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## Time Allocation and Declining Work From Home in Offshoring: Evidence from Japan, 1976-2016

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# Time Allocation and Declining Work From Home in Offshoring: Evidence from Japan, 1976-2016 

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#### Abstract

This paper investigates how work from home (WFH) affects time use for work, housework, leisure, and sleep in daily life. Our focus is WFH without using Information and Communication Technologies (ICTs), that is, handiwork or homebased subcontracting for manufacturing firms (so-called old WFH). We use longrun worker-level time-use data for Japan, from 1976 to 2016. Since such laborintensive handiwork has declined, due to globalization and automation, old WFH has declined. WFH females tend to reduce their working hours and spend more time on housework, while WFH males tend to devote more time to leisure. There are significant impacts of old WFH on the flexibility in time allocation in the 19902000s, but the impact disappears in the 2010s.


Keywords: Work from Home, Time-use survey, Handiwork, Working hours, Housework hours, Offshoring
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## 1 Introduction

Since the spread of the COVID virus early in 2020, work from home (WFH) has gained great attention. Under the nationwide lockdown against the virus, workers were requested to work remotely at home using ICTs. WFH has dramatically changed our daily life and work style. Prior to the COVID pandemic, WFH had long been on the policy agenda, aimed at improving work-life balance. WFH makes our working hours more flexible and efficient and facilitates devoting more time to leisure, childcare, and family nursing, which leads to an improved quality of life (e.g., Kahn, 2022). Now, many companies, all over the world, have adopted WFH aggressively.
Indeed, the importance of WFH has been recognized in recent years and has dramatically gained popularity under COVID. However, it is not a brand-new concept. Going back in history, WFH without using ICTs existed, that is, working at home, often in the form of piecework. In the past, many women did piecework at home to support their family's finances while also undertaking childcare, nursing care, and household chores. This type of work involves routine tasks such as sewing clothes or assembling parts of machines at home and delivering the finished work to the firm, as a subcontractor for manufacturing firms, allowing for daily life benefits from a high degree of freedom, in particular the high flexibility of working hours. The tasks comprise various kinds of labor-intensive handiwork, such as repairing of clothes, handicraft, and assembling of parts of electrical equipment. This sort of WFH was often seen as recently as the 1950-1980s in developed countries, accompanied by the rapid growth of manufacturing. According to Brinton (1993), it was especially notable in Japan: over one-third of Japanese female self-employed workers were home-based handicraft laborers in 1980. Japan had remained strongly conservative on the division of labor by gender, where husband works and wife does housework due to conservatism of gender roles. Because female wages were generally very low and jobs were unstable in the past, such WFH attracted females and was thought of as the "best way" for females to balance housework (aided by the advent of house appliances but limited automation in those days) and support the household budget.
During the 1980s and 1990s, as shown in international trade literature (e.g., Autor et al., 2013a, 2015; Feenstra, 2010; Baldwin, 2006), such labor-intensive piecework was increasingly offshored through foreign direct investment and
foreign outsourcing to labor-abundant developing countries. Furthermore, the wave of new globalization from the late 1990s caused by the ICT revolution has led to skill-biased technology change while decreasing wages in labor-intensive jobs and routine tasks (Autor et al., 2003; 2013b). Production was unbundled by outsourcing many tasks to foreign countries, which were used to be done within a firm (Baldwin, 2016). The decline in transportation costs and telecommunication costs has allowed many labor-intensive tasks to be offshored to lower-wage and labor-abundant countries such as China. Accordingly, the old type of WFH ("old WFH") has been dismantled in many developed countries.
Nowadays, the IT revolution has deepened, where AI and robots are spread over the whole economy and change labor market (Acemoglu and Restrepo, 2019, 2020). Frey and Osborne (2013) predicted that in the future, most occupations in the economy will be substitutable with Al and robots, so many routine jobs and manual labor will completely disappear. The new WFH using ICT will be replaced by foreign outsourcing and Al. That is, as predicted by Baldwin (2018), many office work tasks are mainly routine and suitable for the new WFH, and thus they can be easily outsourced to foreign countries or replaced by AI and robots. Therefore, similar to the extinction of the old WFH, the new WFH routine jobs will be outsourced and decline in the near future. This paper also provides some insights from our analysis of the old WFH.
Indeed, the old WFH has a different background and involves different tasks from the current WFH. The old WFH is handiwork without using ICT, where workers are required to do jobs at home at any time and day without any commuting or office work. However, many basic features are common. Both types of WFH flexibly impact time allocation, facilitating housework and leisure and improving people's work-life balance. The new WFH has been investigated by some recent papers (e.g., Dutcher, 2012; Bloom et al.,2015), but they could not measure any long-run effects on a worker's daily life. Furthermore, both types of WFH are routine tasks and thus face the risk of replacement by technological revolution and globalization. In the long term, the wave of automation and AI might replace all kinds of WFH (old and new). Therefore, this paper investigates the impact of the old WFH on time allocation over several decades, using Japanese long-run individual-level survey data (1976-2016).
The paper addresses several questions. First, we investigate whether old WFH affected time allocation and eased work-life balance. Second, we uncover how the job destruction of old WFH by globalization and automation happened and
how it affects working hours and time allocation of WFH workers, that is, how WFH workers reacted to the wave of globalization in their daily life (time allocation) and whether the reduced working hours were replaced by time for job search and training. Third, the paper investigates how different old and new WFH settings are with regard to time allocation and what implications old WFH can provide to the current economy.
In this paper, we obtain several results. First, married or divorced females tend to WFH. More than 10\% of female workers engaged in WFH in 1976. It is limited to specific occupations such as repairing of clothes and assembling of parts of electrical equipment. The number of workers engaged in WFH decreased to less than $1 \%$ in the 1990s and 2000s. Second, WFH workers tended to have fewer working hours, and females spent more time on housework and males on leisure in the 1990s and 2000s. The impacts on time allocation in the 2010s became small and insignificant. Third, WFH workers finish work much earlier than regular working time and enjoy more leisure time in the evenings and at night. They watch TV or relax rather than studying and training for a better job. Fourth, wages of old WFH workers were lower than those of other workers; however, new WFH workers tend to have similar wages to non-WFH workers. Moreover, wage sorting can be observed over time in old WFH, where higher-wage WFH workers tend to survive.
The remainder of the paper is structured as follows. Section 2 reviews the literature, and Section 3 describes the data and some stylized facts. Section 4 studies time allocation and WFH. Section 5 examines some estimations of the time premium revealed by WFH. In Section 6, we make some comparisons with the new WFH. Section 7 provides concluding remarks.

## 2 Literature Review

A new light was shed on WFH by the COVID pandemic. There is a growing body of literature on WFH in a wide range of sciences. The COVID-19 pandemic has accelerated the popularity of WFH. In the US, WFH workers increased from $8 \%$ in February 2020 to $35 \%$ in May 2020 (Bick et al.,2020). ${ }^{1}$ It has also been found

[^0]that WFH is suitable for some specific occupations (Dingel and Neiman, 2020). ${ }^{2}$ Although the mechanisms have not been fully investigated yet, WFH crucially affects time allocation. It was thought to improve work-life balance through more flexible use of time and the workplace (Gajendran and Harrison, 2007; Dutcher, 2012; Bloom et al.,2015; Giménez-Nadal et al.,2019; Coenen and Kok, 2014; Tremblay, 2002; Baines and Gelde, 2003; Wheatley, 2012; Kazekami, 2020). Because WFH does not involve commuting, commute time is saved. More importantly, WFH reduces working hours per se, by avoiding unnecessary meetings and communication.
However, despite WFH having the benefit of flexibility in time use, it is still unclear how WFH affects time-use patterns in daily life. Some US studies have used timeuse survey data. ${ }^{3}$ According to Giménez-Nadal et al. (2019) and Pabilonia and Vernon (2022), WFH allows workers to reduce grooming and commuting times and devote more time to leisure and family. ${ }^{4}$ However, WFH involves the risk of overworking. Eldridge and Pabilonia (2010) found that only 8\% of workers work remotely, but $5 \%$ of workers use that time to finish and catch up on their work at home. Similarly, Golden (2008) found that WFH is associated with long working hours. These studies of WFH and time allocation investigate whether WFH can reduce working hours and increase family time. Our paper is in this vein, but in contrast to all previous studies, our focus is on the old WFH, i.e., home-based work without using ICT.
All prior studies use US time-use data, and very few have examined the relationship between WFH and time allocation in other countries (Natti et al.,2011, for Finland; Callister and Dizon, 2001, for New Zealand; Craig, 2006; Powell and Craig, 2015 for Australia; Okubo, 2022 for Japan). Furthermore, all previous studies investigate short-run analysis (one period). Our paper addresses this gap. Our focus is on time use in long-run analysis, that is, on (i) how much WFH workers could reduce working hours and increase housework and leisure, (ii) how WFH changes time use for males and females over several decades (40 years),

[^1]and (iii) how different the "old" WFH is from the current WFH.
Apart from the impact of WFH on time allocation, there are three related bodies of literature. First, labor economics literature discusses time allocation of workers. Aguiar and Hurst (2007), using the US time-use survey, studied the dynamic change in leisure time from 1965 to 2003. There are a small number of studies using Japanese time-use data. Kuroda (2010) illustrated trends in average working and leisure hours over three decades in Japan, while Mizunoya (2019) and Kagawa (2019) explored the working hours of the day. ${ }^{5}$ Although all these studies examined time-use patterns, none considered the relationship of time use to WFH.

The second strand of the literature is international trade and offshoring. As Baldwin (2016) mentioned, the current globalization and ICT revolution since the late 1990s saw the so-called second unbundling in which firms outsourced some production processes. This was caused by the lowering of telecommunication costs with the development of ICT and the substantial reduction of trade barriers and transportation costs. Many labor-intensive tasks required for production in developed countries were shifted to Asian countries (e.g., Autor et al.,2013a,b; Feenstra, 2010; Baldwin, 2006). Many recent studies have investigated how increased imports from China affect labor markets and the offshoring of tasks. For example, Autor et al. (2013a) illustrated how US imports from China have resulted in job destruction in US labor markets. Grossman and Rossi-Hansberg (2008) modeled outsourcing of tasks (task trade) with globalization. Autor et al. (2003) studied the impact of automation on employment and wages. All these studies investigate the impact on firm growth/dynamics, job destruction/creation of unskilled/skilled labor, reallocation of labor, and wage changes for skilled and unskilled laborers. None investigated the impact on labor-intensive workers' time allocation in daily life. By contrast, our focus is on the impact on old WFH workers (labor-intensive handiwork subcontractors for manufacturing firms) in a developed country (Japan) who are the most vulnerable to task offshoring to Asian countries. We ask how such workers' daily life has reacted to the pressure of offshoring, using worker-level time-use data. This allows us to examine how offshoring reduces WFH workers' working hours and how the high pressure of job destruction by offshoring changes their time allocation, that is, whether their decreased working hours are spent on other activities such as job training and

[^2]search under such high pressure.
Finally, third related but small piece of literature is on "home workers" in Japan. There exist surveys on home workers in a few cities of the pre-war period. Tokyo City conducted the Survey on Home Workers in the 1920s-30s. Previous studies are descriptive or case studies. Sakayori (1958) illustrated some quantitative evidence from Osaka city. Takano (2008) overviewed the long-term decline of home work among females from the 1970s to the 1990s. ${ }^{6}$ However, there are no previous studies on this topic using nationwide micro-data and econometric analysis. Our paper is the first econometric analysis on home work using microdata.

## 3 Data and Stylized Facts

### 3.1 A Brief History of Home Workers in Japan

Home working was popular in the postwar high-growth period of Japan. Home workers are defined as those who work at home all days for tasks outsourced by companies, which does not include family workers and help of family business. Takano (2008) presented some anecdotal evidence for Japan. Females tended to engage in home work, almost always piecework, as subcontractors for manufacturing firms. Such home work was already popular in the 1930s in the Tokyo area. As of 1935 , there were 5,777 home workers in Tokyo City and many of them were young women for textile industries. On average they worked 8 hours a day and earned small income for household expenses (Tokyo City, 1936; Tanimoto, 2011). Prior to the 1980s, labor was divided by gender very strongly due to conservatism of gender roles, that is, men work and women do housework. Regular full-time female workers were rare, while many females worked as part-time/non-regular/self-employed workers, home workers, or housewives (Brinton, 1993). Thus, home work was convenient for females to support their household budget while raising children. According to Takano (2008), home workers accounted for 0.7 million in 1958 and increased to 1.8 million people at its peak in 1970, then decreased in the 1980s ( 1 million in 1986 and 0.7 million in 1993). In 1970, home workers were $15.8 \%$ of the labor force. Around $40 \%$ of the home workers were concentrated in the Greater Tokyo and Osaka areas. This is

[^3]because at that time manufacturing firms were concentrated in Tokyo and Osaka and outsourced piecework tasks to the neighborhood, thus incurring no transportation costs. Occupations were limited to specific manufacturing ones, e.g., textiles (tailoring and sewing), machine equipment (coil winding, soldering, and assembling), and miscellaneous products (umbrella and artificial flowers). After the oil shock of 1973, labor-saving technological growth in manufacturing, that is, automation, replaced home work. Furthermore, the 1980s and 1990s saw geographical diversification of manufacturing firms to many regions within Japan (multiple-plant operation and plant-headquarter separation, Fukao and Yue, 1997; Okubo and Tomiura, 2016) and subsequently to foreign countries (foreign direct investment, Hijzen et al.,2010). Labor-intensive production processes were offshored to labor-abundant countries (Tomiura, 2007). Accordingly, the number of total manufacturing workers as well as home workers decreased in this period. Particularly, from the 1990s onward, many labor-intensive tasks were outsourced to Asian countries, and the supply chain of production networks extended over the whole world. In Japan, employment of unskilled manufacturing workers shrank; the hollowing out of manufacturing industries was conspicuous (Yamashita and Fukao, 2010). Piecework at home almost disappeared from Japan.
Workers have seen working environments change dramatically. In the 1950s and 1960s, females working for companies as regular employees and high-wage jobs were rare. Some females worked at home with low wages under poor labor conditions, while some worked for factories and companies as part-time and nonregular workers. In 1970, the Industrial Homework Act was enacted to legally protect their labor conditions, where outsourced firms are responsible for a guaranteed minimum wage and better working conditions. In the 1980s, the moderate growth period after the oil shock, the improvement of working environments for all workers was one of the most important issues. In 1985, Law for Equal Employment Opportunity of Men and Women was enacted to promote female participation in the labor market so that females equal males in wage and employment status. Many home workers switched to regular workers to stabilize income under better working conditions. A five-working-day system spread widely in the late 1980-1990s. Legally, standard weekly working hours were reduced from 48 to 40 hours in 1982. The working style of Japanese workers shifted from working hard and earning a high income to improving work-life balance and quality of life (Kodama, 2007; Wakisaka, 2007; Kato and Kodama, 2015). The
decades after 1990 are known as the long-run stagnation period (the Lost Decades), in which economic growth, profits, and income were stagnant. During this, the traditional Japanese employment system, lifetime employment and seniority-based wages, collapsed. The number of non-regular workers increased. Meanwhile, the increasingly aging population together with low birth rates resulted in serious labor force shortages. This has led to a further decline in economic growth (Hayashi and Prescott, 2002; Ito and Hoshi, 2020). To tackle this problem, one of the series of economic reforms under Premier Abe is the government's promotion of firms to introduce a new WFH policy, that is, teleworking, since 2016, which is aimed at promoting female participation in the labor market and improving work performance and quality of life through flexible working time (Okubo et al.,2020).

### 3.2 Data and Definitions

This paper uses nationwide large-scale survey data for Japan, the Survey on Time Use and Leisure Activities, conducted by the Ministry of Internal Affairs and Communications (MIAC). ${ }^{7}$ The aim of the survey is to track workers' daily activities and time allocations over 24 -hour periods. The survey uses a time diary of 15 -minute intervals. ${ }^{8}$ The survey was initiated in 1976 and later it has been conducted every five years (in October). All nine waves from 1976 to 2016 are used in this paper. The respondents differ across waves, and thus the data are not in panel structure. Each wave uses a two-stage stratified random sample from the Population Census. Sample sizes and targets are slightly different over waves, although survey questions are in the same format (Appendix Table 1). ${ }^{9}$
In the survey, respondents are first asked about their primary daily activities: leisure/vacation travel, event/ceremonial occasions, business trips/job training, recuperation, holiday, parental leave, nursing care leave, workday, and other activities. Next, respondents are asked to write in a time diary using the precode method. The survey asks how they spend their time every 15 minutes over 24

[^4]hours. Activities are coded in detailed categories as follows: sleeping, personal care (dressing), meals, commuting to and from the office or school, working and doing tasks, schoolwork, housekeeping/household chores, nursing care for the aged, childcare, shopping, moving (excluding commuting), watching TV/listening to the radio/reading magazines or newspapers, rest and relaxation, study and job training (excluding schoolwork), hobbies/amusements, sports, volunteer/social activities, social life (e.g., meeting friends and talking with neighbors), medical treatment, and other (miscellaneous). Following the guidelines by MIAC, the activities are grouped into five categories.

1) Working hours
2) Housework hours, defined as doing household chores, nursing care for the elderly, and childcare
3) Leisure time, defined as watching TV/listening to radio/reading magazines or newspapers, rest and relaxation, study and training (excluding schoolwork), hobbies/amusements, sports, volunteer/social activities, social life (meeting friends), and shopping.
4) Sleep hours
5) Other time, comprising all other categories.

Our sample is limited to working people (including student workers and working mothers but not including full-time students, housewives/husbands, and unemployed people). The survey also asks about the worker's job from more than 50 occupations and 10 employment statuses (regular worker, part-time worker, business owner without employee, business owner with employee, helper for family business, and home work). Importantly, "home work," one of the employment status in the survey, is defined as WFH in our paper. The survey clearly defines "home work" as pieceworking at home by doing tasks outsourced by companies (as a subcontractor) with per-hour/day or per-unit wage.

The survey also asks individuals about their basic characteristics: gender, age, marriage status (single, married, or divorced), educational background, firm size, annual income, and average working hours per week. See Appendix Table 2 for the basic statistics and definitions (as of 1976).

### 3.3 Overview of WFH

The total numbers of survey respondents including students, unemployed people,
and housewives are 191,595 in 1976 and 176,285 in 2016. Our sample is limited to working people. Table 1 shows the number of working people:128,493 in 1976 and 101,717 in 2016 . Note that the total sample size is slightly different across waves (see Appendix Table 1). Decomposing by gender, there are 75,301 males and 53,192 females in 1976 and 54,831 males and 46,886 females in 2016.
The upper panel of Table 2 shows the numbers of WFH workers and all workers. The number of WFH employees dramatically decreases over time. In 1976, 5,830 out of 128,493 are WFH employees ( $4.5 \%$ ), while only 487 out of 101,717 are WFH employees in 2016 ( $0.4 \%$ ). The middle and bottom panels of Table 2 show the share of WFH workers by gender. There are more females than males. The WFH share of females is much higher than that of males in all periods. The female WFH share accounts for $10 \%$ in 1976, but it falls to $0.9 \%$ in 2016. Figure 1 summarizes the outcome. The share is more than $10 \%$ in the 1970 s and sharply decreases to $5 \%$ in the 1980s. In the 1990s, the share dramatically decreases from $4 \%$ to less than $1 \%$. This is consistent with the findings of Takano (2008), who showed the number of home workers in the 1970-1990s from the Outline Survey of Home Work (the Ministry of Labour).
Table 3 reports the number of WFH workers by detailed occupation from 1991 to 2006. It is evident that WFH is limited to some specific occupations in manufacturing. Detailed occupation/task information on home workers is available only from 1991 to 2006. In 1991, the largest occupation is tailors for female and child clothes $(1,576)$, and the second, third, and fourth largest are assemblers of electric machinery parts (525), yarn, twisting, and textile workers (180), and metal cutting and shaping machine workers (93), respectively. The number of clothes tailors, assemblers of electric machinery parts, and metal cutting and shaping machine workers are dominant in the 1990s, but all declined significantly while keeping some large shares in 2006 (Table 3 and Appendix Figure).
There are a number of reasons for the survival of some WFH jobs. Although our data are not in panel structure, we can derive some outcomes. First, some tasks are difficult to outsource to foreign countries. Offshoring of labor-intensive tasks from Japan to Asia is peculiar to the wave of globalization in the 1990s. However, some assembling and repairs are costly and time-consuming to transport. Some products are too heavy to transport, e.g., order-made clothes and hand embroidery of Japanese traditional Kimonos, or require multiple trips for the assembly of parts in electronic equipment. These tasks are done in the
neighborhood and are less likely to be offshored. A further reason is information asymmetry. Home workers are subcontractors for manufacturing firms, and thus it is sometimes costly to supervise them. It is efficient to outsource to the neighborhood in particular for specific tasks, such as minute handiwork, ordermade jobs, and repairs. Third, some handiwork tasks are relation-specific and need high skills and craftsmanship. The products may be, for example, traditional handicrafts of wood and pottery. These tasks are less likely to be offshored. Fourth, because of the low wage of home workers, many female workers have switched to part-time workers who work at the workplace with a higher wage. However, some home workers under some specific family circumstances remain to keep work-life balance and devote themselves to housework with family nursing and childcare.
Table 4 shows the demographics of WFH employees. The average age of WFH workers increased from 43 years in 1976 to 60 years in 2016, while for non-WFH workers it gradually increased from 41 years to 49 years. This indicates that WFH workers got older without new entrants. WFH workers are generally uneducated, a five-fold increase for WFH workers ( $3 \%$ in 1976 and $14 \%$ in 2016) compared with just over a two-fold increase for non-WFH workers (14\% in 1976 and 34\% in 2016). WFH workers have higher percentages of being married or divorced compared with non-WFH workers. In sum, WFH workers tend to be older, be less educated, and have higher rates of marriage and divorce. These tendencies have become more prominent in recent years.
Next, Table 4 presents the basic features of WFH by gender. WFH females are younger than males (59 years for females and 67 years for males in 2016). WFH females have a higher rate of divorce than males ( $7 \%$ for males and $20 \%$ for females in 2016).
Finally, the survey asks whether respondents enjoy flexible working hours. As shown in Table 4, a flexible working hour system is more likely to be adopted for WFH. Around $30-40 \%$ of WFH workers enjoy a flextime system compared with around $9-10 \%$ of non-WFH workers. Pieceworkers are paid per unit produced, and thus a flexible time system is suitable for them.

## 4 Time-use Patterns

### 4.1 Work, Housework, Leisure, and Sleep Hours

Our main interest is all employees who are working during the survey period (i.e., a workday). We now discuss the average working hours on workdays (in hours).

Table 5-1 shows working hours per day (excluding commuting, meals, and breaks). Overall, males worked longer hours than females. For males, working hours were around 8-9 hours. Both male and female's working hours steadily increased over time. By contrast, working hours in WFH were shorter by a few hours than non-WFH (around 6 hours for males and 5 hours for females). After the 1980s and 1990s, working hours in WFH decreased remarkably over time. Figure 2-1 summarizes the outcome. The working hour gap between WFH and non-WFH expanded slightly over time.
Next, Table 5-2 (Figure 2-2) shows housework hours. Overall, females devoted many more hours to housework than males. WFH females spent 1-2 hours more on housework than non-WFH females. By contrast, WFH males marginally increased their housework but averaged only 0.2-0.6 hours. Japanese males' housework hours are well-known as one of the lowest in the world. Furthermore, both non-WFH and WFH females slightly reduced housework hours after the middle 1980s. This implies that WFH females reduced working hours but did not use this time to do more housework.
Table 5-3 (Figure 2-3) shows leisure hours. Overall, males devoted more time to leisure than females. Both WFH males and females enjoyed longer leisure hours than non-WFH males and females and that increased over time. WFH males enjoyed 1-2 hours more leisure time than non-WFH males, while WFH females enjoyed $0.5-1$ hours more than non-WFH females. While male non-WFH workers slightly decreased leisure hours over time after the middle 1980s, male WFH workers steadily increased it. Likewise, while female non-WFH workers slightly reduced leisure hours after the 2000s, female WFH workers slightly increased those hours over time. The last ten years saw a small expansion of the gap between WFH and non-WFH workers' (mainly males') leisure time.
Table 5-4 (Figure 2-4) shows sleep hours. Both males and females decreased sleep hours over time. WFH males slept slightly more, while WFH females slept almost the same as non-WFH females. WFH had no or a marginal impact on sleep hours.
In sum, WFH workers reduce working hours and enjoy more leisure and housework. WFH does not help increase hours of sleep. WFH females tend to devote more time to housework and leisure, while WFH males tend only to enjoy more leisure. In particular, compared with non-WFH workers, WFH sees females devote 1.5 hours more to housework and $0.5-1$ hours more to leisure while working 2 hours less. For males, WFH increases leisure by 1-1.5 hours and
decreases work by 2 hours. Turning to transitional change, WFH workers tend to work fewer hours and instead enjoy more leisure time over time. This trend might be due to steadily falling demand for tasks in automation and foreign offshoring in the wave of globalization.
Now we examine increased leisure hours enjoyed by WFH and non-WFH workers. Figure 3 shows the decomposition of leisure hours by subcategories in 1976 and 2016. Leisure hours are decomposed into watching TV/listening to radio/reading magazines/newspapers, rest/relaxation, hobbies/amusement, sports, volunteer work/social activities, social life, shopping, and studying/training. WFH workers have increased total leisure hours from 1976 to 2016. Both WFH and non-WFH workers tend to increase rest/relaxation by 0.5-1 hours. While WFH workers do not change hours for watching TV/listening to radio over time, non-WFH workers reduce them. WFH workers also increase hobbies/amusement. Regardless of job destruction by offshoring, hours for studying/training are pretty short. It seems that they do not spend any time on improving their jobs through studying, but instead enjoy more leisure hours watching TV and relaxing. Although offshoring reduces working hours for WFH workers, spare time tends to be devoted to more amusement and entertainment. The core message of this is that labor market adjustment is always slow with mismatching because workers with the highest risk of job destruction decrease working hours but never spend time on training and studying for next job.

### 4.2 Time Use by Type of Workers

WFH and non-WFH Workers might vary the timing of their activities over the day. To investigate this, Figures 4 plot the share of workers in each time-use category at 15-minute intervals for 24 hours in 2011 by gender for WFH and non-WFH workers ("WFH_Male," "WFH_Female," "Non-WFH_Male," and "NonWFH_Female"). The sample comprises all workers who worked on the survey day. Note that work hours do not include commuting time. The first panel of Figure 4 plot the share of workers at work (working hours). Overall, most workers in all groups work during core working hours (9:00-17:00). In working hours, although male WFH workers have similar distributions in the morning to non-WFH males, they are less likely to work in the afternoon. They finish working earlier (after 15:00 or 16:00) or engage in other activities. WFH females see much smaller humps in the morning and afternoon than female non-WFH workers. They tend to start working later in the morning and finish in the middle or late afternoon and
also tend to do other activities over midday. Peculiar to WFH females is a hump at night. Some WFH females tend to work again between 20:00 and 23:00. This reflects how flexible working hours are for WFH.
The middle panel of Figure 4 shows the share of workers on housework hours. Housework hours tend to be much greater for females. Many female workers tend to do their housework in both mornings and evenings. Compared with non-WFH females, WFH females see much higher humps with long tails. Many spend much longer time on housework in both mornings and evenings. In particular, many WFH females spend longer time on housework from 5:00 to 10:00 and start housework earlier than non-WFH females by 1 hour (16:00-17:00).
The bottom panel of Figure 4 shows the share of workers spending on leisure. Leisure hours are longer for males. Non-WFH males tend to enjoy leisure time at night after 19:00. By contrast, WFH males see more humps over the whole day and a much bigger hump earlier at night than non-WFH males. Some start their leisure time at 16:00, and more than half of them are at leisure from 19:00 to 22:00. Even in the morning and noon, $10-20 \%$ of WFH males are at leisure. Although WFH females have a similar distribution at night to non-WFH females, they enjoy more leisure time in the mornings and afternoons. Around 30\% of WFH females are at leisure all afternoon.
Overall, WFH males and females spend fewer hours working in the afternoon and finish working earlier than the end of regular working hours (17:00). Most of the WFH females spend longer time on housework in the morning and evening; however, male WFH workers do not. Both WFH males and females tend to enjoy more leisure at night and some of them enjoy leisure and do housework even in the middle of the day. WFH males tend to enjoy more leisure at night than any other group. These findings indicate that WFH allows a highly flexible time allocation.

## 5 Time Premium for WFH

### 5.1 Estimation Strategy

We now conduct econometric analysis on the impact of WFH on time allocation. Using OLS estimation, we regress a WFH dummy and some independent variables on time use, work, leisure, housework, and sleep:

$$
\begin{equation*}
\text { Time }_{i}=\beta W F H_{i}+\alpha X_{i}+\varepsilon_{i}, \tag{1}
\end{equation*}
$$

where WFH is a dummy for WFH. $X$ denotes a set of basic traits such as age, gender, annual income, as well as several categorical variables: marriage status, educational background, firm size, occupation, and residential prefecture. Because our data are not panel structured, our estimations are conducted repeatedly for each wave from 1976 to 2016.
However, the simple OLS estimates of WFH are biased due to unobserved heterogeneity in workers, which is correlated with both time allocation and WFH. For example, divorced women with small children living independently are more likely to do WFH to earn income as well as engage in more childcare and household chores. Talented educated women who could easily get regular jobs in big companies (non-WFH) can reduce their working hours using their high capability to work at a high level. Thus, their family and personal conditions simultaneously affect the choice of WFH and time allocation between working and housework. Accordingly, the coefficients of the WFH dummy would combine the impact of WFH on time with other such impacts. This would overestimate or underestimate the true impact of WFH on time. To deal with the unobserved heterogeneity, we estimate bounds on the coefficients of WFH, as proposed by Altonji et al. (2005). Practically, we use the methodology of Oster (2019). Oster's beta $\beta^{*}$ is calculated as $\beta^{*}=\tilde{\beta}-\delta(\beta-\tilde{\beta})\left(\frac{R_{\max }-\tilde{R}}{\tilde{R}-R}\right) . \tilde{\beta}$ and $\tilde{R}$ are coefficients of WFH and R -squared when using all controls, respectively, while $\beta$ and R are coefficients of WFH and R-squared without any controls, respectively. Following Oster (2019), we set $\delta=1$ and $R_{\max }=1.3 \tilde{R}$. If the range between OLS estimates and Oster's beta (Oster bounds) includes zero, then the OLS estimates are not robust to omitted variable bias. For all statistically significant coefficients, when the Oster bounds do not include zero, our results on the impact of WFH are robust to bias from unobservables.

### 5.2 Results

Table 6 reports only OLS coefficients of WFH in each estimation (work, housework, leisure, and sleep) and Oster beta values for males and females. We omit all other coefficients due to limited space. Here we pick up only significant bounds of coefficients being robust in terms of Oster's beta.
In 1976, WFH males reduce their working hours by 1.1-1.2 hours, while WFH females reduce by 0.99-1.32 hours. By contrast, WFH males increase leisure hours by $0.56-0.66$ hours and sleep hours by $0.25-0.32$ hours, while females
increase housework hours by $0.3-0.6$ hours and leisure hours by $0.67-0.71$ hours. In the 1980s, WFH is more likely to affect females' time allocation. Females tend to devote less time to working and more to housework. In 1981 (1986), females work less by 1.3-1.4 hours (0.9-1.2 in 1986). Females increase housework hours by $0.8-0.9$ hours ( $0.6-0.8$ hours) and leisure time by $0.79-0.83$ hours ( $0.62-0.63$ ). In the 1990-2000s, it is evident that both males and females work less and enjoy more leisure time. WFH significantly reduces working hours by $0.97-1.23$ hours for males and 0.92-1.19 hours for females in 1991 (0.71-1.01 hours for males and 1.09-1.33 hours for females in 2001). WFH significantly increases leisure by $0.83-1$ hours for males and 0.57 hours for females in 1991 ( $0.98-1.16$ hours for males and 0.46-0.54 hours for females in 2001).
In the 2010s, the impact of WFH becomes much weaker and insignificant in most time categories. Only significant and robust results are presented as follows. In 2016, males reduce working by $0.52-1.12$ hours, while females reduce working by $0.26-0.77$ hours and increase housework by $0.44-0.72$ hours. In 2011, females decrease working hours by 0.72 to 1.04 hours and increase housework by 0.61-0.84 hours. WFH mainly affects females: reducing working hours and increasing housework hours. All other time allocations are neither significant nor robust for the WFH dummy.
To summarize, Figure 5 plots the trends of Oster bounds. The 1970-1980s see some partial impact of WFH, mainly contributing to reducing female working hours and instead allocating it to housework. In the 1990-2000s, males and females both reduce working hours and increase leisure hours greatly. In the 2010s, the impact of WFH on time disappears. More importantly, it is remarkable that females have significant and robust impacts in working and housework hours in all periods. WFH reduces many working hours and increases many housework hours for females.
This indicates that the 1980s saw automation and offshoring, which decreased many WFH jobs. Working hours for WFH females fell. By contrast, hours for WFH males did not decrease significantly and had no significant impact on time allocation. However, in the 1990-2000s, the wave of globalization and ICT greatly reduced both male and female WFH working hours by a similar magnitude. Instead, both male and female WFH workers increased their leisure time, but males tended to increase their leisure time more than females. Finally, in the 2010s, the impact of WFH almost disappeared, because a small number of WFH survived (Table 2).

## 6 Further Investigations

### 6.1 Wage Distribution and Sorting

Figure 6 plots the distribution of wages per hour in 1976, 1986, 1996, and 2006. We note that the numbers of WFH workers in 2011 and 2016 are too small to plot proper distributions. The distribution of per-hour wages for WFH workers is almost dominated by that of non-WFH workers. On average, the WFH wage is always lower than the non-WFH wage, because WFH workers are less educated and compete with low wages in Asia. However, the peaks of the distributions of WFH become lower over time. This means wage distributions have gradually dispersed. Furthermore, there are small humps in the range of higher wages. The humps at higher-wage levels become clearer and larger over time. This indicates that highly skilled home workers survived, and low-wage workers were more likely to have disappeared. The sorting might happen through the destruction of laborintensive piecework jobs due to offshoring.
In sum, in spite of lower wages, some WFH workers, in particular higher-waged workers, survive over time. There are some possible reasons. First, as discussed above, some specific piecework jobs are not substitutable with foreign outsourcing. Their jobs are relation-specific and require high skills and solid craftsmanship. They remain attractive to workers working at home. Second, those who remain working at home might be under some peculiar family circumstances. Due to some family reasons (e.g., divorced with small children), they balance devoting time to housework with keeping some income. Third, as shown above, WFH workers have more spare time but do not spend their time on training and studying for a new job. In the end, they remain on a low wage without upgrading to better jobs.

### 6.2 Comparison with "New WFH"

### 6.2.1 Basic Features of New WFH

We now compare the old WFH with the current WFH, remote work using ICT, which we call "new WFH." Previously, Okubo (2022) found flexible time allocation of new WFH using the 2016 survey. Both old and new WFH settings have some common features in making workers' time allocation more flexible. Both types of WFH have some advantages for females, helping them to earn income while raising children and doing housework. However, tasks of the old WFH are likely to be labor-intensive piecework with a lower wage. Old WFH faces a high risk of
offshoring and extinction in the wave of globalization and automation. By contrast, the new WFH promotes work-life balance and female participation in the labor market, promoted by the government. In general, unlike the old WFH, new WFH workers are employed by companies with a permission-based approach. Thus, some office workers are allowed to work at home using ICT for a whole day on some specific days. In other words, tasks are basically the same as when commuting to the workplace, the advantage being that WFH affords flexible time allocation.
In the data, new WFH can be identified only in 2011 and 2016 surveys. It is socially recognized in recent years and thus has been a subject in the survey since 2011. In the survey, WFH workers are rigorously defined as workers who are allowed to work at home for the whole day by their workplaces/employers. The survey asks whether respondents worked from home on the survey day. Table 7 presents some basics on the new WFH. First, a small number of workers take advantage of the new WFH. In total, there are only 449 WFH workers in 2011 and 304 workers in 2016. This finding is consistent with other studies (MLIT, 2016; Kazekami, 2020). ${ }^{10}$ Japan has a long tradition of workers commuting and working together in the workplace. A limited number of companies allowed WFH in 2016. Second, occupations are substantially different from the old WFH. As shown in Appendix Table 3, there are 213 males and evenly 236 females in 2011. This is in a sharp contrast with old WFH which is dominated by females. Table 7 shows the number of new WFH workers by occupation. Compared with old WFH (Table 3), new WFH covers much more varieties. Most new WFH workers are office workers. The largest are general clerical office workers (50 in 2011 and 31 in 2016) and the second largest are sales workers (36) in 2011 and authors and journalists (30) in 2016. Appendix Table 3 shows basic statistics on average age, university degree and marriage status. Compared with old WFH and non-WFH in Table 4, new WFH workers are younger and more educated than old WFH, while new WFH females are older, less educated, more married or divorced than nonWFH ones.

[^5]
### 6.2.2 Comparison of Time Use and Wages

Old and new WFH settings are compared by time allocation. Appendix Table 3 shows basic statistics on average hours for working, housework, leisure, and sleep. Compared with old WFH (Tables 5-1 to 5-4), new WFH workers tend to devote more time to working and less time to leisure and housework. Following the methodology of Oster beta in Section 5-1, Table 8 reports the results for new WFH in the 2011 and 2016 surveys. Although old WFH workers do not see many significant and robust results in the 2010s (Table 6), the impact on time for new WFH workers is substantial (larger magnitudes). Almost all are significant and robust (Table 8). They can significantly reduce more work time and spend much more time on housework and leisure. WFH females tend to increase more housework, while WFH males increase more leisure. Figure 7 summarizes the results for the Oster's bound estimates. The bounds are smaller than those of old WFH (Figure 5). New WFH has to be permitted by employers to allow workers to work at home, and thus many WFH workers are temporary and limited under specific conditions. This results in less bias due to unobserved heterogeneity in workers' heterogeneity. Hence, the bounds are smaller. Furthermore, some clear reasons and purposes are necessary to get permission for WFH such as childcare and nursing. Such clear purposes could properly promote WFH's flexibility in time allocation. For this reason, the impact of new WFH on time allocation is more substantial.

Next, Figures 8 plot the percentage of workers in activities by gender for new and old WFH at 15-minute intervals for 24 hours in the 2011 survey. ("WFH_Male," "WFH_Female," "New-WFH_Male," and "New-WFH_Female"). For working hours, although old and new female WFH workers both have a similar time schedule, there are some small differences. New WFH females have similar finishing hours in that most of them keep working until 18:00, one hour later than old WFH females. Turning to males, there is a large contrast. New WFH males work much longer and most of them finish work around 20:00. They have smaller humps than old WFH males. This indicates that new WFH males are more likely to do other activities at midday than old WFH males.
Housework hours are also slightly different between old and new WFH females. New WFH females tend to have dinner and lunch slightly later than their older counterparts. Old WFH females have a higher hump in the morning and noon. This implies that new WFH females tend to devote less time to housework. In leisure hours, old WFH females see higher humps. Old WFH males show a much
larger hump with a long tail at night, while old WFH females show some humps in the daytime. Because old WFH workers are not required to co-work with colleagues or others at the office or other places, they have no constraints on working hours and can take leisure time and perform housework as they please. Therefore, we can state that both old and new WFH workers can reduce their working hours, but old WFH workers are much more flexible in allocating their time, taking more leisure time in the day, and spending more time on housework in the morning and noon. Then, their working hours are shorter compared with those of new WFH workers. They can spend more time on leisure. In particular, old male WFH workers take leisure time in the late afternoon, earlier than usual closing hours (17:00).
Old WFH females' working time sees a hump at night after completing housework related to dinner, while new WFH females do not exhibit this pattern. Because the old WFH workers are flexible and mainly perform piecework, their working hours are much more flexible. By contrast, new WFH workers are required to co-work with their colleagues using ICT tools, and thus they work during the regular working hours, 9:00-17:00. Their working hours are similar to office workers, although they avoid commuting time but may overwork. New WFH allows finishing work at regular working times and then immediately switching to housework such as cooking meals and caring for children.
Finally, we discuss wage distribution. Figure 9 shows the distribution of wages per hour. Unlike old WFH workers, new WFH workers' wages are almost identical or slightly higher than for non-WFH workers. The new WFH workers are temporarily working from home and tend to be educated with high ICT skills (Okubo, 2022). Therefore, wages should be higher than old WFH workers and similar to non-WFH office workers.

### 6.3 Implications

Old WFH had significant and robust impacts on time use mainly in the 1990s to 2000s. After the 2010s, the impact has disappeared. This is due to job destruction in the wave of globalization. On the other hand, new WFH has significantly larger impacts on time allocation in the 2010s, because it is permission-based and workers are required to have clear aims for WFH.
However, both new and old WFH tends to involve routine work, although new WFH uses ICT and is permission-based. As discussed in Baldwin (2018), in the wave of globalization and IT revolutions, routine workers including WFH office
workers (teleworkers) in developed countries are most likely to be exposed to the risk of job destruction in the future. The current globalization and IT revolution have led to skill-biased technology development, which always involves labor adjustment problems such as unemployment and wage inequalities. In the end, routine workers tend to reduce income and lose jobs. In spite of it, WFH can make time allocation flexible with or without ICT tools. WFH workers enjoy more leisure and housework, boosting life satisfaction. However, our results on old and new WFH show that they tend to spend more leisure time through reducing working hours in particular on amusement and entertainment rather than job search or studying and training for their next job. This implies that such behaviors have led to a sluggish adjustment of the labor market.

## 7 Conclusion

This paper studies old WFH, that is, piecework at home or home work, by subcontractors for manufacturing firms, as shown by worker-level long-run timeuse data in Japan, from 1976 to 2016. Old WFH workers do labor-intensive tasks. Occupations are specific, e.g., handicrafts of textiles and assembling of parts of electrical machines. The number of old WFH workers drastically decreased in the wave of globalization and automation. These are in contrast with the current WFH. However, there are some common features with the current WFH teleworkers using ICT. We find that females are more likely to WFH. WFH can improve the flexibility in time use, in which working hours can be reduced, and workers can devote more time to leisure and housework. This is advantageous to females with small children. Unlike new WFH, labor-intensive tasks of old WFH face the risk of extinction by offshoring. Workers tend to reduce their working hours over time; however, they do not spend that time studying for the next job but instead spend it on more leisure. In addition, their wages are lower; however, high-wage WFH workers tend to survive.
Our analysis has some limitations. The survey does not ask about life satisfaction. Therefore, we cannot correlate WFH and life satisfaction (or happiness). In addition, the survey does not ask any questions on exposure to globalization and automation. Such variables would allow us to explore these issues.

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## Table 1: Sample Size (Workers only)

Year

|  | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| Male | 75,301 | 81,645 | 90,542 | 92,825 | 89,059 | 62,077 | 57,208 | 55,563 | 54,831 |
| Female | 53,192 | 58,472 | 67,223 | 72,038 | 68,001 | 48,632 | 46,324 | 45,646 | 46,886 |
| All | 128493 | 140,117 | 157,765 | 164,863 | 157,060 | 110,709 | 103532 | 101209 | 101,717 |

Table 2: Number of Work from Home (WFH)

| Total | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| WFH | 5830 | 3455 | 3559 | 3,226 | 1,704 | 1,085 | 800 | 581 | 487 |
| All | 128493 | 140,117 | 157,765 | 164,863 | 157,060 | 110,709 | 103532 | 101209 | 101,717 |
| WFH share | 0.045372 | 0.024658 | 0.022559 | 0.019568 | 0.010849 | 0.0098 | 0.007727 | 0.005741 | 0.004788 |


| Male | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| WFH | 281 | 124 | 123 | 164 | 109 | 117 | 82 | 62 | 68 |
| All | 75,301 | 81,645 | 90,542 | 92,825 | 89,059 | 62,077 | 57,208 | 55,563 | 54,831 |
| WFH share | 0.003732 | 0.001519 | 0.001358 | 0.001767 | 0.001224 | 0.001885 | 0.001433 | 0.001116 | 0.00124 |


| Female | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| WFH | 5,549 | 3455 | 3,436 | 3,062 | 1,595 | 968 | 718 | 519 | 419 |
| All | 53,192 | 58,472 | 67,223 | 72,038 | 68,001 | 48,632 | 46,324 | 45,646 | 46,886 |
| WFH share | 0.10432 | 0.059088 | 0.051113 | 0.042505 | 0.023456 | 0.019905 | 0.0155 | 0.01137 | 0.008937 |

## Table 3: WFH by Occupation

| Occupations | 1991 | 1996 | 2001 | 2006 |
| :--- | ---: | ---: | ---: | ---: |
| General office clerks | 18 | 24 | 6 | 7 |
| Pottery workers | 28 | 17 | 2 | 1 |
| Metal cutting and shaping machine workers | 93 | 64 | 43 | 39 |
| Assemblers of general machinery parts and repairmen | 33 |  | 9 | 16 |
| Assembers of electronic machinery parts and repairmen | 525 | 244 | 114 | 93 |
| Assemblers of clocks and watches and repairmen | 37 | 21 | 10 | 6 |
| Bread and sweets production workers | 6 | 10 | 10 | 5 |
| Yarn, twisting and textile workers | 180 | 84 | 50 | 28 |
| Tailors for female and child clothes | 1576 | 877 | 474 | 276 |
| Wooden product producers | 42 | 8 | 9 | 9 |
| Paper craft producers | 48 | 31 | 25 | 14 |
| Printing workers | 21 | 3 | 5 | 3 |
| Rubber product workers | 90 | 60 | 43 | 34 |
| Leather product producers | 45 | 72 | 18 | 10 |
| Misc | 473 | 154 | 267 | 259 |

Table 4: Basic Features of WFH and non-WFH
Age

| Non-WFH | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| Male | 41.22556 | 42.14704 | 42.96979 | 43.99145 | 44.57432 | 46.21096 | 47.39075 | 48.12501 | 49.47634 |
| Female | 40.11037 | 41.64935 | 42.00795 | 42.69453 | 43.43793 | 44.94407 | 45.98136 | 46.57653 | 48.01621 |
| All | 40.79243 | 41.94623 | 42.57192 | 43.43801 | 44.08858 | 45.66012 | 46.76508 | 47.43059 | 48.8061 |


| WFH | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| Male | 59.85409 | 56.54032 | 59.13821 | 64.85366 | 64.95413 | 63.45299 | 65.35366 | 67.66129 | 67.85294 |
| Female | 42.33339 | 43.26449 | 44.87602 | 48.08818 | 50.5279 | 53.14979 | 55.06128 | 56.17534 | 59.00955 |
| All | 43.17787 | 43.74096 | 45.36892 | 48.94048 | 51.4507 | 54.26083 | 56.11625 | 57.40103 | 60.24435 |


| University | Non-WFH | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1: degree | Male | 0.173447 | 0.206798 | 0.249782 | 0.256947 | 0.282473 | 0.294254 | 0.326174 | 0.365075 | 0.352464 |
| 0 : non-degree | Female | 0.087358 | 0.130477 | 0.196984 | 0.199301 | 0.247252 | 0.273645 | 0.320967 | 0.376604 | 0.335077 |
|  | All | 0.14001 | 0.176003 | 0.227942 | 0.232348 | 0.267418 | 0.285293 | 0.323862 | 0.370245 | 0.344483 |
|  | WFH | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
|  | Male | 0.088968 | 0.024194 | 0.03252 | 0.018293 | 0 | 0.042735 | 0.085366 | 0.112903 | 0.132353 |
|  | Female | 0.026672 | 0.04323 | 0.105937 | 0.087198 | 0.104702 | 0.102273 | 0.151811 | 0.16763 | 0.145585 |
|  | All | 0.029674 | 0.042547 | 0.1034 | 0.083695 | 0.098005 | 0.095853 | 0.145 | 0.16179 | 0.143737 |


| Married | Non WFH | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1: married | Male | 0.801813 | 0.792282 | 0.789613 | 0.769029 | 0.750343 | 0.739445 | 0.734919 | 0.722564 | 0.713219 |
| 0 : unmarried | Female | 0.644019 | 0.67797 | 0.685594 | 0.669117 | 0.653691 | 0.658904 | 0.653993 | 0.644913 | 0.651215 |
|  | All | 0.740525 | 0.746159 | 0.746586 | 0.726393 | 0.70903 | 0.704426 | 0.698994 | 0.687741 | 0.684758 |


| WFH | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| Male | 0.782918 | 0.830645 | 0.788618 | 0.829268 | 0.87156 | 0.811966 | 0.768293 | 0.758065 | 0.75 |
| Female | 0.849162 | 0.839688 | 0.864959 | 0.844546 | 0.820063 | 0.795455 | 0.830084 | 0.749518 | 0.73747 |
| All | 0.845969 | 0.839363 | 0.862321 | 0.843769 | 0.823357 | 0.797235 | 0.82375 | 0.75043 | 0.73922 |


| Divorced | Non-WFH | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |  |
| :--- | :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 1: divorced | Male | 0.024167 | 0.026225 | 0.026908 | 0.029484 | 0.032861 | 0.038702 | 0.043991 | 0.049927 | 0.053083 |  |
| 0: non-divorced | Female | 0.125412 | 0.12072 | 0.107937 | 0.10508 | 0.108831 | 0.110335 | 0.118493 | 0.126709 | 0.12921 |  |
|  | All | 0.063491 | 0.064353 | 0.060426 | 0.061743 | 0.065334 | 0.069848 | 0.077065 | 0.08436 | 0.088027 |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | WFH | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |  |
|  | Male | 0.092527 | 0.064516 | 0.113821 | 0.085366 | 0.073395 | 0.068376 | 0.085366 | 0.064516 | 0.073529 |  |
|  | Female | 0.114075 | 0.130291 | 0.104482 | 0.126715 | 0.142947 | 0.166322 | 0.130919 | 0.190751 | 0.202864 |  |
|  | All | 0.113036 | 0.127931 | 0.104805 | 0.124613 | 0.138498 | 0.15576 | 0.12625 | 0.177281 | 0.184805 |  |


| Flextime(\%) | Non-WFH | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Male | 8.37 | 8.65 | 10.45 | 9.81 | 9.95 | 10.15 | 10.79 | 9.36 |
|  | Female | 12.45 | 10.85 | 12.34 | 11.09 | 10.34 | 9.88 | 10.22 | 8.06 |
|  | All | 10.02 | 9.56 | 11.26 | 10.36 | 10.12 | 10.03 | 10.53 | 8.76 |
|  | WFH | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
|  | Male | 27.42 | 30.08 | 43.29 | 52.29 | 35.9 | 42.68 | 41.94 | 27.94 |
|  | Female | 35.54 | 28.29 | 34 | 36.61 | 33.99 | 31.2 | 40.08 | 38.9 |
|  | All | 35.25 | 28.35 | 34.47 | 37.62 | 34.19 | 32.38 | 40.28 | 37.37 |

Table 5-1: Working Hours
Unit: hour

| Male | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| Total | 8.179234 | 8.140677 | 8.407035 | 8.716645 | 8.785673 | 8.63787 | 8.886198 | 8.838783 | 8.840683 |
| Non-WFH | 8.185422 | 8.141555 | 8.408415 | 8.720585 | 8.788863 | 8.64157 | 8.889548 | 8.84166 | 8.844543 |
| WFH | 6.274257 | 7.628931 | 7.392858 | 6.654515 | 6.40625 | 6.799383 | 6.465688 | 6.511628 | 6.033333 |


| Female | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| Total | 6.833688 | 6.855783 | 6.907453 | 7.01878 | 7.02274 | 6.847898 | 7.084033 | 7.066433 | 7.13925 |
| Non-WFH | 7.001866 | 6.946164 | 6.994868 | 7.08482 | 7.066958 | 6.88265 | 7.11423 | 7.088655 | 7.158543 |
| WFH | 5.339665 | 5.42838 | 5.335358 | 5.577203 | 5.331108 | 5.197155 | 5.259978 | 5.26814 | 5.1295 |

Table 5-2: Housework hours
Unit: hour

| Male | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| Total | 0.070303 | 0.079437 | 0.112643 | 0.122661 | 0.116288 | 0.187066 | 0.169138 | 0.187066 | 0.212936 |
| Non-WFH | 0.069941 | 0.079286 | 0.112228 | 0.122209 | 0.115848 | 0.150667 | 0.168836 | 0.186499 | 0.212465 |
| WFH | 0.181683 | 0.167453 | 0.324468 | 0.359375 | 0.444445 | 0.645349 | 0.387255 | 0.645349 | 0.555556 |


| Female | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| Total | 2.198648 | 2.377561 | 2.49191 | 2.418516 | 2.18459 | 2.198512 | 2.142424 | 2.087553 | 2.049721 |
| Non-WFH | 2.068169 | 2.296138 | 2.408272 | 2.347272 | 2.147213 | 2.170007 | 2.116653 | 2.070664 | 2.036501 |
| WFH | 3.357775 | 3.663481 | 3.996085 | 3.973728 | 3.61449 | 3.55244 | 3.699003 | 3.454258 | 3.437763 |

## Table 5-3: Leisure hours

Unit: hour

| Male | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| Total | 3.575037 | 4.003134 | 4.209408 | 4.007523 | 3.820373 | 3.939845 | 3.752468 | 3.775563 | 3.661493 |
| Non-WFH | 3.570369 | 4.002176 | 4.208415 | 4.004483 | 3.818803 | 3.936438 | 3.750285 | 3.773558 | 3.65855 |
| WFH | 5.011881 | 4.562107 | 4.93956 | 5.598958 | 4.989583 | 5.632715 | 5.328433 | 5.39535 | 5.8 |


| Female | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| Total | 3.172857 | 3.546819 | 3.623133 | 3.648703 | 3.59419 | 3.75165 | 3.65955 | 3.686763 | 3.53531 |
| Non-WFh | 3.092794 | 3.505759 | 3.590728 | 3.625703 | 3.576733 | 3.73795 | 3.647553 | 3.6788 | 3.527438 |
| WFH | 3.884101 | 4.195277 | 4.205953 | 4.150768 | 4.262118 | 4.40244 | 4.384148 | 4.33123 | 4.361815 |

Table 5-4: Sleep hours
Unit: hour

| Male | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| Total | 7.938413 | 7.981087 | 7.742485 | 7.57911 | 7.570428 | 7.517903 | 7.457425 | 7.40385 | 7.32061 |
| Non-WFH | 7.936645 | 7.980348 | 7.741883 | 7.577865 | 7.569045 | 7.517473 | 7.456245 | 7.402833 | 7.32002 |
| WFH | 8.482673 | 8.41195 | 8.186813 | 8.230903 | 8.600695 | 7.731483 | 8.308823 | 8.226745 | 7.75 |


| Female | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| Total | 7.526719 | 7.571939 | 7.35813 | 7.207688 | 7.23465 | 7.202853 | 7.114355 | 7.056758 | 7.018053 |
| Non-WFh | 7.529468 | 7.573575 | 7.362265 | 7.21001 | 7.234365 | 7.201613 | 7.113735 | 7.054488 | 7.015633 |
| WFH | 7.502304 | 7.546102 | 7.28377 | 7.157033 | 7.24555 | 7.261788 | 7.151885 | 7.240538 | 7.272153 |

Table 6: Bound Estimates

|  |  | 1976 |  | 1981 |  | 1986 |  | 1991 |  | 1996 |  | 2001 |  | 2006 |  | 2011 |  | 2016 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Working | Male | -1.2 | *** | -0.238 |  | -0.255 |  | -1.232 | *** | -1.527 | *** | -1.01 | *** | -1.236 | *** | -0.511 |  | $-1.127^{* *}$ |
|  |  | -1.1039 |  | -0.155 |  | -0.0847 |  | -0.9708 |  | -1.193 |  | -0.7155 |  | -0.87 |  | 0.0006 |  | -0.5261 |
|  | Female | -1.324 | *** | -1.412 | *** | -1.203 | *** | -1.199 | *** | -1.26 | *** | -1.332 | *** | -1.315 | *** | -1.04 | *** | $-0.772^{* * *}$ |
|  |  | -0.9989 |  | -1.344 |  | -0.9754 |  | -0.9279 |  | -0.997 |  | -1.0986 |  | -1.0013 |  | -0.7254 |  | -0.267 |
| Housework | Male | 0.0397 |  | 0.0514 |  | 0.186 | ** | 0.19300 | ** | 0.204 |  | 0.13400 | * | 0.0954 |  | 0.184 |  | 0.232 |
|  |  | 0.02403 |  | 0.0402 |  | 0.17472 |  | 0.17672 |  | 0.1832 |  | 0.12129 |  | 0.0811 |  | 0.1646 |  | 0.20245 |
|  | Female | 0.603 | *** | 0.986 | *** | 0.858 | *** | 0.797 | *** | 0.862 | *** | 0.862 | *** | 0.946 | *** | 0.84 | *** | $0.723^{* * *}$ |
|  |  | 0.30755 |  | 0.8543 |  | 0.60032 |  | 0.24801 |  | 0.4796 |  | 0.58168 |  | 0.63266 |  | 0.6153 |  | 0.44917 |
| Leisure | Male | 0.662 | ** | 0.4 | ** | 0.120 |  | 1.001 | *** | 0.745 | ** | 1.16 | *** | 0.852 | ** | 0.507 |  | 0.00731 |
|  |  | 0.56401 |  | 0.3512 |  | 0.00698 |  | 0.83523 |  | 0.5379 |  | 0.98159 |  | 0.61347 |  | 0.1229 |  | -0.1132 |
|  | Female | 0.717 | *** | 0.792 | *** | 0.635 | *** | 0.571 | *** | 0.58 | *** | 0.541 | *** | 0.538 | *** | 0.122 |  | 0.130 |
|  |  | 0.67457 |  | 0.8302 |  | 0.62763 |  | 0.57869 |  | 0.5435 |  | 0.46357 |  | 0.42518 |  | -0.0831 |  | 0.07672 |
| Sleep | Male | 0.326 | *** | 0.244 | ** | 0.252 |  | 0.286 | *** | 0.569 | *** | -0.279 |  | 0.456 | *** | 0.314 |  | 1.079 |
|  |  | 0.25685 |  | 0.1873 |  | 0.14992 |  | 0.14206 |  | 0.4083 |  | -0.4376 |  | 0.32921 |  | 0.1711 |  | 0.65629 |
|  | Female | -0.0724 | *** | 0.00957 |  | -0.158 | *** | -0.0173 |  | -0.00733 |  | 0.0349 |  | -0.0298 |  | 0.219 | ** | 0.118 |
|  |  | -0.035 |  | 0.0212 |  | -0.1857 |  | 0.01415 |  | 0.0006 |  | 0.03276 |  | -0.0655 |  | 0.2236 |  | -0.1414 |

*** $\mathrm{p}<0.01,{ }^{* *} \mathrm{p}<0.05,{ }^{*} \mathrm{p}<0.1$

## Table 7: Occupations of New WFH year

| Occupation | 2011 | 2016 |
| :---: | :---: | :---: |
| Administrative government officers | 5 |  |
| Administrative and managerial | 3 | 1 |
| Researchers | 1 | 1 |
| Engineers | 13 | 9 |
| Public health and medical workers | 16 | 9 |
| Social welfare workers | 7 | 3 |
| Teachers | 16 | 5 |
| Authors, journalists, editors, Artists, designers, photographers | 18 | 30 |
| Other professional workers | 11 | 13 |
| General clerical | 50 | 31 |
| Accountancy clerical | 17 | 21 |
| Production-related clerical | 2 | 1 |
| Sales clerks |  | 3 |
| Outdoor service | 1 |  |
| Office appliance operators | 4 | 4 |
| Commodity sales | 36 | 13 |
| Sales related workers | 1 | 2 |
| Sales workers | 20 | 11 |
| Family Life Support and Care Service | 3 | 2 |
| Nurcing service | 13 | 9 |
| Health service | 1 |  |
| Occupational health and hygiene | 11 | 9 |
| Food and drink cooking | 9 | 5 |
| Serving and waiter | 16 | 6 |
| Residential facilities and buildings | 4 | 2 |
| Other service workers | 7 | 11 |
| Security workers | 6 | 6 |
| Agriculture | 9 | 17 |
| Forestry |  | 1 |
| Fishery | 1 |  |
| Manufacturing process (metal products) | 8 | 6 |
| Manufacturing process (excl. metal products) | 22 | 13 |
| Machinery mechanics | 2 | 5 |
| Machinery repairers | 6 | 1 |
| Product inspection | 4 | 1 |
| Production-related worker | 2 | 2 |
| Car operation | 19 | 6 |
| Transport operation | 1 |  |
| Machine operation |  | 1 |
| Construction | 17 | 5 |
| Building and related electricians | 3 |  |
| Others | 27 | 23 |
| Carrying | 14 | 9 |
| Cleaning | 8 | 1 |
| Packaging | 4 | 2 |
| Other carrying, cleaning, packaging | 11 | 4 |
|  | 449 | 304 |

Table 8: Bound Estimates on New WFH
2011

|  | Working | Housework | Leisure | Sleep |
| :---: | :---: | :---: | :---: | :---: |
| Male | -0.877 *** | 0.146 | $1.156^{* * *}$ | $0.268{ }^{* *}$ |
|  | -0.75673 | 0.45758 | 1.03594 | 0.3106 |
| Female | -0.656 *** | $0.52^{* * *}$ | $0.569{ }^{* * *}$ | 0.101 |
|  | -0.58288 | 0.865 | 0.54947 | 0.12488 |

*** $\mathrm{p}<0.01$, ${ }^{* *} \mathrm{p}<0.05,{ }^{*} \mathrm{p}<0.1$

2016

|  | Working | Housework | Leisure | Sleep |
| :--- | :--- | :---: | :---: | :---: |
| Male | $-1.779^{* * *}$ | $0.534^{* * *}$ | $1.046^{* * *}$ | $0.535^{* *}$ |
|  | $-1.69212^{*}$ | 0.51453 | $1.006^{* *}$ | 0.54516 |
| Female | $-1.14099^{* * *}$ | $0.969^{* * *}$ | $0.406^{* *}$ | 0.259 |
|  | $-1.00562^{*}$ | 0.80927 | 0.41105 | 0.02821 |

*** $\mathrm{p}<0.01$, ${ }^{* *} \mathrm{p}<0.05$, ${ }^{*} \mathrm{p}<0.1$

Figure 1 WFH share (by gender)



## Figure 2-2: Housework Hours

Housework hours (male)



Figure 3: Decomposition of Leisure Hours (1976 and 2016)



## Figure 4: Share of Workers on Each Time Use for WFH and non-WFH workers





## Figure 5: Oster's Bound Estimates

BB: Blue bars indicate significant and robust bounds. White bars indicate insignificant and not robust bounds.


Figure 6: Per-hour Wage Distributions
Unit: 1000 yen, bw:0.5-0.7

1976


1986


1996


2006


Figure 7: Bound Estimates on New WFH


## Figure 8: Share of Workers on Each Time Use for Old and New WFH Workers




Figure 9: Per-hour wage distribution of New WFH (2011) Unit: 1000 yen


Appendix Table 1: Outline of the Survey on Time Use and Leisure Activities

| Wave | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Year | 1976 | 1981 | 1986 | 1991 | 1996 | 2001 | 2006 | 2011 | 2016 |
| Day of survey | $\begin{aligned} & \text { One day from Oct } \\ & 17 \text { th to } 23 \text { rd } \end{aligned}$ | October 1st |  |  |  | October 20th |  |  |  |
| Num Respondents (thousand persons) | 190 | 210 | 240 | 250 | 270 | 190 | 190 | 190 | 180 |
| Min age of respondents | Age 15 |  |  |  | Age 10 |  |  |  |  |
| Sampling base: Year of Population Census | 1975 | 1980 | 1985 | 1990 | 1995 | 1995 | 2000 | 2005 | 2010 |

## Appendix Table 2: Basic Statistics (Year 1976)

NB: workers at work (workdays)

| stats | N | mean |  | min | $\max$ |  |
| :--- | ---: | :--- | ---: | ---: | ---: | ---: |
| sd |  |  |  |  |  |  |
| Working hours (unit: hour) | 103323 | 7.670038 | 0.1 | 24 | 2.336588 |  |
| Housework hours (unit: hour) | 103323 | 0.931612 | 0 | 14.1 | 1.654122 |  |
| Leisure hours (unit: hour) | 103323 | 3.387786 | 0 | 16 | 1.881177 |  |
| Sleep hours (unit: hour) | 103323 | 7.760522 | 0 | 17.3 | 1.098344 |  |
| (old) WFH | 104104 | 0.040901 | 0 | 1 | 0.198063 |  |
| Sex (1: male, 2: female) | 104104 | 1.403299 | 1 | 2 | 0.490562 |  |
| Age (In) | 104098 | 3.645604 | 2.70805 | 4.532599 | 0.346391 |  |
| Annual Income (In) | 103125 | 0.949101 | -0.69315 | 2.302585 | 0.626179 |  |
| Own house (dummy) | 104104 | 0.693019 | 0 | 1 | 0.461244 |  |
| university degree | 104104 | 0.131282 | 0 | 1 | 0.33771 |  |
| married dummy | 104104 | 0.749558 | 0 | 1 | 0.43327 |  |
| divorce dummy | 104104 | 0.061535 | 0 | 1 | 0.24031 |  |

## Appendix Table 3: New WFH (Year 2011)

|  | Num New WF |
| :--- | ---: |
| Male | 213 |
| Female | 236 |
| Total | 449 |


|  | Age | University | Married | Divorced |
| :--- | :--- | :--- | :--- | :---: |
| Male | 48.83099 | 0.4647887 | 0.699531 | 0.042254 |
| Female | 52.36864 | 0.3559322 | 0.716102 | 0.131356 |
| Total | 50.69042 | 0.4075724 | 0.708241 | 0.089087 |

Unit: hour

|  | Working | Housework Leisure | Sleep |  |
| :--- | ---: | ---: | ---: | ---: |
| Male | 7.469698 | 0.5757575 | 4.969698 | 8.098485 |
| Female | 5.654413 | 3.338235 | 3.85294 | 7.279413 |
| Total | 6.548508 | 1.977612 | 4.402985 | 7.682835 |

## Appendix Figure: Old WFH by occupation (1976 to 2016)




[^0]:    ${ }^{1}$ In Europe, 37\% of workers began working remotely (Eurofound, 2020), including 20-50\% of teleworkers (Alipour et al.,2020). In Japan, WFH increased from 6\% in January 2020 to 17\% in June 2020 (Okubo, 2020).

[^1]:    ${ }^{2}$ Dingel and Neiman (2020) identified the occupations that can be performed entirely at home and estimated how much of the population could possibly work from home using job characteristic information on O*NET and US Bureau of Labor Statistics data. It was found that $37 \%$ of US workers could possibly perform their jobs entirely from home.
    ${ }^{3}$ Most of these studies employ the 2004 Current Population Survey Work Schedules and Work at Home Supplement and the 2004-2005 American Time Use or the 2017-2018 ATU Survey Leave and Job Flexibilities module.
    ${ }^{4}$ Giménez-Nadal et al. (2019) found that remote workers devote fewer hours to work than office workers and $60 \%$ of remote workers work regular working hours, whereas $80 \%$ of commuters do so.

[^2]:    ${ }^{5}$ Ito (2019) and Ishida (2019) explored time allocation for hobbies and leisure across generations and various family structures.

[^3]:    ${ }^{6}$ Tominaga (1972) pointed out the problems of home workers' low wage rates. Nakazawa (2021) described home workers and labor administration policies in Kanagawa prefecture in the 1980s based on archival elucidation, while Takano (2018) provides some anecdotal evidence on the labor market for home workers in Osaka.

[^4]:    7 https://www.stat.go.jp/data/shakai/2016/gaiyou.html
    ${ }^{8}$ Kuroda (2010) compared the time-use survey with the Labour Force Survey, the Monthly Labour Survey, and other surveys and found no significant sample bias in the time-use data. A potential problem is that time-use surveys sometimes involve downward bias in working hours because busy people are sometimes unable to correctly record their activities every 15 minutes. However, Kuroda (2010) found no such bias in the Japanese time-use survey. 9 The survey target is the Japanese people living in Japan. The sample sizes are around 190,000 people in 1976 and all waves after 2001, while they are around 210,000-270,000 in 1981-1996. See Appendix Table 1.

[^5]:    ${ }^{10}$ According to MLIT (2016), only 3.5\% of all employees teleworked more than once a week, $82.7 \%$ of teleworkers checked e-mails and searched websites, and $73.9 \%$ listed creating documents as their main task. Using data from the Japanese Panel Study of Employment Dynamics (the Recruit Works Institute), Kazekami (2020) found that $2.4 \%$ of male workers and $1.64 \%$ of female workers were involved in WFH in 2017, but $95 \%$ of them were working on miscellaneous chores.

