Online Appendix to "Consumption Smoothing in the Working-Class Households of Interwar Japan" by Kota Ogasawara

Appendix A Theory Appendix

A.1 Full-risk Sharing

Assume N individuals named $i = 1, ..., N$ in the economy. Individual i receives an uncertain income $y_{i,t}(s_t)$, where $s_t \in S_t$ represents the state of the world at time t, and derives instantaneous utility $u(c_{i,t}(s_t), h_{i,t}(s_t))$ from consumption $c_{i,t}(s_t)$. The weighted sum of expected lifetime utility of N individuals is expressed as:

$$\sum_{i=1}^{N} \omega_i \sum_{t=0}^{\infty} \beta^t \sum_{s_t \in S_t} \pi(s_t) u(c_{i,t}(s_t), h_{i,t}(s_t)), \tag{3}$$

where ω_i is the social planner's weight, which is the reciprocal of the marginal utility of each agent, and satisfies $0 < \omega_i < 1$ (Negishi 1960); $0 < \beta^t < 1$ is the discount factor; $\pi(s_t) \in [0, 1]$ is the probability that state s_t takes place at time t; and $h_{i,t}(s_t)$ is a preference shock. The social planner maximizes the objective function (3) by choosing an allocation of consumption across individuals, subject to the aggregate resource constraint of the form:

$$\sum_{i=1}^{N} c_{i,t}(s_t) = \sum_{i=1}^{N} y_{i,t}(s_t). \tag{4}$$

Postulating a constant absolute risk aversion preference, $u(c_{i,t}(s_t), h_{i,t}(s_t)) = -\frac{1}{\sigma} \exp(-\sigma(c_{i,t}(s_t) - h_{i,t}(s_t)))$, where $\sigma > 0$ is the coefficient of constant absolute risk aversion, I can obtain the first-order condition for individual i:

$$\omega_i \beta^t \pi(s_t) \exp(-\sigma(c_{i,t}(s_t) - h_{i,t}(s_t))) = \lambda(s_t), \tag{5}$$

where $\lambda(s_t)$ is the Lagrange multiplier for the resource constraint (4) at time t. Taking the log of equation (5) and aggregating over agents, I obtain individual i's consumption as follows:

$$c_{i,t}(s_t) = \frac{1}{N} \sum_{i=1}^{N} c_{i,t}(s_t) + \frac{1}{\sigma} \Big(\log \omega_i - \frac{1}{N} \sum_{i=1}^{N} \log \omega_i \Big) + h_{i,t}(s_t) - \frac{1}{N} \sum_{i=1}^{N} h_{i,t}(s_t). \tag{6}$$

For simplicity, I use the conventional notation for a random variable $c_{i,t} \equiv c_{i,t}(s_t)$, $h_{i,t} \equiv h_{i,t}(s_t)$, and $\lambda_t \equiv \lambda(s_t)$. Finally, equation (6) with this notation becomes

$$c_{i,t} = c_t^a + \frac{1}{\sigma}(\log \omega_i - \omega^a) + (h_{i,t} - h_t^a), \tag{7}$$

where

$$c_t^a = \frac{1}{N}\sum_{i=1}^{N} c_{i,t}, \qquad \omega^a = \frac{1}{N}\sum_{i=1}^{N} \log \omega_i, \qquad h_t^a = \frac{1}{N}\sum_{i=1}^{N} h_{i,t}. \tag{8}$$

The first-difference in equation (7) eliminates the individual fixed effects to yield

$$c_{i,t} - c_{i,t-1} = c_t^a - c_{t-1}^a + h_{i,t} - h_{i,t-1} - (h_t^a - h_{t-1}^a). \tag{9}$$

Using the change in individual income $y_{i,t} - y_{i,t-1}$ as a proxy for idiosyncratic shocks, the empirical specification can then be characterized as

$$c_{i,t} - c_{i,t-1} = \alpha_1(c_t^a - c_{t-1}^a) + \alpha_2(y_{i,t} - y_{i,t-1}) + \epsilon_{i,t}, \tag{10}$$

where $\epsilon_{i,t}$ is a disturbance term that includes both the time-varying preference shock, which affects individual-level consumption, and measurement errors in the data. Equation (10) in the case of a constant relative risk aversion preference can also be expressed as

$$\log c_{i,t} - \log c_{i,t-1} = \alpha_1(\log c_t^a - \log c_{t-1}^a) + \alpha_2(\log y_{i,t} - \log y_{i,t-1}) + \epsilon_{i,t}, \tag{11}$$

where $\log(c_{i,t}/c_{i,t-1})$, $\log(c_t^a/c_{t-1}^a)$, and $\log(y_{i,t}/y_{i,t-1})$ are the growth rates of individual consumption, aggregate consumption, and individual income, respectively.

This growth specification (11) assumes that the aggregate measure of consumption captures macroeconomic shocks. However, aggregate consumption in my dataset is for households in the manufacturing industry, making the interpretation of α_1 problematic. To address this issue, I use a two-way fixed-effects model instead of the first-difference model. Following Cochrane (1991) and Ravallion and Chaudhuri (1997), the empirical specification can be simplified as follows:

$$\log c_{i,t} = \theta \log y_{i,t} + \mathbf{x'}_{i,g_t}\psi + \mu_i + \phi_t + u_{i,t}, \tag{12}$$

where $c_{i,t}$ is consumption, $y_{i,t}$ is disposable income, $\mathbf{x}_{i,g_t}$ is a vector of the controls (Section 4.1), μ_i is the household fixed effect, ϕ_t is the month-year fixed effect, and $u_{i,t}$ is a random error term. If risk is fully shared among individuals, the coefficient on the change in the growth rate of individual income becomes zero. Hence, one can surmise that the estimate of θ range from zero (for full-risk sharing, where idiosyncratic shocks are perfectly insured) to one (for the absence of insurance).

A.2 Risk-coping Strategies

To test the risk-coping mechanism, I consider that household consumption can be defined in the spirit of Fafchamps and Lund (2003):

$$c_{i,t} = y_i^P + y_{i,t}^T + z_{i,t} + b_{i,t}, \tag{13}$$

where $z_{i,t}$ and $b_{i,t}$ indicate net income from withdrawals and gifts and borrowing, respectively. y_i^P and $y_{i,t}^T$ are permanent and transitory income, respectively. Equation (7) can then be rewritten by substituting equation (13):

$$z_{i,t} + b_{i,t} = -(y_i^P + y_{i,t}^T) + c_t^a + \frac{1}{\sigma}(\log \omega_i - \omega^a) + (h_{i,t} - h_t^a). \tag{14}$$

The time-constant components (y_i^P, ω_i) and individual-constant components (c_t^a, h_t^a) can be replaced by the individual fixed effects (ν_i) and time fixed effects (λ_t), respectively. Transitory income and preference shocks ($y_{i,t}^T$, $h_{i,t}$) can be replaced by disposable income ($\tilde{y}_{i,t}$) and the observable family characteristics ($\mathbf{x}_{i,g_t}$), respectively. Under these assumptions, the empirical specification is as follows:

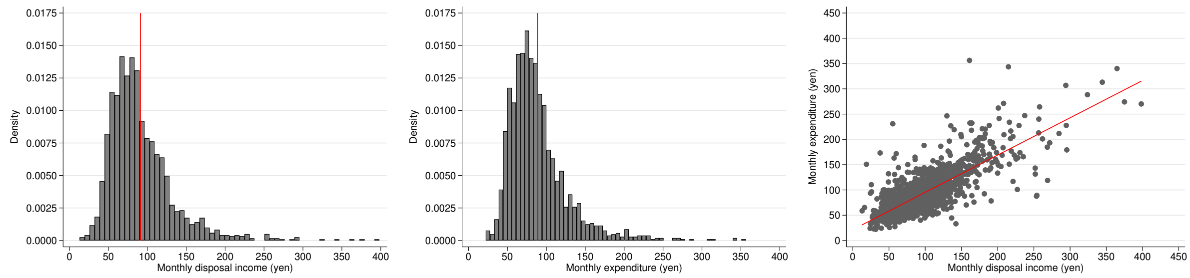
$$z_{i,t} + b_{i,t} = \kappa + \delta\tilde{y}_{i,t} + \mathbf{x'}_{i,g_t}\boldsymbol{\gamma} + \nu_i + \zeta_t + e_{i,t}, \tag{15}$$

where $e_{i,t}$ is a random error term. I regress withdrawals and gifts ($z_{i,t}$) and borrowing ($b_{i,t}$) separately on the shock variable (Section 5.1). If idiosyncratic shocks are compensated by the risk-coping strategies, the estimated coefficient on the shock variable should be negative and statistically significant.

Appendix B Data Appendix

B.1 Monthly Income and Expenditure

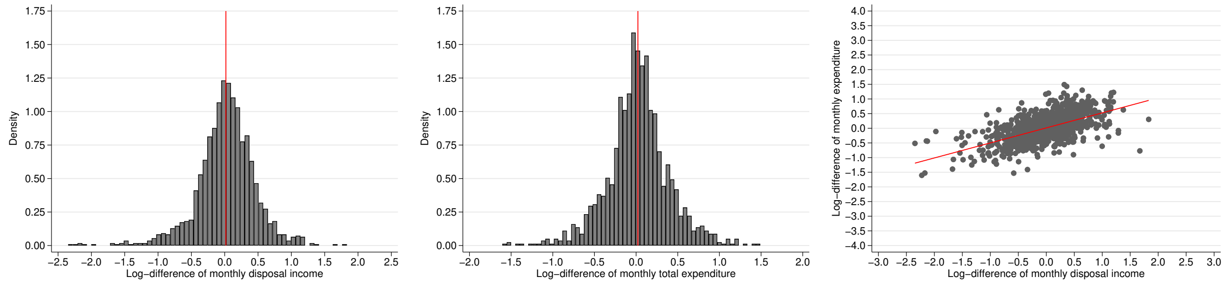
Figures B.1a and B.1b show the monthly disposable income and expenditure of RLR households, respectively. The distribution of both figures is right skewed, thus showing the typical distribution of income and expenditure. The mean values of disposable income and expenditure are 91.3 and 88.7 yen, respectively. Since outliers are excluded as noted in the main text, no specific observations take extremely high values. Figures B.2a and B.2b show the distributions of the log-differences in disposable income and expenditure, respectively. Figure B.2c describes the correlation between the log-differences in monthly disposable income and expenditure. Figure B.3 presents the log-difference in monthly expenditure for the 10 subcategories. Figure B.4 describes the distribution of monthly income from savings withdrawals and gifts (a); deposits to savings (b); borrowing (c); and liquidation of loans (d), confirming that no systematic outliers exist.



(a) Disposable income (b) Expenditure (c) Correlation

Figure B.1: Disposable income and expenditure (yen)

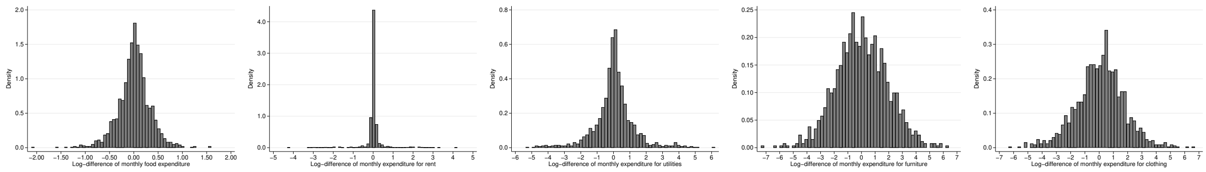
Notes: Monthly disposable income and expenditure are illustrated in the figures. Disposable income is income excluding tax payments. The solid red lines in Figure B.1a and B.1b indicate mean monthly disposable income and expenditure, respectively. Figure B.1c illustrates the correlation between monthly disposable income and monthly expenditure. Sources: Created by the author from the Municipal Bureau of Labor Research of Osaka (1919–1920).



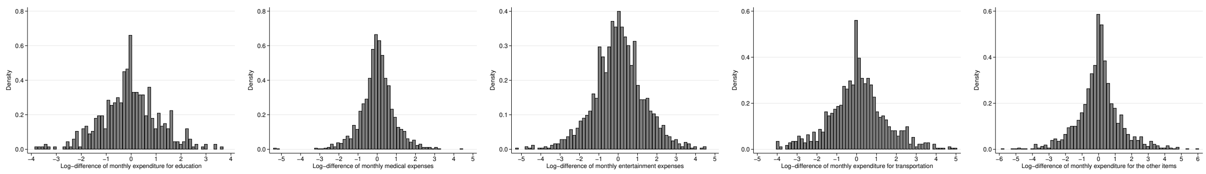
(a) Disposable income (b) Expenditure (c) Correlation

Figure B.2: Log-difference in disposable income and expenditure

Notes: Distributions of the log-differences in disposable income and expenditure are shown in Figures B.2a and B.2b, respectively. Disposable income is income excluding tax payments. The solid red lines in Figures B.2a and B.2b indicate the mean of the log-differences in monthly disposable income and expenditure, respectively. Figure B.2c describes the correlation between the log-differences in monthly disposable income and expenditure. Sources: Created by the author from the Municipal Bureau of Labor Research of Osaka (1919–1920).



(a) Food (b) Housing (c) Utilities (d) Furniture (e) Clothing



(f) Education (g) Medical (h) Entertainment (i) Transportation (j) Miscellaneous

Figure B.3: Distribution of the log-difference of the 10 subcategories

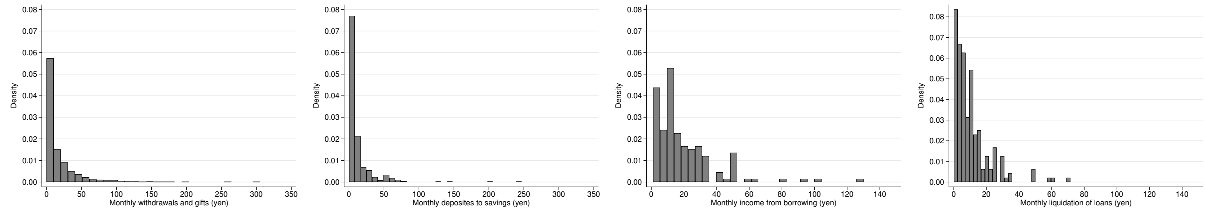
Notes: The distribution of the log-differences in monthly expenditure for the 10 subcategories listed in panel A of Table 2 is shown in the figures. Sources: Created by the author from the Municipal Bureau of Labor Research of Osaka (1919–1920).

B.2 Monthly Income of Adult Male Factory Workers

Prediction Equation

The monthly income of adult male factory workers in the manufacturing sector (s), listed in column (2) of panel B in Table 1, is calculated as follows:

$$Monthly\ Income_s = \frac{(Wage_s^{Adult} + Miscellaneous) \times Annual\ Working\ Days_s + Bonus_s}{12}, \tag{16}$$



(a) Withdrawals and gifts (b) Deposits to savings (c) Borrowing (d) Liquidation of loans

Figure B.4: Distribution of monthly income from temporary sources and the corresponding expenditure (yen)

Notes: Figure B.4c illustrates the distribution of monthly withdrawals and gifts. Figure B.4b shows the distribution of monthly deposits to savings. Figure B.4c illustrates the distribution of monthly temporary income from borrowing. Figure B.4d shows the distribution of monthly liquidation of loans. The range of the x-axis is fixed at zero to 350 (150) in the savings (borrowing) category. Sources: Created by the author from the Municipal Bureau of Labor Research of Osaka (1919–1920).

Table B.1: Calculating the Monthly Income of Adult Male Factory Workers

Panel A: Components in equation 16

			Annual Working Days$_s$		*Bonus*$_s$ (yen)	
	(1) $Wage_s^{Adult}$	(2) *Miscellaneous*	(3)	(4)	(5)	(6)
Sector	(yen)	(yen)	Conservative	+12 days	(3) used	(4) used
Textile	1.83	0.15	322	334	49.1	50.9
Machine	2.16	0.31	320	332	57.6	59.8
Chemical	2.01	0.20	331	343	55.4	57.5
Food	2.02	0.13	322	334	54.2	56.2
Miscellaneous	2.08	0.20	328	340	56.9	58.9

Panel B: Monthly income of adult male factory workers

	Monthly Income$_s$ (yen)	
	(1)	(2)
Sector	*Annual Working Days*$_s$ = (3)	*Annual Working Days*$_s$ = (4)
Textile	57.2	59.4
Machine	70.7	73.3
Chemical	65.6	68.0
Food	62.2	64.5
Miscellaneous	67.1	69.5

Notes: $Wage_s^{Adult}$ in column (1) in panel A is calculated using equation 17. *Miscellaneous* in column (2) in panel A is the average daily income from sources other than daily wages (see *Miscellaneous Income* section in Online Appendix B.2). *Annual Working Days*$_s$ in columns (3) and (4) in panel A indicate the annual average number of working days. *Bonus*$_s$ (yen) in columns (5) and (6) in panel A are the one-month equivalent bonus calculated using the average number of working days listed in columns (3) and (4), respectively. *Monthly Income*$_s$ in columns (1) and (2) in panel B are calculated based on equation 16.
Sources: Data used to calculate the wage are from Osaka City (Osaka City Office 1921 pp. 8(44)–8(45); 1922, pp. 8(46)–8(47)). Data on miscellaneous income are from the Department of Social Affairs, Osaka City Office (1923, pp. 143–156). Data on working days are from the Department of Social Affairs, Osaka City Office (1923, p. 196).

where $Wage^{Adult}$ is the average daily wage of adult male factory workers, *Miscellaneous* indicates the average daily miscellaneous income other than wage, *Annual Working Days* is the average number of annual working days, and *Bonus* is the bonus. The calculation method for each component is summarized in the subsections below.

Average Daily Wage of Adult Male Factory Workers

The average daily wages of adult male factory workers in the manufacturing sectors are not explicitly reported in the manufacturing census. Therefore, following the method suggested by Ohkawa et al. (1967), I systematically back calculated it as follows:

$$Wage_s^{Adult} = \frac{Wage_s^{Average}(Workers_s^{Adult} + Workers_s^{Child}) - Wage_s^{Child} \times Workers_s^{Child}}{Workers_s^{Adult}}, \tag{17}$$

where $Wage^{Average}$ is the average daily wage of male factory workers, $Wage^{Child}$ is the average minimum daily wage, and $Workers^{Adult}$ and $Workers^{Child}$ are the number of male factory workers aged 20 years and older (*seinen kō*) and less than 20 years (*shōnen kō*), respectively. The minimum wage is used for child workers because they had received bottom wages in factories (Department of Social Affairs, Osaka City Office 1923, p. 159). All these available data are taken from the manufacturing census reported by Osaka City Office (1921 pp. 8(44)–8(45); 1922, pp. 8(46)–8(47)). The RLR periods range from 1919 to 1920 (Section 3.1). Thus, I calculated the $Wage^{Average}$ for both 1919 and 1920 and then weighted both figures using analytical weights based on the number of observations in the RLR sample, say four (for 1919) to five (for 1920), to obtain the average daily wage of male factory workers.[1] Column (1) in panel A of Table B.1 lists the calculated wage in each manufacturing sector. These figures are reasonably higher than the average daily wage of male factory workers in each sector in Osaka city (Osaka City 1921 pp. 8(44)–8(45); 1922, pp. 8(46)–8(47)).

Miscellaneous Income

In addition to daily wages, factory workers received a small amount of miscellaneous income from their factories, which includes allowances, division of profits (*rijyun bunpai*), and payments for overtime hours worked.[2] Although the systematic statistics on these sources by manufacturing sector are scarce, an official factory survey documented the

[1] The results are materially similar if I use equal weights (i.e., one (for 1919) to one (for 1920)) instead of the analytical weight.

[2] Although the division of profits is not very common at that time, most of the factories had payed any of those miscellaneous incomes to the workers (Department of Social Affairs, Osaka City Office 1923, pp. 138–139).

average daily miscellaneous income for 156 factories in Osaka city (Department of Social Affairs, Osaka City Office 1923, pp. 143–156). While this survey covers all factories with more than 100 workers, the data obtained from this survey should not be critically biased upward because the average number of workers per factory was roughly 156 at that time, which is sufficiently above the threshold value (Department of Social Affairs, Osaka City Office 1926, p. 1).[3] Despite this, I choose the 25th percentile as the reference value of the miscellaneous income rather than the mean or median to provide conservative estimates.[4] As shown in column (2) of Table B.1, these figures range from roughly 0.1 to 0.3, which are indeed similar to those documented in the other available sources (Department of Social Affairs, Osaka City Office 1922, p. 74-76), which supports plausibility of this estimate.

Annual Working Days

The average number of annual working days by manufacturing sector listed in column (3) of panel A of Table B.1 is taken from an official report on the factory survey in Osaka city that I used in the prior subsection (Department of Social Affairs, Osaka City Office 1923, pp.196-197). The figures in column (3) are conservative in the following ways. First, the average number of days off reported in the manufacturing census for Osaka was approximately 2.4 days per month, which is one day less than the average obtained herein (Secretariat of Agriculture and Commerce 1921, pp. 156–157). Second, some factories even paid wages for these holidays (Department of Social Affairs, Osaka City Office 1923, pp.198–199). Therefore, while I use the conservative value listed in column (3) for the main calculation, I also consider an alternative case in column (4), which adds 12 days (i.e., one day per month) to those figures.

[3]If the provision and amount of miscellaneous income depended on the scale of the factories, then the figures obtained from this survey may be biased upward. However, there is no statistically significant difference in the average daily wages of adult males (excluding miscellaneous income) between the factories that provided miscellaneous income and those that did not. In addition, there is no clear positive correlation between the average daily wages of adult males (excluding miscellaneous income) and the average miscellaneous income. These results suggest that the potential upward bias is not remarkable.

[4]Note that the slight change in this value does not disturb the overall interpretation because the income from these sources was substantially smaller than the daily wage; for instance, a ± 0.05 yen (i.e., 25%) change in this term results in only a few percentage change in the calculated $\textit{Monthly Income}_s$.

Bonus

The total amount of bonus for factory workers in Osaka city around 1920 was equivalent to one month's pay (Tada 1991a, pp.40–49), which was usually paid in December (Tada 1991b, p.9; Department of Social Affairs, Osaka City Office 1922, p.197). Columns (5) and (6) in panel A of Table B.1 show the one-month equivalent bonus under the conservative setting using the annual working days listed in column (3) and the one-month equivalent bonus calculated using column (4), respectively.

Monthly Income

Column (1) in panel B of Table B.1 shows the calculated $Monthly\ Income_s$, which is also reported in the main text (column (2) of panel B in Table 1). Column (2) in the same panel lists the calculated figures under the tolerant setting in terms of the number of annual working days.

B.3 Comparing the RLR Sample with the Census and Survey Samples

Panel A of Table B.2 provides the mean size of households with heads working in the manufacturing industry across the Japanese archipelago. The mean values of Osaka and Tokyo are 3.99 and 4.19, respectively, close to those of the RLR sample (4.00 with a 95%CI of $[3.79, 4.21]$). At the regional level, the mean values for the Midwest region (including Osaka, Kobe, and Kyoto) and Mideast region (including Tokyo and Yokohama) show similar values of 4.01 and 4.18, respectively. This makes sense because the manufacturing industries in these cities were at a similar developmental stage. In fact, smaller and less developed cities in other regions had larger households. For example, Nagoya, a medium-sized city in the midland region, and the other smaller provincial cities in the southwest and northeast regions have larger households (4.31, 4.22, and 4.63, respectively). Thus, applying the findings from the RLR sample to these provincial cities could be misleading because factory worker households in both regions might have had different preferences for household consumption compared to the smaller households in populated cities.

Table B.2: Household Size, Monthly Income, and Expenditure in the Manufacturing Sector across Regions: Comparing the RLR Sample with the Census and Survey Samples

Panel A: Population census

	Household size (people) in manufacturing industry	Number of households
RLR sample	4.00	237
	[3.79, 4.21]	
Population census		
Representative large cities		
Osaka	3.99	107,340
Tokyo	4.19	168,226
By wider region		
Midwest (Osaka, Kobe, Kyoto)	4.01	208,437
Mideast (Tokyo, Yokohama)	4.18	198,357
Smaller cities in other regions		
Midland (Nagoya)	4.31	36,286
Southwest (four cities)	4.22	45,960
Northeast (four cities)	4.63	22,546

Panel B: Survey of the Living Conditions of Factory Workers
Survey area: Eight cities located from the southwest to the mideast regions
Survey subject: Factory worker households with 4–6 people; head earned more than 30 yen per month
Survey month and year: February and March 1921

	Mean values			
	(1) Monthly household Income (yen)	(2) Monthly household expenditure (yen)	(3) Household size (people)	Number of households
RLR sample	103.17	91.72	4.78	82
	[96.57, 109.78]	[86.45, 96.99]	[4.66, 4.91]	
LCFW sample				
Representative large cities				
Midwest (Osaka, Kobe, Kyoto)	103.18	90.45	4.84	603
Mideast (Tokyo, Yokohama)	103.62	88.97	4.72	399
Smaller cities in other regions				
Midland (Nagoya)	104.40	82.02	4.63	155
Southwest (Nagasaki, Fukuoka)	101.04	87.37	5.08	256

Notes:
1. Panel A compares the mean household size in the RLR sample with the mean size of households in the manufacturing sector in the large cities available from the 1920 population census. In the census, large cities are defined as cities with populations greater than 100,000. The southwest region includes Hiroshima, Kure, Nagasaki, and Kagoshima. The northeast region includes Hakodate, Otaru, Sapporo, and Sendai. The number of households obtained from the census indicates the total number of households in the manufacturing sector.
2. Panel B shows the mean monthly income, expenditure, and household size calculated from the LCFW samples. Altogether, 82 RLR households satisfying the sampling criteria in the LCFW (i.e., household with 4–6 people and the head earned more than 30 yen per month) are used. The monthly income and expenditure in the RLR sample are calculated using the data from February and March 1920 to match the months of the LCFW. The mean monthly income and expenditure from the survey are deflated using the consumer price index provided by the Bank of Japan.
3. The figures in brackets are 95% confidence intervals.
Sources: Calculated by the author from the Municipal Bureau of Labor Research of Osaka (1919–1920); Statistics Bureau of the Cabinet (1929b, pp. 320–385) (for Panel A); Bureau of Social Welfare (1923) (for Panel B). Data on the consumer price index are obtained from Bank of Japan (1986).

In panel B of Table B.2, I provide additional evidence on the representativeness of the RLR sample by using the official report of a large household survey – the Survey of Living Conditions of Factory Workers (LCFW), conducted by the Bureau of Social Welfare in 1921. The LCFW surveyed factory worker households with families consisting of 4–6 people and with heads who earned more than 30 yen per month. Focusing on households with families is useful because the proportion of single workers in the manufacturing sector was considerably low: 1–2% both in the population census and RLR sample (Statistics Bureau of the Cabinet 1929b, pp. 320–325).[5] Moreover, the phenomenon of a head earning less than 30 yen per month was rare, as they were usually considered as poor and belonging to the bottom 1% (Osaka Prefecture 1931, p. 5): in fact, these households account for 0.8% of the RLR sample. Another advantage of the LCFW is that it surveys all representative large cities as well as some smaller cities, thereby allowing me to make a comparison in the same way as in panel A of Table B.2.[6] To ensure a precise comparison, I trim the RLR sample to 82 households, satisfying the sampling criteria of the LCFW. In addition, I limit it to February and March to match the survey months of the LCFW.

Columns (1)–(3) in panel B of Table B.2 present the mean values of monthly household income, expenditure, and household size, showing evidence that the RLR sample can approximate the mean values of household income, expenditure, and household size in representative large cities in the midwest and mideast regions, as confirmed in panel A of Table B.2. Although some figures in smaller cities in the midland and southwestern regions show values that are similar to the large cities, monthly expenditure in Nagoya (82.02 yen) and household size in the southwestern region (5.08) deviate significantly from the RLR samples. This implies that the households in both regions showed different consumption behaviors compared to those in the representative large cities (Section 3.1).

As discussed in the main text, the primary target of this study is factory worker households in Osaka city. Given the similarities, however, it might be conceivable to view factory worker households in other large cities as the secondary target, although with care taken to adapt the findings from the RLR sample.

[5] The comparison for the households with families with 2–3 people, which is not included in the LCFW, should be similar to that in panel B of Table 1. Note that the average monthly earning of households with a couple (or couple and a small child) is similar to that of the heads in breadwinner households (Tada 1991a).

[6] The comprehensiveness of the LCFW could be because it was a systematically designed survey that offered reliable reference materials for planning the initial Health Insurance Act (Tada 1991b, p. 7).

Appendix C Empirical Analysis Appendix

C.1 Additional Results: Robustness to Preference Shifts

I provide additional evidence on the robustness of my main results to potential preference shifts. The most influential event inducing preference shifts is the loss of the head, which can cause both a negative idiosyncratic income shock and a reduction in food consumption. I check the frequency of household head deaths during the sample period in the following two ways.

First, I utilize the data on the household size. In the RLR documents, there are two types of reported household sizes: raw household size is reported in the initial survey month, and adult equivalent household size is reported every month. If the head died, then the adult equivalent size should decrease accordingly. However, I confirmed that the adult equivalent household size remained unchanged throughout the survey period in all the households. This suggested that no heads had died during this period.[7] This is consistent with the fact that most of the factory workers in Osaka city were in their 20s–30s, and the average life expectancy of males at age 20 was approximately 40 years at that time.[8]

Second, I use the information on heads' occupation to check whether there were any losses of heads. I undertook this exercise because the adult equivalent household size reported every month was possibly a repetition of the raw household size reported in the initial period. If a head died, then the head's occupation would change because the wife would have become the breadwinner.[9] I found that there were only six heads who changed their occupation (industry) during the sampled periods. However, these changes were not permanent but one-month temporary changes. This means that these changes were not caused by the losses of heads.

[7] If a head died and an adult man became the new head in the same month, the adult equivalent household size is unchanged. However, this replacement of a head is not likely because the head's occupation rarely changed during the sample period, as explained previously. Moreover, even if such a replacement occurred, there should be no preference shift because the family size was stable regardless of the loss of the head.

[8] See Department of Social Affairs, Osaka City Office (1923, p. 19) and Ministry of Health, Labour and Welfare, (*Life Table*, database) for the statistics.

[9] Note that the wives were rarely employed in the manufacturing sector (Tada 1991a).

Table C.1: Results of Estimating Income Elasticities:
Alternative Specification Including Additional Control Variable

	Disposable income		
Result from the alternative specification	Coef.	Std. error	Observations
Total consumption	0.392	[0.037]***	1880
Food	0.139	[0.032]***	1880
Housing	0.074	[0.043]*	1851
Utilities	0.293	[0.106]***	1733
Furniture	0.663	[0.165]***	1560
Clothes	0.679	[0.113]***	1840
Education	0.091	[0.129]	789
Medical expenses	0.378	[0.077]***	1866
Entertainment expenses	0.552	[0.096]***	1809
Transportation	0.315	[0.129]**	1512
Miscellaneous	0.524	[0.135]***	1854

***, **, 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 for the alternative specification of equation 1: the regressions of the 11 measures of log-transformed consumption on log-transformed disposable income and the family size controls, occupational change dummy, household fixed effects, and month-year fixed effects. The occupational change dummy is an indicator variable that takes the value of one for the year-month cells of six households whose heads had temporarily changed their occupations. The family size controls are interacted with the quarter dummies. The estimated coefficients on log-transformed disposable income are listed in the second column (Coef.).

Next, I quantitatively test the potential influence of preference shifts due to changes in the household size in two ways. First, I include an indicator variable for the six year-month cells of six households whose heads had temporary changed their occupations, in equation 1. The results are shown in Table C.1. The estimates are virtually identical to those listed in Table 3.[10] Second, I exclude all the family size controls from equation 1. If the preference shifts due to changes in family size are the cause of the endogeneity in the regressions, my main results presented in Table 3 should substantially change after excluding the family size controls. Table C.2 shows the results from the specification

[10] I have also confirmed that the results are unchanged from my main results if I simply excluded these six households.

excluding all these controls. Again, the estimates are materially similar to those listed in Table 3.

Table C.2: Results of Estimating Income Elasticities:
Alternative Specification Excluding Family Size Controls

	Disposable income		
Result from the alternative specification	Coef.	Std. error	Observations
Total consumption	0.394	[0.038]***	1880
Food	0.140	[0.032]***	1880
Housing	0.086	[0.047]*	1851
Utilities	0.283	[0.106]***	1733
Furniture	0.645	[0.165]***	1560
Clothes	0.684	[0.111]***	1840
Education	0.113	[0.124]	789
Medical expenses	0.373	[0.075]***	1866
Entertainment expenses	0.553	[0.094]***	1809
Transportation	0.306	[0.128]**	1512
Miscellaneous	0.529	[0.134]***	1854

***, **, 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 for the alternative specification of equation 1: the regressions of the 11 measures of log-transformed consumption on log-transformed disposable income as well as on the household fixed effects and month-year fixed effects. The estimated coefficients on log-transformed disposable income are listed in the second column (Coef.).

The foregoing results support the evidence that the family size in my RLR sample had been relatively stable and thus, the preference shifts should not disturb the main findings in this paper. Despite this, the estimates listed in Table C.2 are slightly larger than those listed in Table 3, albeit these differences are negligible. Therefore, to be conservative, I prefer to include the family size controls in equations 1 (Section 4.1).

C.2 Additional Results: Alternative Definition of the Shock Variable

My baseline specification uses disposable income as the shock variable (Section 4.1). In this subsection, I use an indicator variable for a negative income shock instead of disposable income in equation 1 to test whether my main results are derived from negative rather than positive shocks. Specifically, the indicator variable takes one if disposable income is below households' mean disposable income, whereas it takes zero if disposable income is equal to or above the mean. Intuitively, this indicator switches to one if the household experiences a negative idiosyncratic shock on its income relative to its potential permanent income. One can expect that consumption changes little with positive shocks, but co-moves with income following negative shocks, as in Deaton (1991). Therefore, the estimated coefficient on this indicator variable should be negative, which means that consumption responds to negative shocks relative to positive shocks (and the case of no change in income).

Table C.3 presents the results, which confirm that the estimates are negative in most cases. The estimated coefficients across the categories are similar to those of the main results (Table 3). In Table C.4, I also use an indicator variable for negative income shocks instead of disposable income in equation 2. The results in this table are also consistent with those in Table 4. Similarly, Table C.5 shows the results from the specification using an indicator variable for negative shocks to the income of the household head instead of that income in the labor supply equations in Table 6.

The foregoing results confirm that my results presented in the main text are robust to the variable definition. However, one must be careful about the fact that these alternative specifications using the indicator shock variable tend to cut off the useful information in the small changes in disposable income because it is simply rounded to one or zero based on the threshold. This leads to an identification issue because of the smaller variation in the key indicator variable, especially with few observations. I acknowledge that the regressions for testing the heterogeneous responses (with respect to the borrowing, clothes, and furniture categories) using the small sample size presented in Table 5 are no longer computationally practical. Despite this, the weight of evidence shown in Tables C.3, C.4, and C.5 suggests that the definition of the key variable does not matter for those regressions.

Table C.3: Results of Estimating Income Elasticities:
Alternative Specification using Alternative Definition of Shock Variable

	Negative Shock (=1)		
Result from the alternative specification	Coef.	Std. error	Observations
Total consumption	-0.149	[0.015]***	1880
Food	-0.045	[0.045]***	1880
Housing	-0.040	[0.040]*	1851
Utilities	-0.110	[0.110]**	1733
Furniture	-0.300	[0.087]***	1560
Clothes	-0.259	[0.061]***	1840
Education	0.023	[0.068]	789
Medical expenses	-0.137	[0.037]***	1866
Entertainment expenses	-0.208	[0.047]***	1809
Transportation	-0.109	[0.064]*	1512
Miscellaneous	-0.163	[0.054]***	1854

***, **, 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 for the alternative specification of equation 1: the regressions of the 11 measures of log-transformed consumption on the indicator variable for the negative income shock, family size controls, household fixed effects, and month-year fixed effects. The family size controls are interacted with the quarter dummies. The estimated coefficients on log-transformed disposable income are listed in the second column (Coef.).

Table C.4: Results of Testing the Risk-Coping Mechanisms:
Alternative Specification using Alternative Definition of Shock Variable

Panel A: Testing the role of savings	Dependent variable	
	(1) Withdrawals and gifts	(2) Deposits to savings
Negative shock (=1)	17.819***	-15.195**
	[5.083]	[7.729]
Observations	1,711	1,711

Panel B: Testing the role of borrowing	Dependent variable	
	(1) Borrowing	(2) Liquidation of loans
Negative shock (=1)	12.132*	-7.820*
	[6.318]	[4.085]
Observations	599	599

Panel C: Testing the role of pawnshops	Dependent variable	
	(1) Expenditure on clothes	(2) Expenditure on furniture
Negative shock (=1)	-3.323***	0.180
	[1.205]	[1.846]
Observations	599	599

***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. The results from the fixed-effects Tobit model, as proposed by Honoré (1992), are reported in columns (1) and (2) in each panel. A quadratic loss function is applied for the estimation to ensure computational tractability. Robust standard errors are in brackets. Standard errors are clustered at the household level in the linear models.
Notes: Panel A presents the results for the savings category: withdrawals and gifts (column (1)) and deposits to savings (column (2)). Panel B presents the results for the borrowing category: borrowing (column (1)) and liquidation of loans (column (2)). Panel C presents the results for expenditure on clothes (column (1)) and furniture (column (2)). All the regressions in each panel include the indicator variable for the negative income shock, family size controls, household fixed effects, and month-year specific fixed effects. The family size controls are interacted with the quarter dummies.

Table C.5: Results of Testing Labor Supply Adjustments:
Alternative Specification using Alternative Definition of Shock Variable

Panel A: Testing labor supply adjustments

	Dependent variable	
	(1) Wife's income	(2) Child's income
Negative shock (=1)	1.850	9.492***
	[1.361]	[4.291]
Observations	1,627	1,627

Panel B: Testing the heterogeneous responses

	Households' mean monthly deposits to savings			
	≤ Median		> Median	
	income from		income from	
	(1) wife	(2) child	(3) wife	(4) child
Negative shock (=1)	4.636***	13.025**	0.406	-0.297
	[1.786]	[6.613]	[1.851]	[6.546]
Observations	784	784	843	843

***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. The results from the fixed-effects Tobit model, as proposed by Honoré (1992), are reported. A quadratic loss function was applied for the estimation to ensure computational tractability. Robust standard errors are in parentheses.

Notes: Panel A shows the results for the 194 households with three or more family members. Panel B stratifies households based on the median of households' mean monthly deposits to savings. Columns (1) and (2) show the results for the 97 households below the median and columns (3) and (4) present the results for the 97 households above the median. All the regressions in each panel include the indicator variable for the negative shock on the income of the household head, family size controls, household fixed effects, and month-year fixed effects. The family size controls are interacted with the quarter dummies.

C.3 Additional Results: Robustness to Trimming

To deal with censoring in the dependent variables, I used the trimmed subsample to investigate the risk-coping mechanisms (Section 5.1). I present the evidence on the validity of this procedure as follows.

First, I show that the main findings remain unchanged if I use the full sample. Table C.6 shows the results. The results in columns (1) and (3) of panel A in Table C.6 are similar to those listed in the same columns of panel A in Table 4. This makes sense because the censoring is not severe in these dependent variables for savings. Columns (1) and (3) of panel B in Table C.6 are attenuated but still show statistically significant results. This attenuation also makes sense because the degree of censoring is much more severe in these dependent variables for borrowing.

Second, the estimates from the fixed-effects Tobit models, listed in columns (2) and (4) of Table C.6, are identical to those listed in Table 4. This is consistent with the fact that this model is robust to the existence of the completely censored units (households) that do not have any within variations in the dependent variable (Honoré 1992). The estimation becomes unfeasible when the number of units that have within variations in the dependent variable is considerably small relative to the number of completely censored units, especially when the model is complex. The regression for the liquidation of loans listed in column (4) of panel B in Table C.6 is the case, in which the valid estimate is computationally unavailable. Despite this, the result from the linear model in column (3) confirms that trimming the sample does not upset the finding for liquidation of loans.

Finally, Table C.7 presents the results for the balancing tests using the family size variables listed in panel C of Table 2. If the trimmed subsample and the remaining samples share similar characteristics, the family size variables should be uncorrelated with the usage of these temporary incomes. Column (1) of Table C.7 shows the result from a Probit model that regresses the binary dependent variable for the households receiving income from withdrawals and gifts on the family size controls. Similarly, Column (2) shows the result for borrowing. Clearly, all the estimated coefficients are close to zero and statistically insignificant. The Wald statistics support the null results, confirming that there are no statistically significant differences in the family characteristics between the

Table C.6: Results of Testing the Risk-Coping Mechanisms: Results for Full Sample

Panel A: Testing the role of savings	Dependent variable			
	Withdrawals and gifts		Deposits to savings	
	(1)	(2)	(3)	(4)
Disposable income	-0.183***	-0.457***	0.061***	0.321***
	[0.037]	[0.097]	[0.022]	[0.088]
Model	Linear	Nonlinear	Linear	Nonlinear
Observations	1,880	1,880	1,880	1,880
Panel B: Testing the role of borrowing	Dependent variable			
	Borrowing		Liquidation of loans	
	(1)	(2)	(3)	(4)
Disposable income	-0.024**	-0.516***	0.016*	–
	[0.012]	[0.143]	[0.009]	–
Model	Linear	Nonlinear	Linear	Nonlinear
Observations	1,880	1,880	1,880	1,880

***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. The results from the fixed-effects Tobit model, as proposed by Honoré (1992), are reported in columns (2) and (4) in each panel. A quadratic loss function is applied for the estimation to ensure computational tractability. Robust standard errors are in brackets. Standard errors are clustered at the household level in the linear models.
Notes: Panel A presents the results for the savings category: withdrawals and gifts (columns (1) and (2)) and deposits to savings (columns (3) and (4)). Panel B presents the results for the borrowing category: borrowing (columns (1) and (2)) and liquidation of loans (columns (3) and (4)). Valid estimate is computationally unavailable in column (4) due to severe censoring. All the regressions in each panel include the disposable income, family size controls, household fixed effects, and month-year fixed effects. The family size controls are interacted with the quarter dummies.

subsamples.

C.4 Additional Results: Net Savings and Net Borrowing

Columns (1) and (2) of Table C.8 present the results for net savings (withdrawals minus deposits) and net borrowing (borrowing minus liquidation of loans), respectively. As I explained in Section 5.1, the estimate for the net savings is a combination of the estimates listed in columns (1) and (3) in panel A of Table 4: $-0.202 - 0.067 = -0.269$. Similarly, the estimate for net borrowing is a combination of the estimates shown in columns (1) and (3) in panel B of the same table: $-0.122 - 0.072 = -0.194$.

Table C.7: Results for the Balancing Tests

	DV: Indicator variable for the households receiving any income from either withdrawals and gifts or borrowing	
	(1) Withdrawals and gifts	(2) Borrowed
Size	0.134	-0.032
	[0.092]	[0.075]
Children aged 6–9 (%)	-0.006	0.013
	[0.010]	[0.010]
Children aged 10–12 (%)	-0.002	-0.002
	[0.013]	[0.011]
Children aged 13–16 (%)	-0.003	0.006
	[0.010]	[0.009]
Men aged 17+ (%)	0.008	-0.013
	[0.009]	[0.008]
Women aged 17+ (%)	-0.002	-0.001
	[0.008]	[0.008]
Intercept	0.398	-0.145
	[0.798]	[0.659]
Wald χ^2 statistics for zero slope (p-value)	2.83 (0.8297)	8.64 (0.1951)
Maximized Log-likelihood	-97.68	-134.95
Pseudo R-squared	0.0156	0.0307
Number of households	237	237

The results from Probit models are reported. Robust standard errors are in brackets.
Notes: The dependent variable in column (1) is an indicator variable that takes one if the household has received temporary income from withdrawals and gifts. The dependent variable in column (2) is an indicator variable that takes one if the household has received temporary income from borrowing. The proportion of children aged 0–5 years (%) is used as the reference group.

C.5 Additional Results: Alternative Cut-off Variable

Evidence suggests that the type of housing depended on the wealth of the households (Nakagawa 1985, pp. 116–117). A representative example is that the disadvantaged households with lower assets lived in the tunnel-type single story row houses called *nagaya*, with cheaper rents (Tokyo City Social Welfare Bureau 1921). This means that the expenditure on housing can be used as a proxy of the wealth level of households.

Using the data on expenditure on housing for investigating the monthly saving behaviors is also an advantage. As previously explained, the expenditure on housing has little underlying variations in most of the households (Figure B.3b). Moreover, it is nearly independent from the monthly income (Figure 3b). This means that the expenditure on housing does not co-move with the short-run (monthly) earning and saving behaviors and thus, is a plausible measure for the cut-off variable.

Table C.8: Risk-Coping Mechanism Test Results
: Net Savings and Net Borrowing

	Dependent variable	
	(1) Net savings	(2) Net borrowing
Disposable income	-0.269***	-0.194***
	[0.040]	[0.066]
Model	Linear	Linear
Observations	1,711	599

*** denotes statistical significance at the 1% level. Standard errors clustered at the household level are in brackets.
Notes: Column (1) reports the estimate for net savings (withdrawals minus deposits). Column (2) reports the estimate for net borrowing (borrowing minus liquidation of loans). All the regressions in each panel include the disposable income, family size controls, household fixed effects, and month-year fixed effects. The family size controls are interacted with the quarter dummies.

Table C.9 shows the results. Column (1) shows the estimate for households with less than or equal to the median of mean monthly expenditure on housing. Meanwhile, column (2) shows the estimate for the households with more than the median. The results are similar to those listed in columns (1) and (3) of panel A in Table 5, supporting the validity of the cut-off variable used in the main text.

Table C.9: Results of Testing the Role of Savings:
Alternative Thresholds using Expenditure for Housing

	Households' mean monthly expenditure on housing	
	$\leq$ Median	$>$ Median
	(1) Withdrawals and gifts	(2) Withdrawals and gifts
Disposable income	-0.568***	-0.468***
	[0.114]	[0.136]
Observations	724	987

*** denotes statistical significance at the 1% level. The results from the fixed-effects Tobit model, as proposed by Honoré (1992), are reported. A quadratic loss function is applied for the estimation to ensure computational tractability. Robust standard errors are in brackets.
Notes: The analytical sample used in panel A of Table 4 is stratified into two subsamples based on the median of households' mean monthly expenditure on housing: column (1) for 101 households less than or equal to the median, and column (2) for 101 households more than the median. All the regressions include the disposable income, family size controls, household fixed effects, and month-year specific fixed effects. The family size controls are interacted with the quarter dummies.

Deaton (1991) suggests that precautionary savings protect consumption against income shocks. This prediction is based on the theory regarding households under a liquidity constraint. Thus, it cannot be directly applied to households without liquidity

Table C.10: Result of Testing the Role of Savings:
Alternative Subsample Stratified using Expenditure for Housing

	Households' mean monthly expenditure on housing
	< 25 percentile
	(1) Withdrawals and gifts
Disposable income	-0.624***
	[0.217]
Observations	323

*** denotes statistical significance at the 1% level. The result from the fixed-effects Tobit model, as proposed by Honoré (1992), is reported. A quadratic loss function is applied for the estimation to ensure computational tractability. Robust standard error is in bracket.
Notes: The analytical sample includes 62 households below the 25th percentile of households' mean monthly expenditure on housing, and that had not received any income from borrowing. The regression includes the disposable income, family size controls, household fixed effects, and month-year specific fixed effects. The family size controls are interacted with the quarter dummies.

constraints (Deaton 1991, p. 1221). Moreover, since the data on whether the household faced a liquidity constraint are unavailable, it is difficult to identify which household had faced borrowing constraints. Despite this, I try to assess whether the result in Table C.9 is robust when I limit the sample to households that potentially faced borrowing constraints.

To do so, I first kept the households that had never received any income from borrowing because those households presumably include households facing a borrowing constraint. Then, I used the 25th percentile of the mean monthly expenditure on housing as the threshold value, and excluded all the households above this threshold. This does not mean that all the households under the threshold faced borrowing constraints. Instead, it implies that those households would be more likely to face the constraints compared to households above this threshold. Table C.10 shows the result. The estimate is still negative and statistically significant.

References used in the Appendices

[1] Cochrane, John H. "A Simple Test of Consumption Insurance." *Journal of Political Economy* 99, no. 5 (1991): 957–976.

[2] Deaton, Angus. "Saving and Liquidity Constraints." *Econometrica* 59, no. 5 (1991): 1221–1248.

[3] Fafchamps, Marcel, and Susan Lund. "Risk-sharing Networks in Rural Philippines." *Journal of Development Economics* 71, no. 2 (2003): 261–287.

[4] Honoré, Bo E. "Trimmed LAD and Least Squares Estimation of Truncated and Censored Regression Models with Fixed Effects." *Econometrica* 60, no. 3 (1992): 533–565.

[5] Nakagawa, Kiyoshi. A City Lower Layer of Japan. [in Japanese] Tokyo: Keisō Shobō, 1985.

[6] Negishi, Takashi. "Welfare Economics and Existence of an Equilibrium for a Competitive Economy." *Metroeconomica* 12, nos. 2–3 (1960): 92–97.

[7] Ohkawa, Kazushi, Miyohei Shinohara, and Mataji Umemura. *Estimates of Long-term Economic Statistics of Japan since 1868, volume.8.* [in Japanese] Tokyo: Toyo Keizai Shinposha, 1967.

[8] Ravallion, Martin, and Shubham Chaudhuri. "Risk and Insurance in Village India: Comment." *Econometrica* 65, no. 1 (1997): 171–184.

Statistical Reports used in the Appendices

[1] Bank of Japan. *Nihonginkō hyakunenshi, shiryō hen* (The Hundred Year History of the Bank of Japan, Source Material). [in Japanese] Tokyo: Bank of Japan, 1986.

[2] Bureau of Social Welfare. *Shokkō seikei jyōtai chōsa* (Survey of Living Conditions of Factory Workers). [in Japanese] Tokyo: Bureau of Social Welfare, 1923.

[3] Department of Social Affairs, Osaka City Office. *Rōdō shōsa hōkoku, dai jyūnanashū* (Report of Labor Research, Series 17). [in Japanese] Osaka: Osaka City Office, 1922.

[4] Department of Social Affairs, Osaka City Office. *Rōdō shōsa hōkoku, dai nijyūnishū* (Report of Labor Research, Series 22). [in Japanese] Kyoto: Koubundou Shobō, 1923.

[5] Ministry of Health, Labour and Welfare. *Seimei hyō* (Life Table). [in Japanese] https://www.mhlw.go.jp/toukei/saikin/hw/life/19th/gaiyo.html#3 (last accessed on

7th February 2022).

[6] Municipal Bureau of Labor Research of Osaka. "Rodō chōsa hōkoku, dai ni, yon, go, hachishū (Report of Labor Research, Series 2, 4, 5, and 8)." [in Japanese] In *Collection of Household Budget Surveys in the Taisho Era*, edited by Yoshizo Tada. Tokyo: Seishi Sha, 1919–1920.

[7] Osaka City Office. *Osakashi tōkeisho, Taishō hachinen* (Statistical Table of Osaka City, 1919 Edition). [in Japanese] Osaka: Osaka City Office, 1921.

[8] Osaka City Office. *Osakashi tōkeisho, Taishō kyūnen* (Statistical Table of Osaka City, 1920 Edition). [in Japanese] Osaka: Osaka City Office, 1922.

[9] Secretariat of Agriculture and Commerce. *Kojyō tōkeihyō, Taishō hachinen* (Census of Manufactures, 1919 Edition). [in Japanese] Tokyo: Secretariat of Agriculture and Commerce, 1921.

[10] Osaka Prefecture. *Hōmen kādo tōroku kakei no seikatsu jyōtai* (Living Conditions of the Poor Households). [in Japanese] Osaka: Osaka Prefecture, 1931.

[11] Statistics Bureau of the Cabinet. *Taishō kyūnen kokusei chōsa hōkoku, zenkoku no bu dai sankan* (Population Census of Japan, Vol. 3, 1920 Edition). [in Japanese] Tokyo: Statistics Bureau of the Cabinet, 1929b.

[12] Tada, Yoshizo. *Taishō kakei chōsa shūsei, dai sankan* (Collection of Household Budget Surveys in the Taisho Era, Vol. 3). [in Japanese] Tokyo: Seishi Sha, 1991a.

[13] Tada, Yoshizo. *Taishō kakei chōsa shūsei, dai yonkan* (Collection of Household Budget Surveys in the Taisho Era, Vol. 4). [in Japanese] Tokyo: Seishi Sha, 1991b.

[14] Tokyo City Social Welfare Bureau. *Tokyōshinai no saimin ni kansuru chōsa* (Survey of Poor in Tokyo City). [in Japanese] Tokyo: Tokyo City Social Welfare Bureau, 1921.