PRI Discussion Paper Series (No.25A-07)

What are the incentives behind working-hour adjustments by second earners?

Faculty of Economics, Meiji Gakuin University, Japan
Naomi Kodama
Graduate School of Humanities and Social Sciences, Hiroshima University, Japan
Shohei Momoda
Policy Research Institute, Ministry of Finance, Japan
Masahiro Mikayama
Policy Research Institute, Ministry of Finance, Japan
Tomohiro Iguchi

September 2025

Research Department Policy Research Institute, MOF
3-1-1 Kasumigaseki, Chiyoda-ku, Tokyo 100-8940, Japan
TEL 03-3581-4111

What are the incentives behind working-hour adjustments by second earners?*

Naomi Kodama†
Shohei Momoda‡
Masahiro Mikayama§
Tomohiro Iguchi⁋

Abstract

This study estimates the elasticity of hours worked with respect to hourly wages among female part-time workers to examine the influence of the labor supply. Using data on female part-time workers in Japan from 1998 to 2022, we find that wage elasticity is consistently negative, indicating that higher hourly wages are associated with reduced hours worked. This relationship remains stable across income levels, including those around the tax and social insurance premium thresholds. While taxes and social insurance contributions reportedly play a major role in the adjustment of hours worked, this evidence suggests that these policies are not the primary drivers of working hours adjustments. Further analysis reveals that many women, particularly married women and those in their 30s to 50s, tend to seek additional income to meet economic needs as second earners in their households. When income targets serve as reference points to meet these needs, women often adjust their working hours to reach these targets even under relatively low wage rates. Female part-time workers are more likely to adjust their hours worked in response to income targets rather than to taxes or social insurance premium thresholds. These results suggest that tax and social insurance reforms alone may be insufficient to increase working hours among second earners in Japan.

Keywords: Labor supply elasticity, Second earner, Income target, Tax and social insurance premiums
JEL Classification: J22, H24, J16

* This study is supported by the Policy Research Institute, Ministry of Finance, Japan. The views in this paper are solely the authors' responsibility and should not be interpreted as reflecting the views of the Ministry of Finance. We thank Ayako Kondo and participants at the seminars in Kyoto University and the Policy Research Institute, Ministry of Finance, Japan. Any remaining errors are the sole responsibility of the authors.
† Corresponding author. Faculty of Economics, Meiji Gakuin University, 1-2-37 Shirokanedai, Minato-ku, Tokyo, 108-8636, JAPAN. kodama@eco.meijigakuin.ac.jp.
‡ Graduate School of Humanities and Social Sciences, Hiroshima University, 1-3-2 Kagamiyama, Higashi- Hiroshima City, Hiroshima 739-8511, JAPAN. shohei.momoda.econ@gmail.com.
§ Policy Research Institute, Ministry of Finance, Japan. masahiro.mikayama.econ@gmail.com.
⁋ Policy Research Institute, Ministry of Finance, Japan. tomohiro19930507@yahoo.co.jp.

1 Introduction

Secondary earners have much larger intensive and extensive margins of working hours than primary earners. This is actually observed in many countries, where secondary earners tend to adjust their working hours. Taxes and social insurance contributions reportedly play a major role in this. We could give many examples of studies that show that changes in the income tax schedule have affected the employment rate and working hours of married women (e.g. Keane (2011), LaLumia (2008), Crossley and Jeon (2007), Eissa (1996), Eissa and Liebman (1996)). Adjusting working hours to keep annual income just below the point where marginal and average tax rates increase is widely observed throughout the world(Saez (2010), Chetty et al. (2011), Chetty (2012), Kleven and Waseem (2013), Gelber et al. (2020), Aronsson et al. (2022)). The joint tax system has a complex impact on women's working hour adjustments[1]. While many countries adopt individual taxation (Borella et al. (2023)), which is independent from spouse income, some countries, such as Germany, Denmark, Belgium, the US, and France, have joint taxation. When both progressive and joint taxation are imposed, secondary earners face higher marginal tax rates than singles (Keane (2022)).

In general, secondary earners, who are often married women, have greater labor supply elasticity. This is because the time spent by married women is highly substitutable for time spent on domestic production, such as childcare and housework. Once progressive and joint taxation is imposed together, the marginal tax rate for the secondary earner increases, so married women will hold back on supplying labor. Keane (2022) argues that the shift from joint to individual taxation improves welfare and significantly increases the labor supply of married women. Taxes have little effect on working hours for married men, but have a significant effect on married women(Bick and Fuchs-Schündeln (2018)). Many studies have shown that tax system changes have affected women's labor supply in the U.S. (LaLumia (2008), Eissa (1996), Eissa and Liebman (1996)), Canada (Crossley and Jeon (2007)), and Japan (Kondo and Fukai (2023), Yokoyama (2018), Yokoyama and Kodama (2016)).

While labor income taxes are an important driving force behind female labor supply, they only capture part of the rise in the labor supply of married women over the years from the 1980s to the early 1990s(Bick et al. (2019)). Labor participation cannot be explained solely when considering the impact of the Earned Income Tax Credit (EITC) and income transfers on the labor of low-income groups. Some studies, including those by Saez (2010), have attempt to explain income adjustments through the kink in the budget constraint

[1]In the US, where joint taxation is applied, both the marriage penalty (married taxpayers pay higher taxes than singles) and the marriage bonus (married taxpayers pay less taxes) have been criticized. The Congressional Budget Office (1997) reports that in 1996, 42% of joint taxpayers had a marriage penalty and 51% got a marriage bonus.

caused by taxes. They point out that the income of the self-employed, business owners, and professionals with high incomes is adjusted by tax schedule. On the other hand, full-time employees find it difficult to flexibly adjust their income to avoid taxes. However, even if they are employed, part-time workers, unlike full-time workers, can adjust their income through adjustments to working hours.

In this paper, we empirically examine whether secondary earners are suppressing labor supply in Japan. Japan is an ideal place to observe the behavior of secondary earners. This is because there are social norms in which women bear the brunt of household labor, resulting in low employment rates among married women, and many those who are employed work part-time. Additionally, while full-time workers tend to have inflexible working hours and work long hours in Japan, part-time workers have flexible working hours. In addition to social norms, the tax and social insurance systems also discourage women from working full-time. The secondary earner's income tax and social insurance contributions are reduced as a dependency exemption. In this paper, we examine whether the behavior of secondary earners changes due to taxes and social insurance premiums, or for other reasons, by examining whether working hours are suppressed around the level where income tax and social insurance premiums are reduced. In addition, we present a theoretical model that can explain the suppression of working hours.

First, this study measures the labor supply elasticity of all female part-time workers by age group and probability of marriage using long time series data from the Basic Survey on Wage Structure (Wage Census). Our focus is on the intensive margin, so we will limit our target to part-time workers, as full-time workers have little choice in their working hours once they choose to work. Following Brown et al. (1982), Card and Krueger (1995), we also conduct estimation using the minimum wage as an instrumental variable to address endogeneity in the labor supply function[2]. When the labor market is perfectly competitive, the IV identifies the elasticity of labor demand. On the other hand, the equilibrium is purely monopsonistic, where all firms are labor supply constrained, the own wage elasticity (OWE) would measure how compliers' labor supply responds to an increase in the firm-level wage(Dube and Zipperer (2024)). The real world is somewhere between a completely competitive state and a completely monopsonistic state. Women who are responsible for housework and childcare are in a situation that is closer to a monopsony market than men, because they are constrained to working near their homes(Manning (2011), Bacheron et al. (2024)). Dong and Ibaragi (2023) describes that the Japanese female part-time labor market is in a state of monopsony. Furthermore, to estimate the labor supply function, we control for

[2]We exploit the fact that the minimum wage in Japan varies from year to year and from prefecture to prefecture.

labor demand factors. To control for time-invariant labor demand factors, the establishment fixed effects are introduced following Addison et al. (2014). In addition, the industry*year fixed effects are also included to control for the business cycle in each industry. Furthermore, the employment size of the establishment is added to control for a part of time-variant labor demand factors such as sales changes. We find that the elasticity of working hours with respect to hourly wages for female part-time workers is negative to hours worked. However, although the application of Japan's tax and social insurance premiums differs depending on annual income, little difference is found in the magnitude of the elasticity by annual income. The Japanese tax and social insurance systems have been changed several times last 25 years, but few links have been found between these changes with the elasticity.

Even if the elasticity of hours worked with respect to wages is negative, we don't know why. So next, we will discuss the background of this. Specifically, using the data from the part-time employment survey, we will observe the proportion of people who do not adjust their working hours, those who adjust their working hours for tax and social insurance reasons, and those who adjust their working hours for total income targets, by age group and marital status. As a result, we find that around 90% of women in the groups that are likely to be affected by taxes and social insurance (married, 30-50s, annual income of 1.0-1.1 million yen, 1.2-1.3 million yen) are adjusting their working hours. However, these women are not necessarily suppressing their working hours for tax or social insurance reasons. According to an analysis of a survey on part-time work, among women who are adjusting their working hours, more respondents say they have an income target because they are working to supplement their household income than those who say they are adjusting their working hours for tax and social insurance reasons. For these women, the reason for working is financial, not self-fulfillment. Additionally, as they are not the primary earners in their households, they withdraw from the labor market once they reach the income target required by their households. The increase in the number of women working to supplement their household income can be explained by changes in the labor market by employment and marriage status. Compared to around 2000, the number of part-time workers with more time constraints increased in 2020. This is because some women who were not in the labor force around 2000 entered the part-time labor market, and some of the women who were working as part-time workers with less severe time constraints around 2000 began working as full-time workers. This suggests that, compared to 20 years ago, more workers are reducing their labor supply once they reach their income targets. Our findings show that elasticity has decreased over time, which can be explained by changes in demographics such as employment status and marital status.

Here, we discuss the income target model, which can explain negative labor supply elas-

ticity. In the canonical economics textbooks, labor supply increases with wages at a low-wage level, and when wages exceed a certain level, labor supply elasticity becomes negative. However, in developing countries, a downward-sloping labor supply function is sometimes observed among relatively low-wage level. When wages decrease, low-income people are forced to work more to maintain a basic standard of living. However, not only in developing countries, but also in developed countries such as the United States, an inverted S-shaped labor supply curve is observed (Dessing (2002), Nakamura and Murayama (2010), Tavor et al. (2022)). The income target can explanin that the elasticity of labor supply is negative even for relatively low-income earners[3]. Our evidence is consistent by the income target model. The income target serve as a useful tool for explaining the changes in women's labor supply that have been pointed out in some studies, changes that cannot be explained by taxes or social insurance. Our results suggest that changes to the tax system and social insurance system are not enough to encourage part-time female workers to work longer hours. In order to increase the working hours of secondary earners, it is effective to shift their motivation from supplementing the income of primary earners.

This study is constructed as follows. The following sections present the model. Section 2 describes the tax and social insurance system and population and labor supply of women in Japan. Section 3 describes our data and empirical model. Section 4 presents the results, Section 5 discusses the cause of the work hour adjustment, followed by concluding remarks in Section 6.

2 Changes in the tax and social insurance systems and female labor supply in Japan

2.1 Changes in tax and social insurance system

Low-income workers often withhold labor supply in Japan, especially women. Factors that have been pointed out include the exemption of workers' income tax, the tax deduction

[3]Camerer et al. (1997) showed negative elasticity based on the total income target model using data from New York taxi drivers. On the other hand, Farber (2005), Farber (2008) used different data to show that people choose when to finish their work based on total hours worked rather than total income, and that behavior based on income targets is not supported. Crawford and Meng (2011) presented a model that is dependent on both the total income target and the number of hours worked, and using the same data as Farber (2005), he showed that it is based on both the number of hours worked and the total income target. Applying this framework to other professions, Richards (2020) used the total income target model to explain farmers' behavior, while Dodini (2023) applied the same model to door-to-door salespeople. The above-mentioned study assumes a daily income target, but Nagase (2004) pointed out that women working part-time in Japan decide their working hours based on an annual income target.

for spouses, and the exemption from social insurance premium, which is applied when annual income is below a certain amount.

Individuals are usually taxed on an individual basis in Japan. The income tax exemption limit is the annual income of 1.03 million yen. If this amount is exceeded, an income tax of 5% will be imposed. This does not vary by gender or marital status. There were no changes in the limit during the analysis period. The limit of exemption from resident tax is 0.96–1 million yen, which varies from one municipality to another. Again, this does not differ by gender or marital status. Therefore, the impact of taxation on working hours should be the same regardless of gender.

Although individuals are usually taxed on an individual basis in Japan, there are some exceptions to the principle of individual taxation. These are the spousal deduction and the special spousal deduction. The spousal deduction and special spousal deduction reduce the taxable income of workers with spouses with income below a certain threshold. Since these are income tax deductions, the higher the income of the worker, the more income tax deductions they can receive.

Concerning the spousal deduction/spousal special deduction, to be eligible for the full income tax deduction, the spouse's income must be below a certain threshold. The thresholds are 0.7 million yen for 1987–2003, 1.05 million yen for 2004–2017, and 1.5 million yen for 2018 and thereafter. As the spouse's income rises, the amount of the income tax deduction is reduced in stages. The income deduction will be zero if it is more than 1.41 million yen in 1987-2017, if it is more than 2.01 million yen after 2018.

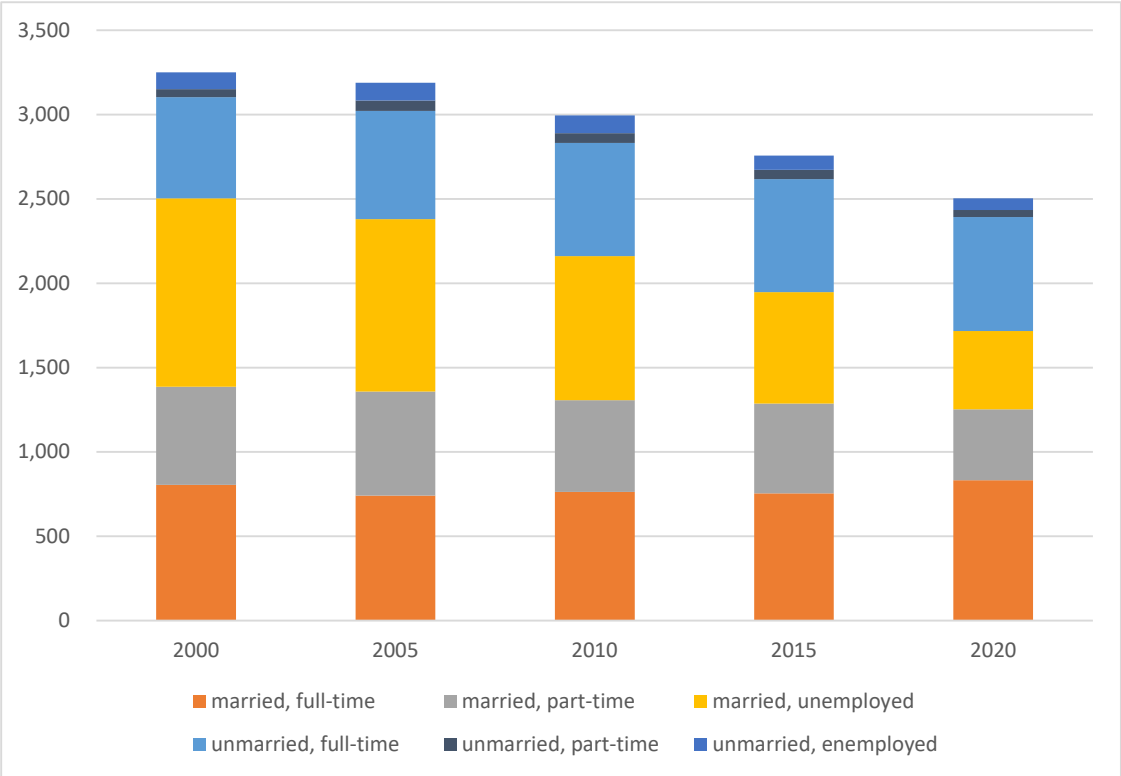
For social insurance premiums, dependents with an annual income of less than 1.3 million yen are exempt from paying pension and health insurance social insurance premiums, and can join social insurance as a dependent family member free of charge. In 2016, the annual income requirement for large companies with an employee size of 500 or more was lowered from 1.3 million yen to 1.06 million yen.

The thresholds of deduction of income tax and resident tax do not differ by gender or marital status. In contrast, the limits of spousal deduction/spousal special exemption and exemption of social insurance premiums for dependent spouses are different according to whether or not the worker has a dependent spouse with a certain income level or below. This can induce adjustment of working hours for secondary earners, in many cases, female part-time workers. In order to determine whether taxes and social insurance premiums have an impact, we use cross terms between hourly wages and annual income categories of 100,000 yen when estimating elasticity. Furthermore, since the thresholds of deduction of tax and social insurance premium were changed in 2004, 2016, and 2017, the sample will also be divided into pre-2004, 2004-2010, 2011-2016, and post-2017 for the following analysis.

2.2 Population and labor supply of women in Japan

The demographic trends of the population by employment and marital status of Japanese women in 2000-2020 are shown in Figure 1. Compared to 2000, the number of women aged 25-64 in 2020 declined by 23%. Among this, the number of married women declined by 31%, while the number of unmarried women increased by 5%. Even with the declining population, the number of married women working full-time increased by 3%. On the other hand, the number of married part-time workers decreased by 28%, and the number of unemployed women decreased by 58%. In particular, the change between 2015 and 2020 was significant. Married women face severe time constraints because they spend a lot of time on housework and childcare. The work style reforms of the 2010s have increased the flexibility of working hours and places, and the number of married women choosing to work full-time has increased. Among those who chose not to work around 2000, those with relatively less time constraints have moved into part-time work, and among those who chose part-time work, those with relatively less time constraints have moved into full-time work. Among married women who still choose part-time work, those with relatively less time constraints are few, so few of them want to work beyond their income target.

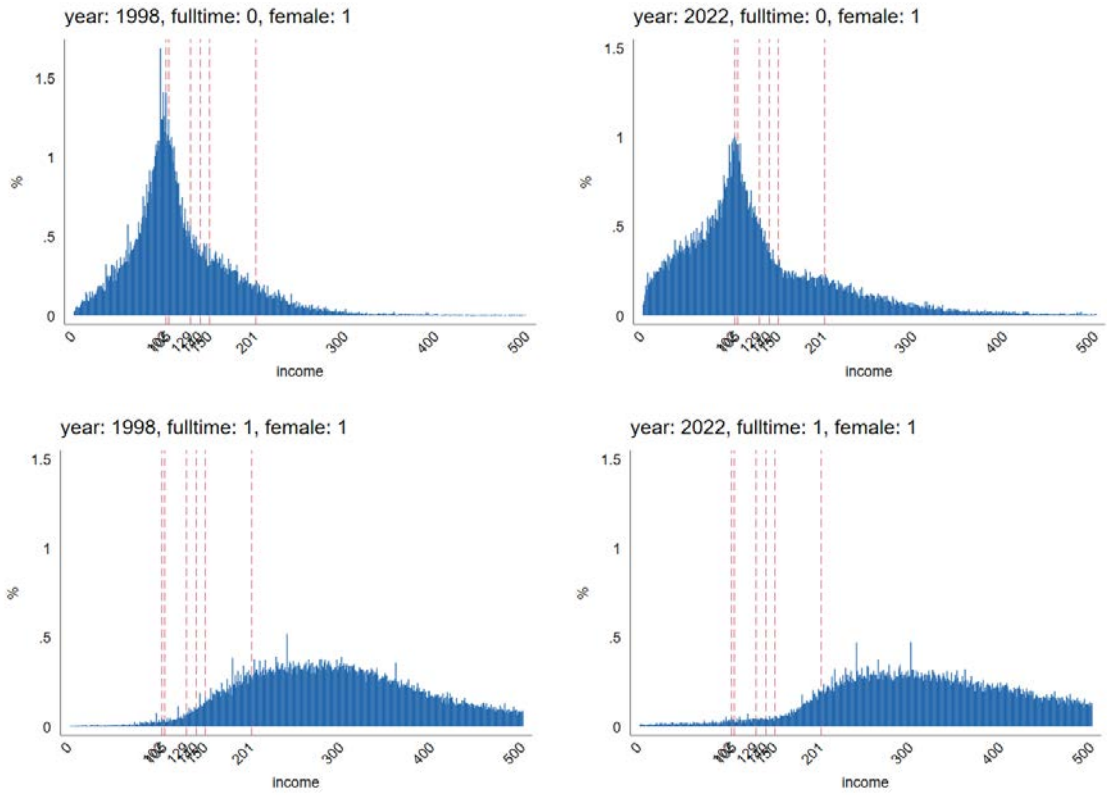
Figure 1: Population by employment and marital status in 2000-2020



Source: Population Census
Note: The Unit for the vertical axis is 10,000 people. Women aged 25-64.

Figure 2 displays the distribution of annual income of part/full-time workers in 1998 and 2022. The distribution of annual income for part-time workers in 1998 is roughly symmetrical, while the distribution of annual income for part-time workers in 2022 is not symmetrical, with the left side being thick and the right side thin. This suggests that women who would not have worked in the past are now working as part-time workers. In 1998, there were many part-time female workers with an annual income of 1-2 million yen, but in 2022, the number of women in that income bracket decreased significantly. In other words, in 2022, there was a polarization between those who earned more than 2 million yen working full-time and those who worked part-time to supplement their household income.

Figure 2: Distribution of annual income of part/full-time workers in 1998 & 2022



Source: Author's own calculations based on the Basic Survey on Wage Structure.
Note: The total number of workers in each category of female part/full-time workers is normalized to 100%.

These results indicate that, compared to around 2000, the number of unemployed women decreased and the number of women working full-time increased in the 2020s. The number of part-time workers changed little. However, these facts suggest that the number of workers with time constraints is increasing in the part-time labor market.

3 Data and Empirical Model

3.1 Data

3.1.1 Wage Census

To examine the effects of wage rate on hours worked, we use the Basic Survey on Wage Structure (Wage Census), which is the most comprehensive wage survey conducted every year by the Ministry of Health, Labour and Welfare in Japan. The Wage Census is designed

to select establishments and workers for the survey using the following two-tiered sampling method.[4] First, a stratified sample of establishments in all industries, except for agriculture, forestry, fisheries, and public services, is selected. Establishments are stratified by prefecture, industry, and establishment size. Second, selected establishments are asked to provide payroll records of randomly sampled workers. Sampling rates for workers vary by establishment size; in order to sample a good number of individuals from small establishments, as well as large ones, a higher sampling rate of employees is applied to small-sized establishments.

Our data covers the years from 1998 to 2022. Approximately 1.2 million workers from 70,000 establishments are included in each year's data. The data contains information on each worker's monthly salary (including base pay and overtime pay), annual bonus, working hours, gender, age, education, employment tenure, job title, and job type. The monthly salary is the salary for the month of June, and the bonus is the bonus paid during the previous year. Therefore, annual income is calculated by adding the bonus to 12 times the monthly salary. Our data includes only employees, which means we estimate the intensive margin of elasticity of labor supply. The Economic Census and the Establishment and Enterprise Census are used to construct establishment-level panel data because there are no establishment identification numbers in the Wage Census.

We use only part-time female workers with annual incomes of JPY 0.3–3 million in this analysis[5]. Since full-time workers do not have the flexibility to choose their working hours, we focus on part-time workers. Part-time workers with annual incomes of more than 3 million yen and less than 0.3 million yen are excluded from the analysis, as the numbers are small and the variation in wage rates is very large.

Table 1 summarizes the basic statistics of key variables in our analysis among women. The average hours worked per month are 96.4 hours, including overtime. The average hourly wage is 1.102 thousand yen, which is denominated by the CPI. Hourly wage is calculated as (monthly salary including overtime pay and 1/12 of annual bonus) / (regular working hours + overtime hours). 16% of sample are female workers in their 20s or younger, 16% are female in their 30s, 26% are female in their 40s, 25% are female in their 50s, and 17% are female in their 60s or older. Women are more likely to be part-time workers in their 40s and 50s. 25% of our sample has an annual income (nominal) of less than 0.8 million, 9% has 0.8–0.9 million yen, 11% has 0.9–1 million yen, 11% has 1–1.1 million yen, 8% has 1.1–1.2 million yen, 6% has 1.2–1.3 million yen, 8% has 1.3-1.5 million yen, 13% has 1.5-2 million yen, and 8% has over 2 million yen.

[4]All estimates are weighted by the inverse of the extraction probability.

[5]Part-time workers with annual incomes of less than 0.3 million yen and more than 3 million yen were excluded from the analysis because they were very few and their wage rates varied widely.

A yearly number of observations is shown in the Appendix Table A1. Our data cover the period 1998–2022 and include a total of 4339027 workers.

Table 1: Summary statistics: Wage Census

	female			
	mean	sd	min	max
hours worked per month (100 hours)	0.964	0.397	0.000	3.840
wage rate (1000 yen)	1.102	0.817	0.167	190.381
Minimum wage rate (1000 yen)	0.773	0.096	0.589	1.018
Age (20s)	0.160	0.366	0.000	1.000
Age (30s)	0.160	0.366	0.000	1.000
Age (40s)	0.258	0.438	0.000	1.000
Age (50s)	0.250	0.433	0.000	1.000
Age (60s)	0.172	0.378	0.000	1.000
1987-2003	0.179	0.384	0.000	1.000
2004-2010	0.265	0.441	0.000	1.000
2011-2016	0.274	0.446	0.000	1.000
2017-2022	0.282	0.450	0.000	1.000
annual income under 0.8M	0.248	0.432	0.000	1.000
annual income 0.8-0.9M	0.086	0.280	0.000	1.000
annual income 0.9-1M	0.112	0.316	0.000	1.000
annual income 1-1.1M	0.112	0.316	0.000	1.000
annual income 1.1-1.2M	0.083	0.275	0.000	1.000
annual income 1.2-1.3M	0.064	0.245	0.000	1.000
annual income 1.3-1.5M	0.084	0.278	0.000	1.000
annual income 1.5-2M	0.130	0.337	0.000	1.000
annual income over 2M	0.080	0.272	0.000	1.000
log(hours worked)	-0.139	0.497	-4.605	1.345
log(wage rate)	0.020	0.324	-1.792	5.249
lnMW	-0.265	0.122	-0.529	0.017
Observations	4339027			

Note: The observations cover all part-time workers with income 0.3–3 million yen from 1998–2022.

3.1.2 Part-time Survey

While the Wage Census provides long-term, consistent information on working hours and income, it lacks detailed information on individual worker attributes and the reasons for working part-time. To complement the analysis of the Wage Census, we utilize the General Survey on Part-time Workers (Part-time Workers Survey) conducted by the Ministry of

Health, Labour and Welfare. The survey is conducted approximately every five years in October. This study mainly uses the 2021 survey, and also includes some data from the 2006, 2011, 2016, and 2021 surveys[6].

The Part-time Workers Survey uses stratified two-stage random sampling. First, establishments are sampled by industries (19 categories) and establishment size (5 categories), and then individuals are sampled from among those sampled establishments. Each survey has a total sample size of approximately 15,000, and all of them are part-time workers. The survey asks part-time workers about their gender, age, educational background, marital status, spouse's employment status and annual income, whether they live with family members, length of service, working hours, reasons for working, reasons for choosing their current employment status, annual income, employment insurance and social insurance coverage, and whether they have made any adjustments to their working hours and the reasons for doing so[7]. In our analysis, we limit the sample to female workers with incomes between 0.3 and 3 million yen, as with the Wage Census. To exclude samples not working in the previous year, we restrict that the working period must be at least 18 months.

Summary statistics for the Part-time Workers Survey are shown in Table 2. 79% of women are married in the survey. This analysis classifies the status of working hour adjustments into three categories. The first category includes adjustments made for tax or social insurance reasons (Tax/Social Insurance), the second one consists of adjustments made to achieve income targets (Income Target), and the third one consists of no adjustments (None). Appendix A.2 provides more detail definition of these three categories. As shown in Table 2, 21% of respondents adjust their hours worked for reasons for tax and social insurance, 72% adjust their hours worked for reasons for income target. Respondents who selected "Income Target" are likely to have financial motivation to supplement the income of the primary earners. 24% for neither reason[8].

[6]The survey changed its target in 2021 and the name was changed to the "General Survey on Part-time and Fixed-term Employment Workers".

[7]In the Survey, annual income refers to the income for the previous year.

[8]"Tax/Social Insurance" and "Income Target" come from different questions, so there is some overlap.

Table 2: Summary statistics: Part-time Workers Survey

	All	
	mean	sd
Married	0.792	0.406
Tax/Social Insurance	0.217	0.412
Income Target	0.726	0.446
None	0.240	0.427
annual income under 0.8M	0.069	0.253
annual income 0.8-0.9M	0.044	0.204
annual income 0.9-1.0M	0.092	0.290
annual income 1.0-1.1M	0.150	0.357
annual income 1.1-1.2M	0.065	0.247
annual income 1.2-1.3M	0.109	0.311
annual income 1.3-1.5M	0.103	0.304
annual income 1.5-2.0M	0.231	0.421
annual income 2.0-3.0M	0.137	0.344
Age (20s)	0.023	0.150
Age (30s)	0.112	0.315
Age (40s)	0.307	0.461
Age (50s)	0.352	0.478
Age (60s)	0.206	0.405
Observations	3712	

Note: The observations cover female part-time workers with income 0.3–3 million in 2021.

3.2 Empirical model

To measure the elasticity of labor supply with respect to wages, first, we assume a simple model without interaction terms:

$$ln(hours)_{it} = \beta ln(wage)_{it} + \gamma X_{it} + \epsilon_{it}. \tag{1}$$

As we explained in Section 2, there are some thresholds with respect to tax and social insurance premiums. The elasticity of hours worked with respect to hourly wages may vary with annual income. To test this, we then estimated the following model with cross-terms of wages and income categories:

$$ln(hours)_{it} = \sum_s \beta_s ln(wage)_{it} * \mathbf{I}[z_{it} \in \Gamma_s] + \gamma X_{it} + \epsilon_{it}, \tag{2}$$

where $ln(hours)_{it}$ is monthly working hours (100 hours) of worker i in year t, $ln(wage)_{it}$ is real wage rate (thousand yen). X_{it} is a vector of control variables that includes establishment size, a dummy variable indicating income categories, establishment fixed effects, and interaction terms between industry and year fixed effects. In addition to that, z_{it} is nominal annual income (million yen). $\mathbf{I}[z_{it} \in \Gamma_s]$ is 1 if $z_{it} \in \Gamma_s$ and 0 otherwise, where Γ_s is a dummy variable indicating income categories (under 0.8, 0.8–0.9, 0.9–1, 1–1.1, 1.1–1.2, 1.2–1.3, 1.3–1.5, 1.5–2, and over 2 million yen).

To control unobserved establishment attributes, we also control for establishment fixed effects.

$$ln(hours)_{it} = \beta ln(wage)_{it} + \gamma X_{it} + \epsilon_{it}, \tag{3}$$

$$ln(hours)_{it} = \sum_s \beta_s ln(wage)_{it} * \mathbf{I}[z_{it} \in \Gamma_s] + \gamma X_{it} + \epsilon_{it}. \tag{4}$$

In general, it is difficult to estimate labor supply because the demand function and supply function are simultaneously determined. Thus, we control labor demand factors and use the minimum wage as an instrument. The establishment fixed effects are used to control for the time-invariant labor demand, as in Addison et al. (2014). The number of workers at each establishment is controlled for to capture some of the labor demand that changes over time. The interaction terms of industry and year fixed effects are included to control for the business cycle in each industry. We use the minimum wage as an instrumental variable to deal with endogenous problems following Brown et al. (1982), Card and Krueger (1995). If the labor market is purely monopsonistic, where all firms are under labor supply constraints

before and after the policy change in minimum wage, the elasticity of labor inputs to wages measures the labor supply response by using minimum wage as an instrument (Dube and Zipperer (2024)). Because employers possess high monopsony power over women, we control the endogeneity by using the instrument[9].

Our first-stage equations in our instrumental variable (IV) estimation are as follows:

$$ln(wage)_{it} = \eta ln(MW)_{it} + \rho X_{it} + u_{it} \tag{5}$$

$$ln(wage)_{it} = \sum_{s} \eta_s ln(MW)_{it} * \mathbf{I}[z_{it} \in \Gamma_s] + \rho X_{it} + u_{it} \tag{6}$$

where $\ln(\mathrm{MW})_{it}$ is minimum wage by prefecture and year. In Japan, minimum wages are determined by each prefecture and revised annually. The minimum wage is often determined by balancing considerations with the cost of public assistance and by political pressure to achieve wage increases, as well as local economic conditions. Our second-stage equations are followings:

$$ln(hours)_{it} = \beta ln(\widehat{wage})_{it} + \gamma X_{it} + estFE + \epsilon_{it} \tag{7}$$

$$ln(hours)_{it} = \sum_{s} \beta_s ln(\widehat{wage})_{it} * \mathbf{I}[z_{it} \in \Gamma_s] + \gamma X_{it} + estFE + \epsilon_{it} \tag{8}$$

4 Results

4.1 Labor supply elasticity with respect to ages: all sample

Table 3 presents the estimated impacts of hourly wages on hours worked for all female workers in 1998–2022[10]. Columns (1)–(2) report the estimated coefficients of the cross-section model. Column (1) shows the coefficients of the estimates of simple model without interaction terms (eq. 1), and column (2) is the estimates controlling for income bracket dummies (0.8–0.9, 0.9–1, 1–1.1, 1.1–1.2, 1.2–1.3, 1.3–1.5, 1.5–2, and 2–3 million yen) (eq. 2); Columns (3)–(4) show the estimated coefficients controlling for establishment fixed effects, prefecture fixed effects, and year fixed effects as in eq. 3 and 4; columns (5)–(6) represent the coefficients using IV method in eq 7 and 8.

[9]See Sharma (2022) and Farmand and Ghilarducci (2022).

[10]The first-stage estimates are shown in Appendix Tables A3. IV designs require that instrumental variables be correlated with the endogenous variables. In the models with cross-terms, there is no problem of weak instruments, as the instrumental variables have statistically significant effects on treatments.

The coefficients of the single term for hourly wages in columns (1), (3), and (5) are negative, which means that a marginal increase in hourly wages decreases hours worked. Although the sizes of coefficients for the three models are approximately the same, the coefficient for the IV-FE model (Column (5)) is not precisely estimated.

All the coefficients of interaction terms for hourly wages and income bracket dummies are negative in the CS model, FE model, and IV-FE model. All coefficients of interaction terms in the three models are statistically significant at the 1% significance level. In each model, the magnitudes of coefficients for cross terms for wages and income dummy variables of between 0.8–1.5 million yen are similar. The cross terms with the coefficients for wages and income below 0.8 million yen are smaller, and those above 1.5 million yen are larger. This suggests that part-time workers earning between 800,000 and 1.5 million yen will work shorter hours if their hourly wage is high.

Compared with the same explanatory variables in the three models, the coefficients of the IV-FE models are rather smaller than the other two models, which can be explained by the coefficient values estimated by the IV method are the local average treatment effects (LATE). Because the treatment effects are heterogeneous, compliers, who are more likely to be significantly affected by changes in the minimum wage, will reduce their hours worked to a greater degree with changes in hourly wages.

Table 3: Effects of wages on working hours for female workers

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	female_all_CS	female_all_CS	female_all_FE	female_all_FE	female_all_IV	female_all_IV
lnwage*under 0.8M		-1.0362***		-1.0181***		-1.2559***
		(0.0031)		(0.0034)		(0.1257)
lnwage*0.8-0.9M		-0.9973***		-0.9742***		-1.0952***
		(0.0009)		(0.0031)		(0.1403)
lnwage*0.9-1M		-0.9952***		-0.9764***		-1.1105***
		(0.0010)		(0.0020)		(0.1455)
lnwage*1-1.1M		-0.9931***		-0.9795***		-1.1144***
		(0.0010)		(0.0024)		(0.1477)
lnwage*1.1-1.2M		-0.9939***		-0.9841***		-1.1194***
		(0.0009)		(0.0019)		(0.1528)
lnwage*1.2-1.3M		-0.9967***		-0.9859***		-1.1243***
		(0.0010)		(0.0024)		(0.1649)
lnwage*1.3-1.5M		-0.9926***		-0.9806***		-1.1196***
		(0.0008)		(0.0024)		(0.1664)
lnwage*1.5-2M		-0.9599***		-0.9460***		-1.0240***
		(0.0052)		(0.0064)		(0.2154)
lnwage*over 2M		-0.8887***		-0.8741***		-0.9173**
		(0.0056)		(0.0052)		(0.4220)
lnwage	-0.6162***		-0.5873***		-0.5953	
	(0.0228)		(0.0187)		(0.4346)	
Constant	-0.1538***	-0.7280***	-0.1479***	-0.7100***		
	(0.0015)	(0.0018)	(0.0005)	(0.0028)		
Observations	2,926,710	2,926,710	2,875,104	2,875,104	2,875,104	2,875,104
R-squared	0.200	0.913	0.511	0.928	0.093	0.859
Est FE	No	No	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes	Yes
Ind*Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Dep mean	131.4	131.4	132.9	132.9	132.9	132.9

Note: This table shows the estimation results of the elasticity of working hours to wages using the data of female workers in 1998–2022. Columns (1)–(2) apply a cross-section model, columns (3)–(4) control for establishment fixed-effects, and columns (5)–(6) apply an IV method with fixed-effects. All regressions control for income bracket dummies (-0.8, 0.8-0.9, 0.9-1, 1-1.1, 1.1-1.2, 1.2-1.3, 1.3-1.5, 1.5-2, and 2-3 million yen), prefecture fixed effects, and year fixed effects. Robust cluster standard errors are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

4.2 Labor supply elasticity with respect to ages by age

Next, we split the sample into age categories and repeated the same analysis. Table 4 presents the estimated impacts of hourly wages on hours worked for female workers using the IV-FE model. Columns (1)–(5) are used for samples of workers in their 20s and younger,

30s, 40s, 50s, and 60s and older, respectively.

The coefficients for the intersection terms of the 30s, 40s, and 50s are all negative and statistically significant at the 1% significance level. In contrast, the absolute values of coefficients for workers in their 20s and below are larger than those for workers in their 30s–50s. For workers in their 60s and above, the coefficients are not so different from those for workers in their 30s–50s, but the standard error is large and statistically insignificant. These results suggest that female workers in the age group where the spouse is the main breadwinner are more likely to adjust their hours of work.

Table 4: Effects of wages on working hours for female workers by age

	(1)	(2)	(3)	(4)	(5)
VARIABLES	female_D20s	female_D30s	female_D40s	female_D50s	female_D60s
lnwage*under 0.8M	-0.7236***	-1.3332***	-1.2578***	-1.2903***	-1.0508
	(0.2246)	(0.0750)	(0.0819)	(0.0640)	(0.7034)
lnwage*0.8-0.9M	-0.5860**	-1.1583***	-1.0516***	-1.1146***	-0.9308
	(0.2214)	(0.0737)	(0.0727)	(0.0713)	(0.6926)
lnwage*0.9-1M	-0.5834**	-1.1659***	-1.0622***	-1.1244***	-0.9470
	(0.2228)	(0.0821)	(0.0770)	(0.0790)	(0.7041)
lnwage*1-1.1M	-0.5783**	-1.1686***	-1.0647***	-1.1358***	-0.9497
	(0.2241)	(0.0781)	(0.0802)	(0.0791)	(0.7325)
lnwage*1.1-1.2M	-0.5482**	-1.1635***	-1.0709***	-1.1331***	-0.9311
	(0.2404)	(0.0827)	(0.0800)	(0.0789)	(0.7446)
lnwage*1.2-1.3M	-0.5592**	-1.1596***	-1.0627***	-1.1337***	-0.9221
	(0.2443)	(0.0793)	(0.0865)	(0.0754)	(0.7853)
lnwage*1.3-1.5M	-0.5458**	-1.1643***	-1.0875***	-1.1464***	-0.9053
	(0.2385)	(0.0868)	(0.0822)	(0.0826)	(0.8221)
lnwage*1.5-2M	-0.3442	-1.0936***	-0.9886***	-1.0509***	-0.8271
	(0.3105)	(0.1051)	(0.1013)	(0.1073)	(0.9954)
lnwage*over 2M	0.1481	-1.0349***	-0.8484***	-0.9499***	-0.5973
	(0.5122)	(0.1521)	(0.1317)	(0.1265)	(1.8587)
Observations	647,106	602,515	1,010,908	977,495	651,570
R-squared	0.769	0.877	0.888	0.886	0.865
Est FE	Yes	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes
Ind*Year FE	Yes	Yes	Yes	Yes	Yes
Dep mean	-0.286	-0.0707	-0.0652	-0.0534	-0.176

Note: This table shows the estimation results of the elasticity of working hours to wages using the data of female workers in 1998–2022 with the IV-FE model. Columns (1)–(5) are used for samples of workers in their 20s and younger, 30s, 40s, 50s, and 60s and older, respectively. All regressions control for income bracket dummies (-0.8, 0.8-0.9, 0.9-1, 1-1.1, 1.1-1.2, 1.2-1.3, 1.3-1.5, 1.5-2, and 2-3 million yen), prefecture fixed effects, and year fixed effects. Robust cluster standard errors are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

4.3 Labor supply elasticity with respect to ages by propensity of marital status

A woman's marital status greatly affects her working hours and income, as well as the amount of income tax and social insurance premiums she is entitled to deduct. Although the Wage Census does not include the variable of marital status, this variable should have a significant impact. According to the Part-Time Workers Survey, 91.2% of married female part-time workers reported living mainly on their spouse's income, while 60.2% of unmarried female part-time workers reported living mainly on their own income, and 30.1% mainly on their parents' income.

We therefore predict the propensity of marital status in the Wage Census using the estimated coefficients of marital status by individual attribute in the Part-time Workers Survey.[11].

The estimated coefficients are reported in Appendix Table A4. The coefficient for annual income for women is positive, and that for income squared is negative. Women in their late 30s to early 60s are more likely to be married than younger and older generations. By educational background, women with a junior college/technical school degree have the highest propensity of married.

Next, we estimated labor supply elasticity for each sub-sample with high/low propensity of being married. The sample was divided into those with an estimated marriage probability of 50% or more and those with a probability of less than 50%.

Table 5 shows the estimated impacts of hourly wages on hours worked for female workers using the IV-FE model. According to the sub-sample analysis by marriage propensity, the estimated coefficients of hourly wages to hours worked are negative and statistically significant among both women with high propensity of marriage and low propensity (Columns (3) and (6) in Table 5). The estimated coefficients for workers with a high propensity of marriage are smaller than those with a low probability of marriage, and the standard errors for workers with a high propensity of marriage are also smaller. This result means that married women, whose spouses are often the main breadwinners, are more likely to adjust their working hours than unmarried women.

[11]The Part-time Workers Survey is conducted by the Ministry of Health, Labour and Welfare every 5 years and covers part-time workers at establishments with at least five permanent employees.

Table 5: Effects of wages on working hours for female workers by marital status

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	female_ps_high_CS	female_ps_high_FE	female_ps_high	female_ps_low_CS	female_ps_low_FE	female_ps_low
lnwage*under 0.8M	-1.0671***	-1.0500***	-1.2229***	-0.9822***	-0.9487***	-0.8597***
	(0.0033)	(0.0031)	(0.0372)	(0.0058)	(0.0078)	(0.1616)
lnwage*0.8-0.9M	-0.9982***	-0.9774***	-1.0475***	-0.9958***	-0.9657***	-0.7764***
	(0.0010)	(0.0025)	(0.0401)	(0.0048)	(0.0086)	(0.1741)
lnwage*0.9-1M	-0.9959***	-0.9797***	-1.0541***	-0.9972***	-0.9714***	-0.7941***
	(0.0014)	(0.0024)	(0.0406)	(0.0042)	(0.0077)	(0.1769)
lnwage*1-1.1M	-0.9940***	-0.9817***	-1.0591***	-0.9913***	-0.9709***	-0.7804***
	(0.0013)	(0.0019)	(0.0418)	(0.0046)	(0.0109)	(0.1745)
lnwage*1.1-1.2M	-0.9944***	-0.9833***	-1.0575***	-0.9973***	-0.9854***	-0.7873***
	(0.0011)	(0.0016)	(0.0438)	(0.0046)	(0.0092)	(0.1829)
lnwage*1.2-1.3M	-0.9968***	-0.9848***	-1.0580***	-0.9969***	-0.9870***	-0.7819***
	(0.0016)	(0.0018)	(0.0459)	(0.0037)	(0.0124)	(0.1954)
lnwage*1.3-1.5M	-0.9943***	-0.9826***	-1.0635***	-0.9941***	-0.9741***	-0.7387***
	(0.0009)	(0.0021)	(0.0468)	(0.0027)	(0.0059)	(0.2013)
lnwage*1.5-2M	-0.9574***	-0.9422***	-0.9827***	-0.9487***	-0.9182***	-0.5732**
	(0.0063)	(0.0072)	(0.0590)	(0.0095)	(0.0107)	(0.2759)
lnwage*over 2M	-0.8889***	-0.8723***	-0.8720***	-0.8763***	-0.8374***	-0.2676
	(0.0077)	(0.0083)	(0.0821)	(0.0051)	(0.0092)	(0.3667)
Constant	-0.6948***	-0.6765***		-0.8238***	-0.8037***	
	(0.0024)	(0.0029)		(0.0013)	(0.0021)	
Observations	3,699,330	3,625,761	3,583,218	638,013	577,423	572,359
R-squared	0.931	0.944	0.884	0.888	0.912	0.785
Est FE	No	Yes	Yes	No	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes	Yes
Ind*Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Dep mean	-0.0945	-0.0948	-0.0970	-0.239	-0.261	-0.264

Note: This table shows the estimation results of the elasticity of working hours to wages using the data of female workers by marital status with the IV-FE model. Columns (1)–(3) show results of a cross-section, establishment fixed-effects, and IV with fixed-effects model for workers with a high propensity of marriage, while columns (4)-–(6) present the corresponding estimates for low propensity of marriage. High propensity of marriage is defined to be those with marriage propensities greater than 50 percent. The estimation method of the marriage propensity is shown in Appendix A.4. All regressions control for income bracket dummies (-0.8, 0.8-0.9, 0.9-1, 1-1.1, 1.1-1.2, 1.2-1.3, 1.3-1.5, 1.5-2, and 2-3 million yen), prefecture fixed effects, and year fixed effects. Robust cluster standard errors are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

4.4 Labor supply elasticity with respect to ages by year

As noted in Section 2, the thresholds for the spouse tax deduction were changed in 2004 and 2018. In addition, the social insurance spousal deduction thresholds were changed in 2016. Therefore, we also broke our analysis into three time periods: 1998-2003, 2004-2010, 2011-2016, and 2017-2022.

Table 6 presents the estimated impacts of hourly wages on hours worked for female workers in 1998–2003. Columns (1)–(2) show the estimated coefficients using the cross-

section model; columns (3)–(4) represent the coefficients using the fixed-effects model, and columns (5)–(6) present the IV-FE method. While the coefficient of a single term for hourly wages is negative in CS models and FE models, which means that a marginal increase in hourly wages decreases hours worked, the coefficient in the IV-FE model (Column (5)) is negative but not precisely estimated. All the coefficients of interaction terms for hourly wages and income bracket dummies are negative in all three models, though some coefficients in model (6) are statistically insignificant. In model (6), the sizes of coefficients for cross terms for wages and dummy variables of between 0.8–1.5 million yen are almost the same, but the cross terms with the coefficients for wages and income above 1.5 million yen are larger. Our results show that women with an annual income of 0.8 to 1.5 million yen work fewer hours when they are paid higher hourly wages.

Table 6: Effects of wages on working hours for female workers: 1998–2003

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	female_all_CS	female_all_CS	female_all_FE	female_all_FE	female_all_IV	female_all_IV
lnwage*under 0.8M		-1.0171***		-0.9999***		-1.0968*
		(0.0070)		(0.0101)		(0.4927)
lnwage*0.8-0.9M		-0.9945***		-0.9763***		-0.9735*
		(0.0023)		(0.0036)		(0.4783)
lnwage*0.9-1M		-0.9914***		-0.9844***		-0.9575
		(0.0027)		(0.0052)		(0.4789)
lnwage*1-1.1M		-0.9904***		-0.9836***		-0.9621*
		(0.0018)		(0.0043)		(0.4763)
lnwage*1.1-1.2M		-0.9922***		-0.9821***		-0.9585*
		(0.0018)		(0.0028)		(0.4747)
lnwage*1.2-1.3M		-0.9929***		-0.9825***		-0.9688*
		(0.0016)		(0.0034)		(0.4738)
lnwage*1.3-1.5M		-0.9924***		-0.9789***		-0.9659
		(0.0021)		(0.0039)		(0.4827)
lnwage*1.5-2M		-0.9210***		-0.9026***		-0.7873
		(0.0086)		(0.0086)		(0.5834)
lnwage*over 2M		-0.8534***		-0.8309***		-0.6294
		(0.0074)		(0.0068)		(0.8280)
lnwage	-0.4539***		-0.4580		-1.7673	
	(0.0282)		(0.0000)		(4.1823)	
Constant	-0.0206***	-0.6939***	-0.0225	-0.6694***		
	(0.0016)	(0.0037)	(0.0000)	(0.0036)		
Observations	682,997	682,997	668,125	668,125	620,336	620,336
R-squared	0.139	0.917	0.524	0.932	-0.416	0.861
Est FE	No	No	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes	Yes
Ind*Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Dep mean	0.0800	0.0800	0.0786	0.0786	0.0782	0.0782

Note: This table shows the estimation results of the elasticity of working hours to wages using the data of female workers in 1998–2003. Columns (1)–(2) apply a fixed-effects model, and columns (3)–(4) apply an IV method with fixed-effects. All regressions control for income bracket dummies (-0.8, 0.8-0.9, 0.9-1, 1-1.1, 1.1-1.2, 1.2-1.3, 1.3-1.5, 1.5-2, and 2-3 million yen), establishment fixed effects, prefecture fixed effects, and year fixed effects. Robust cluster standard errors are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

In Table 7, we perform the same analysis using a sample of female workers in 2004–2010. The coefficients of the single term for hourly wages are negative and statistically significant in all models. All coefficients for interaction terms for hourly wages and income bracket dummies are negative and statistically significant. Again, the estimated coefficients of cross terms between wage and income of 0.8 to 1.5 million yen are almost the same. The interaction terms of column (6) in Table 7 have smaller coefficients than those of column (6) in Table

6, which means that the elasticity shifted downward after 2004 compared to before 2003. During this period, the tendency for female workers to work shorter hours when their hourly wage increases became stronger than it was before 2003.

Table 7: Effects of wages on working hours for female workers: 2004–2010

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	female_all_CS	female_all_CS	female_all_FE	female_all_FE	female_all_IV	female_all_IV
lnwage*under 0.8M		-1.0314***		-1.0061***		-1.1647***
		(0.0052)		(0.0048)		(0.0903)
lnwage*0.8-0.9M		-0.9947***		-0.9651***		-0.9908***
		(0.0007)		(0.0019)		(0.0991)
lnwage*0.9-1M		-0.9927***		-0.9734***		-1.0113***
		(0.0009)		(0.0029)		(0.1036)
lnwage*1-1.1M		-0.9911***		-0.9739***		-1.0006***
		(0.0012)		(0.0033)		(0.1033)
lnwage*1.1-1.2M		-0.9928***		-0.9796***		-1.0155***
		(0.0013)		(0.0028)		(0.1046)
lnwage*1.2-1.3M		-0.9956***		-0.9810***		-1.0082***
		(0.0013)		(0.0040)		(0.1010)
lnwage*1.3-1.5M		-0.9910***		-0.9747***		-1.0031***
		(0.0015)		(0.0032)		(0.1042)
lnwage*1.5-2M		-0.9479***		-0.9322***		-0.9057***
		(0.0074)		(0.0083)		(0.1238)
lnwage*over 2M		-0.8902***		-0.8692***		-0.7960***
		(0.0064)		(0.0074)		(0.1986)
lnwage	-0.6030***		-0.5542***		-1.9570*	
	(0.0219)		(0.0184)		(0.8641)	
Constant	-0.1349***	-0.7073***	-0.1308***	-0.6854***		
	(0.0013)	(0.0024)	(0.0018)	(0.0031)		
Observations	1,221,515	1,221,515	1,197,693	1,197,693	1,197,693	1,197,693
R-squared	0.206	0.909	0.536	0.926	-0.455	0.850
Est FE	No	No	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes	Yes
Ind*Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Dep mean	-0.103	-0.103	-0.104	-0.104	-0.104	-0.104

Note: This table shows the estimation results of the elasticity of working hours to wages using the data of female workers in 2004–2010. Columns (1)–(2) apply a fixed-effects model, and columns (3)–(4) apply an IV method with fixed-effects. All regressions control for income bracket dummies (-0.8, 0.8-0.9, 0.9-1, 1-1.1, 1.1-1.2, 1.2-1.3, 1.3-1.5, 1.5-2, and 2-3 million yen), establishment fixed effects, prefecture fixed effects, and year fixed effects. Robust cluster standard errors are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Table 8 provides the results of the same analysis for female workers in 2011–2016. While the coefficients of a single term in models (1) and (3) are negative and statistically significant, that in model (5) is positive but statistically insignificant. In model (6), almost all

the coefficients of interaction terms of hourly wages and income brackets are negative but statistically insignificant. Around 2010, the ratio of part-time workers increased. This would have brought a diverse group of workers with different values to enter the labor market. The fact that the sizes of absolute values of coefficients in the IV-FE model are larger than in CS and FE models can be explained by the coefficient values estimated by the IV method are the local average treatment effects (LATE). Because the treatment effects are heterogeneous, compliers, who are more likely to be significantly affected by changes in the minimum wage, will reduce their hours worked to a greater degree with changes in hourly wages.

Table 8: Effects of wages on working hours for female workers: 2011–2016

VARIABLES	(1) female_all_CS	(2) female_all_CS	(3) female_all_FE	(4) female_all_FE	(5) female_all_IV	(6) female_all_IV
lnwage*under 0.8M		-1.0370***		-1.0188***		-1.2725*
		(0.0037)		(0.0051)		(0.6102)
lnwage*0.8-0.9M		-0.9979***		-0.9751***		-1.1541
		(0.0012)		(0.0042)		(0.6271)
lnwage*0.9-1M		-0.9963***		-0.9758***		-1.1639
		(0.0012)		(0.0035)		(0.6351)
lnwage*1-1.1M		-0.9942***		-0.9789***		-1.1578
		(0.0014)		(0.0037)		(0.6442)
lnwage*1.1-1.2M		-0.9937***		-0.9834***		-1.1700
		(0.0011)		(0.0024)		(0.6473)
lnwage*1.2-1.3M		-0.9963***		-0.9842***		-1.1738
		(0.0018)		(0.0038)		(0.6915)
lnwage*1.3-1.5M		-0.9932***		-0.9815***		-1.1691
		(0.0011)		(0.0034)		(0.7089)
lnwage*1.5-2M		-0.9604***		-0.9465***		-1.0956
		(0.0052)		(0.0076)		(0.8735)
lnwage*over 2M		-0.8892***		-0.8730***		-1.0871
		(0.0066)		(0.0069)		(1.6279)
lnwage	-0.6183***		-0.5886***		0.9338	
	(0.0227)		(0.0160)		(13.7477)	
Constant	-0.1491***	-0.7231***	-0.1507***	-0.7052***		
	(0.0012)	(0.0011)	(0.0059)	(0.0022)		
Observations	1,283,131	1,283,131	1,253,994	1,253,994	1,253,994	1,253,994
R-squared	0.204	0.914	0.524	0.930	-0.532	0.854
Est FE	No	No	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes	Yes
Ind*Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Dep mean	-0.142	-0.142	-0.144	-0.144	-0.144	-0.144

Note: This table shows the estimation results of the elasticity of working hours to wages using the data of female workers in 2011–2016. Columns (1)–(2) apply a fixed-effects model, and columns (3)–(4) apply an IV method with fixed-effects. All regressions control for income bracket dummies (-0.8, 0.8-0.9, 0.9-1, 1-1.1, 1.1-1.2, 1.2-1.3, 1.3-1.5, 1.5-2, and 2-3 million yen), establishment fixed effects, prefecture fixed effects, and year fixed effects. Robust cluster standard errors are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Table 9 represents the estimated impacts of hourly wages for female workers in 2017–2022. From 2017 onwards, the coefficients of the hourly wage in CS and FE models (Columns (1) and (3)) are negative and statistically significant, while the coefficient in the IV-FE model turns to positive but not statistically significant. The size of the coefficients in the IV-FE model gradually increased after 1998, and the size of the standard errors also increased. This suggests that in recent years, more workers have been adjusting their working hours, and

that the number of workers who behave differently even within the same income bracket has increased.

Table 9: Effects of wages on working hours for female workers: 2017–2022

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	female_all_CS	female_all_CS	female_all_FE	female_all_FE	female_all_IV	female_all_IV
lnwage*under 0.8M		-1.0261***		-1.0170***		-1.6298*
		(0.0048)		(0.0033)		(0.7751)
lnwage*0.8-0.9M		-1.0017***		-0.9915***		-1.5434*
		(0.0011)		(0.0031)		(0.7595)
lnwage*0.9-1M		-0.9997***		-0.9896***		-1.5700*
		(0.0012)		(0.0037)		(0.7667)
lnwage*1-1.1M		-0.9964***		-0.9910***		-1.5746
		(0.0015)		(0.0021)		(0.7899)
lnwage*1.1-1.2M		-0.9967***		-0.9919***		-1.5865
		(0.0010)		(0.0036)		(0.8157)
lnwage*1.2-1.3M		-0.9994***		-0.9965***		-1.6058
		(0.0017)		(0.0025)		(0.8255)
lnwage*1.3-1.5M		-0.9960***		-0.9922***		-1.6063
		(0.0015)		(0.0024)		(0.8275)
lnwage*1.5-2M		-0.9760***		-0.9658***		-1.6412
		(0.0051)		(0.0052)		(0.9687)
lnwage*over 2M		-0.8885***		-0.8775***		-2.1262
		(0.0095)		(0.0095)		(1.8772)
lnwage	-0.6577***		-0.6721***		1.6330	
	(0.0357)		(0.0351)		(2.5636)	
Constant	-0.1695***	-0.7732***	-0.1693***	-0.7577***		
	(0.0042)	(0.0015)	(0.0049)	(0.0014)		
Observations	1,149,700	1,149,700	1,122,259	1,122,259	1,122,259	1,122,259
R-squared	0.199	0.926	0.507	0.938	-1.252	0.744
Est FE	No	No	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes	Yes
Ind*Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Dep mean	-0.216	-0.216	-0.219	-0.219	-0.219	-0.219

Note: This table shows the estimation results of the elasticity of working hours to wages using the data of female workers in 2017–2022. Columns (1)–(2) apply a fixed-effects model, and columns (3)–(4) apply an IV method with fixed-effects. All regressions control for income bracket dummies (-0.8, 0.8-0.9, 0.9-1, 1-1.1, 1.1-1.2, 1.2-1.3, 1.3-1.5, 1.5-2, and 2-3 million yen), establishment fixed effects, prefecture fixed effects, and year fixed effects. Robust cluster standard errors are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

5 Discussion

We find that Japanese female part-time workers' elasticity of hours worked with respect to wages is negative, and there are few differences in the elasticities between income groups in the previous section. In this section, we discuss its drivers and implications.

5.1 Conceptual model

In textbooks of microeconomics (e.g. Mankiw (2012), Varian (2009)), the labor supply curve is backward-bending and thus hours worked could decrease in a wage increase when wages are sufficiently large because an income effect is larger than a substitution effect of leisure. However, the results of our analysis imply that negative elasticities for relatively low-wage workers are observed. The downward labor supply curve for relatively low-wage workers has been reported not only in Japan, but also in other developed countries (Dessing, 2002; Nakamura and Murayama, 2010; Tavor et al., 2022).

An important hypothesis for explaining the negative elasticities is that thresholds of tax and social insurance contribution drive them. For example, a progressive income tax is imposed on a higher tax rate for income that is over a certain income level. It is known that individuals who have large ranges to control their own income, like self-employed workers and entrepreneurs, tend to adjust their income under the level (e.g., Saez, 2010; Keane, 2022). In Japan, the income tax is imposed on income exceeding 1.03 million yen. Social insurance premiums must be paid by workers with annual incomes exceeding 1.3 million yen. In addition, if an individual is married and has a spouse with no income or with an income below a certain amount, they will be eligible for a deduction on their income tax[12]. If tax and social insurance premiums were the main drivers of the adjusting hours worked of Japanese female part-time workers, strong negative elasticities would be observed in the income levels around the thresholds of deduction of tax and social insurance premiums. However, our results show that the elasticity values are unrelated to workers' income levels. This suggests that reasons other than tax and social insurance are likely to be one of the main drivers of the adjustment in hours worked.

In this subsection, we show that an income target can be considered as a main driver of the negative elasticities. Some papers demonstrated that workers have income targets and determine their hours worked according to it, examining cases of taxi drivers, farmers, and door-to-door sales persons (Camerer et al., 1997; Richards, 2020; Dodini, 2023). Here, we propose a simplified model based on Crawford and Meng (2011) and the labor supply elasticity could be negative when a worker has an income target.

[12]See Section 3.1.2 for details.

Suppose that a part-time worker has an income target $R > 0$. Given the wage $w > 0$, he/she maximizes the utility u as follows:

$$\max_{\ell} \ u = w\ell - \frac{1}{2}\ell^2 + \mu(R - w\ell),$$

where ℓ is hours worked and the function $\mu(\cdot)$ is a reference dependent term. The disutility of labor is assumed to be quadratic. $\mu(\cdot)$ is negative when the income exceeds the reference point R. We specify the function $\mu(\cdot)$ as follows:

$$\mu(R - w\ell) = \eta(R - w\ell) \text{ if } w\ell < R,$$
$$\mu(R - w\ell) = \eta\lambda(R - w\ell) \text{ if } w\ell \geq R,$$

where $\eta \geq 0$, loss aversion term $\lambda \geq 1$, and $\eta\lambda \leq 1$. First-order conditions are

$$\ell - (1 - \eta)w \text{ if } w\ell < R,$$
$$\ell - (1 - \eta\lambda)w \text{ if } w\ell \geq R.$$

Therefore, the optimal labor supply ℓ^* are

$$\ell^* = \begin{cases} (1-\eta)w & \text{if } \ (1-\eta)w^2 < R & \Leftrightarrow & \text{if } \ w < \sqrt{\frac{R}{1-\eta}}, \\ \frac{R}{w} & \text{if } \ (1-\eta\lambda)w^2 < R \leq (1-\eta)w^2 & \Leftrightarrow & \text{if } \ \sqrt{\frac{R}{1-\eta}} \leq w < \sqrt{\frac{R}{1-\eta\lambda}}, \\ (1-\eta\lambda)w & \text{if } \ (1-\eta\lambda)w^2 \geq R & \Leftrightarrow & \text{if } \ w \geq \sqrt{\frac{R}{1-\eta\lambda}}. \end{cases}$$

When a worker has an income target and a utility function in which the marginal utility is lower beyond the target, labor supply becomes inversely proportional to the wage rate in the range $\sqrt{\frac{R}{1-\eta}} \leq w < \sqrt{\frac{R}{1-\eta\lambda}}$. In this case, as the wage increases, workers reduce their labor supply in a way that their income matches their income target, resulting in a labor supply elasticity of -1 with respect to the wage.

One possible explanation for the elasticity estimates in the previous section is that Japanese female part-time workers adjust their working hours according to income targets. Several factors may contribute to whether workers adopt income targets. While thresholds of the tax and social insurance premiums are highlighted in this paper may influence the adoption of income targets, this explanation appears inconsistent with the results in the previous section, which showed similarly negative elasticities across a wide range of income levels. Alternatively, when a worker is responsible for home production, such as housework or childcare, constraints on the labor they can supply to the market may be related to the

formation of income targets[13]. The extent to which these factors determine whether a worker has an income target is unclear. However, individuals who are not the primary earners in their households but work with purposes that require a certain amount of income may regard the amount as their income targets. In the next section, we examine the proportion of Japanese female part-time workers who are likely to hold income targets, using another data source.

5.2 Reasons for adjusting working hours

In Section 4, the analysis using Wage Census data revealed that the labor supply elasticity is negative for all groups. This result indicates that part-time workers in Japan tend to reduce their working hours when wages increase, whereas they increase their working hours when wages decrease. Furthermore, the estimated elasticity remains almost the same for annual income levels of 0.8-1.5 million yen. If tax and social insurance premiums were the sole drivers influencing adjusting hours worked, the elasticity would be expected to be particularly low in the ranges from 1-1.1 million yen and from 1.2-1.3 million yen. Thus, the results suggest that tax and social insurance premiums are not the only reasons for adjusting hours worked. Our results show that between-group differences are larger than within-group differences across income levels. For example, the difference between married and unmarried women is larger than the difference among women with different incomes within the married (or within the unmarried) group as shown in Table 5.

To analyze whether the thresholds of the tax and social insurance premium affect adjusting hours worked, we examine the reasons for adjusting hours worked using data from the Part-time Workers Survey. Adjusting hours worked refers to the adjustment of annual income or working hours for reasons such as tax and social insurance premiums or income targets. As shown in Subsection 5.1, if workers have income targets when determining hours worked, the elasticity of labor supply could be negative.

To investigate why workers adjust their working hours, we employ the following two types of questions: whether workers have income targets and whether they have tax and social insurance incentives[14]. Since there are respondents who have both reasons for working hours adjustment, the following two definitions are used to illustrate the extreme cases:

- Definition 1: Those who cited both reasons are classified as adjusting hours worked for tax and social insurance reasons.

[13]Indeed, many studies have pointed out that, as a result of the division of labor within the household, Japanese women bear a significantly greater share of household production than men(Tsutsui, 2016; Nagase and Brinton, 2017; Hertog, 2025).

[14]See Section 3.1.2.

- Definition 2: Those who cited both reasons are classified as adjusting hours worked for income targets.

For workers who select both reasons, it is not clear from this survey which is the critical reason for suppressing hours worked. Under Definition 1, they are considered to be adjusting their working hours for reasons such as taxes and social insurance premiums. Under Definition 2, they are considered to be adjusting hours worked due to income targets. Applying Definition 1 means focusing on the maximum possible influence of tax and social insurance premiums on the adjustment of hours worked, while applying Definition 2 means focusing on the minimum possible influence of them.

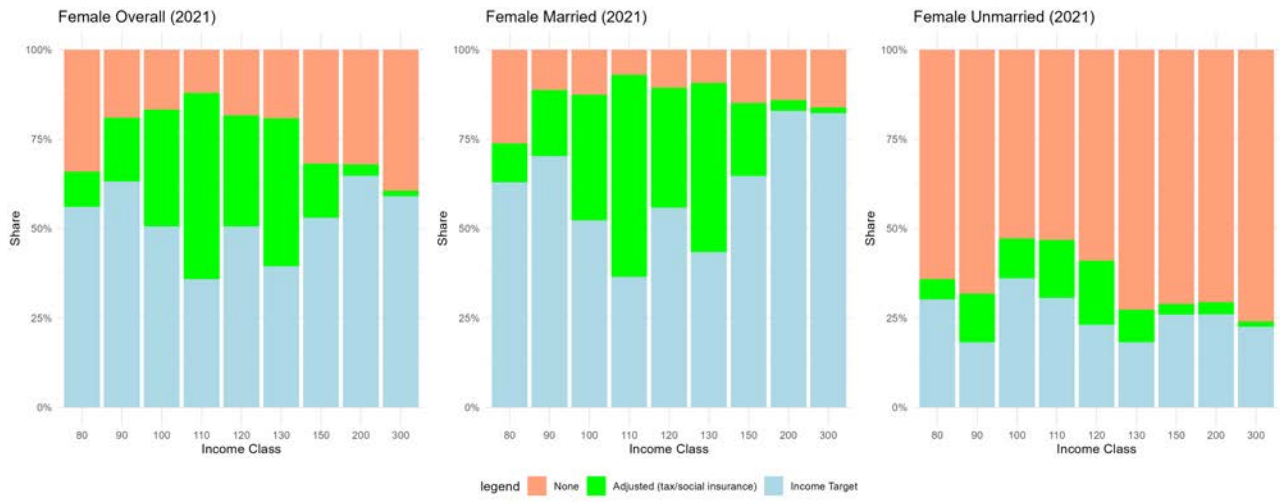
Figures 3–6 show the percentage of reasons for adjusting working hours, broken down into three categories: adjusting working hours due to taxes and social insurance premiums (Adjust (tax/social insurance)), adjusting working hours due to income targets (Income Target), and not adjusting working hours (None). The numbers 80, 90, 100, 110, 120, 130, 150, 200 and 300 on the horizontal axis indicate respectively, represent annual incomes of less than 8 million yen, 8-9 million yen, 9-10 million yen, 10-11 million yen, 11-12 million yen, 12-13 million yen, 13-15 million yen, 15-20 million yen, and 20-30 million yen. The income categories shown on the horizontal axis correspond to the income categories used in the regression analysis in the previous section.

Figure 3 presents shares of three categories, more specifically, adjusting working hours due to taxes and social insurance premiums, adjusting working hours due to income targets, and not adjusting working hours, in the whole sample and samples split by marital status. In Figure 3, the whole sample analysis (left figure) reveals that approximately 80% of respondents in the annual income range of 0.9-1.3 million yen adjust their hours worked, and the reasons are approximately evenly split between tax and social insurance premium considerations and income targets. Sub-sample analysis by marital status shows that differences by marital status are substantial. Over 80% of married female part-time workers with annual incomes below 1.5 million yen adjust their hours worked. Although the percentages of "tax and social insurance reasons" and "income targets" vary depending on annual income, the percentage of "no adjustment in working hours" remains almost constant between annual incomes of 0.8 million yen and 3 million yen. This is consistent with the results of the previous chapter, which showed that the elasticity was almost the same for annual incomes between 0.8-1.5 million yen. Among married women with an annual income of 0.9-1.3 million yen, a relatively high proportion of workers are adjusting their working hours due to taxes and social insurance premiums. Among them, approximately half of those adjusting their working hours do so for reasons related to taxes and social insurance premiums. Meanwhile, only 30-50% unmarried workers adjust their working hours among unmarried people. Female

workers who adjust their working hours for reasons related to taxes and social insurance premiums account for less than one third of those who adjust their working hours. As shown in Section 3.1, the ratio of married individuals is 74% in this dataset. Therefore, the overall picture strongly reflects the results for married people.

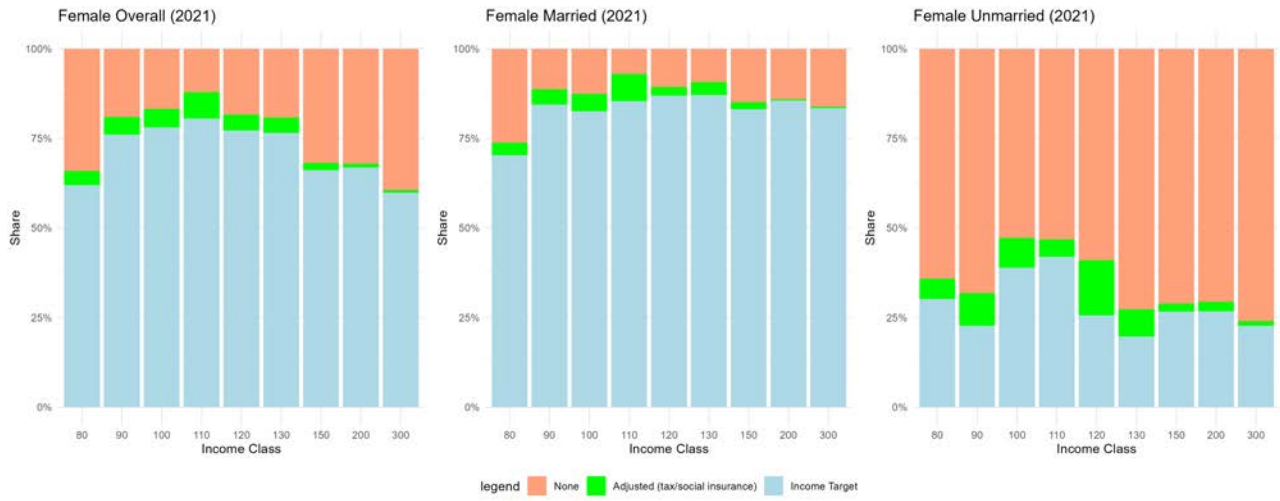
Figure 4 shows the results of repeating the same calculations using Definition 2. Among single women with an annual income of 1 million to 1.2 million yen, the percentage of those who adjust their working hours to match their income targets is relatively high, but the percentage of those who set income targets is 20% to 40% across all income brackets. For those with an annual income of 0.9 million to 3 million yen, there is little variation in the percentage of married women who have income targets. Due to taxes and social insurance premiums, few people in any income bracket adjust their working hours. Compared to the results based on Definition 1, most of the respondents who selected taxes and social insurance premiums as the reason for adjusting their working hours also chose income targets as the reason for adjusting their working hours.

Figure 3: Percentage of reasons for adjusting/not adjusting working hours by marital status: Definition 1



Note: Authors' calculation using data from the Part-time Workers Survey. "None" refers to not adjusting working hours, "Adjust (Tax/social insurance)" refers to adjustment of annual income or working hours for reasons related to tax and social insurance premiums, and "Income Target" refers to adjustment of annual income or working hours for reasons of income targets. The numbers 80, 90, 100, 110, 120, 130, 150, 200 and 300 on the horizontal axis indicate respectively, represent annual incomes of less than 8 million yen, 8-9 million yen, 9-10 million yen, 10-11 million yen, 11-12 million yen, 12-13 million yen, 13-15 million yen, 15-20 million yen, and 20-30 million yen.

Figure 4: Percentage of reasons for adjusting/not adjusting working hours by marital status: Definition 2

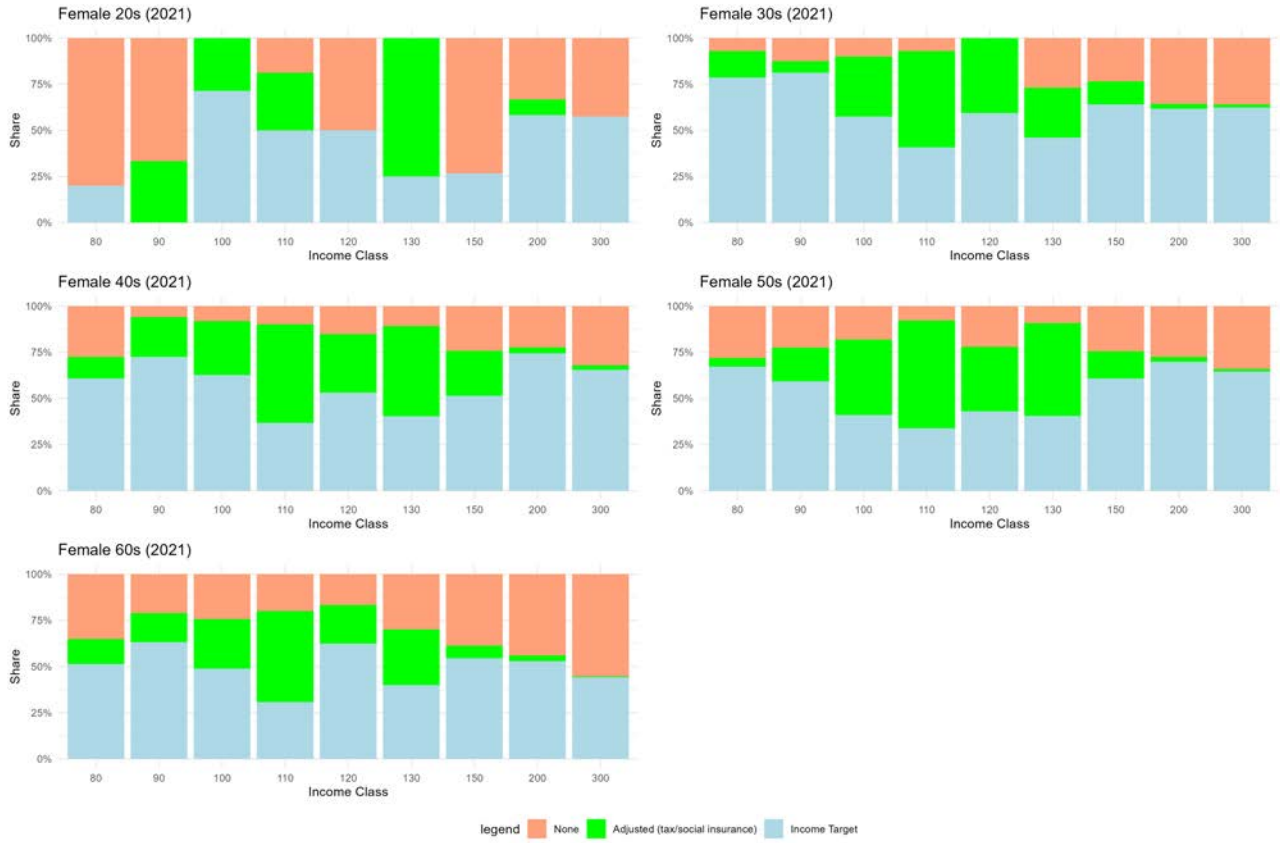


Note: Authors' calculation using data from the Part-time Workers Survey. "None" refers to not adjusting working hours, "Adjust (Tax/social insurance)" refers to adjustment of annual income or working hours for reasons related to tax and social insurance premiums, and "Income Target" refers to adjustment of annual income or working hours for reasons of income targets. The numbers 80, 90, 100, 110, 120, 130, 150, 200 and 300 on the horizontal axis indicate respectively, represent annual incomes of less than 8 million yen, 8-9 million yen, 9-10 million yen, 10-11 million yen, 11-12 million yen, 12-13 million yen, 13-15 million yen, 15-20 million yen, and 20-30 million yen.

Figures 5 and 6 show the shares of reasons for the adjustment of hours worked by age group. Among women in their 30s to 50s, a relatively large number are adjusting their working hours. In Figure 5, over 90% of women in their 30s and 40s with annual incomes of 0.8-1.5 million yen are adjusting their working hours, and this ratio is almost the same across all income brackets. This is also consistent with the results of the previous chapter, which showed that the elasticity was almost the same for annual incomes between 0.8-1.5 million yen. In Definition 1, a higher percentage of workers in their 30s to 50s adjust their working hours for tax and social insurance premiums. Among women in their 40s with an annual income of 1–1.1 million yen, who have the highest rate of adjusting working hours for tax and social insurance reasons, the proportion of women adjusting working hours for tax and social insurance reasons is nearly the same as those adjusting for income targets. However, in other age and income brackets, the proportion of those adjusting working hours for income targets is higher than those adjusting for tax and social insurance reasons. Figure 6 reveals that few women adjust their working hours due to taxes and social insurance premiums. Even among women in their 30s, 40s, and 50s, only a few percent adjust their working hours for tax and social insurance reasons, with the overwhelming majority doing so to achieve

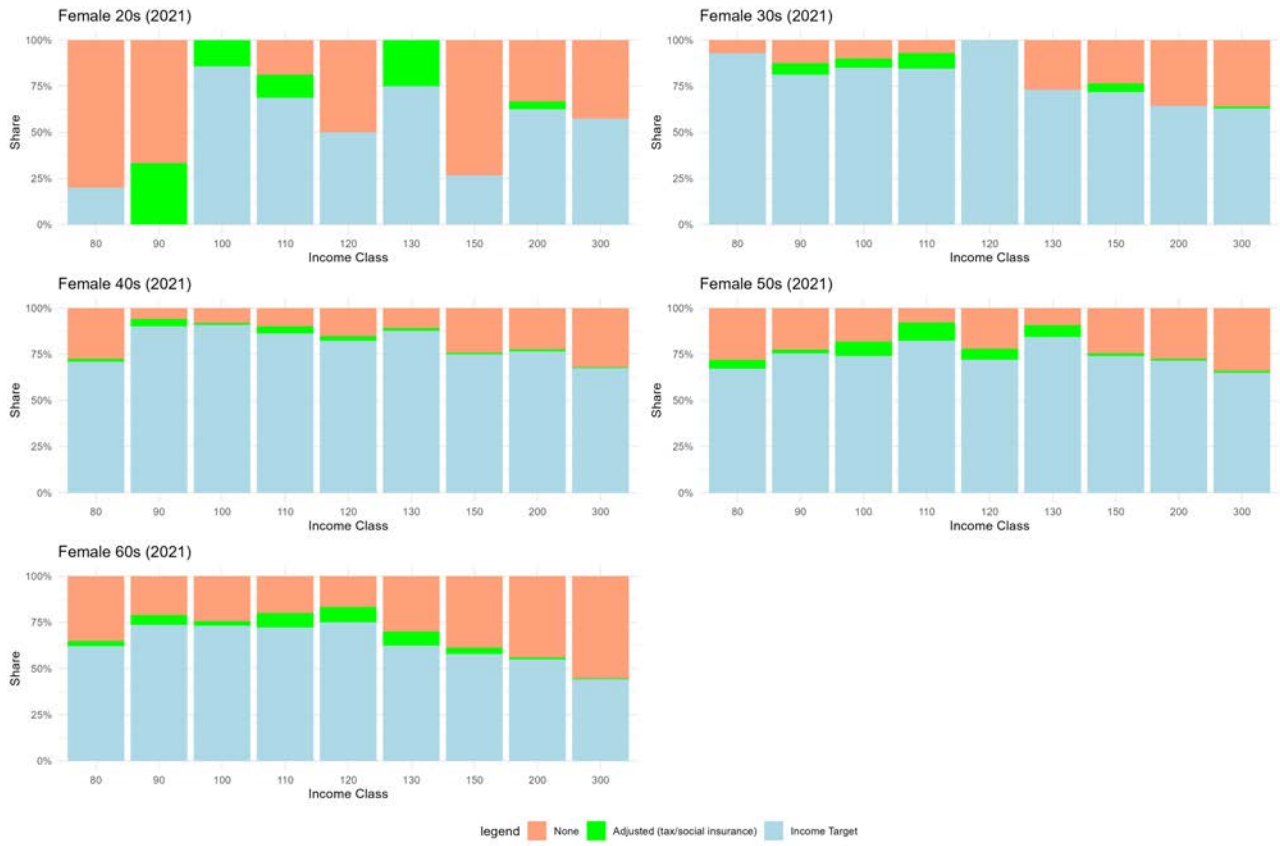
income targets. Compared with Figures 5 and 6, few women adjust their working hours solely to reduce their tax and social insurance contributions. This means that almost no women adjust their working hours to remain below the standard amounts for taxes and social insurance contributions.

Figure 5: Percentage of reasons for adjusting/not adjusting working hours by age: Definition 1



Note: Authors' calculation using data from the Part-time Workers Survey. "None" refers to not adjusting working hours, "Adjust (Tax/social insurance)" refers to adjustment of annual income or working hours for reasons related to tax and social insurance premiums, and "Income Target" refers to adjustment of annual income or working hours for reasons of income targets. The numbers 80, 90, 100, 110, 120, 130, 150, 200 and 300 on the horizontal axis indicate respectively, represent annual incomes of less than 8 million yen, 8-9 million yen, 9-10 million yen, 10-11 million yen, 11-12 million yen, 12-13 million yen, 13-15 million yen, 15-20 million yen, and 20-30 million yen.

Figure 6: Percentage of reasons for adjusting/not adjusting working hours by age: Definition 2



Note: Authors' calculation using data from the Part-time Workers Survey. "None" refers to not adjusting working hours, "Adjust (Tax/social insurance)" refers to adjustment of annual income or working hours for reasons related to tax and social insurance premiums, and "Income Target" refers to adjustment of annual income or working hours for reasons of income targets. The numbers 80, 90, 100, 110, 120, 130, 150, 200 and 300 on the horizontal axis indicate respectively, represent annual incomes of less than 8 million yen, 8-9 million yen, 9-10 million yen, 10-11 million yen, 11-12 million yen, 12-13 million yen, 13-15 million yen, 15-20 million yen, and 20-30 million yen.

Our findings show that the proportion among married women and among women in their 30s to 50s, who adjust their working hours, is high, and that the proportion is also roughly the same among those earning between 0.8 and 1.3 million yen per year. This is consistent with the findings of the previous section, which showed that the elasticity of working hours with respect to hourly wages is small for married women and women in their 30s to 50s, and is almost the same in the range of 0.8-1.5 million yen. For married women and women in their 30s to 50s, although the proportion of people adjusting their income due to taxes and social insurance premiums is large in the income range of 0.9-1.3 million yen, even in the definition 1 that estimates the maximum impact of taxes and social insurance premiums,

the proportion of people adjusting their working hours to meet their income targets exceeds half.

Considering the results of definitions 1 and 2 together, it suggests that most women who adjust their working hours for reasons related to taxes and social insurance premiums also have income targets. As indicated in Section 3.1, the sample of women with an annual income of 0.9 to 1.3 million yen accounts for around 40% of all female part-time workers, and a larger proportion of the sample has an annual income of 1.3 to 3 million yen. When population weights are also taken into account, factors such as income targets that are not directly dependent on policy have a greater impact on adjusting working hours than taxes and social insurance premiums.

6 Conclusion

This study estimates the elasticity of hours worked with respect to hourly wages among female part-time workers in Japan. We find that the hourly wage elasticity of female part-time workers is negative for hours worked. However, there is almost no difference in the size of the elasticity depending on annual income, despite the fact that the thresholds for the Japanese taxation and social insurance systems differ depending on annual income. Furthermore, although the Japanese tax and social insurance systems have been changed many times over the past 25 years, there is little correlation between these changes and elasticity. Our findings show that elasticity is not changing with changes in the tax and social insurance schedule, but is declining over time. This can be explained by the increase in the number of women working as secondary earners due to changes in demographics, such as employment and marital status. Our evidence is consistent with the income target model. In the model, workers adjust their working hours to meet the income targets under relatively low wage rates. We find that substantial share of married women are second earners and face economic needs that lead them to seek additional income. Because they work to meet those needs, it is likely that they have income targets. The income target model can potentially explain the changes in women's labor supply that some studies have noted, changes that cannot be explained by taxes or social insurance. This suggests that changes to the tax and social insurance systems alone will not increase the hours worked by part-time female workers.

The employment rate for married women is low, and many married women who have jobs work part-time. The obstacles, such as child penalties, prevent women from working in the labor market(Kleven et al. (2019)). In addition, rigid working practices and long working hours for full-time employees also make it difficult for women to work in the labor

market. In Japan, where non-regular employment accounts for more than 40% of the working population, a decrease in the supply of non-regular labor, which has a large amount of leeway in terms of working hours, combined with a decrease in the working population due to the aging of society and the declining birthrate, could lead to a serious labor shortage. In order to increase the working hours of secondary earners, it can be effective to shift their motivation from supplementing the income of primary earners.

References

Addison, John T., Pedro Portugal, and José Varejão, "Labor Demand Research: Toward a Better Match between Better Theory and Better Data," *Labour Economics*, October 2014, *30*, 4–11.

Aronsson, Thomas, Katharina Jenderny, and Gauthier Lanot, "The Quality of the Estimators of the ETI," *Journal of Public Economics*, August 2022, *212*, 104679.

Bacheron, Johanne, Sylvie Blasco, Eva Moreno Galbis, and Jeremy Tangu, "Labour Market Concentration and Gender Gaps," 2024.

Bick, Alexander and Nicola Fuchs-Schündeln, "Taxation and Labour Supply of Married Couples across Countries: A Macroeconomic Analysis," *The Review of Economic Studies*, July 2018, *85* (3), 1543–1576.

_ , Bettina Brüggemann, Nicola Fuchs-Schündeln, and Hannah Paule-Paludkiewicz, "Long-Term Changes in Married Couples' Labor Supply and Taxes: Evidence from the US and Europe since the 1980s," *Journal of International Economics*, May 2019, *118*, 44–62.

Borella, Margherita, Mariacristina De Nardi, and Fang Yang, "Are Marriage-Related Taxes and Social Security Benefits Holding Back Female Labour Supply?," *The Review of Economic Studies*, January 2023, *90* (1), 102–131.

Brown, Charles, Curtis Gilroy, and Andrew Kohen, "The Effect of the Minimum Wage on Employment and Unemployment: A Survey," *Journal of Economic Literature*, 1982, *20* (2), 487–528.

Camerer, Colin, Linda Babcock, George Loewenstein, and Richard Thaler, "Labor Supply of New York City Cabdrivers: One Day at a Time," *The Quarterly Journal of Economics*, May 1997, *112* (2), 407–441.

Card, David and Alan B. Krueger, *Myth and Measurement: The New Economics of the Minimum Wage - Twentieth-Anniversary Edition*, rev - revised ed., Princeton University Press, 1995.

Chetty, Raj, "Bounds on Elasticities With Optimization Frictions: A Synthesis of Micro and Macro Evidence on Labor Supply," *Econometrica*, 2012, *80* (3), 969–1018.

_ , John N. Friedman, Tore Olsen, and Luigi Pistaferri, "Adjustment Costs, Firm Responses, and Micro vs. Macro Labor Supply Elasticities: Evidence from Danish Tax Records," *The Quarterly Journal of Economics*, May 2011, *126* (2), 749–804.

Crawford, Vincent P. and Juanjuan Meng, "New York City Cab Drivers' Labor Supply Revisited: Reference-Dependent Preferences with Rational-Expectations Targets for Hours and Income," *American Economic Review*, August 2011, *101* (5), 1912–1932.

Crossley, Thomas F. and Sung-Hee Jeon, "Joint Taxation and the Labour Supply of Married Women: Evidence from the Canadian Tax Reform of 1988*," *Fiscal Studies*, 2007, *28* (3), 343–365.

Dessing, Maryke, "Labor Supply, the Family and Poverty: The S-shaped Labor Supply Curve," *Journal of Economic Behavior & Organization*, December 2002, *49* (4), 433–458.

Dodini, Samuel, "Making Reference-Dependent Preferences: Evidence from Door-to-Door Sales," https://samueldodini.github.io/workingpapers/pest_control_refdep/ June 2023.

Dong, Yanli and Syun Ibaragi, "The Impact of Minimum Wage Increases on Employment in Japan: A Meta-Analysis," *Japan Journal of Labor Research*, January 2023, *750*, 93–107.

Dube, Arindrajit and Ben Zipperer, "Own-Wage Elasticity: Quantifying the Impact of Minimum Wages on Employment," September 2024.

Eissa, Nada, "Labor Supply and the Economic Recovery Tax Act of 1981," in "Empirical Foundations of Household Taxation," University of Chicago Press, January 1996, pp. 5–38.

_ **and Jeffrey B. Liebman**, "Labor Supply Response to the Earned Income Tax Credit," *The Quarterly Journal of Economics*, 1996, *111* (2), 605–637.

Farber, Henry S., "Is Tomorrow Another Day? The Labor Supply of New York City Cabdrivers," *Journal of Political Economy*, February 2005, *113* (1), 46–82.

_ , "Reference-Dependent Preferences and Labor Supply: The Case of New York City Taxi Drivers," *American Economic Review*, June 2008, *98* (3), 1069–1082.

Farmand, Aida and Teresa Ghilarducci, *Monopsony Power, Race, and Gender*, Oxford University Press, May 2022.

Gelber, Alexander M., Damon Jones, and Daniel W. Sacks, "Estimating Adjustment Frictions Using Nonlinear Budget Sets: Method and Evidence from the Earnings Test," *American Economic Journal: Applied Economics*, January 2020, *12* (1), 1–31.

Hertog, Ekaterina, "Education and the Gender Division of Labor in Japan: Trends in Paid and Unpaid Work From 1991 to 2016," *Gender, Work & Organization*, 2025, *32* (4), 1632–1648.

Keane, Michael P., "Labor Supply and Taxes: A Survey," *Journal of Economic Literature*, December 2011, *49* (4), 961–1075.

_ , "Recent Research on Labor Supply: Implications for Tax and Transfer Policy," *Labour Economics*, August 2022, *77*, 102026.

Kleven, Henrik, Camille Landais, Johanna Posch, Andreas Steinhauer, and Josef Zweimüller, "Child Penalties across Countries: Evidence and Explanations," *AEA Papers and Proceedings*, May 2019, *109*, 122–126.

Kleven, Henrik J. and Mazhar Waseem, "Using Notches to Uncover Optimization Frictions and Structural Elasticities: Theory and Evidence from Pakistan," *The Quarterly Journal of Economics*, May 2013, *128* (2), 669–723.

Kondo, Ayako and Taiyo Fukai, "Analysis of Married Women's Adjustment of Work Using Municipal Tax Data," *RIETI Discussion Paper Series 23-J-049*, November 2023.

LaLumia, Sara, "The Effects of Joint Taxation of Married Couples on Labor Supply and Non-Wage Income," *Journal of Public Economics*, July 2008, *92* (7), 1698–1719.

Mankiw, N. Gregory, *Principles of Microeconomics* 2012.

Manning, Alan, "Imperfect Competition in the Labor Market," in David Card and Orley Ashenfelter, eds., *Handbook of Labor Economics*, Vol. 4, Elsevier, January 2011, pp. 973–1041.

Nagase, Nobuko, "Standard and Nonstandard Work Arrangements, Pay Differences, and Choice of Work by Japanese Mothers," *Nonstandard Work in Developed Economies: Causes and Consequences (Susan Houseman, and Machiko Osawa, eds.)*, January 2004, pp. 267–306.

_ **and Mary C. Brinton**, "The Gender Division of Labor and Second Births: Labor Market Institutions and Fertility in Japan," *Demographic Research*, January 2017, *36*, 339–370.

Nakamura, Tamotsu and Yu Murayama, "A Complete Characterization of the Inverted S-Shaped Labor Supply Curve," *Metroeconomica*, 2010, *61* (4), 665–675.

Richards, Timothy J., "Income Targeting and Farm Labor Supply," *American Journal of Agricultural Economics*, 2020, *102* (2), 419–438.

Saez, Emmanuel, "Do Taxpayers Bunch at Kink Points?," *American Economic Journal: Economic Policy*, August 2010, *2* (3), 180–212.

Sharma, Garima, "Monopsony and Gender," *working paper*, December 2022.

Tavor, Tchai, Limor Dina Gonen, and Uriel Spiegel, "The Double-Peaked Shape of the Laffer Curve in the Case of the Inverted S-Shaped Labor Supply Curve," *Mathematics*, January 2022, *10* (6), 858.

Tsutsui, Junya, "Female Labor Participation and the Sexual Division of Labor: A Consideration on the Persistent Male-Breadwinner Model," *Japan Labor Review*, 2016, *13* (3), 80–100.

Varian, Hal R., *Intermediate Microeconomics: A Modern Approach*, 8 ed., New York: W W Norton & Co Inc, December 2009.

Yokoyama, Izumi, "How the Tax Reform on the Special Exemption for Spouse Affected the Work-Hour Distribution," *Journal of the Japanese and International Economies*, September 2018, *49*, 69–84.

_ **and Naomi Kodama**, "Women's Labor and Taxes: Current Situation Analysis Using Data," *Financial Review*, 2016, *2016* (2), 49–76.

A Appendix

A.1 Sample size

The sample size by year is described in the Appendix Table A1. The sample used in this analysis is part-time workers with annual incomes of 300,000–3,000,000 yen. The sample size is approximately 100,000–300,000 per year.

Table A1: Number of observations by year

	all sum	female sum	male sum
1998	4202591	3471738	730853
1999	4163456	3460517	702939
2000	3928277	3255593	672684
2001	3859066	3202082	656984
2002	4532172	3651112	881060
2003	4569773	3662628	907145
2004	5894863	4630661	1264202
2005	5679200	4237490	1441710
2006	5346417	4048810	1297607
2007	5187476	3919054	1268422
2008	6127022	4624444	1502578
2009	6021151	4503708	1517443
2010	6134443	4604842	1529601
2011	5980131	4418032	1562099
2012	7226681	5314264	1912417
2013	6935864	5131326	1804538
2014	7378714	5427757	1950957
2015	7592538	5610744	1981794
2016	7731798	5696099	2035699
2017	7492080	5492601	1999479
2018	7141222	5253570	1887652
2019	7630647	5613467	2017180
2020	7365031	5508325	1856706
2021	7170952	5308920	1862032
2022	7217272	5361207	1856065
Observations	5766381	4339027	1427354

A.2 Survey response choices

The Part-time Workers Survey asks respondents whether they are adjusting their income or working hours and the reason why. The specific choices are as follows.

Table A2: Choices of reasons for working

No.	Reasons for working
1	To serve as the household's primary source of earnings and maintain our family's basic standard of living
2	To maintain our family's basic standard of living, despite not being the household's primary source of earnings
3	To cover our children's educational expenses or future financial needs, despite not being the household's primary source of earnings
4	To contribute to repaying mortgages or other loans, despite not being the household's primary source of earnings
5	To supplement our household budget for other purposes, despite not being the household's primary source of earnings
6	To cover my own tuition or entertainment expenses
7	To utilize my qualifications or skills
8	To draw on my previous work experience
9	To find a sense of purpose or participate in society
10	To make productive use of my spare time
11	To take advantage of the time freed up once my children no longer require constant care
12	For other reasons

Note: A multiple-response question about reasons for working in the Part-time Workers Survey.

The survey asks whether workers adjust their working hours to avoid paying taxes and social insurance premiums. "Tax/Social Insurance" refers to those who answered 'yes' to this question. "Income Target" refers to those who adjust their hours worked for reasons for income targets discussed in Section 5. To identify respondents who have income targets, we use choices 2 to 5 in Appendix Table A2. Respondents who selected these choices are likely to have financial motivation to supplement the income of the primary earners. "Tax/Social Insurance" and "Income Target" come from different questions, so there is some overlap. "None" covers respondents not included under either "Tax/Social Insurance" or "Income Target."

A.3 First stage estimates

Appendix Table A3 shows the result of the first-stage equation using a sample of women for 1998–2022. Column (1) estimates the simple model of minimum wage without interaction terms in Equation (5). The results of the F-test are reported on the bottom line. Columns (2)–(10) display the coefficients of the first stage for the model with interaction terms of minimum wage and income brackets in Equation (6). In the model with cross-terms, all F-statistics are large enough, and there is no problem with the weak instruments. In almost all estimates, the coefficients of the intersection terms between the minimum wage and a particular income group have positive and significant effects on the wage rates for that income group.

Table A3: Effects of minimum wage on wage rates for female workers: first stage

VARIABLES	(1) IV500_lnwage	(2) IV505_lnwage_i_u08	(3) IV505_lnwage_i_0809	(4) IV505_lnwage_i_0910	(5) IV505_lnwage_i_1011	(6) IV505_lnwage_i_1112	(7) IV505_lnwage_i_1213	(8) IV505_lnwage_i_1315	(9) IV505_lnwage_i_1520	(10) IV505_lnwage_i_o20
lnMW_i_u08		0.7821***	-0.0386***	-0.0464***	-0.0428***	-0.0317***	-0.0483***	-0.0593***	-0.1099***	-0.0120
		(0.0211)	(0.0090)	(0.0102)	(0.0114)	(0.0085)	(0.0088)	(0.0106)	(0.0142)	(0.0141)
lnMW_i_0809		-0.1682***	0.8530***	-0.0459***	-0.0393***	-0.0284***	-0.0482***	-0.0569***	-0.1068***	-0.0087
		(0.0204)	(0.0119)	(0.0103)	(0.0114)	(0.0086)	(0.0088)	(0.0107)	(0.0142)	(0.0141)
lnMW_i_0910		-0.1573***	-0.0352***	0.7878***	-0.0390***	-0.0272***	-0.0477***	-0.0581***	-0.1027***	-0.0071
		(0.0203)	(0.0091)	(0.0119)	(0.0114)	(0.0086)	(0.0088)	(0.0106)	(0.0142)	(0.0141)
lnMW_i_1011		-0.1576***	-0.0330***	-0.0431***	0.7520***	-0.0274***	-0.0480***	-0.0571***	-0.1019***	-0.0057
		(0.0202)	(0.0090)	(0.0102)	(0.0130)	(0.0086)	(0.0088)	(0.0106)	(0.0142)	(0.0141)
lnMW_i_1112		-0.1650***	-0.0338***	-0.0430***	-0.0434***	0.7800***	-0.0476***	-0.0555***	-0.1084***	-0.0113
		(0.0203)	(0.0090)	(0.0102)	(0.0114)	(0.0114)	(0.0089)	(0.0107)	(0.0142)	(0.0142)
lnMW_i_1213		-0.1651***	-0.0336***	-0.0444***	-0.0423***	-0.0292***	0.7676***	-0.0569***	-0.1152***	-0.0165
		(0.0204)	(0.0090)	(0.0102)	(0.0113)	(0.0086)	(0.0127)	(0.0108)	(0.0143)	(0.0142)
lnMW_i_1315		-0.1719***	-0.0335***	-0.0454***	-0.0407***	-0.0274***	-0.0506***	0.7783***	-0.1271***	-0.0226
		(0.0203)	(0.0090)	(0.0102)	(0.0113)	(0.0086)	(0.0089)	(0.0134)	(0.0143)	(0.0142)
lnMW_i_1520		-0.1668***	-0.0305***	-0.0360***	-0.0316***	-0.0242***	-0.0475***	-0.0626***	0.5613***	-0.0303**
		(0.0202)	(0.0090)	(0.0101)	(0.0113)	(0.0085)	(0.0088)	(0.0106)	(0.0160)	(0.0143)
lnMW_i_o20		-0.1578***	-0.0274***	-0.0311***	-0.0240**	-0.0177**	-0.0409***	-0.0453***	-0.0869***	0.4092***
		(0.0202)	(0.0090)	(0.0101)	(0.0112)	(0.0085)	(0.0088)	(0.0107)	(0.0144)	(0.0172)
lnMW	0.2499***									
	(0.0281)									
Constant	0.0867***	0.1808***	-0.0097***	-0.0123***	-0.0113***	-0.0084***	-0.0130***	-0.0163***	-0.0296***	-0.0034
	(0.0075)	(0.0056)	(0.0024)	(0.0027)	(0.0030)	(0.0023)	(0.0023)	(0.0028)	(0.0038)	(0.0037)
Observations	4,221,263	4,221,263	4,221,263	4,221,263	4,221,263	4,221,263	4,221,263	4,221,263	4,221,263	4,221,263
R-squared	0.654	0.431	0.320	0.335	0.311	0.278	0.275	0.283	0.335	0.638
Est FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ind*Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-stat	78.81	3612	2700	3074	2405	1378	742.8	964.5	1495	6029

Note: This table shows the coefficients of minimum wage on wage rates using the data of female workers in 1998–2022. Columns (1) shows the estimates of Eq. 5, and columns (2)–(10) the estimates of Eq. 6. All regressions control for income bracket dummies (-0.8, 0.8-0.9, 0.9-1, 1-1.1, 1.1-1.2, 1.2-1.3, 1.3-1.5, 1.5-2, and 2-3 million yen), establishment fixed effects, prefecture fixed effects, and year fixed effects. Robust cluster standard errors are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

A.4 Propensity of marriage

The wage census does not provide information on marital status. Therefore, we (1) estimate the propensity of being married by individual attributes such as age and educational background using data from the Survey of Part-Time Workers, (2) predict the probability of being married in the wage census data using the estimated coefficients of individual attributes in (1) and individual attributes from the Wage Census, and (3) divide the sample into two sub-groups according to the estimated propensity of marriage, labor supply elasticity are estimated for each group.

Appendix Table A4 shows the coefficients for propensity of having a spouse using pooling data of the Survey of part-time workers in 2006, 2011, 2016, and 2021.

The estimated model is as follows:

$$married_i = \alpha + \beta_1 lninc_i + \beta_2 lninc_i^2 + \gamma educ_i + \theta Dage_i + \epsilon_i \tag{9}$$

where outcome, $married_i$ is propensity of having a spouse of worker i, $lninc$ is log of annual income (JPY) (/100), $lninc^2$ is log of annual income squared, $Dage$ is the age category in 5-year increments (15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–), and $Deduc$ is the education category (Junior high school graduate, high school graduate, junior college/technical school graduate, university graduate or above).

Table A4: Propensity of being married

VARIABLES	(1) female_all
lnincome_year_hundred	9.2507**
	(3.9559)
lnincome_year_hundred_2	-0.5605***
	(0.2130)
Dfemale = o,	-
Dage==2024	2.4755**
	(1.1016)
Dage==2529	5.9396***
	(1.0721)
Dage==3034	6.6852***
	(1.0747)
Dage==3539	7.3036***
	(1.0700)
Dage==4044	7.3830***
	(1.0692)
Dage==4549	7.9518***
	(1.0689)
Dage==5054	7.8904***
	(1.0750)
Dage==5559	7.6278***
	(1.0743)
Dage==6064	7.4633***
	(1.0896)
Dage==6599	6.7769***
	(1.0833)
Gakureki==2	0.4477**
	(0.2021)
Gakureki==3	0.8146***
	(0.2244)
Gakureki==4	0.7516***
	(0.2145)
Constant	-43.9439**
	(18.2580)
Observations	29,321
Dep mean	0.737
pseudo-R-sq	0.187

Note: This table shows the estimated coefficients of the logit model for the propensity of marriage. Gakureki is 1 if a Junior high school graduate, 2 if a high school graduate, 3 if a junior college/technical school graduate, and 4 if a university graduate or above. Column (1) uses data for both women and men, while columns (2) and (3) use data for women and men only. The reference group is age 15–19, and a junior high school graduate. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.