Tokyo City Office (1922a, pp. 864–865).

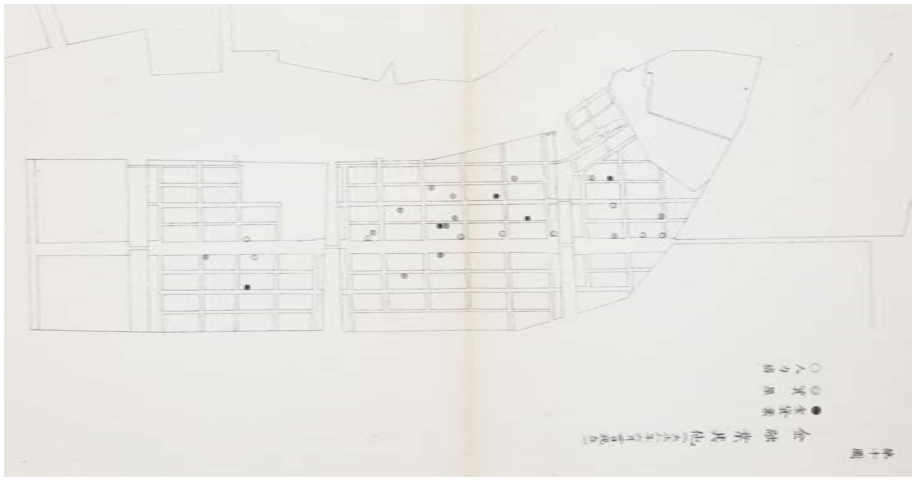


Figure A.2: Pawnshops and Money Lenders

Notes: This map shows the location of the pawnshops and moneylenders in Tsukishima. The bullseye indicates the pawnshop (*shichiya*). The black circle shows the money lenders (*kanekashi gyō*). The white circle shows the rickshaw station (*kuruma yado*).
Source: Department of Health, Ministry of the Interior 1923c, tenth map. The tone was adjusted by the author using Adobe Photoshop 24.7.0.

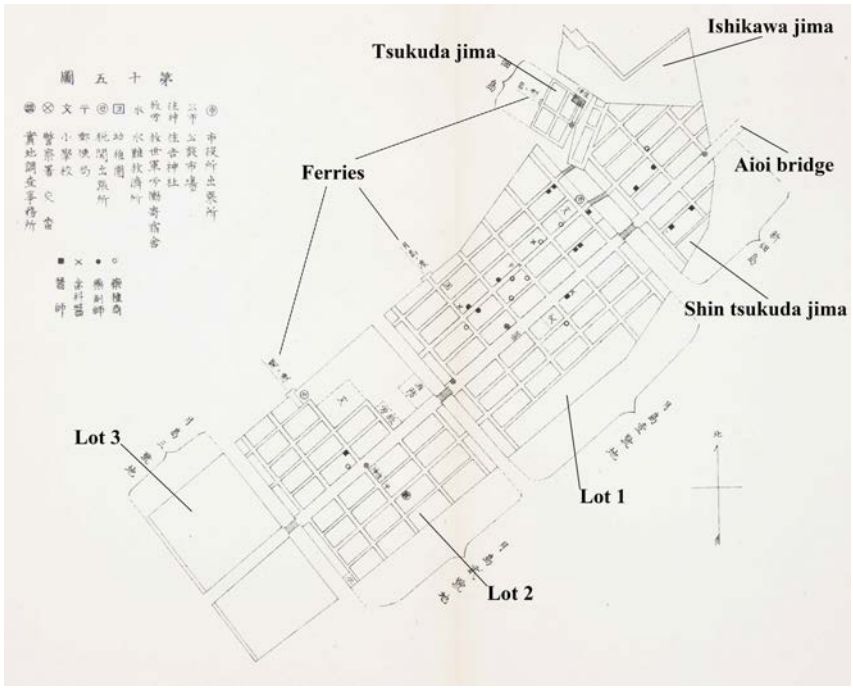


Figure A.3: Tsukishima: Ishikawajima, Tsukudajima, Shin-tsukudajima, and Lots 1–3

Notes: Tsukishima contains Ishikawajima, Tsukudajima, Shin-tsukudajima, and Tsukishima Lots 1–3. This map does not illustrate the northernmost part of Ishikawa jima (see Figure 3 for this part). "Ferries" shows the Tsukishima to the mainland of Kyobashi Ward sea routes called Tsukuda, Tsukishima, and Kachidoki routes (right to left). "Aioi bridge" links Shin tsukudajima and Fukagawa ward.
Source: Department of Health, Ministry of the Interior 1923c, 15th map. The author modified and adjusted the tone using Adobe Photoshop 24.7.0.

and served to signal the position of ships entering the Nihonbashi direction. In 1870, the Ishikawajima Prison became a place of imprisonment (*toba*) and was renamed the Ishikawajima Jail Station of the Metropolitan Police Department in 1877. The prison was finally moved to Sugamo in Kitatoshima County in Tokyo prefecture, and the penitentiary on Ishikawajima was closed in 1895.

The area adjacent to Ishikawajima is called Tsukudajima, where fishermen from "Tsukuda" in Osaka prefecture settled in 1644 after receiving land from the Shogunate. In 1645, the "Tsukuda ferry" began, and throughout the Edo period, Tsukudajima was known as a fishing island for whitefish for the Shogun's household. In 1863, the Tsukudajima Battery was built on the south side of Tsukudajima—one of 13 batteries used to defend Edo Bay. This battery later became the starting point for the reclamation of Lot 1 of Tsukishima.

In 1884, the Port of Tokyo Waterway Dredging Project was initiated. This was to secure the passage of ships by sweeping away the sediment in the shipping channel, and the Tsukishima landfill was created using the deposit. The first Tsukishima site was completed in 1891, and the "Tsukishima ferry" began the same year. The second site was created in 1894; the Shin Tsukudajima (namely, new Tsukudajima) was built in 1896. From the west shore of Shin Tsukudajima, the island overlooks the Boso Peninsula in Chiba Prefecture, making it a favorite vacation spot for writers. Cultural figures such as Toson Shimazaki and Kaoru Osanai stayed here from 1907 to the early Taisho period. In 1903, the Aioi Bridge was completed, bringing water and electricity to Tsukishima and improving transportation convenience, which contributed to development of industry.[85] The "Kachidoki Ferry" began to deliver to Lot 2 in 1905. Lot 3 was finally completed in 1913.

A.4 Housing in Tsukishima

The Tsukishima Survey included a housing survey (Table B.1). Table A.4 summarizes the housing types measured in this survey. As shown, 88 (46%) of the detached homes are in Tsukudajima. Tsukudajima is reported to be "superior to other areas in terms of housing quality, and the percentage of inferior housing is meager."[86] Shin-tsukudajima had a low percentage of detached homes. The report states that it was indeed "inhabited by unskilled laborers" and "occupied the most inconvenient housing status of all the islands." Lot 1 was the center of life in Tsukishima and was a cluster of numerous residences, mainly tenements. Lot 2 had a relatively high percentage of single-family and two-family houses and appears to be characterized as a "workers' residential area" than Lot 1. These indicate that there might have been some geographic differences in income distribution regarding housing type. Overall, however, of the 989 dwellings in Tsukishima, 799 (81%) were row houses, and only 190 were single-family homes. This confirms that Tsukishima was an industrial area with many working families. The workers lived in similar tenements and with similar standards of living. Figure A.4 is a photo showing these tenement houses.

[85] Until then, a retailer named Suzukiiya had been selling water to supply the entire island using a ferryboat.

[86] The description in this section is based on the Department of Health, Ministry of the Interior (1923a, pp. 69–76).

Table A.4: Housing Types in Tsukishima

		Tenement (*nagaya*)						
	(A) Detached	(B) 2 families		3+ families		Total	(A)+(B)	%
		2-story	1-story	2-story	1-story			
Tsukuda jima	88	32	26	6	23	175	146	83.4
Shin-tsukuda jima	16	27	10	36	59	148	53	35.8
Lot 1	58	62	74	73	200	467	194	41.5
Lot 2	28	27	43	9	92	199	98	49.2
Total	190	148	153	124	374	989	491	49.6

Note: This table summarizes the housing types in Tsukishima surveyed on June 30, 1919.
Source: Department of Health, Ministry of the Interior 1923a, pp. 69–76.

(a) 2-story tenement (b) 1-story tenement

Figure A.4: Photographs of the Tenements in Tsukishima
Note: Figures A.4a and A.4b show the two- and one-story tenements in Tsukishima, respectively.
Source: Department of Health, Ministry of the Interior 1923c, figures 62–63; 66.

A.5 Machinery Factories in Tsukishima

First, I used the results of the Primary School Children Survey included in the Tsukishima Survey to analyze the occupation (industry) of the household heads in Tsukishima. This is a survey of 4th-6th graders at Tsukishima 1st and 2nd Elementary Schools in July 1919. There were 1,173 children in these grades, and the survey included all 1,100 children who resided in Tsukishima. At that time, there were no other elementary schools. Thus, this survey is a complete survey for all children in grades 4–6 in Tsukishima. Although it does not include households without children in grades 4–6, it is undoubtedly a beneficial survey that provides an overview of the households with children—the main target of this study.

Panel A of Table A.5 shows the industrial structures. The composition ratios are similar to the census-based statistics reported in Panel A of Table 1. It does not specify whether brothers and sisters in the same household were counted twice. Despite this, the similarity confirms that the statistics obtained from this survey are useful to identify overall trends in family households in Tsukishima.

Panel B of Table A.5 divides the "social classes" of the household heads working in the manufacturing sector into six categories. In the report, large business owners were classified into the capitalist class; small business owners, free enterprise owners, and directors were regarded as the middle class; workers were defined as the working class (Department of Health, Ministry of the Interior 1923a, p. 50). Most heads of households were workers, with only 1% of the capitalist class and less than 20% of the middle class. While the definition of "executive" is unclear, "small business owners" must be small factory owners who could have had similar earnings to the skilled worker households (Department of Health, Ministry of the Interior 1923a, p. 64).

In November 1920, there were 214 factories in Tsukishima, 168 of them (approximately 80%) were classified as machinery factories. The official report documented that the wooden pattern factories could be included in the machinery sector because they were incorporated into the casting processes (Department of Health, Ministry of the Interior 1923a, p. 388). The share of machinery factories becomes approximately 90% if I include those 24 wooden pattern factories. Panel A of Table A.6 uses the manufacturing survey in the Tsukishima Survey to classify the 168 machinery factories by size and industrial sector. First, more than 90% of the plants are in the three sectors of machinery and equipment manufacturing, can manufacturing, and blacksmithing, with only 15 plants in the casting sector. 113 (67%) of the machinery factories have less than 15 workers. Second, many smithing factories have fewer than 15 workers. Hence, almost all of Tsukishima's smithing industry was classified as small businesses.[87]

Panel B of Table A.6 classifies the types of the 620 workers based on the results of the primary school survey used in Table A.5. There are 455 skilled and 165 unskilled workers. The same report shows that 490 out of 620 workers are industrial workers. The day laborers are classified as non-industrial workers. In fact, 620 workers minus 120 day laborers become 490, which is identical to the number of industrial workers documented. Therefore, approximately 90% of factory workers (455/490) can be regarded as skilled workers in the industrial sector: 65% work in factories, 17% in cottage industries, and 18% are craftsmen. Since workers in cottage and handicraft industries are classified as working in small factories, 65% of these workers might have worked in the middle- to large-scale factories (with 15+ workers).

Notably, this survey only includes household heads with primary school children aged 9–11 (i.e., 4th to 6th grades), suggesting that most of these heads are in their thirties, in the skilled workers age range. Therefore, the proportion of skilled workers to the entire worker group could be smaller than the 90%. Nevertheless, this confirms that most of the Tsukishima workers in their 30s were skilled workers at that time.

A.6 Works in the Machinery Factories

Tsukishima Survey includes the factory survey that counts the number of machinery factories in Tsukishima. Panel A of Table A.6 summarizes the number of machinery

[87]The report suggests that 43 of the 47 smithing factories were "town factories" or "workplaces." The definition of "town factory" is not clear in the report (p. 392). Since they were always counted more than the number of factories with 15 or fewer workers, they are likely to include smaller factories operated as small businesses.

Table A.5: Industrial Structure and Social Classes in Tsukishima: Evidence from Tsukishima Primary School Survey

Panel A: Industrial Structure

Name of survey	Tsukishima Survey
Survey area	Tsukishima
Survey month and year	July 1919
Survey subject	Heads of all the students in grades 4–6 in Tsukishima 1st and 2nd Primary Schools

	# of heads	% share
Agriculture	1	0.1
Fisheries	13	1.2
Mining	2	0.2
Manufacturing	623	58.6
Commerce	259	24.4
Transport	72	6.8
Public service and professions	55	5.2
Other industry	38	3.6
Observations	1,100	100

Panel B: Worker Types of Heads in Manufacturing Sector

Name of survey	Tsukishima Survey
Survey area	Tsukishima
Survey month and year	July 1919
Survey subject	All students in grades 4–6 in Tsukishima 1st and 2nd Primary Schools

	Tsukudajima	Shin-tsukudajima	Lot 1	Lot 2	Total
Large business owner	0	0	5	3	8
Small business owner	1	10	49	13	73
Self-employed	0	0	0	0	0
Executive	3	13	28	7	51
Worker	23	94	265	108	490
Unemployed/Unknown	0	0	0	0	0
Total	27	117	347	131	622
% share of workers	85.2	80.3	76.4	82.4	78.8

Notes: This table summarizes the statistics from the complete survey on the 4th–6th graders in Tsukishima1st and 2nd Primary Schools in July 1919. Panel A summarizes the heads' industries, and Panel B sorts the "worker type" of the heads in the manufacturing sector, respectively.
Source: Department of Health, Ministry of the Interior 1923a, pp. 386–387.

Table A.6: Scale of Machinery Factories and Type of Workers in Tsukishima

Panel A: Scale of Machinery Factories

Name of survey	Tsukishima Survey
Survey area	Tsukishima
Survey month and year	November 1920
Survey subject	All machinery factories

	Machinery and equipment	Can	Casting	Smithing	Total
# of workers ≥ 15	22	15	10	8	55
# of workers < 15	44	25	5	39	113
Total	66	40	15	47	168
% shares	39.3	23.8	8.9	28.0	100

Panel B: Type of Workers (All Industries)

Name of survey	Tsukishima Survey
Survey area	Tsukishima
Survey month and year	July 1919
Survey subject	All students in grades 4–6 in Tsukishima 1st and 2nd Primary Schools

Skilled workers		Unskilled workers	
Factory workers	295	Factory workers	42
Cottage industry	76	Cottage industry	3
Handicraft industry	84	Day laborer	120
Total	455		165

Notes: Panel A summarizes the number of machinery factories by the scale and type of the factory. Statistics are from the manufacturing census conducted in the Tsukishima Survey (November 1, 1920). The threshold of the scale (i.e., 15 workers) is based on the application of the Factory Act enacted in 1916.
Panel B sorted the heads by their skill level and job type. Statistics are obtained from the Complete Survey on the 4th–6th graders in Tsukishima1st and 2nd Primary Schools in July 1919.
Sources: Panel A: Department of Health, Ministry of the Interior 1923a, pp. 386–387; 410–414. Panel B: Department of Health, Ministry of the Interior 1923a, p. 149.

factories by type of plant. The machinery and equipment manufacturing factories shared 39% of all the machinery factories. Typical jobs for workers in machinery and equipment manufacturing plants are finishers (or fitters) and turners. A finisher is "a skilled worker responsible for finishing, assembling, and commissioning machine components" and is "one of the finest skilled workers because it requires skills in all aspects to correct defects in machine making" (Department of Health, Ministry of the Interior 1923a, p. 393). The turner is the "middle axis of machinists," to which most semi-skilled and skilled workers belong. Becoming a full-fledged finisher and lathe operator takes at least five years. Generally, apprentices enter the workforce at approximately 14–18, but they do not work in the same factory for many years within the apprenticeship system. After learning the skills for 1–2 years, they often move to another factory to improve their skills (Department of Health, Ministry of the Interior 1923a, p. 394). Wages are usually paid on a piece-work basis or on a time basis. In Tsukishima, a time contract is broadly adopted, and payment is based on the "residual time" method. The "residual time" method means that "if the work is completed within the contracted time, the remaining time is considered a bonus." For example, if 12 hours are contracted and the work is completed in 10 hours, 2 hours are paid as a bonus (pp. 396-397). Wages are paid by dividing one month into two periods (the first and second half of the year). The average work hours are reported to be approximately ten hours, with occasional all-night work (p. 402). Overtime hours are approximately two hours per day (Department of Health, Ministry of the Interior 1923a, p. 402).

Next, I summarize labor in the canning factory, which accounts for 24% of all the factories. The canning factory is engaged in shipbuilding, bridges, steel frames for construction, and other works, including fabrication and repair of gas reservoirs (p. 406). Workers in a canning factory are called "boiler makers" and are typically involved in bending steel plates and jointing them with rivets. Workers are divided into rivetter, holder-up, plater, angle-ironsmith, and caulking. The work is usually done in groups, with the skilled angle-ironsmith and caulking. The "bōsin" of the rivetter gives the instructions as the head of the group. Wages are paid on a piece-rate contract basis. Because of the contracted wage, the cannery workers' income is unstable; thus, they are paid a fixed wage (daily wage amount) during the off-season.

Smithing is the second most common industry, accounting for 28% of the total. Panel A of Table A.6 reveals that most of the smithing industry is relatively small in scale. They make boulders, nuts, rivets, lathe stops, jigs, and spanners for can manufacturing and construction. They are subcontractors who manufacture metal parts for the larger factories in Tsukishima (Department of Health, Ministry of the Interior 1923a, p. 412). There are three types of jobs: *yokoza*, *sakite*, and *tatara-fuki* (bellows-blower). The *yokoza* is a self-employed skilled worker (called *oyakata*), while the other two are young unskilled laborers. In small operations, wages are based on a percentage based on voluntary business discussions with the proprietor, and working hours are not regular (pp. 411–413).

Appendix B Data Appendix

B.1 Tsukishima Survey: The First Social Survey in Japan

According to Kawai (1980), the methodology of social research in Japan was formed in the 1930s. During the 1910s and 1920s, "numerous social surveys were conducted by various survey entities, including government agencies, research groups, local administrative bodies, private organizations, survey research institutes, and researchers." He saw that circa WWI, there were many problems in labor, lifestyle, urban, health and sanitation, public safety, and citizens due to the heavy and chemical industrialization, the monopolization of capitalism, and urban expansion (p.48). The Report on Field Survey in Tsukishima, Kyobashi Ward, Tokyo (called Tsukishima Survey)[88] used in this study is the most pioneering survey of urban communities (Sekiya 1970, p. 43).

First, I summarize the investigators, research questions, and subjects of the Tsukishima Survey. The person responsible for the Tsukishima Survey was Iwasaburō Takano (hereafter "Takano"), a professor of social statistics and social policy at the Law School of Tokyo Imperial University. Takano became a professor of economics at Tokyo Imperial University in 1919, and became the director of the OISR in 1920. Takano placed great importance on gathering objective statistics about workers through social surveys (Sekiya 1970, p. 33). He had the experience of conducting the first household survey in Japan in 1916[89] He was a member of the seventh subcommittee (Rural Sanitation Subcommittee) of the Ministry of Home Affairs' Health and Sanitation Investigation Committee since 1916.[90] In 1917, the seventh subcommittee evolved into the Section on Urban and Rural Sanitary Conditions (Kawai 1981a, pp. 12–13). On October 22, 1918, Takano submitted a proposal to the subcommittee for a field survey of urban sanitary conditions. The survey aimed to determine the housing conditions, household budget status, and health status (child health, production, stillbirths, deaths, and diseases) in the areas where skilled-worker families congregated (Sekiya 1970, p. 6). Initially, the survey area was planned to be Yanagibashi Yokogawa-chō in Honjo Ward. However, at a committee meeting on November 23, the survey site was changed to Tsukishima in Kyobashi Ward, which had more skilled worker households than in Yokogawa-chō (Kawai 1980, pp. 55–59).[91]

[88]Takano himself, who was responsible for overseeing the survey, refers to this field survey as the "Tsukishima Survey" (Department of Health, Ministry of the Interior 1923a, p. 6). Considering this, I use the Tsukishima Survey as the name of this survey throughout this paper.

[89]This is called the "Survey of Household Income and Expenditure of 20 Artisans and Workers in Tokyo," which was inspired by Charles Booth (Miyoshi 1980, p. 33). The original documents of this survey, preserved at Tokyo Imperial University, were destroyed in the Great Kantō Earthquake (Takano 1933, pp. 727–728). Before this household survey, Takano conducted a field survey in a poor area of Tokyo when he was a student at Tokyo Imperial University. The findings were reported in April 1894 as an exercise entitled "East London in Tokyo" (Kawai 1981b, p. 3).

[90]The Health and Sanitation Investigation Committee of the Ministry of Home Affairs was established on June 27, 1916, under the second Shigenobu Okuma Cabinet by issuing Imperial Ordinance No. 172. Initially, 34 members were appointed, and the first meeting was held on July 8. The reason for the establishment of this committee was the need for a policy response regarding the establishment and institutionalization of various investigation organizations and the penetration of the capitalist economy during the Meiji period. Another reason was the requirement for a public health response to the rising mortality rate, exemplified by the tuberculosis epidemic (Kawai 1981a, pp. 10–13).

[91]Takeda (2015, pp. 75–76) provides more details on how the survey site was changed. Takano was

Although the statistical sampling method was not yet common at that time, Takano selected the survey sites based on his visionary thinking. He stated that "there can be no dispute that we have chosen Tokyo as the target of our metropolitan survey. However, it is impossible to survey the entire Tokyo area. We have no choice but to conduct a partial survey. For this purpose, it would be the best idea to select a representative area in Tokyo and survey that area narrowly but deeply." (Department of Health, Ministry of the Interior 1923a, pp. 2–3). Takano further explained the need to focus on the working-class, which makes up most of the citizens, rather than to see the political and commercial center: "Most of Tokyo citizens are wage earners who subsist on labor. As is usual in large cities, a large number of people are engaged in manual labor in Tokyo. However, the most genuine type of worker is the skilled worker. Therefore, the area where many families of skilled workers congregate can be regarded as a representative area of Tokyo. Further, it seemed to me that a study of the social and sanitary conditions in that area could explain a large part of the social and sanitary conditions in Tokyo." (Department of Health, Ministry of the Interior 1923a, pp. 3).

It is necessary to investigate the point where Takano states that "the most genuine type of worker is the skilled workers" and the fact that the main target of the Tsukishima Survey was skilled workers.[92] The description by Kawai (1981a, pp. 13–18) is helpful in this regard. As summarized in Section 2, Japan's mechanical and chemical industrialization throughout WWI led to a large concentration of city workers. As a result, the ratio of small-scale conventional factories based on "master employees" (as is often observed in the textile industry) decreased. Conversely, the number of factories with a direct "factory owner-employee" employment relationship increased, particularly in the machinery and equipment, metal, and chemical industries. These workers in the modern industrial sector accumulated skills, formed households, and settled in the cities. It can be said that a new urban worker lifestyle was being formed. In short, although the city had a class of workers engaged in traditional industries, Takano believed that the skilled workers in the modern industrial sector would play a central role in terms of the labor force, labor movement, and urban life.

In addition, Sekiya notes the rise of the labor movement. As explained in Section 2, while wages rose throughout WWI, inflation caused relative wages to decline. In 1916,

looking for a commissioned researcher to conduct the survey and asked Sakuzō Yoshino, a colleague at Tokyo Imperial University, to recommend a suitable person. Yoshino approached his former student Kotora Tanahashi, who had become a member of the fraternity club, a mutual aid organization for workers, to accept the investigator position. The diary written by Kotora Tanahashi ("Tanahashi Kotora Diary") is in the possession of the OISR, and Takeda (2015, pp. 76–77) used the diary to analyze the circumstances surrounding the change of survey location. Tanahashi eventually recommended Yoshitsuru Yamana, who was his classmate in high school and Tokyo Imperial University, as a researcher and considered Tsukishima to be the best research area because of the ease of selecting survey households using the fraternity's network. On October 26, Tanahashi and Yamana—together with the Kyobashi Branch of the fraternity club—conducted an on-site inspection of Tsukishima. Based on this inspection, Tanahashi and Yamana approached Takano about locating the survey station in Tsukishima. Finally, Takano and Yamana conducted an on-site inspection there on October 30 and decided on Tsukishima as the survey site.

[92]In other words, the Tsukishima Survey was not designed for poor households. Therefore, unlike the surveys conducted in the UK by Booth and Rowntree, investigating the standard of living was not the main objective of the survey (Sekiya 1970, p. 42).

Japan's first labor protection legislation, the Factory Law, was enacted. However, the number of working days and hours did not decrease. Consequently, the number of labor disputes steadily increased (Sekiya 1970, pp. 24–26). Given this, Takano believed that workers should organize labor unions to help themselves with labor problems that could not be resolved through labor protection legislation. Sekiya (1970, pp. 26–40) speculates that Takano's intention in conducting the Tsukishima Survey was to obtain basic data for solving labor problems, specifically to identify the scope of matters to be solved by workers on their own initiative (or covered by labor protection legislation).

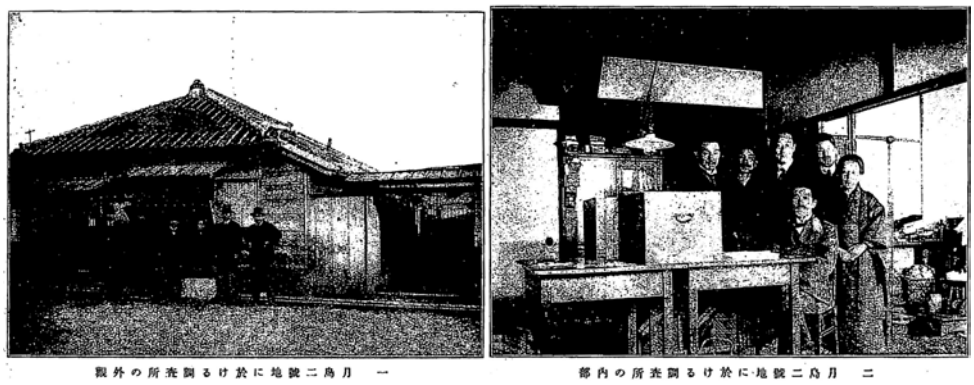
Kawai (1981b, pp. 15; 17) assessed the 40 households covered by the household survey included in the Tsukishima Survey as "the representativeness of the sample has remained ambiguous." There are no systematic descriptions of how the sample households were characterized among the worker households in Tsukishima. The official report stated that "to find suitable persons to fill in the form, we must ask for the assistance of school principals, police officers, physicians, and laborers, and we have requested a meeting of these persons at the survey office to explain the purpose of the survey, and to solicit applicants for the distribution of the household account book" (Department of Health, Ministry of the Interior 1923a, pp. 8–9). As explained, the target households were not randomly selected because the statistical sampling method was not prevalent. However, as described in Section 3, the THBS households can be regarded as standard skilled factory worker households in Tsukishima. Therefore, it is plausible that Takano designed this household budget survey in the sampling framework to capture representative households in Tsukishima.

Table B.1: Survey Categories in the Field Study of Tsukishima Survey

	Periods of the field studies	Chapter in the published report
1. Social mapping	Nov. 1918–May 1919	A2
2. Physical examination of children	Jan. 1919–July 1919	3
3. Physical examination of workers	June 1919	3
4. Nutrition survey of the worker households	May 1919	3
5. Survey of tenement houses	Autumn, 1919	3
6. Survey of sanitation occupation	June 1919	3
7. Sanitary survey in elementary schools	Unknown	3
8. Factory labor survey	Unknown	4
9. Labor household survey	Nov. 1918–Jan.1920	2
10. Elementary school survey	July 1919	2
11. Restaurant survey	Dec. 1919 & April 1920	2
12. Field survey of vaudeville	Dec. 1919	2
13. Survey of stalls and passersby	Dec. 1919	2
14. Photographing	Oct. 1920–Nov.1920	A2

Notes: The years/months listed in the first column ("Periods of the field studies") are based on the description in the Department of Health, Ministry of the Interior (1923a, pp. 10–17). Figures listed in the second column ("Chapter in the published report") are based on the table of contents in the Department of Health, Ministry of the Interior (1923a, pp. 1–12; 1923b, pp.1–2). "A2" indicates the Appendix 2.
Sources: Department of Health, Ministry of the Interior (1923a, 1923b, 1923c).

Next, I overview the survey items and methodology. The investigation was primarily



(a) Outside of the office (b) Inside of the office

Figure B.1: Photographs of the Survey Office in Tsukishima

Note: Figures B.1a and B.1b show the outside and inside of the survey office in Tsukishima, respectively.
Source: Department of Health, Ministry of the Interior 1923a, figures 1 and 2.

divided into "documentary" and "field" surveys. The former was an analysis of the characteristics of Tsukishima, using published statistics such as the Police Department Statistics Book (Department of Health, Ministry of the Interior 1923a, p. 10). This was a pioneering attempt at the time and influenced subsequent urban studies (Kawai 1980, pp. 61–62). The latter was a field survey including 14 survey items (Table B.1). It is not possible to describe all the survey items in detail, but following the report, they can be divided into four large categories: 1. survey on workers' livelihood (chapter 2); 2. survey on sanitary conditions (chapter 3); 3. survey on labor conditions (chapter 4); and 4. social mapping and photography (appendix). The survey was conducted over two years, from November 1918 to November 1920, although the timing varied depending on the survey items (Table B.1).

A unique feature of the survey methodology is the use of young researchers as commissioned researchers. The household budget survey and leisure life survey were conducted by Yasunosuke Gonda, a faculty member of the Doitsugaku kyōkai gakkō (Association for German Sciences), who had researched cinematograph and entertainment. Tetsuo Hoshino, a medical doctor, was responsible for the sanitary survey. The labor survey was managed by Yoshitsuru Yamana, a graduate of Tokyo Imperial University who contributed to the organization of labor unions. In addition, Toyotaro Miyoshi, a sociology student at the Tokyo Imperial University, and others became temporary employees (see footnote 55). At the time, the Health Bureau of the Ministry of the Interior conducted several sanitary surveys of rural areas. Takano may have designed the urban sanitary survey from this background (Kawai 1981a, pp. 8–9). However, based on the idea that "health and sanitation surveys can at least encompass economic and social surveys," Takano included a wide range of survey items, not limited to sanitation surveys (Department of Health, Ministry of the Interior 1923a, p. 56). Kawai (1980, p. 55) credits the Tsukishima Survey as a noteworthy pioneering concept: "going beyond a mere insurance and sanitation survey, it attempted to accurately depict the state of urban workers' lives as they became established in the city during modernization, with skilled workers as its core."

Takano stated, "To be as complete as possible, it is best to continue the survey over as long period as possible and to obtain accurate facts by recording the workers' household income and expenditures." For this reason, he believed that "the best method of investigation would be to establish a survey station directly in the survey area and to have a full-time investigator reside there as much as possible, familiarize himself with the area and the people, and conduct the field survey" (Department of Health, Ministry of the Interior 1923a, p. 4). In fact, through the mediation of the Tsukishima police station, a survey office was rented at 9-3 Higashinakadōri, Tsukishima, where Yoshitsuru Yamana moved in from November 1918 and contacted worker households (Department of Health, Ministry of the Interior 1923a, p. 7; Takeda 2015, p. 77). The survey office was open from November 1918 to December 1920, including the entire survey period. Figure B.1 shows the photographs of the survey office.

It is also important to note that Takano and his team held *weekly* meetings at the office during the survey period. Toyotaro Miyoshi, who was an assistant in the survey, recalls the situation at that time as follows:

> After the start of the survey office, all the members gathered once a week with Iwasaburo Takano present to discuss the implementation and progress of the survey and administrative matters. Iwasaburo Takano would always attend each meeting, happily listening to the results of the week's research, inspecting the materials, providing detailed and thoughtful guidance, and usually ending the study session in a friendly atmosphere. Even now, I can recall the warm face of sensei (i.e., Professor Takano) of those days. It was always a friendly, laboratory-like atmosphere in which the Booth and Rowntree investigations were occasionally discussed.
> Miyoshi (1980, p. 38)

He also states the following about Takano:

> When the Tsukishima Survey was launched, the Faculty of Economics (in the Tokyo Imperial University) was becoming independent, and he was swamped both inside and outside the university. However, his enthusiasm for the Tsukishima Survey was extreme, and he was always present on his business trips to Tsukishima. Moreover, he made every effort to carry out his duties with precision.
> Miyoshi (1980, p. 40)

Kawai (1981b, p. 28) assessed that there were no interconnections among the survey items mentioned above and that the survey "ended up being several fragmentary surveys rather than a comprehensive and systematic survey of workers' lives." This difficulty may explain the reason why previous academic studies have rarely used the Tsukishima Survey. However, as already explained, Takano did not intend to conduct a large-scale social survey in Tsukishima in the first place. Instead, as Takano noted, the best method is to investigate a representative area "narrowly but deeply." The goal was to improve the quality of the investigation rather than the scale of it. In this light, the fact that the researchers lived in the survey area and were constantly organizing and revising the

Figure B.2: Official Published Report of the Tsukishima Survey

Notes: This photograph shows an example of the official report of the Tsukishima Survey published by the Department of Health, Ministry of the Interior, in 1923.
Source: Department of Health, Ministry of the Interior 1923b, title page. The tone was adjusted by the author using Adobe Photoshop 24.7.0.

survey results should be appreciated. Although the Tsukishima Survey is an early social survey in Japan, it is undoubtedly of high quality.

Finally, I summarize the format of the published report and the unpublished materials. The results of the Tsukishima Survey were officially summarized in one report published in December 1921 by the Sanitary Bureau of the Ministry of the Interior and in two appendices (Figure B.2 is an example of the front cover). The report was published under the name "Report on Field Survey in Tsukishima, Kyobashi, Tokyo," and consists of four sections. The first section is a comprehensive review by Takano and outlines the survey. The second section summarizes the living conditions of the workers, and was written by Gonda (partly by Yamana). Hoshino wrote the third section. It summarizes the sanitary conditions of workers. In the fourth section, Yamana summarizes the labor situation in Tsukishima. There are two appendices. One contains statistical tables related to the above report, and the other organizes social maps and photographs. The correspondence between the survey items and the report is summarized in Table B.1. The Ministry of Home Affairs has already published these materials, which are available at the Gonda Yasunosuke Library of the OISR and the University of Tokyo Library.[93]

[93]In the OISR, these are included in the Archives of Gonda Yasunosuke (7-2; 7-3; 7-4). In addition, there is a second manuscript of the Tsukishima Survey report. This is the manuscript of the second series, which was preserved in the home of Gonda Hayao, the second son of Gonda Yasunosuke, and was discovered by Terade Koji. The second series includes a summary of the results of a household survey of elementary school teachers' households in Tokyo, conducted as a supplementary survey to the Tsukishima Survey (see Terade (1982) for details). The manuscript of this second series was later donated to the OISR and is now available as part of the Gonda Yasunosuke Collection at the Institute (The OISR, Archives of Gonda Yasunosuke (8-12; 8-13; 8-14; 8-15)).

B.2 Original Micro-spreadsheets from the Household Budget Survey in Tsukishima Survey

The official report does not include household-level information, and only a small quantity of the original forms used to prepare the report have survived. Fortunately, however, some of the original micro-spreadsheets are kept in the archives of the OISR because Takano was its first director. This study uses the original micro-spreadsheets from the household budget survey (No. 9 in Table B.1), which was used by Gonda to write the second section of the official report. While they have yet to be publicly available, I received permission from the OISR to use the original forms stored in the archives: the OISR, Archives of the Tsukishima Survey (THBS, unreleased).[94]

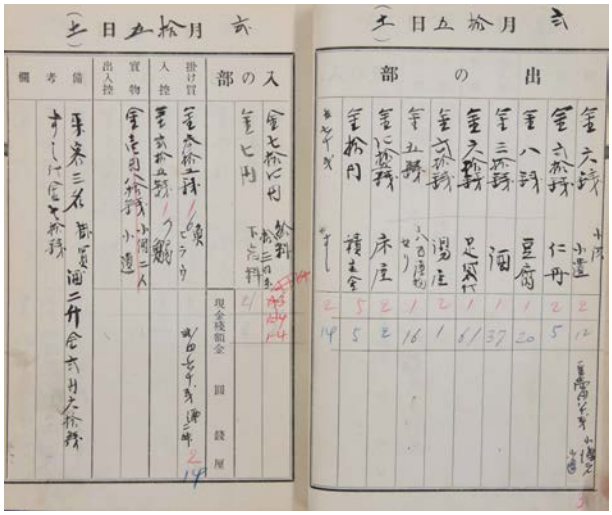


Figure B.3: An Example Page of the Budget Book
in the Tsukishima Household Budget Survey

Notes: This photograph depicts a sample page from the household expenses account of the THBS. The right page documents the details of costs. The left page includes the details of revenue and receiving and making payments on the goods (actual things, including gifts).
Source: The THBS, account #6, 15th February, 1919. The tone was adjusted by the author using Adobe Photoshop 24.7.0.

The budget book used for the household budget survey is named the *Kinsendeiri hikaechō* (money receipts and disbursements account book). The design of this budget book was based on the form used in Takano's first household survey (Online Appendix B.1).[95] The budget book was to be filled out daily and included four sections: income, expenses, receipts from credit purchases, and receipts and disbursements of actual goods. Most of the entries were in the income and expenses sections, indicating that their daily living was conducted through wage receipt and consumption in cash. Figure B.3 shows an example of the budget book.

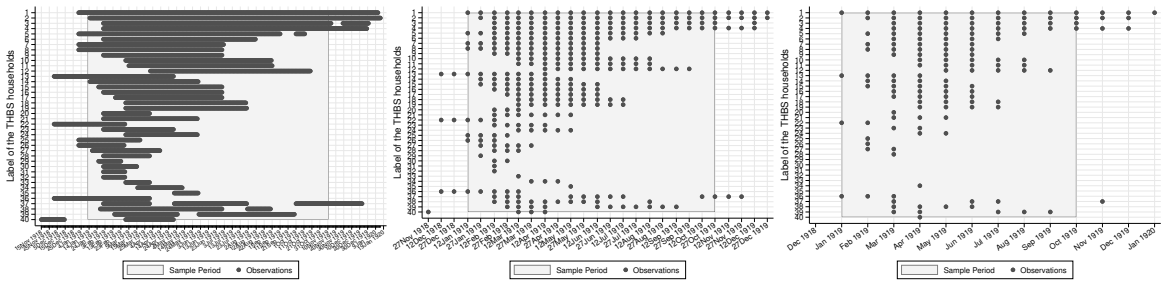
As described, the method used to select households for the survey was not recorded in detail (Online Appendix B.1). According to the report, they initially recruited just over

[94]I would like to express my sincere thanks to Professor Kazue Enoki, Deputy Director of the OISR, for allowing me access to the documents. I wish to thank Ms. Mika Nakamura, an archivist at the institute, for her careful assistance during the research.

[95]Department of Health, Ministry of the Interior (1923a, p. 152).

90 households through the factories, police station, and elementary schools in Tsukishima. Of these, 50 households completed the book for at least one month, but 10 were deemed incomplete and not included in the report. In addition to the 40 budget books used to prepare the report, therefore, the OISR has another set of budget books marked as "discarded." According to my survey, about six incomplete books of the worker households have been determined to be in this "discarded" category. Therefore, based on the condition of the remaining books, it is plausible to believe that approximately 50 households participated in the survey. Of the 40 households included in the report tally, two households maintained records for more than one year, 11 households for 6–12 months, and the remaining 27 households registered for less than six months (Department of Health, Ministry of the Interior 1923a, pp. 152–153). Initially, the survey period was intended to be six months, but the average bookkeeping period for the 40 households was four months.

B.3 Trimming



(a) Daily panel dataset (b) Semi-monthly panel dataset (c) Adj. monthly panel dataset

Figure B.4: Structures of the THBS Datasets by Different Time Frequencies

Note: Figure B.4a, B.4b, and B.4c show the observations in the daily, semi-monthly, and adjusted monthly panel datasets, respectively. For example, a marker in Figure B.4a indicates an observation in a specific year-month-date cell. Strictly, semi-monthly, and monthly datasets include both panel and cross-sectional units because aggregation shall trim fractions in the edges of the survey period. Figure B.4b shows 35-panel units and five cross-sectional units (#29; #31-33; #35). Figure B.4c shows 28-panel units and six cross-sectional units (#20; #25; #26; #28; #34; #40). Five cross-sectional units in the semi-monthly panel do not appear in this figure (#29; #31-33; #35). Note that unit #30 having two semi-monthly cells is not included because those cells are separated into different adjusted months (February and March, respectively). Source: Created by the author using the THBS sample.

To check whether the statistics from THBS budget books contained any missing information, I digitized all 40 household budget books. Throughout this digitization process, I found that there are a few misreporting issues in the budget books.

First, there is a household that does not include income information (household #37). Although the official report by Gonda reported the average monthly income for this household (Department of Health, Ministry of the Interior 1923a, p. 183), no documentation enabled me to determine how this average income was calculated. Hence, I excluded this household's budget book. Similarly, a household does not include information on the payments to the credit purchases (household #39). Although this household's budget book documented the amount purchased in credit purchases, I excluded this household's budget book because the expenditure series became systematically smaller due to the omission of the payment information.

Second, the final pages of the budget books are sometimes omitted. This may be because the vendor who bound the budget books accidentally truncated the last page. All these incomplete sheets could not be included in the analysis.

Third, several households did not complete their budget books in the first and/or last month of the survey period. For example, the budget book of household #1 has statistics from January 1, 1919 to January 12, 1920. Similarly, the book of household #29 contains statistics from January 26 to February 23, 1919. In semi-monthly and monthly datasets, these censored budget books may not be included in the aggregation. In the latter case, for instance, the budget sheets of January 26 and after February 11, 1919, are not included in a semi-month cell because the semi-month cell is defined from the 27th to the 11th of the next month, in this case. Thus, household #29 only has a cross-sectional observation and could not be included in my analytical sample.

Figure B.4 summarizes the structure of the 40 THBS households. Figures B.4a and B.4b show the observations in the daily and semi-monthly datasets, respectively. As explained, there are five cross-sectional units (#29; #31-33; #35) in the semi-monthly dataset. Therefore, there are 35 units with a panel structure. After excluding two units without complete information on income and credit purchases (#37; #39), I obtained the 33 THBS households as the analytical sample for my panel data analysis.

Regarding the time dimension, I trimmed all the observations before January 12, 1919, and after November 11, 1919, because the number of surveyed households is substantially small in the edge periods. For example, Figure B.4b shows that the number of cross-sectional units is three or less in both periods, causing substantial fluctuations in the net income. Consequently, my analytical sample includes 33 households measured between January 12 and November 11, 1919. The average number of semi-months per unit is 8.8 (Std. Dev. = 5.0). The characteristics of the 33 THBS households are summarized in detail in Section 3.

Regarding the adjusted monthly series, I further exclude several units that have insufficient observations for constructing the monthly panel: 26 THBS households are included in my adjusted monthly panel dataset. Figure B.4c shows the observations in the adjusted monthly dataset.

B.4 Testing the Potential Influence of the Lack of balance

In this subsection, I test whether attrition leads to selection bias in the THBS sample. If the difference in the preference for consumption predicted large attritions, there must be statistically significant correlations between the family size variables and attrition. In other words, the units with shorter (longer) time-series observations have different preferences from those with longer (shorter) time-series observations. Table B.2 summarizes the results of the balancing tests (Section 3.2). The dependent variable is an indicator variable that takes one if the household has time-series observations less than the median (column 1), 75 percentile (column 2), and 25 percentile (column 3). In Column 1, all the estimated coefficients on the family size variables are close to zero and statistically insignificant, and the Wald statistics p-value suggests the null results. This is unchanged if I use the third and first quantiles in columns (2) and (3), respectively. Therefore, the family characteristics are similar between the households with short-term observations

Table B.2: Results for the Balancing Tests

	DV: Indicator variable for the households with shorter time-series observations		
	Threshold:		
	(1) Median (150 days)	(2) 75 percentile (184 days)	(3) 25percentile (79 days)
Size	-0.243	0.238	-0.135
	[0.244]	[0.254]	[0.294]
Children aged 6–12 (%)	0.017	-0.011	0.026
	[0.020]	[0.019]	[0.022]
Children aged 13–16 (%)	0.029	-0.050	0.057
	[0.038]	[0.045]	[0.041]
Men aged 17+ (%)	-0.008	0.008	-0.010
	[0.019]	[0.018]	[0.026]
Intercept	1.149	-0.576	-0.164
	[2.107]	[2.048]	[2.805]
Zero slope (p-value)	0.710	0.753	0.160
Maximized Log-likelihood	-21.8	-18.5	-15.2
Pseudo R-squared	0.046	0.046	0.171
Number of households	33	33	33

The results from Probit models are reported. Robust standard errors are in brackets.
Notes: The dependent variable is an indicator variable that takes one if the household has shorter time-series observations. Column 1 uses the median of the number of days per unit as the threshold. The result from the regression using the average number of days per unit (144 days) as the threshold is identical to that listed in column 1. Column 2 uses the 75 percentile of the number of days per unit as the threshold. Column 3 uses the 25 percentile of the number of days per unit as the threshold. All family size variables are the time-series average in each unit over the sample period. The proportion of children aged 0–5 years (%) is used as the reference group. Wald χ^2 statistics p-values for the null of the zero-slope hypothesis are reported in the sixth row. The results from the expanded regressions including the head's age and earnings are materially similar. The null of the zero-slope hypothesis is not rejected in all the specifications at the conventional level (not reported).

and those with long-term observations. This result supports the evidence that the lack of balance in the THBS dataset is unlikely to lead to selection bias.

B.5 Comparing Distributions of the Household Size

Figure B.5 illustrates the household size distributions measured in the census and THBS sample. The Pearson chi-squared test does not reject the null hypothesis of the equality of distributions with p-value of 0.948. This supports the evidence that the THBS sample has a similar household size distribution to that of the entire Tsukishima population (Section 3.1). As described in Section 3.2, while the THBS sample does not cover households with one person and with a very large number of people, it covers most of the classes in the household sizes with reasonable approximation to the population distribution.[96]

[96]The number of households with one people is 362, accounting for only 6% of the total number of households. Similarly, the number of households with nine or more people is 294, accounting for only 5% (Section 3.2).

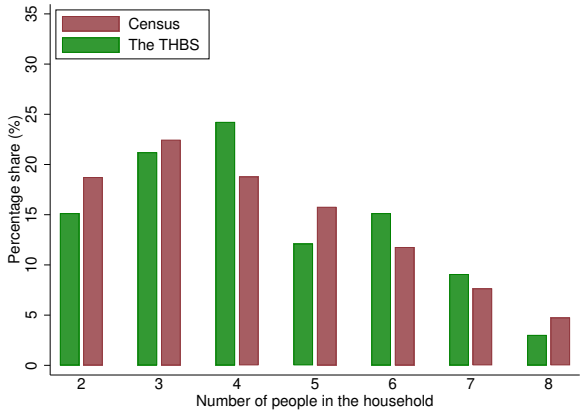


Figure B.5: Distribution of the Household Size:
Population Census v. the THBS sample

Notes: This figure shows the distribution of household size measured in the 1920 Population Census (red) and the THBS sample (green). The Pearson chi-squared test does not reject the null hypothesis of the equality of distributions with p-value of 0.948. The share in each household size measured in the census is used as the theoretical probability in calculating χ^2 test statistic (Pearson 1900).
Sources: Created by the author using the Tokyo City Office (1922a, pp. 262–283) and the THBS dataset.

B.6 Estimating Average Head's Monthly Income

The time-series figures of average wages in prewar Japan were provided by the Long-Term Economic Statistics (hereafter LTES). Specifically, the LTES estimates the average national salary series of "general occupations," "manufacturing sector," and "manufacturing occupations (by medium classification)." For the manufacturing occupations category, the LTES reports the average wage per day of factory workers in Tokyo and Osaka cities from 1917 to 1922 (Ohkawa et al. 1967, p. 255). These values were estimated using the "Annual Statistics of the City of Tokyo" (hereafter, the ASCT) and "Osaka City Statistical Table." However, the household survey includes the household head's monthly income but no information on the daily wage. Hence, the "average daily wage per factory worker" estimated in the LTES is not useful for comparing the heads' average monthly income from the THBS. In this section, I use available wage and labor statistics to estimate the average monthly income of male factory worker households in Tokyo and compare it to the THBS heads' average monthly earnings.

To clarify the problem in estimating the monthly earnings, I first estimate average monthly earnings in the simplest way. To do so, I use the ASCT (Volume 17), which provides wage statistics as of the end of 1918, as a case study. For each industrial sector, the ASCT (Volume 17) provides the "average daily wage of male factory workers aged 15 and over," "the number of male factory workers aged 15 and over," and "average number of working days per year" for four factory categories: factories with ten or fewer workers, and factories using or not using motive power. Using the "number of workers over 15 years old" in each factory category cell (c) as weight, I can obtain the average wage per month for a worker in each industrial sector. For example, in the manufacturing sector,

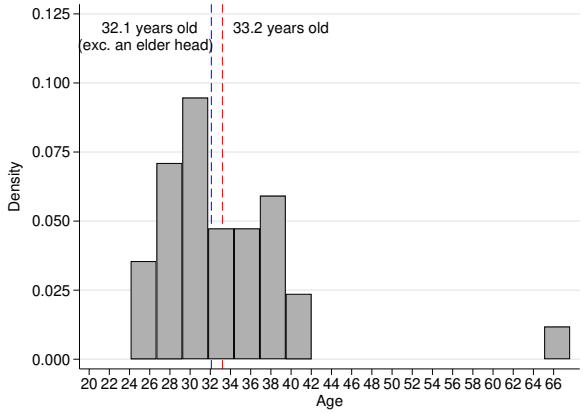


Figure B.6: Distribution of the THBS Heads' Age

Notes: This figure shows the density of the THBS heads' age calculated from the THBS daily panel dataset. The dashed line (red) indicates the average age of all the heads (33.2 years old). The dashed line (blue) shows the average age of the heads, excluding an elder head aged 67.6 (32.1 years old). The difference between the two average figures is statistically insignificant with $p = 0.4087$.
Source: Created by the author using the THBS dataset.

this can be calculated as:

$$Wage^{15+}_{Machine} = \frac{\sum_c \{(Daily\ Wage^{15+}_{Machine,c} \times Working\ Days_{Machine,c}) \times Workers^{15+}_{Machine,c}\}}{12 \sum_c Workers^{15+}_{Machine,c}}, \tag{5}$$

which is estimated to be 27.8 yen. This is the most straightforward estimate using daily wages, the number of workers, and the number of working days. Thus, it has a few critical issues that cause a downward bias in the estimate.

The first issue is that the wages of factory workers are aggregated in a "15 years old or older" category in the ASCT (Volume 17). Figure B.6 shows the THBS heads' age distribution. The sample mean is 33.2 years old, which is unchanged if I exclude a head aged more than 60 (i.e., 32.1 years old). This means that I should refer to the average daily wage for the 30s to 40s for comparison. However, since many workers are in their twenties in the distribution of entire workers, the average wages reported in the ASCT are considerably lower than the average wage for factory workers at approximately 30 years old. This means that I need the wage profiles by age to correct this downward bias.[97]

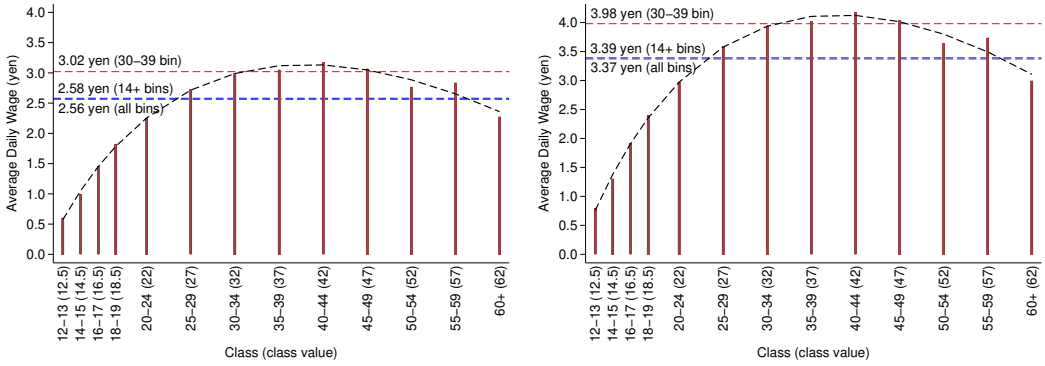
Second, there is no consideration of ancillary pay such as bonus and allowance. As explained later, these wages share a non-negligible proportion of the head's earnings. Thus, estimation excluding ancillary wages would have a strong downward bias.

In the following subsections, I summarize the procedure for correcting these factors leading to the downward bias in the monthly income estimation.

B.6.1 Daily Wage Distribution by Ages

As the early wage surveys focused only on the average wage for entire workers, official statistics in the 1910s never included average wage statistics by age (bin). In the "Sta-

[97]The ASCT (Volume 18), which contains statistics for 1919, no longer lists such wages by age group



(a) 1918 (b) 1919

Figure B.7: Average Daily Wage by Age Bins

Notes: This figure shows the average daily wage distribution by age bins based on the manufacturing census in 1924. Figures B.7a and B.7b show the distributions under 1918 and 1919 prices, respectively. The weighted average daily wage for a 30–39-year-old bin is shown in red. The weighted averages for all and 14+ bins are shown in gray and blue lines, respectively. The fitted fractional polynomial models are shown in the dashed lines. For the 1918 price data, the fitted model is $\hat{y}^{Daily\ Wage} = -10.01 + 4.15a^{1/2} - 0.33a^2$ with $R^2 = 0.99$. For the 1919 price data, the fitted model is $\hat{y}^{Daily\ Wage} = -13.18 + 5.47a^{1/2} - 0.43a^2$ with $R^2 = 0.99$. Sources: Created by the author using the Tokyo City Statistics Division (1926a, pp. 16; 244–245). Data on the consumer price index for the cities are obtained from Ohkawa et al. (1967, p. 135).

tistical Data Field Survey Law" (Law No. 52) in April 1922, average wages by age group were surveyed for the first time in the "Labor Statistics Field Survey" in October 1924 conducted by the Social Affairs Bureau of the Ministry of Home Affairs (Committee for the History of the Labor Movement 1964, p. 14). The result of this survey in Tokyo was published as the "Labor Statistics Table for Tokyo City and Suburbs" (hereafter, LST) by the Tokyo City Statistics Division in 1926.

Based on the LST, Figure B.7 shows the average daily wages of male factory workers in Tokyo City's machinery and equipment manufacturing industry by age group. In the LST, there are 13 age bins, and the number of workers and average wages are listed for each bin. Figure B.7a shows the distribution of wages adjusted to 1918 prices using the consumer price index (CPI) for urban areas (Ohkawa et al. 1967, p. 135). The weighted average for ages 14 and older is 2.58 yen, which is about the same as the weighted average for daily wages of 2.56 yen. The 2.58 yen is between the average values for the 20–24 age bin and the 25–29 age bin. Thus, it is likely to represent the daily wage of workers at approximately 25. This is consistent with the fact that workers are concentrated in the twenties. However, the weighted average for the 30–39 age bin is 3.02 yen, which deviates significantly from 2.58 yen. The distribution of wages at 1919 prices shows a similar result (Figure B.7b). This means that the unweighted average leads to the erroneous conclusion that the sample households are upwardly biased.

To address this issue, I use the following steps to estimate the distribution of wages of the factory workers in Tokyo City in 1918–1919, the observation period of the THBS sample. I use 1918 as an example below.

First, the distribution of daily wages by age group was predicted from statistics obtained from the LST. Following Royston and Altman (1994), I consider a fractional poly-

(average wages only). As is clear, the same problem arises in this case.

nomial of degree m as follows:

$$\phi_m(a; \boldsymbol{\varphi}, \mathbf{p}) = \varphi_0 + \sum_{j=1}^{m} \varphi_j a^{(p_j)}, \tag{6}$$

where a (> 0) denotes class value of age bin, $\boldsymbol{\varphi}$ is a vector of coefficients and $\mathbf{p}$ is a vector of powers, satisfying $p_1 < p_2 < ... < p_m$. $a^{(p_j)}$ indicates the Box-Tidwell transformation, taking $\ln(a)$ if $p_j = 0$ and a^{p_j} if $p_j \neq 0$. As suggested in Royston and Altman (1994, p. 433), the models requiring a degree higher than two ($m > 2$) are rare in practice. The wage by age bin distribution illustrated in Figure B.7 clearly shows a simple quadratic curve. Thus, I consider a fractional polynomial function with degree two as follows:

$$\phi_2(a; \varphi_0, \varphi_1, \varphi_2, p_1, p_2) = \varphi_0 + \varphi_1 a^{(p_1)} + \varphi_2 a^{(p_2)}. \tag{7}$$

To model the function, I consider a set of powers $\mathscr{P} = \{-2, -1, -0.5, 0, 0.5, 1, 2, 3\}$ following Royston and Altman (1994, p. 434).

The maximum likelihood estimation is used to search for the most suitable candidate of the coefficients for a given m. Since $m = 2$, there are ${}_8\mathrm{H}_2$ ($= 36$) repeated combinations for the candidates of the parameters. By adding the 8 simple candidates under the nested models (i.e., the models with degree-1 fractional polynomial) to be conservative, I run 44 regressions in total to find out the model with the highest maximized log-likelihood. The best power vector suggested is $(p_1, p_2) = (0.5, 1)$.[98] The projection model fitted using the best power vector is as follows:

$$\hat{y}^{Daily\ Wage} = -10.01 + 4.15a^{\frac{1}{2}} - 0.33a^1, \quad R^2 = 0.99. \tag{8}$$

The dashed curve in Figure B.7 is the predicted distribution in equation 8. The fitting suggests that the predicted distribution works properly, especially below the 50–54 bin.

Next, I shift the predicted distribution based on the difference in the average daily wages in the ASCT and LST. The weighted average of the daily wage is 2.56 yen for the LST, whereas that for the ASCT is 1.05 yen, meaning that there is approximately 1.5 yen difference.[99] Thus, I shift the functional polynomial function by this amount of difference to yield the proxy distribution for 1918.[100] Figure B.8a illustrates this operation: dotted curve is a fractional polynomial shifted from the original fractional polynomial shown as a short dashed curve.

[98]The deviance, defined as the twice negative (maximized) log-likelihood, is calculated to be -31.5. Royston and Altman (1994) proposed the deviance difference, $D(m, \mathbf{p}) - D(m, \tilde{\mathbf{p}})$, where $\tilde{\mathbf{p}}$ is the best power vector to compare the different models. This statistic has an asymptotic chi-squared distribution with m degree of freedom. The estimated deviance difference with the simplest linear model (i.e., $m = 1$ and $p_1 = 1$) is 54.6 with p-value $= 0.000$. Similarly, the difference with an another non-linear model with $m = 1$ and $p_1 = -2$ is 34.2 with p-value $= 0.000$.

[99]For the LST, I use the number of factory workers in each age bin as weight. The ASCT reports the average daily wage for four different categories of factories in each manufacturing sector: the factory scale (ten+ or below ten workers) and engines (use or not). I calculate the weighted average of the daily wage using the number of factory workers in each age bin (12–14 and 15+) and in each category as weights.

[100]This operation, therefore, assumes that the wage-by-age distributions in 1918 and 1924 are reasonably similar. In the LST (i.e., the statistic on which the predicted distribution is based), the weighted average

The average daily wage for 12–14-year-old bin is reported to be 0.42 yen in the ASCT, whereas that for 12–13-year-old bin in the LST is 0.60 yen. This difference (i.e., 0.18 yen) is smaller than the difference in the weighted average for all age bins (i.e., 1.5 yen). This implies that the daily wage by age distribution in the ASCT could be smoother (i.e., flatter) than that of the LST. Thus, the shifted fractional polynomial would provide stronger shrinkage for those bins of younger age. In other words, the shifted curve shall get closer to the actual (unobservable) wage distribution as age increases.

The long dashed curve in Figure B.8a examines this relationship by fitting another fractional polynomial model using the 12–14-year old bin figure of the ASCT and the predicted wages for 25–65 from the shifted fractional polynomial.[101] Let this curve predict wage distribution for the true distribution. The average daily wage for the 30–40-year-old bin in the shifted fractional polynomial is 1.55 yen, which is similar to that for the same-age bin in the predicted wage distribution (i.e., 1.52 yen). However, the wage gaps for the younger ages show more significant differences. If our interest is in the late 20s to the early 40s, it is plausible to employ the predicted wages for the wage comparison in Section 3.

Figure B.8b illustrates the result of the same analysis from the wage data of 1919 price, reflecting the increasing trend in price between 1918 and 1919. The average daily wage for a 30–40-year-old bin in the shifted fractional polynomial is 2.46 yen. Again, this is similar to that for the predicted wage distribution (i.e., 2.42 yen).

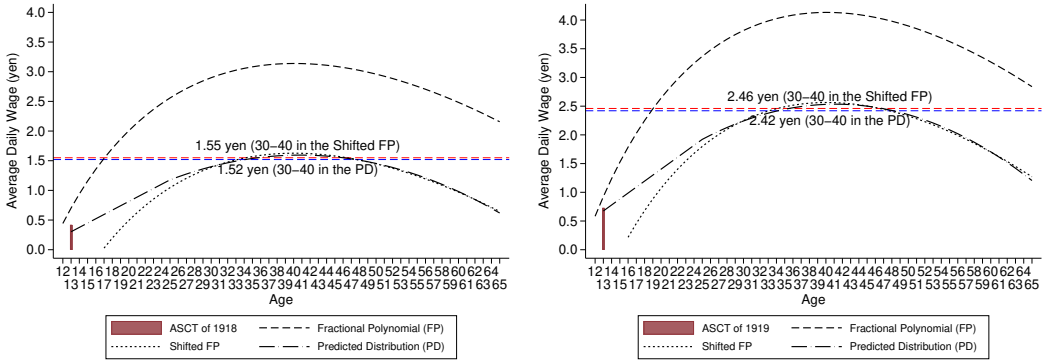
B.6.2 Ancillary Wage

The daily wage estimated in Section B.6.1 is a fixed salary and thus, does not include additional salaries such as bonuses and allowances (hereafter, wages other than regular salaries are collectively referred to as ancillary wages). However, there are no systematic statistics on the ancillary wages throughout the prewar period (Committee for the History of the Labor Movement 1964, pp. 14–15). Moreover, since the Tsukishima Survey targets skilled worker households, information on the ancillary wages paid to skilled workers is necessary. Fortunately, I found a survey report named "Wage Survey Report" edited by Kitazawa (1924). This report includes the result of a survey on the wages for machine finishers (fitters) and turners at six machine factories in Tokyo from May–October 1921. Thus, this is particularly useful material to know the wage structure of skilled factory workers.

According to Kitazawa (1924), there are two methods of paying wages to workers in the machine industry: one is to use hourly wages to calculate fixed salaries, and the other is to combine hourly wages with piece-rate wages, with the former being the most common (p. 33). Despite this, wages paid in both methods are usually divided into fixed salaries and other ancillary wages, and there is not much difference in essence (p. 39). Fixed wages are salaries added from a fixed hourly wage rate, while ancillary wages include bonuses

for those aged 14 and older was 3.25 yen. In comparison, the overall weighted average is 3.23 yen, a difference of only 0.02 yen. A similar trend can be observed in the statistics obtained from the ASCT: the weighted average for those aged 15 and older is 1.14, while the overall average is 1.13, a difference of only 0.01 yen. This suggests that the wage distribution in the ASCT is similar to that in the LST.

[101] The fitted model is as follows: $\hat{y}^{Daily\ Wage} = -1.19 + 0.14a^1 - 0.002a^2, \quad R^2 = 0.98$. The deviance is reported to be -149. I used the 25–65 age range for the prediction based on the age bins used in the LST.



(a) 1918 (b) 1919

Figure B.8: Daily Wage by Ages Distribution: Shifted Fractional Polynomial

Notes: The short dashed curve illustrates the fractional polynomial (FP) in Figure B.7. The dotted curve indicates the FP shifted by the difference in the average daily wage between the ASCT and LST. The ASCT documents the wage statistics for four different categories for each manufacturing sector: the scale of the factory (10+ or below ten workers) and engines (use or not). I calculated the weighted average of the daily wage using the number of factory workers in each age bin and the category as weights. The long-dashed curve shows the FP refitted using the average daily wage for 12–14-year-old bin (0.42 yen) measured in the ASCT and the daily wages for 25–65-year-old suggested in the shifted FP. The average daily wage for a 12–14-year-old bin is only available for the ASCT of 1918. Therefore, this figure for the 1919 price is calculated using the ratio between the average daily wage (1.05 yen) and that for 12–14 years old bin (0.42) in 1918 as $1.80 \times (0.42/1.05)$, where 1.80 is the average daily wage measured in the ASCT of 1919. The red dashed line is the average daily wage for 30–40-year-old in the shifted FP. The blue dashed line is the average daily wage for 30–40-year-old in the refitted FP.
Sources: Created by the author using the Tokyo City Office (1921, pp. 726–757); Tokyo City Statistics Division (1926a, pp. 16; 244–245).

and overtime pay, night shift pay, and labor premiums (profit sharing). In the case of a combination of hourly and piece-rate pay systems, the ancillary wage includes a share of the piece-rate profit.

Panel A in Table B.3 summarizes the survey results. The surveyed factories included 86, 157, 376, 623, 928, and 2,837 workers, ranging from small to large plants. The percentage of skilled workers (finishers and turners) in the surveyed factories ranged from 27% to 77%, and the portion of monthly ancillary wages was 12–53%. Figure B.9 is a linear regression fit using log-transformed data on the percentage of ancillary wages and the number of workers. There is a positive correlation between the factory size and ancillary wages. This is consistent with the historical fact that larger factories have more extensive benefits than smaller ones (Odaka 1999).

Next, I estimate the percentage of ancillary wages at the Tsukishima factories. One of the most frequently used statistics on factories in Tokyo is the Handbook of Factories (*kōjyō tsūran*), which covers all the factories with ten or more workers as of January 1, 1920. This handbook is the most comprehensive source for ascertaining the number of factories and their sizes *circa* 1919. This document does not cover the number of tiny working places with less than nine workers. Importantly, however, the purpose of Panel C in Table 2 is to compare the average monthly wage of the skilled factory workers in Tsukishima and the THBS heads' average monthly earnings. Since the THBS heads did not work in the small workplaces, the censoring at the left tail of the factory size distribution is unlikely to influence this purpose.

Figure B.9: Log-Relationship between the Number of Workers and Share of Ancillary Wage: Original Data from the Factory Survey by Kitazawa (1924)

Notes: This scatter plot shows the relationship between the log-transformed number of factory workers and the log-transformed share of ancillary wage. The raw data are listed in Table B.3. The dashed line indicates the linear fit using the log-transformed variables: the fitted regression is $\hat{y} = 0.747 + 0.428x$ with $R^2 = 0.82$. The predictions are materially similar if I use the fractional polynomial using the raw data on the number of factory workers and share of ancillary wage in Table B.3. In the case of fitting based on the raw data, the fitted fractional polynomial model is $\hat{y}^{Daily\ Wage} = 53.6 - 399.3a^{-1/2} + (2.84 \times 10^{-10})a^3$ with $R^2 = 0.87$. I prefer to use linear regression herein because it can provide more precise fitted values for small-and medium-scale factories.
Source: Kitazawa (1924, pp. 20; 58–62).

Panel B of Table B.3 summarizes the distributions of the number of factories, the total number of workers, and the estimated average share of ancillary wage in Tokyo City (Column 1) and Tsukishima (Column 2). The average ancillary wage at the Tsukishima factories is 12%, which is slightly larger than the value for the entire city of Tokyo (9%). The percentage shares of the number of factory workers by each bin are listed in Columns (1) and (2) of Panel C in Table B.3. As shown, Tsukishima factories tended to have larger factories than those of the entire city, which is reflected in the slightly larger estimate in the average ancillary wage for the Tsukishima factories. In Column (3) of Panel C in Table B.3, the number of THBS heads whose occupation, factory name, and factory size are available are listed. While the percentage shares of the heads in each bin show a similar distribution to that of the Tsukishima factories, the share of middle (large) sized factories is larger (smaller) than the population. If interpreted literally, this tendency implies that the (unobservable) true average ancillary wage for the THBS heads may be slightly lower than the population mean. However, note that the purpose of Panel C in Table 2 is to compare the average monthly wage of the skilled factory workers employed in the Tsukishima factories to the THBS heads' average monthly earnings. Therefore, the purpose herein is to estimate the average ancillary wage for the target population, for example, the Tsukishima factories, but not to calculate the average ancillary wage for the THBS sample itself.

Table B.3: Estimating the Average Share of Monthly Ancillary Wage

Panel A: Original Data on the Share of Ancillary Wage
Document: Report of Factory Survey by Kitazawa (1924)
Survey subject: Six Machinery Factories in Tokyo City
Survey month and year: May to October 1921

Factory	Number of factory workers	Share of skilled workers (%)	Share of fixed wage (%)	Share of ancillary wage (%)
A	157	44	83	17
B	86	53	88	12
C	376	27	57	43
D	623	77	68	32
E	2,837	NA	47	53
F	928	41	60	40

Panel B: Estimating the Average Share of Ancillary Wage
Document: Handbook of Factories (1921 edition)
Survey subject: Machinery Factories with 10+ workers in Tokyo City
Survey month and year: January 1920

	Machinery Factories					
	(1) Tokyo City			(2) Tsukishima		
Factory size	Number of factories	Number of factory workers	Average share of ancillary wage (%)	Number of factories	Number of factory workers	Average share of ancillary wage (%)
10–99 workers	760	18,760	8	39	1,252	9
100–199 workers	52	7,155	17	5	713	18
200+ workers	34	21,764	31	3	3,851	38
Total	846	47,679	9	47	5,816	12

Panel C: Comparisons of the Distributions of Factory Size

	Machinery Factories					
	(1) Tokyo City		(2) Tsukishima		(3) THBS	
Factory size	Number of factory workers	% share	Number of factory workers	% share	Number of THBS heads	% share
10–99 workers	18,760	39	1,252	22	6	21
100–199 workers	7,155	15	713	12	7	25
200+ workers	21,764	46	3,851	66	15	54
Total	47,679	100	5,816	100	28	100

Notes:
Panel A: This panel shows the size of factories and the share of fixed and ancillary monthly wages in six factories surveyed in Kitazawa (1924). The number of factory workers surveyed in factories A–F are 14, 23, 9, 11, 11, and 16, respectively. The share of these surveyed skilled workers to all skilled workers is 20.3 in Factory A, 50.0 in Factory B, 5.3 in Factory C, 2.3 in Factory D, and 4.2 in Factory F, respectively. This figure for factory E is unavailable because the number of skilled workers is unknown (Kitazawa 1924, p. 21).
Panel B: Subcolumns 1–2 and 4–5 summarize the number of factories and total number of workers in Tokyo City and Tsukishima, respectively (Handbook of Factories 1921). Subcolumns 3 and 6 show the average share of ancillary monthly wage predicted in Figure B.9 for Tokyo City and Tsukishima, respectively.
Panel C: Columns 1–3 summarize the number of factory workers and its share in percentage points in Tokyo City, Tsukishima, THBS sample, respectively. The statistics in Columns 1 and 2 (same figures used in Panel B) are from the Handbook of Factories (1921). In Column 3, the THBS heads who worked in the machinery factories are considered. There are 28 heads whose factory names and size are available. For a blacksmith included in these heads, I assume the number of workers to be ten, based on the report (Department of Health, Ministry of the Interior 1923a, p. 412).
Sources: Panel A: Kitazawa (1924, pp. 20; 58–62). Panel B: The number of factory workers is taken from the Ministry of Agriculture and Commerce (1921, pp. 613–629; 674). The average shares of ancillary wage are calculated using Kitazawa (1924, pp. 20; 58–62). See also Figure B.9. Panel C: Data on the number of factory workers and factories are from the Ministry of Agriculture and Commerce (1921, pp. 613–629; 674). Data on the number of heads are from the THBS sample.

Table B.4: Estimating the Monthly Income of Adult Male Factory Workers in Machinery Sector

	Weight for the Ancillary Wage	
	(1) Tsukishima $\vartheta = 0.12$	(2) Tokyo City $\vartheta = 0.09$
Panel A: Components in equation 14: w_j^{Daily}, l_j, and n_m		
Average daily wage (w_j^{Daily})		
w_{1918}^{Daily}	1.52	1.52
w_{1919}^{Daily}	2.42	2.42
Average annual working days (l_j)		
l_{1918}	313	313
l_{1919}	322	322
Frequency weights (n_m)		
n_1	5	5
n_2	11	11
n_3	19	19
n_4	22	22
n_5	21	21
n_6	18	18
n_7	11	11
n_8	8	8
n_9	5	5
n_{10}	4	4
Panel B: Estimated monthly earning: w^{Total}		
w^{Total}	56.0	54.5

Notes:
1. Average daily wage (w_j^{Daily}): The average daily wage of male factory workers in the skilled age range (aged 30–40) in the machinery sector is calculated using two official reports of the manufacturing censuses documented in the ASCT and LST. Details in the calculation steps are summarized in Online Appendix B.6.1.
2. Average annual working days (l_j): The ASCT documents the number of factories and average annual working days for each machinery sub-sector in two factory-size bins. I use the number of factories in each machinery sub-sector and factory size bin as the weights to calculate the weighted average of the annual working days in the entire machinery sector.
3. Weight for the ancillary wage (ϑ): The average share of monthly ancillary wage in the machinery sector is calculated based on the factory survey report in Kitazawa (1924). The calculation steps are described in Online Appendix B.6.2. Column 1 uses the share based on the factory size distribution in Tsukishima, whereas column 2 uses that in the entire Tokyo City.
4. Frequency weights (n_m) are based on the number of cross-sectional observations between January and October 1919 in the adjusted monthly panel dataset.
5. w^{Total} is calculated using equation 14.
Sources: Data used to calculate the average daily wage are from the Tokyo City Office (1921, pp. 726-757); Tokyo City Office (1922, pp. 732-733); Tokyo City Statistics Division (1926a, pp. 16; 244–245). Data used to calculate the average annual working days are from the Tokyo City Office (1921, pp. 726–741) and Tokyo City Office (1922, pp. 716–725). Data used to calculate the average share of monthly ancillary wage are from Kitazawa (1924, pp. 20; 58–62) and the Ministry of Agriculture and Commerce (1921, pp. 613–629; 674).

B.6.3 Estimating Monthly Income of Adult Male Factory Workers

Following the institution described in Online Appendix B.6.2, the monthly wage of the male workers in the skilled age range (w^{Total}) is defined as follows:

$$w^{Total} = w^{Regular} + w^{Ancillary}, \tag{9}$$

where $w^{Regular} > 0$ is the monthly regular wage and $w^{Ancillary} \geq 0$ indicates the monthly ancillary wage. Online Appendix B.6.2 shows that $w^{Ancillary}$ can be calculated as the product of the monthly regular wage and weight for the ancillary wage, $\vartheta \in (0, 1)$.[102] The monthly wage equation is then specified as follows:

$$w^{Total} = (1 + \vartheta)w^{Regular}. \tag{10}$$

To calculate equation 10, I have to conduct a few final tunings in my wage data. First, I fix the deviations in the timing of the manufacturing censuses and the THBS observations. Let $w_j^{Regular}$ be the monthly regular wage calculated using wage statistics measured in year $j \in \{1918, 1919\}$ as follows:

$$w_j^{Regular} = w_j^{Daily} l_j / 12, \tag{11}$$

where w_j^{Daily} is the average daily wage of male factory workers in the skilled age range and l_j is the average annual working days (Online Appendix B.6.1). The THBS were conducted from November 1918 to January 1920, and my THBS sample was observed from December 1918 to December 1919 (Section 3). However, $w_j^{Regular}$ is calculated using the wage statistics measured in the manufacturing census conducted in *December* of 1918 and 1919. This means that if I used $w_{1919}^{Regular}$ alone for equation 10, it shall provide upward-biased wage due to the deviation between the timing of the THBS observations and of the manufacturing census. To manage this issue, I use the weighted average between $w_{1918}^{Regular}$ and $w_{1919}^{Regular}$ to yield monthly wage series as follows:

$$w_m^{Regular} = \{(12 - m)w_{1918}^{Regular} + m w_{1919}^{Regular}\}/12, \tag{12}$$

where $m \in \{0, 1, 2, ..., 12\}$ corresponds to the year-month cells from December 1918 to December 1919. This way of weighting assumes that the average daily wage of machinery workers had increased during this period. This assumption is plausible given the historical fact that the average wage in the manufacturing industry indeed showed a secular increasing trend *circa* 1920 in Tokyo City (Ohkawa et al. 1967, p. 255).

Second, I use the number of observations in each year-month cell as the frequency weight. Let n_m be the number of households measured in year-month cell m. Then, the average monthly wage can be defined as:

$$w^{Regular} = \frac{\sum_m n_m w_m^{Regular}}{\sum_m n_m}, \tag{13}$$

[102] Strictly, this weight may not be required to be in this range. I use this range because all the cases reported in Kitazawa (1924) take the weights between zero and one.

where $m \in \{\text{December 1918}, \text{January 1919}, ..., \text{December 1919}\}$ is the year-month cell and n_m is the frequency weight for year-month cell m.

Substitute equation 11, 12, and 13 into equation 10 to yield the final specification:

$$w^{Total} = (1+\vartheta)\frac{\sum_m n_m\{(12-m)w_{1918}^{Daily}l_{1918} + mw_{1919}^{Daily}l_{1919}\}}{12^2\sum_m n_m}. \tag{14}$$

Panel A in Table B.4 summarizes all the components in equation 14. In Column 1 of Panel B in Table B.4, I calculate the average monthly wage under the share of the ancillary wage for the factories in Tsukishima (ϑ). The estimate is 56 yen, which is similar to the average and median of monthly earnings in the THBS heads (59 and 56 yen, respectively; see Panel C of Table 2). Therefore, I can conclude that the deviation from the population mean (56 yen) is not too large to infer the mean household strategies of the skilled workers in the machinery factories in Tsukishima. Given that the average daily wage of the male factory workers in the skilled age range is 2.5 yen (Figure B.8), 3 yen difference from the average monthly income is approximately one day's earnings. This is consistent with the findings in my descriptive analyses that show the similarities in the distribution of family structure, average household size, and share of ancillary wage between the THBS households and Tsukishima households (Section 3; Online Appendix B.6.2).

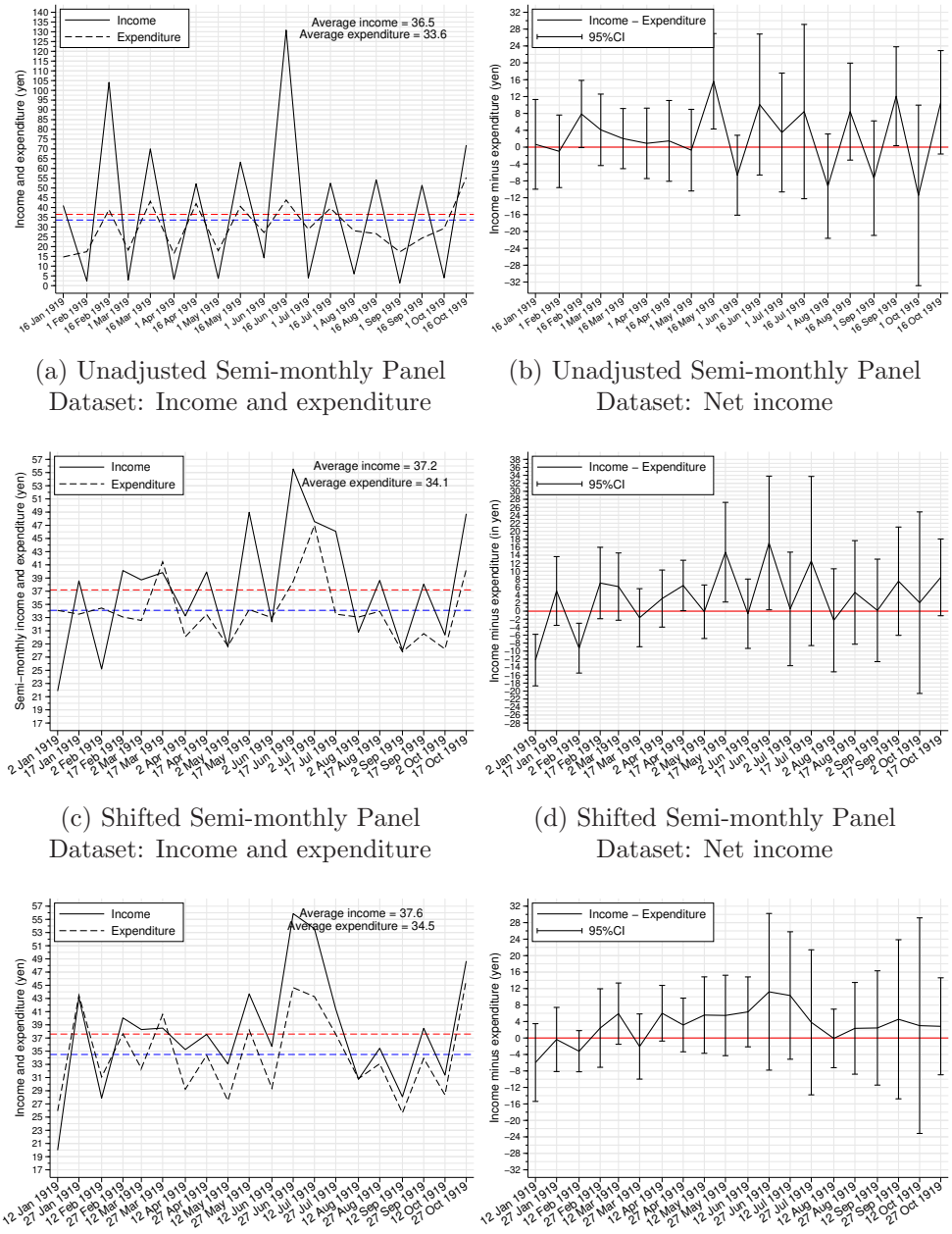
Column 2 uses the share of the ancillary wage for the entire Tokyo City ($\vartheta = 0.09$) to calculate the average monthly wage. The estimate is 54.5 yen, which is slightly smaller than that in Column 1, reflecting the difference in the weights for the ancillary wages. If I view this figure as an unbiased estimate for the entire Tokyo City, the difference in the average factory size between the entire Tokyo City and Tsukishima may be reflected in this deviation (Panel B in Table B.3).

B.7 Measurement Errors in the Unadjusted Panel Dataset

Figure B.10 explains how different methods of aggregation influence the time-series in income and expenditure. Figures B.10a, B.10c, B.10e show the average semi-monthly income and expenditure calculated from unadjasted, shifted, and adjusted panel datasets, respectively.

The unadjusted (calender-month) series defines the days from the 1st to the 15th of each month as the first half and the days from the 16th to the end of each month as the second half. This series shall contain substantial measurement errors due to the mismatches in the income and expenditure data explained in Section 3.3. The time-series plots of average income in Figure B.10a have a substantially large variance and fluctuate over time. This is because some semi-monthly income is assigned to the wrong semi-month cells. In these wrong cells, the measured incomes take unnaturally greater values than usual. Moreover, the time-series plots of average expenditure do not chase those of average income. For example, the average expenditure in the second half of June greatly differs from the average income in the same cell. Consequently, the average net income (i.e., income minus expenditure) in each semi-month takes unnaturally large positive values in a few cells (Figure B.10b).

The shifted series defines the days from the 2nd to the 16th of each month as the first half and the days from the 17th to the 1st of the following month as the second half.



(a) Unadjusted Semi-monthly Panel Dataset: Income and expenditure

(b) Unadjusted Semi-monthly Panel Dataset: Net income

(c) Shifted Semi-monthly Panel Dataset: Income and expenditure

(d) Shifted Semi-monthly Panel Dataset: Net income

(e) Adjusted Semi-monthly Panel Dataset: Income and expenditure

(f) Adjusted Semi-monthly Panel Dataset: Net income

Figure B.10: Comparisons of Average Semi-monthly Income and Expenditure from Different Aggregations

Note: Figures B.10a, B.10c, B.10e show the average semi-monthly income and expenditure calculated from unadjusted, shifted, and adjusted panel datasets, respectively. Unadjusted series defines the days from the 1st to the 15th of each month as the first half, whereas the days from the 16th to the end of each month as the second half. The shifted series defines the days from the 2nd to the 16th of each month as the first half, whereas the days from the 17th to the 1st of the following month are the second half. Adjusted series is the baseline definition in the main text, which uses the days from 12th to 26th in each month as the "first-half" and those from 27th to 11th in the next month as the "second-half."
As explained in Section 3, the raw series contains considerable measurement errors due to the timing of payday. The shifted series can manage the measurement errors from the timing of payday but cannot adjust the difference in the payday timing and expenses. In other words, the shifted series ignores the households' decision on the consumption schedule in each semi-month. The adjusted series reflecting the exact timing of the household expenses can manage measurement errors. Figures B.10b, B.10d, B.10f illustrate the average semi-monthly income minus expenditure calculated from unadjusted, shifted, and adjusted panel datasets, respectively.
Source: Created by the author using the THBS sample.

Although the shifted series can partly manage the measurement errors in income, it does not adjust the difference in the timing of paydays and expenses. Figure B.10c obtains a much smaller variance in the average incomes over time because all the paydays are now fixed to assign suitable semi-month cells. However, the expenditure series still does not chase the income series well because the payday is placed on the *latter* edge in each semi-month cell. In other words, the average expenditure in each semi-month reflects a large part of the consumption based on the income of the previous semi-month cell. Since the average incomes take a better series than Figure B.10a, the average net income offers better time-series plots (Figure B.10d). However, it still has a few cells with large negative and large values due to the deviations of expenditure from income.

The adjusted series uses the days from the 12th to 26th of each month as the "first half" and those from the 27th to 11th of the following month as the "second half." By shifting the entire semi-month cells, this adjusted series can manage the measurement errors from the payday shifts and can fix the miss-matching in the timing of income and expenditure. In other words, each payday is assigned to a suitable semi-month cell, and each semi-month cell reflects the household's decision on consumption in response to the latest income. Figure B.10e shows similar time-series plots of average income in Figure B.10c, in which has a corrected semi-monthly average income series only. Notably, the expenditure series are now chasing the income series in Figure B.10e because each semi-month cell's expenditure is based on the income in the same cell. Accordingly, Figure B.10f now shows a smoother series with a smaller variance in the net income.

These illustrations support the evidence that the adjusted semi-monthly datasets can offer cleaner within variations in income and expenditure because they can fix the measurement errors and reflect the households' consumption strategies based on their latest incomes measured in the same semi-month cell.

B.8 Distribution of the Idiosyncratic Shocks

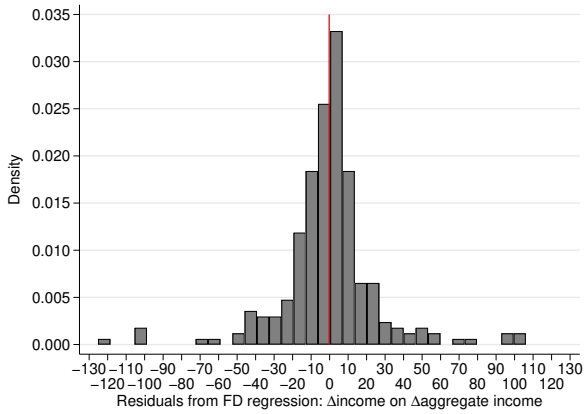


Figure B.11: Distribution of the Idiosyncratic Shocks

Notes: This figure shows the distribution of idiosyncratic shocks in the semi-monthly THBS panel dataset. The idiosyncratic shocks are estimated as the residuals from the regression of the first difference in income on the first difference in aggregate income. The red line indicates the mean of the idiosyncratic shocks (−0.235). Source: Created by the author using the THBS sample.

Figure B.11 illustrates the distribution of the idiosyncratic shocks predicted using the semi-monthly panel dataset.[103] The idiosyncratic shocks are calculated as residuals from the regression in the first difference in semi-monthly income on the first difference in aggregate semi-monthly income. Let n_t be the number of households in semi-month t in the year 1919. For household i in semi-month t cell, the residual is then defined as follows:

$$\Delta\hat{v}_{i,t} = \Delta Income_{i,t} - \hat{\alpha}\Delta\overline{Income}_{.,t}, \tag{15}$$

where $\overline{Income}_{.,t} = \sum_{i=1}^{n_t} \frac{Income_{i,t}}{n_t}$ and $\hat{\alpha}$ is the estimated coefficient. Figure B.11 shows that the residuals satisfy the zero-average property. However, this figure also indicates that the residuals have rich variations, supporting that the THBS households had experienced both favorable and adverse idiosyncratic shocks during the survey periods.

B.9 Unit Root and Autocorrelations

Table B.5 presents the results of the Fisher-type panel unit root tests for the total expenditure in the semi-monthly (Column 1) and adjusted monthly (Column 2) panel datasets. Both columns show that the null hypothesis of unit roots in all the panels is rejected at the conventional level. The results of the unit root tests for consumption subcategories and variables used to test the risk-coping mechanisms are not reported in this table because those are materially similar results. In Section 4, I used the cluster-robust variance-covariance estimator in the regressions to allow arbitrary autocorrelations (Arellano 1987). Despite this, I confirmed that the null hypothesis of no serial correlation is not rejected at the conventional level in Wooldridge's autocorrelation test for almost of the consumption and net income variables (Wooldridge 2002).

B.10 Risk Preferences

The potential influences of heterogeneous risk preference on standard risk-sharing regressions are discussed in a few works (Schulhofer-Wohl 2011; Mozzoco and Saini 2012). In my empirical setting, the heterogeneity in the risk preference is assumed to be removed by using the household fixed-effect. When the risk preferences are differenced over households like $\sigma = \sigma_i$, equation 26 becomes:

$$\log c_{i,t} = \log c_t^a + \frac{1}{\sigma_i}(\log \omega_i - \omega^a) + (\theta_{i,t} - \theta_t^a). \tag{16}$$

The first differencing removes the second term with the coefficient of relative risk aversion in the right-hand side of this equation, even though it varies over the households.

Schulhofer-Wohl (2011) shows a specific case (utility function) that the heterogeneous risk preference may lead to bias in the estimation of the income elasticity under the standard risk-sharing regressions and proposes a parametric test for that heterogeneity.

[103] I use the semi-monthly panel dataset to overview the entire distribution of the idiosyncratic shocks rather than the daily panel datasets. This is because the daily panels include a set of consecutive household-date cells with no income. These cells cannot be used to predict the idiosyncratic shocks as the residuals are economically meaningfully, and thus it is practically impossible to illustrate the idiosyncratic

Table B.5: Results of the Unit Root Tests

Test statistics	(1) Semi-Monthly	(2) Adjusted Monthly
P-statistic p-value	0.0000	0.0001
Z-statistic p-value	0.0000	0.0000
L^*-statistic p-value	0.0000	0.0000
P_m-statistic p-value	0.0000	0.0000

Notes: The results of the Fisher-type panel unit root tests based on augmented Dickey-Fuller (ADF) tests are reported in this table. The null hypothesis is that all the panels contain unit roots, whereas the alternative hypothesis is that at least one panel is stationary. In all the specifications, the process under the null hypothesis is assumed to be a random walk with drift. The demeaned data are used to address the effect of cross-sectional dependence. The number of lagged differences in the ADF regression equation reported is set as one because including two or more two lags reduces a large part of the panel units available for computing the test statistics due to the lack of balance of the panels. I confirm that including two lags in the semi-monthly panels does not change the results. Including two lags in the adjusted monthly panels and three lags in the semi-monthly panels is impossible. See Choi (2001) for the details of the tests. These tests need both the first-differenced dependent variable and the lagged dependent variable. Therefore, the units with less than four time-series observations are excluded in the regressions.
Source: Calculated by the author using the THBS sample.

This test is valid under a particular utility function. Specifically, the bias could be raised in the case that the coefficient of relative risk aversion interacts with the aggregate shock in the first-order condition for consumption because the interaction means that the aggregate shock cannot be removed using the time-fixed effect in the risk-sharing regressions.[104] As explained, this setting differs from the one used in this current study. Mozzoco and Saini (2012) consider a more general case for testing the homogeneity of risk preferences. Their test requires a panel dataset with a very long time dimension that is not applicable to my THBS dataset.[105]

shocks based on the daily dataset.

[104]Specifically, Schulhofer-Wohl (2011, pp. 928–929) considers the utility maximization problem under the following weighted sum of discounted expected utilities:

$$\sum_i \dot{\alpha}_i E\left[\sum_t \dot{\beta}^t \frac{[c_{i,t}(s_t)]^{1-\dot{\gamma}_i}}{1-\dot{\gamma}_i}\right], \tag{17}$$

where $\dot{\alpha}_i$ is Parate weight and $\dot{\gamma}_i$ is the coefficient of relative risk aversion for household i. The log-transformed first-order condition becomes:

$$\log c_{i,t} = \frac{\log \dot{\alpha}_i}{\dot{\gamma}_i} - \frac{\log \dot{\lambda}_t}{\dot{\gamma}_i}, \tag{18}$$

where $\dot{\lambda}_t$ indicates the Lagrangian multiplier. This result implies that the effects of the aggregate shocks ($\dot{\lambda}_t$) depend on the household's attitudes toward risk and that the first-differencing does not remove the second term in equation 18.

[105]The data used in their study covers the household-level monthly panel dataset surveyed in rural India between 1975 and 1985. The households with fewer than 80 data points are not included in the homogeneity tests (Mozzoco and Saini 2012, p. 453). See also Shrinivas and Fafchamps (2018) and Mozzoco and Saini (2018) for the subsequent discussions.

An alternative way to test potential heterogeneity in the risk preference is to use direct measures on the risk preferences of workers. Schulhofer-Wohl (2011) uses the results of experimental risk-tolerance questions on the workers' risk preferences in the Health and Retirement Study to test whether the correlations between earnings and aggregate shocks differ across high- and low-risk-tolerance workers.[106] They found that the high-risk-tolerance workers have more procyclical incomes than the low-risk-tolerance workers.

Since the THBS has no experimental questions, it is impossible to apply the same test. Given this limitation—that the direct test using experimental risk-tolerance question is unavailable—I compare the correlations between the heads' income and aggregate consumption over sub-groups to obtain insights into the potential difference in the heads' attitudes toward risks. For household i and semi-month t, the specification is characterized as follows:

$$\log \tilde{y}_{i,t} = \xi_1 \log c_t^a + \xi_2 d_i \log c_t^a + o x_{i,t} + \iota_i + \varepsilon_{i,t}, \tag{19}$$

where $\tilde{y}_{i,t}$ is head's earnings, c_t^a is aggregate consumption, $x_{i,t}$ is the household size, ι_i is the household fixed-effect, and $\varepsilon_{i,t}$ is a random error term. The aggregate consumption is calculated as the cross-sectional average of the total expenditure among the THBS sample, given that the population mean of consumption expenditures among all the skilled factory workers' households in Tsukishima is unavailable.

d_i is an indicator variable that takes one if a household i belongs to a specific group that might have had different preferences on their jobs than the other heads in the sample. Firstly, I test the hypothesis that the heads who work in the large-scale factories have different risk preferences. Although there are no specific anecdotes behind this, the workers in the large-scale factories might have had a lower risk tolerance than those in the small- and medium-scale enterprises. Thirteen heads who worked in the Ishikawajima shipyard and governmental factory are classified into this group. Secondly, I test the hypothesis that the heads who work in the smithing and the non-machinery factories have different risk preferences. As described in Online Appendix A.5, skilled workers in the smithing sector could be small business owners.[107] The workers in non-machinery factories might also have different job preferences than the machinery factory workers. This group has only three heads: one worked in a smithing factory, and two worked in food and paper-making factories.

Table B.6 presents the results. In Column (1), the estimated coefficient on the interaction term is close to zero and statistically insignificant. Thus, the sensitivities to aggregate consumption are similar across different scales of factories. Column (2) further shows that the estimated coefficient on the interaction term is not statistically significant under an alternative proxy of risk tolerance. It suggests that the heads who work in the smithing and non-machinery factories show similar responses to the aggregate shock. Since the aggregate consumption is the cross-sectional sample average, the aggregate variable may contain noise in the period with the small number of cross-sectional observations. To manage this potential issue, I exclude October and November 1919 in Columns (3) and

[106]This question is asking if the respondents would be willing to take a risk to get a new job with a higher income, even if there was a 50-50 chance of a reduction in income by a third (Schulhofer-Wohl 2011, P. 931).

[107]Workers in the canning factories might have had a different preference on the risk preferences (Online Appendix A.6). However, my THBS sample does not include the workers in canning factories.

(4). As shown, the estimated coefficients on the interaction terms are largely unchanged in both columns.

This finding is consistent with the fact that these heads have similar characteristics because the THBS focused on skilled factory workers in a representative manufacturing area, Tsukishima. Therefore, it is plausible that the THBS households had similar attitudes toward the risks.

Table B.6: Results for Testing Heterogeneous Risk Preferences

	DV: ln(head's earnings)			
	Analytical Period			
	(1) Full	(2) Full	(3) Jan. to Sept.	(4) Jan. to Sept.
Aggregate Consumption	0.277*	0.273	0.361**	0.362*
	[0.158]	[0.198]	[0.164]	[0.198]
Aggregate Consumption	-0.041		-0.061	
× Large Scale Factory	[0.453]		[0.415]	
Aggregate Consumption		-0.089		-0.178
× Smithing/Non-machinery		[0.215]		[0.215]
Observations	261	261	239	239

***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in brackets are clustered at the household level.

Notes: This table shows the results of equation 19 for the semi-monthly panel dataset. 'Aggregate Consumption' indicates the cross-sectional sample average of the total expenditures. 'Large Scale Factory' indicates an indicator variable that takes one if the head worked in the Ishikawajima Shipyard or governmental factory. 'Smithing/Non-machinery' indicates an indicator variable that takes one if the head worked in the smithing, food, or paper-making factories. All the regressions include the family size variable and household fixed effect. Columns 1–2 show the results for the entire sample period. Columns 3–4 show the results for the period between January and September 1919 to remove year-month cells with the smaller (cross-sectional) number of households (Online Appendix Figure B.4).

Appendix C Empirical Analysis Appendix

C.1 Conceptual Framework

Consider the economy where household $i = 1, ..., N$ receives an uncertain income at time t depending on the state of the world $s_t \in S_t$ as $y_{i,t}(s_t)$. For infinite time horizon, the state s_t realizes with probability $\pi(s_t) \in [0, 1]$. The weighted sum of the expected lifetime utility of N households in the economy is expressed as:

$$\sum_{i=1}^{N} \omega_i \sum_{t=0}^{\infty} \rho^t \sum_{s_t \in S_t} \pi(s_t) u(c_{i,t}(s_t), \theta_{i,t}(s_t)), \tag{20}$$

where ω_i is the social planner's weight representing the reciprocal of the marginal utility of each household ($0 < \omega_i < 1$ and $\sum_{i=1}^{N} \omega_i = 1$), $0 < \rho^t < 1$ is the discount factor, $c_{i,t}(s_t)$ is consumption, and $\theta_{i,t}(s_t)$ is a preference shock. For all states s_t, the aggregate resource constraint is given by:

$$\sum_{i=1}^{N} c_{i,t}(s_t) = \sum_{i=1}^{N} e_{i,t}(s_t), \tag{21}$$

where $e_{i,t}(s_t)$ is household i's exogenous endowment at time t.

Following Mace (1991), I assume that the aggregate idiosyncratic shocks approach zero as N gets large. Consider the situation in which the household's endowment can be decomposed into the permanent component ($e^P_{i,t}$), shock linked to macroeconomic trends ($\varrho^a_{i,t}(s_t)$), and idiosyncratic shock ($\varsigma_{i,t}(s_t)$) as:

$$e_{i,t}(s_t) = e^P_{i,t} + \varrho^a_{i,t}(s_t) + \varsigma_{i,t}(s_t). \tag{22}$$

Given the random nature of the idiosyncratic shock ($\forall t, E[\varsigma_{i,t}(s_t)|s_t] = 0$), the sample average of the idiosyncratic shock satisfies $N^{-1} \sum_{i=1}^{N} \varsigma_{i,t}(s_t) \xrightarrow{p} 0$ as N gets large ($\because$ WLLN). This means that the aggregate endowment is written without the idiosyncratic shock as: $e_t(s_t)^a = e_t^{P,a} + \varrho^a_t(s_t)$. Intuitively, this implies that the idiosyncratic shocks are shared among an economy with numerous households.

Subject to equation(21), the social planner maximizes equation(20) by choosing an allocation of consumption across households. The first-order condition at time t is derived as follows:

$$\omega_i \rho^t \pi(s_t) u_c(c_{i,t}(s_t), \theta_{i,t}(s_t)) = \lambda(s_t), \tag{23}$$

where λ is the Lagrange multiplier for the single lifetime resource constraint. To derive my empirical specification, I assume a constant relative risk aversion preference as:

$$u(c_{i,t}(s_t), \theta_{i,t}(s_t)) = \frac{c^{1-\sigma}_{i,t}(s_t)}{1-\sigma} \exp(\sigma \theta_{i,t}(s_t)), \tag{24}$$

where $\sigma > 0$ is the coefficient of relative risk aversion. Below, I consider a particular history of the state of the world so that the subscript t can represent dependence on the state (Hayashi et al. 1996). This simplifies the notation in equation 23 as:

$$\omega_i \rho^t \pi_t c^{-\sigma}_{i,t} \exp(\sigma \theta_{i,t}) = \lambda_t. \tag{25}$$

Taking the log of equation (25) and aggregating over households, consumption for household i is expressed as:

$$\log c_{i,t} = \log c_t^a + \frac{1}{\sigma}(\log \omega_i - \omega^a) + (\theta_{i,t} - \theta_t^a), \tag{26}$$

where

$$c_t^a = \exp\left(\frac{1}{N}\sum_{i=1}^{N} \log c_{i,t}\right), \qquad \omega^a = \frac{1}{N}\sum_{i=1}^{N} \log \omega_i, \qquad \theta_t^a = \frac{1}{N}\sum_{i=1}^{N} \theta_{i,t}. \tag{27}$$

The first-difference in equation (26) eliminates the household time-constant effect to yield:

$$\log c_{i,t} - \log c_{i,t-1} = \log c_t^a - \log c_{t-1}^a + (\theta_{i,t} - \theta_{i,t-1}) + (\theta_t^a - \theta_{t-1}^a). \tag{28}$$

Individual income is a conventional proxy variable for the preference shock (Mace 1991). Using the growth rate of household income $\log y_{i,t} - \log y_{i,t-1}$ as a proxy for idiosyncratic shock and adding a measurement error in consumption $\epsilon_{i,t}$, the empirical specification can be characterized as follows:

$$\log c_{i,t} - \log c_{i,t-1} = \alpha_1(\log c_t^a - \log c_{t-1}^a) + \alpha_2(\log y_{i,t} - \log y_{i,t-1}) + \epsilon_{i,t}. \tag{29}$$

The aggregate consumption growth in equation(29) is assumed to reflect macroeconomic shocks in Tsukishima in the case of my empirical setting. As discussed in Section 3.4, the consumption of the THBS households captures the overall macroeconomic trend. Despite this, interpreting α_1 is difficult because the THBS households include the factory workers' households in Tsukishima alone. To manage this potential issue, I use a two-way fixed-effects model instead of the first-difference model, following Cochrane (1991). Another potential issue is that $\epsilon_{i,t}$ may include household-specific time-varying preference shock, which might be correlated with idiosyncratic income shock. Family size influences the household's preference because the marginal utility of consumption increases with family size (Jappelli and Pistaferri 2017). As explained, family size was stable during the sample period in the THBS households, meaning that the preference shifts rarely occurred (Section 3.4). To be conservative, however, I include the number of family members as a control variable for representing potential preference shock.

Considering these modifications, the empirical specification can finally be characterized as follows:

$$\log c_{i,t} = \gamma \log y_{i,t} + \delta x_{i,t} + \mu_i + \phi_t + u_{i,t}, \tag{30}$$

where $c_{i,t}$ is consumption, $y_{i,t}$ is disposable income, $x_{i,t}$ is family size, μ_i is the household fixed effect, ϕ_t is the time fixed effect, and $u_{i,t}$ is a random error term. The estimate of γ shall range from zero (i.e., idiosyncratic shocks are perfectly insured) to one (for the absence of insurance).

To test the risk-coping mechanisms, I consider the following representation of individual consumption following Fufchamps and Lund (2003).

$$c_{i,t} = y_i^P + y_{i,t}^T + r_{i,t}, \tag{31}$$

where y_i^P is permanent income and $y_{i,t}^T$ is transitory income. $r_{i,t} = \boldsymbol{z}_{i,t}'\mathbf{1}$ is a linear combination of the net temporary incomes expressed using a $k \times 1$ net income vector ($\boldsymbol{z}$) and a vector of ones. Substituting equation 31 into equation 26 and taking the first-difference removes the time-constant components, including permanent income. It follows that my empirical specification can be characterized as follows:

$$r_{i,t} = \kappa \tilde{y}_{i,t} + \eta x_{i,t} + \nu_i + \zeta_t + \epsilon_{i,t}, \tag{32}$$

where $\tilde{y}_{i,t}$ is the head's earning, $x_{i,t}$ is the family size control, ν_i indicates the household-fixed effect, ζ_t indicates the time-fixed effect, and $\epsilon_{i,t}$ is a random error term. I herein use the head's earnings ($\tilde{y}_{i,t}$) as the idiosyncratic shock variable instead of the disposable income.[108] The regression is separately run for each component in the net income vector ($\boldsymbol{z}$).

C.2 Raw Relationship between Income and Expenditures

Figure C.1 summarizes the densities of the log-differences (LD) of the semi-monthly expenditures. Figure C.1a illustrates the LD distribution of the total expenditure, whereas Figures C.1b–C.1l summarize the LD distributions of the 11 subcategories of the expenditure. These figures confirm no specific outliers in all these expenditure categories.

Figure C.2 summarizes the scatter plots between the LD of the semi-monthly disposable income and expenditures. Figure C.2a illustrates the relationship between the LD of the semi-monthly disposable income and total expenditure. Figures C.2b–C.2l illustrate the correlations between the LD of the semi-monthly disposable income and 11 expenditure subcategories.

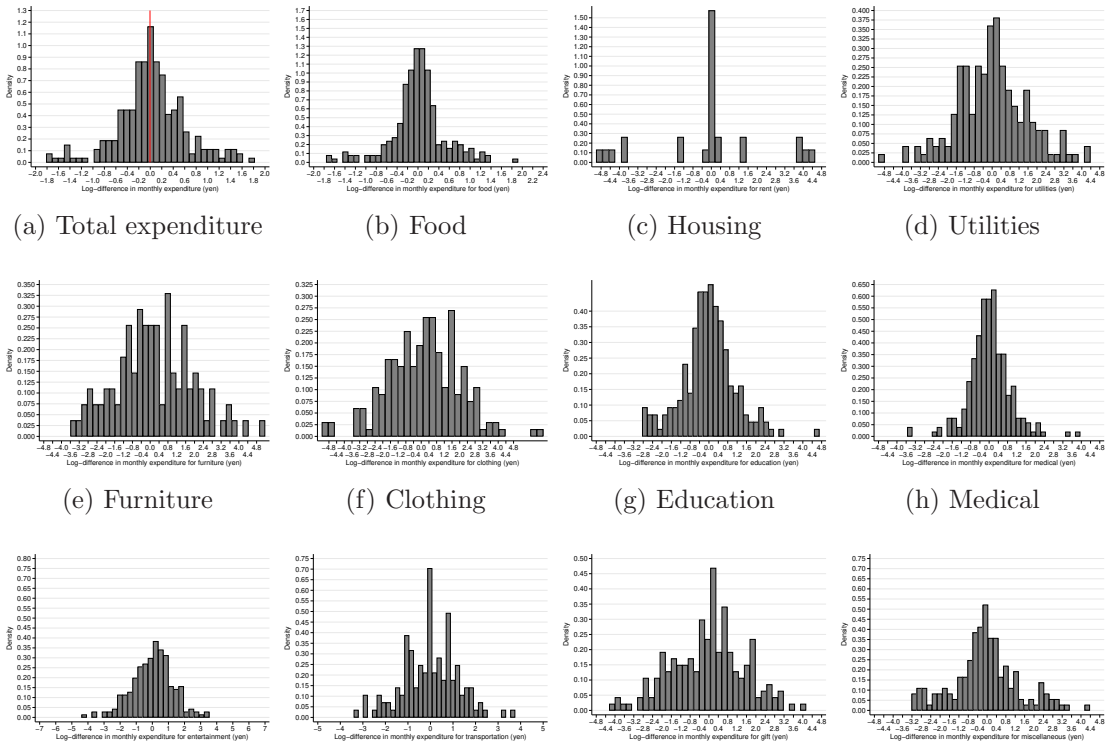
Generally, rent was paid once per month. This means that the semi-monthly dataset fails to capture the variations in rent payment because it includes some semi-monthly cells with zero values. In addition, the water bills are included in the rent subcategory but not in the utility subcategory. This means that a semi-month cell takes a minimal value when the payment of rent is not included in that cell. Figure C.1c shows that the LD of rent generates some larger values in the semi-monthly panel dataset due to those water bill payments. These cells taking large LD values substantially increase the slope, as shown in Figure C.2c.

Given this technical issue, the adjusted monthly panel dataset is suitable for estimating the income elasticity for the rent category. In fact, Figure C.4c confirms that the scatter plot from the adjusted monthly variation shows a flatter relationship.

C.3 Retail Sales in Tokyo City: A Retail Store Survey of 1935

Table C.1 summarizes the contribution of regular customers to their total sales, social classes of the customers, and sales methods in the retailers selling white rice, fish, fruit and vegetable, and fuels (firewood and charcoal) by scale of business. In the original

[108] In the analysis, I consider the labor-supply adjustment variable and sales of miscellaneous assets as the additional dependent variables in addition to the net income variables $r_{i,t}$ (Section 4.2). The former variable is the total earnings of the family members except for the head, meaning that the simultaneous



(a) Total expenditure (b) Food (c) Housing (d) Utilities

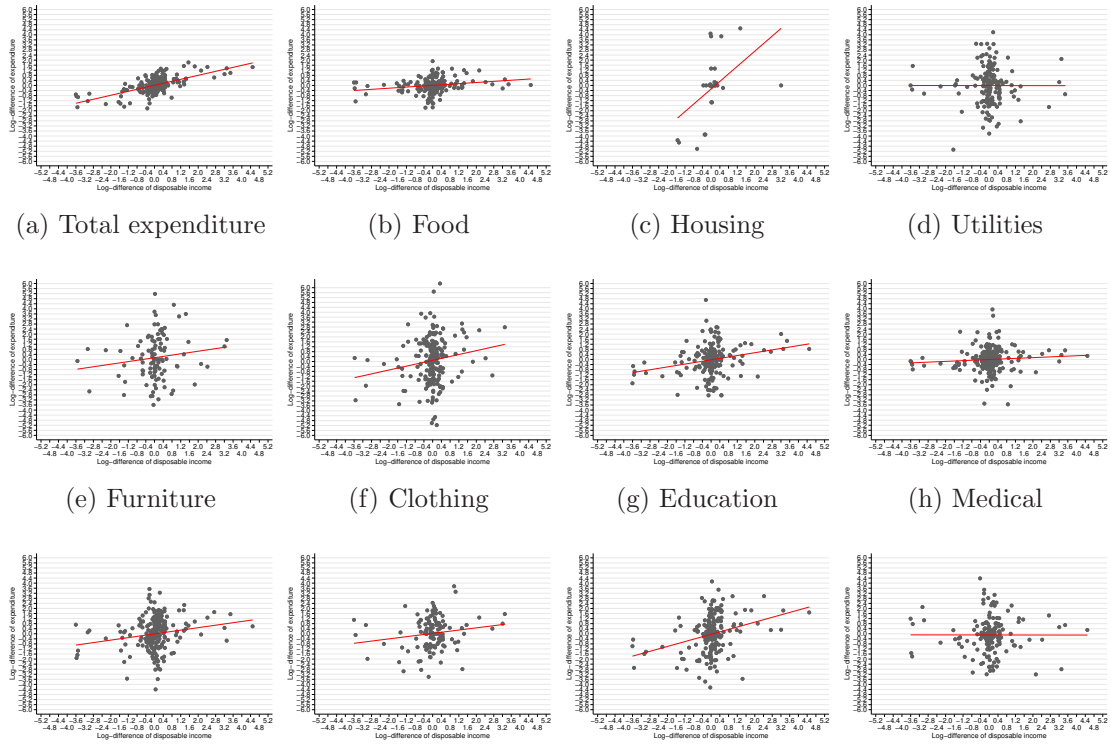
(e) Furniture (f) Clothing (g) Education (h) Medical

(i) Entertainment (j) Transportation (k) Gifts (l) Miscellaneous

Figure C.1: Distributions of the Log-differences of the Semi-monthly Expenditures

Notes: The distribution of the log-difference in semi-monthly total expenditure is shown in Figure C.1a. Figures C.1b–C.1l show the distributions of the log-differences in semi-monthly expenditure for the 11 subcategories listed in panel A of Table 3.

Source: Created by the author using the THBS sample.



(a) Total expenditure (b) Food (c) Housing (d) Utilities

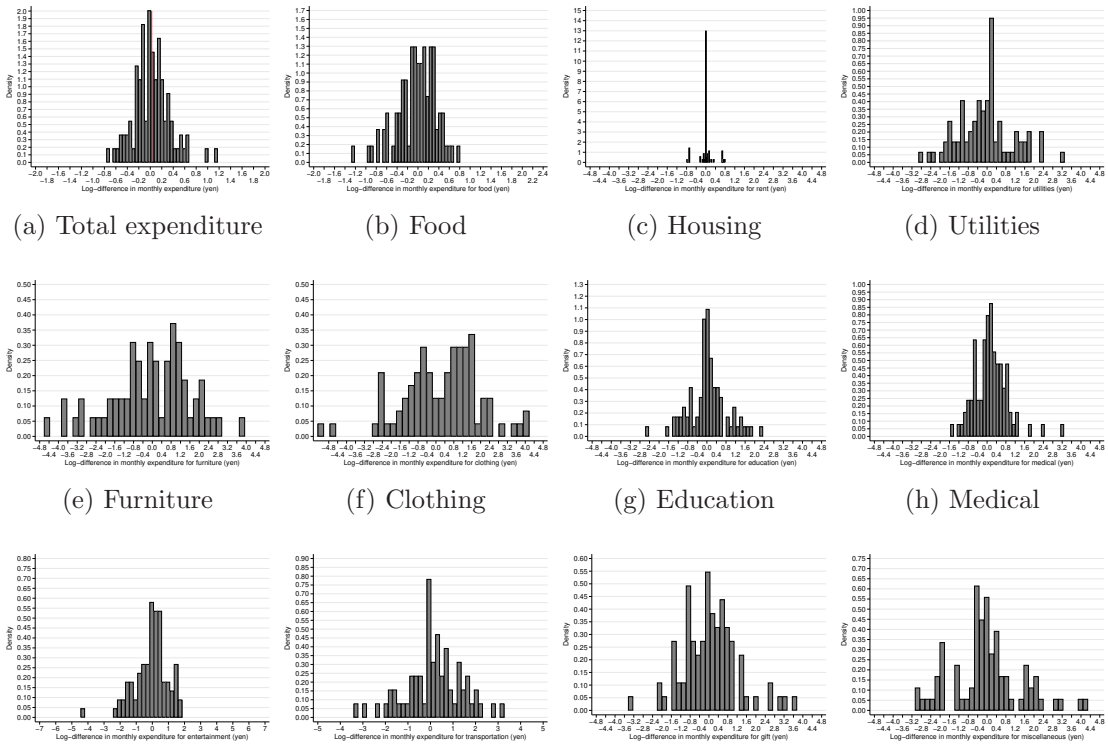
(e) Furniture (f) Clothing (g) Education (h) Medical

(i) Entertainment (j) Transportation (k) Gifts (l) Miscellaneous

Figure C.2: Raw Relationship between the Log-differences in Semi-monthly Income and Expenditure

Notes: Figure C.2a illustrates the relationship between the log-difference in semi-monthly disposable income and expenditure. Figures C.2b–C.2l illustrate the relationships between the log-differences in semi-monthly disposable income and the 11 expenditure subcategories listed in Panel A in Table 3. The range of the y-axis is fixed across all the figures for comparability.

Source: Created by the author using the THBS sample.



(a) Total expenditure (b) Food (c) Housing (d) Utilities

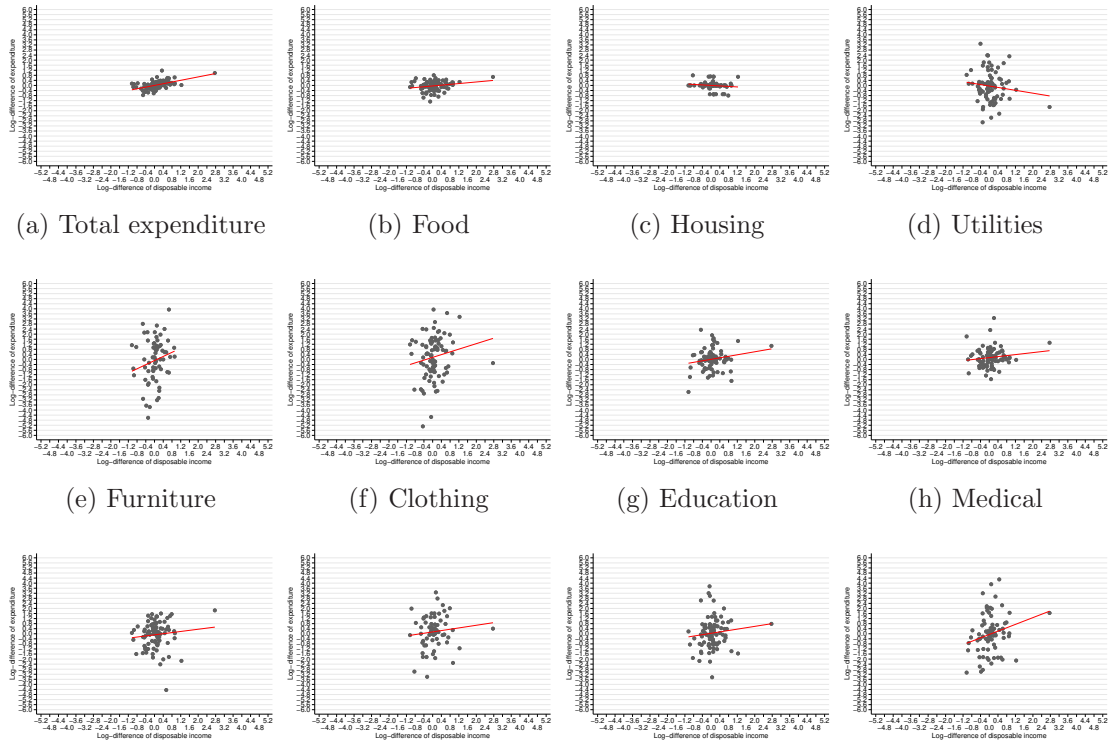
(e) Furniture (f) Clothing (g) Education (h) Medical

(i) Entertainment (j) Transportation (k) Gifts (l) Miscellaneous

Figure C.3: Distributions of the Log-differences of the Monthly Expenditures

Notes: The distribution of the log-difference in adjusted monthly total expenditure is shown in Figure C.3a. Figures C.3b–C.3l show the distributions of the log-differences in adjusted monthly expenditure for the 11 subcategories listed in panel A of Table 3.

Source: Created by the author using the THBS sample.



(a) Total expenditure (b) Food (c) Housing (d) Utilities

(e) Furniture (f) Clothing (g) Education (h) Medical

(i) Entertainment (j) Transportation (k) Gifts (l) Miscellaneous

Figure C.4: Raw Relationship between the Log-differences in Monthly Income and Expenditure

Notes: Figure C.4a illustrates the relationship between the log-difference in semi-monthly disposable income and expenditure. Figures C.4b–C.4l illustrate the relationships between the log-differences in semi-monthly disposable income and the 11 expenditure subcategories listed in Panel A in Table 3. The range of the y-axis is fixed across all the figures for comparability.

Sources: Created by the author using the THBS sample.

document, the figures for "Total" in the firewood and charcoal category are missing in "Sales Method (%)." For these three cells, I filled the averages over the three business-size categories in each sales method: 20.4% for "Cash," 78.4% for "Credit purchase," and 1.3% for "Monthly installment."

Table C.1: Customers, Sales Methods, and Competitiveness in the Retailers in Tokyo City

Selling Item	Scale of Business	Number of stores reported	Share of sales for regular customer (%)	Social Class of the Regular Customer (%)			Sales Method (%)			Number of competitors reported
				Upper	Middle	Other	Cash	Credit purchase	Monthly installment	
White Rice	Small	19	69.7	12.1	49.5	38.4	29.5	70.2	0.3	7.3
	Medium	55	69.5	17.5	41.6	40.9	26.9	72.6	0.5	8.7
	Large	27	81.7	15.9	51.5	32.6	26.7	71.0	2.3	8.8
	Total	101	73.1	16	45.7	38.2	26.9	71.5	1.7	8.5
Fish	Small	34	64.5	5.9	53.2	40.9	42.7	57.3	0	5.1
	Medium	20	62.6	10	58.0	32.0	43.8	56.2	0	5.3
	Large	5	72.0	0	86.0	14.0	44.8	55.2	0	3.4
	Total	59	64.6	6.8	57.6	35.6	43.9	56.1	0	5.0
Greengrocer	Small	46	42.2	8	39.2	52.7	59.7	40.3	0	6.5
	Medium	17	57.1	8.8	43.5	47.6	65.0	35.0	0	6.1
	Large	3	36.7	33.3	40.0	26.7	79.7	20.3	0	3.7
	Total	66	45.4	9.4	40.4	50.2	65.8	34.2	0	6.2
Firewood and charcoal	Small	78	68.5	13.5	50.7	35.8	25.0	74.2	0.8	8.4
	Medium	17	77.7	23.5	49.1	27.4	19.3	79.1	1.6	8.9
	Large	5	33.3	23.0	60.0	17.0	16.8	81.8	1.4	10.6
	Total	100	51.1	15.7	50.9	33.4	20.4	78.4	1.3	8.6

Notes:
This table summarizes the statistics on the sales in the retailers selling white rice, fish, fruit and vegetables, and firewood and charcoal in Tokyo surveyed in 1935.
1. Small, middle, and large-scale businesses include retailers with annual sales of less than 10,000, 10,000–30,000, and 30,000+ yen, respectively.
2. The number of stores reported the share of regular customers (%) are 90, 56, 61, and 93 in the white rice, fish, greengrocers, and firewood and charcoal categories, respectively.
3. The share of regular customers is defined as the percentage of sales for regular customers in the annual total sales in 1935.
4. The definition of the social classes ("Upper"; "Middle"; "Other") is not clearly defined in the report. Therefore, this must be based on the subjective judgment of the retailers.
5. The share of sales method is based on the percentage of sales using each method in the annual total sales in 1935.
6. The number of competitors indicates the number of peers within a three-cho (approximately 327 meters) radius.
Source: Tokyo City Chamber of Commerce and Industry 1937, pp. legend; 20–21; questionnaire.

C.4 Retail Sales in Tokyo City: A Small and Medium Scale Enterprises Survey of 1930

Table C.2 summarizes the use of credit purchase and the losses on the credit sales documented in the 1930 Survey Report. Following the report's style, the item categories are divided into six categories: white rice, other grains, vegetables, fruit, fish, and fuel. The total number of retailers in each category is 157, 7, 67, 16, 46, and 64, respectively. As explained in Section 5, most of them used credit purchases as their selling method.

issue arises if I use the disposable income in this equation.

Importantly, among the retailers using credit purchases, almost all of them suffered losses in sales. For example, 99% of white rice retailers experienced losses. The minimum value of this share is still 97% for the fuel retailers. This means that credit purchase was a loss-making sales method for the retailers.

The statistics in Table C.2 also indicate that many cases have unknown loss amounts. Overall, however, most of the cases seem to be grouped into bins of less than 5% of losses. For example, 87% (97 retailers) of the 111 available rice retailers suffered losses amounting to 5% of sales. Similarly, 65% (32 retailers) of the 49 available fuel retailers are grouped into the same loss category. Systematic statistics are unavailable to indicate the percentage of total profits corresponding to these losses. However, it is worth mentioning that a large part of losses was capped by 5% of total sales in all these different retailers. This implies that while the retailers could not avoid losses, they might have set prices that anticipated losses.

Table C.2: Sales Methods and Losses on Sales under Credit Purchases in Tokyo City

	Selling Item					
	White rice	Other grains	Vegetables	Fruit	Fish	Fuel
Total number of retailers	157	7	67	16	46	64
Cash payment only (never used the credit purchase)	2	0	10	8	8	3
Retailers using credit purchases	155	7	57	8	58	61
Losses among sales amount (%)						
$\leq 1\%$	59	1	14	4	10	18
2–5%	38	1	19	2	8	14
6–10%	8	1	4	0	3	12
11–20%	3	0	0	0	1	3
21–30%	2	0	1	0	0	0
30+%	0	0	0	2	0	0
Unknown	44	4	19	0	16	12
No loss	1	0	0	0	0	2
Retailers using credit purchases (%)	99	100	85	50	79	95
Share of retailers experienced losses (%)	99	100	100	100	100	97

Note: This table summarizes the statistics on the sales methods and losses on sales under credit purchases among the retailers measured in Tokyo City surveyed in 1930. Source: Tokyo City Office 1932, pp. 454–469.

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