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Working paper

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Abstract

This study aims to clarify that imbalances in the division of time within children's household may lead to them becoming young (adult) carers. When we accurately discuss young (adult) carers, we should define them with a specific range of age, household environment, responsibilities, and level of burden. However, deciding on the last term is hard because it depends on children's characteristics. We then introduce the concept of "potential" young (adult) carers: children under 25 burdened with home duties. In addition, we focus on two-parent households. In two-parent households, if the parental division of home duties is functional, it is expected that children would not need to sacrifice rest time to engage in them; therefore, if children engage in home duties during times when they should be sleeping, we would observe a situation suggesting potential young (adult) carers and a lack of functional home duties division within their household. We use the cross-sectional data from time use and leisure activities conducted by the Statistics Bureau, Ministry of Internal Affairs and Communications in 2011 and 2016. We analyze the relationship between the mother's home-duty time and the likelihood of children engaging in them late-night time. As the major results, we found that children tend to be potential young (adult) carers if (i) the mother's home-duty and commuting time increase, children tend to do during times when they should be sleeping. In contrast, the father's home-duty and commuting time decrease, children tend to do during times when they should be sleeping, (ii) father's social status is low, (iii) when the child is female, there is a significant association with engaging in home duties at late-night.

Keywords: young (adult) carers, two-parent household, home-duty time, imbalance in the division of time

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1. Introduction

This study aims to analyze the impact of changing in parents' home-duty time on children's household responsibilities, particularly examining the likelihood of children who is to be burdened with home duties during the times when they should be sleeping, which may contribute to the emergence of potential young (adult) carers.

The Ministry of Health, Labour and Welfare (MHLW) asked Mitsubishi UFJ Research & Consulting (MURC) and The Japan Research Institute (JRI) to survey young carers. MURC (2021) revealed that the rates of young carers were about one in 17 eighth-grade students and one in 24 second-year students at full-time high school. JRI (2022) revealed that the rates of young carers were about one in 15 sixth-grade students and one in 16 third-year students at university. Furthermore, JRI (2022) showed that young carers tend to "be in poor/not so good health," "late or leaving early," "fall asleep in classes," "fail to complete homework or submit it late," and "forget belongings," among sixth-grade students. (For further detail, see Section 2.1.) From the above circumstances, young carers have disadvantages in their education, leisure time, and the progression of their careers.

If some students seem to be in the above circumstances, we can find that they are young carers. However, it is hard to define young carers since we need the conditions of (i) range of age, (ii) home environments, (iii) responsibilities, and (iv) level of burdens. For the conditions of (i)–(iii), there are existing definitions: Becker (2000) defined young carers as people under 18 residing in single-parent households who offer non/specialized support for their family members and relatives having disabilities, some chronic illness, mental health problems, or other related conditions. Becker and Becker (2008) defined young "adult" carers as people aged 18–24 with almost the same responsibilities as young carers.

In previous definitions, there are two problems. First, there are children with both parents having a heavy burden on home duties. MHLW (2017a) used data from time use and leisure activities conducted by the Statistics Bureau, Ministry of Internal Affairs and Communications (MIAC) to show the current status of the division of home duties between married couples. In households where only the husband is employed, the one's day average spent on home-duty time is nine minutes for the husband and 283 minutes for the wife. In dual-income households, the husband spends 12 minutes, while the wife spends 207 minutes on household chores, on average. Even in dual-income households, the husband's time for housework increases by only 3 minutes. Second, there is no specific discussion about the condition (iv) level of burdens on home duties. However, as stated earlier, deciding the condition (iv) is hard because it depends on children's characteristics.

Hence, this study has two novelties: First, we will focus on two-parent households. In the case of single-parent households or parents with disabilities, it is natural for the burden of what the parents cannot bear to shift onto the children, as previous studies showed (see Sections 2.1 and 2.2). However, in two-parent households, parental division of home duties functions properly, it is expected

that children would not need to sacrifice rest time to do in home duties. Second, we will focus on children who spend home-duty time: "potential" young (adult) carers. We will clarify factors leading to children becoming potential young (adult) carers and increasing their burden. Instead of providing the condition (iv), we define that children are potential young (adult) carers if and only if they are up to university enrolment status years old and are responsible for home duties, including household chores, child-rearing, and elderly/nursing care (e.g., assisting with bathing, toileting, meals, nursing for a temporary illness), and shopping for daily commodities based on Becker (2000) and Becker and Becker (2008). Note that the youngest in the data used in this study is ten years old; therefore, our data includes the potential young (adult) carers up to university enrolment status.

We will not focus on specific home duties to evaluate children's burdens comprehensively. Consider the following situation: two children, A and B, spend time on household chores or elderly/nursing care; Child A spends four hours on household chores and zero hours on elderly/nursing care, and Child B spends two hours on household chores and four hours on elderly/nursing care. If we compare their burden on household chores and elderly/nursing care separately, then Child A would have a heavier burden on household chores than Child B, and Child B would have a heavier burden on elderly/nursing care than Child A. However, Child B spends more hours on "home duties" than Child A. Thus, we use their total home-duty time to evaluate their burden.

We use the cross-sectional data from time use and leisure activities conducted by the Statistics Bureau, MIAC, in 2011 and 2016. We employ the children are doing home duties during the times when children should be sleeping and a child's daily home-duty time as the dependent variable. Our data shows that the mothers do most of the home duties, and the fathers' working, two-way commuting, and home-duty time are not correlated. Hence, we analyze the relationship between the mother's home-duty time (one of the independent variables) and the likelihood of children doing home duties late at night. Furthermore, the dependent variable indicates how much the burden is placed on the child when mothers cannot take on some of the home duties and fathers have more power in their households.

We employ the two-stage least squares (2SLS) and the Instrumental Variable probit (IV probit) model since we consider the mother's home-duty time endogenous. We use information on whether the parents took paid leave in the past year and year dummies as instrumental variables (IVs). We assume that when the father takes paid leave, it may promote a more equal distribution of household responsibilities. In contrast, when the mother takes paid leave, the increased time spent at home may temporarily lead to an increase in her time spent on home duties. We also include year dummies to capture policy shocks, such as the Act on Promotion of Women's Participation and Advancement in the Workplace (2014)[1], which may have influenced mothers' home duties. Mothers

[1] The Act on Promotion of Women's Participation and Advancement in the Workplace, which was enacted in April 2016, represents a government-led institutional reform to promote gender equality in employment. This legislative

determine their time schedules, including home-duty time, which serves as the endogenous variable. Furthermore, children's engagement in home duties during times when they should be sleeping, which is the dependent variable, may be influenced by imbalances in the division of time within their household.

We have regression analyses for the following two indicators: Indicator (I), representing a child's daily time spent on home duties for those aged 10–24, and Indicator (II), referring to children aged 10–24 who engage in home duties during the times when they should be sleeping. These two indicators are employed because children's home-duty time is often zero. Therefore, using young (adult) carers as an indicator when they engage in even a minute of home duties may not serve as a reliable measure. From the analysis for Indicator (I), we can find the factors to increase burden on children in two-parent households, and from the analysis of Indicator (II), we can examine the factors leading to children becoming potential young (adult) carers in two-parent households. By comparing the results of these two indicators, this study examines whether Indicator (II) contributed as a predictor of young (adult) carer emergence.

As the major results for Indicator (II), we found that children led to being potential young (adult) carers if (i) when the mother's home-duty and commuting time increase, children tend to engage in home duties during times when they should be sleeping. In contrast, when the father's home-duty and commuting time decrease, children tend to engage during the time when they should be sleeping, (ii) when the father's social status, proxied by educational attainment, declines, children tend to engage during the time when they should be sleeping. (iii) the children do household responsibilities during time when they should be sleeping highlights the persistent gender inequality in the distribution of female' home-duty time, (iv) the number of siblings under the age of 10 plays a significant role in determining the timing of children's household duties, indicating the effect of household structure on children's time allocation.

We obtained three different results with Indicator (I) compared to Indicator (II): (i') their father's burden of home-duty time increase, (ii') if fathers employed in regular jobs, then households with stable income from regular employment tend to rely less on their children for household duties, instead opting for parents themselves to engage the tasks or utilizing external services, (iii') children's household responsibilities tend to increase as they advance in their schooling, reflecting a potential shift in household expectations as children age. As the results for IVs, we found that mothers working in environments where paid leave is accessible tend to have greater time flexibility in managing their daily responsibilities. Furthermore, the father took paid leave during the past year, it leads to an increase in the mother's home-duty time, which lead to do home-duty during times when children

change was externally imposed and not driven by firms' internal preferences or prevailing market conditions, so it can be regarded as an exogenous policy shock. This exogenous makes it well-suited for identifying the causal impact of institutional interventions on firm behavior and labor market outcomes (MHLW, 2017b).

should be sleeping.

The remainder of this paper is structured as follows. Section 2 provides the literature review. Section 3 introduces our regression models, an over-identification test, and endogeneity tests. Section 4 explains our data and variables. Section 5 reports the results, and Section 6 provides the interpretations of the results. Finally, Section 7 shows the concluding remarks.

2. Literature reviews and the novelties of this study

2.1. National scale surveys on young carers in Japan

MHLS has advanced research and study projects to promote child and child-rearing support since 2016.[2] As stated in Section 1, MHLS asked MURC and JRI to conduct national-scale surveys on young carers.[3]

In 2020, MURC (2021) conducted a comprehensive fact-finding survey among junior and senior high school students as one of MHLS's projects.[4] MURC's (2021) survey revealed that 5.7% of eighth graders and 4.1% of full-time high school sophomores in Japan stated that they "are" shouldering the responsibility of caring for their family members. Among the eighth graders and full-time high school sophomores who responded as caregivers for their family members, nearly 50% reported caring for their family members "almost every day," and around 10% stated that they spend an average of 7 hours or more per day in their caregiving role. Regarding family members needing care, "siblings" were the most common, followed by "parents." The most common reason for taking care of siblings is because they are young, and for parents, the most common reason is because of disabilities. The most common caretaking activities were "looking after" for siblings and "household chores" for parents.

In 2021, JRI (2022) conducted the following four fact-finding surveys as another MHLS's project: First, JRI (2022) surveyed primary schools on their support and perceptions of young carers. The results showed that approximately 34.1% of the schools had children considered young carers. Second, JRI (2022) conducted a questionnaire survey among sixth-grade primary students on the state of care for their families. In principle, the students were required to take the questionnaire home to answer the questions. The main results are as follows: (i) 6.5% of primary school students cared for their families (mostly, their siblings or their mothers); (ii) the young cares tend to "be in poor/not so good health," "late or leaving early," "fall asleep in classes," "fail to complete homework or submit it

[2] See the website of MHLS for the details of those projects: MHLS, Research and study projects to promote child and child-rearing support (in Japanese). https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000204863.html (accessed on June 12, 2023).
[3] MURC (2021) and JRI (2022) defined young carers based on the Establishment of Carers Japan, a General Incorporated Association, as follows: young carers are children under 18 who take on caregiving responsibilities for their families similar to those of adults, including home duties and mental care.
[4] MURC (2021) sent this survey to the regional councils for children needing protection throughout the country by e-mail and collected the responses by e-mail from January 25 to February 26, 2021.

late," and "forget belongings"; and (iii) the proportion of non-family adults as their counselors is low. Third, JRI (2022) conducted a web questionnaire survey among third-year college/university students on their home and family care situation. The main results are: (i) 2.9% of students "currently apply" to young carers; (ii) The students who are caring for family members tend to "be in poor/not so good health" and "absent, late/leave early," and "it is hard to secure study or leisure time, join to club activities, have part-time jobs, and have friendship"; (iii) If they started caregiving before entering university, then more than 50% said that they could not take study time for entrance exams and were restricted in terms of commuting to school with constraints such as tuition fees and financial concerns; (iv) university students who are young carers are more likely care for their mothers and grandmothers. (vi) The young carers in single-parent households tend to spend more time in care for family members. Fourth, JRI (2022) conducted a web-based national-wide survey among male and female monitors of a web-based survey company in their 20s to 70s or older to ascertain young carers' level of awareness and consciousness. The main results are as follows: 29.8% of the monitors reported that they "know what a young carer is," 22.3% "have heard of it but do not know much about it," and 48.0% "have never heard of it." The level of recognition (i) is highest among women in their 50s and older, (ii) declines as the age group gets lower and lower, (iii) is generally lower among males, and (iv) is higher among people having children.

2.2. Related studies

This study discusses that imbalances in the division of time within their household may lead to children becoming young (adult) carers. Since no previous study includes simultaneous analysis of young carers and their parents' household chores division, we separately introduce related studies on young carers and the correlation between fathers' household chores/child-rearing/ elderly/nursing care time and mothers' work-life balance.

Related studies on young carers

Shibuya (2014) surveyed the perception of young carers among all members of the Tokyo Medical Social Worker Association (TMSWA) and revealed that (i) a significant majority of young carers are involved in caring for their parents' illnesses, hospitalizations, disabilities, or mental health conditions,[5] (ii) the factors leading to children becoming young carers are single-parent families, having no one to help with care, and having many young siblings, and (iii) a small number of children becoming young carers because of parental neglect.

Next, we introduce previous studies on gender differences among young carers. Di Gessa et al. (2022) used the nationally representative UK Household Longitudinal Study (2009−2021; 11

[5] Shibuya (2014) surveyed from January to March 2013 among all members of TMSWA using a self-administered, anonymous form sent by mail.

waves) and found the differences between male and female young adult carers for people aged 16–29 years at each wave. In addition, they define individuals aged 16–29 engaged in caregiving as young carers. They show that female young adult carers, particularly those aged 25–29, tend to care for longer and more people than male young adult carers. Moreover, they described the lowest income quintiles as positively correlated with the length of caregiving years and caregiving responsibilities.

In Japan, there are three studies regarding the burden of young carers who assume caregiving responsibilities for their family members. Okuyama (2018a) translated the content of Young Carer[6] of Inventory-Revised (YCOPI-R)[7] into Japanese to survey for Japanese people and translated the Japanese version into English again. Okuyama (2018a)[8] revealed a significant positive correlation between burden and stress, which contributed to developing a psychological scale to accumulate valuable knowledge to support young carers effectively. In addition, Okuyama (2018b) revised the item wording of the Japanese-translated version of YCOPI-R and established criteria to identify young carers based on responses from 173 active participants. Based on an internet survey conducted in January 2017 with participants who had enrolled as monitors with the research company.

Moreover, Okuyama (2018b) revealed that through factor analysis[9] that (i) young carers struggle to balance family caregiving and their school lives, and (ii) they have a sense of isolation from social groups. Furthermore, from the ROC analysis[10] using the short version of the "*Japanese version of the Zarit Burden Interview*" as the state variable, Okuyama (2018b) asserted that if a young carer obtains a total of more than 64 points for the following terms, then the young carer is considered to need support: (i) practical burden, (ii) excessive burden, (iii) care role, (iv) inconvenience, (v) desire to escape from their burden, (vi) guilt feelings when they do not provide care. As stated in Section 2.1, JRI (2022) reported that children who were young carers before entering universities had difficulty in finding study time, tuition fees and other financial concerns, and a restricted commuting distance from their parent's home when they entered college.

We then introduce several studies that show young carers' experiences and why they willingly become young carers. Mechling (2011) showed that young carers of mentally ill parents in the United States had witnessed or had to help their parents, such as suicide attempts, psychotic episodes, or aggressive states. Tseliou et al. (2018) found that children who faced long-term physical

[6] They defined children and young people under 18 who provide regular and ongoing care and emotional support to a family member who is physically or mentally ill, disabled, or misuses substances.
[7] YCOPI-R is a comprehensive assessment tool designed to capture various aspects of young carers' lives, including their caregiving tasks, emotional well-being, social support, and the impact on their education and daily activities. It consists of a series of carefully crafted questions or items that young carers respond to, providing valuable insights into their experiences as caregivers.
[8] Okuyama (2018a) conducted an internet survey in January 2017. All the survey cooperators registered the monitor to the survey company.
[9] DeCoster (1998) stated that factor analysis is a statistical method combining many observed variables into smaller factors. This allows for data interpretation and helps visualize data and build predictive models. In addition, factor analysis can identify patterns in the data by grouping correlated variables.
[10] ROC analysis is widely used in the medical field to diagnose diseases and evaluate the effectiveness of treatments. For further details, see Nahm (2022).

or mental ill-health/disability of family members felt forced into inappropriate roles for their age. Metzing-Blau and Schnepp (2008) showed that children became young carers because they were willing to be actively involved in their care out of compassion for their parents and loneliness caused by their parents repeatedly being in and out of the hospital.

The following studies suggest remarkable points when we study the causal factors of young carers. Gowen et al. (2021) showed that young carers' responsibility was not easy to distinguish between inappropriate and excessive caregiving for theirs. They proposed that obtaining criteria for determining inappropriate and excessive caregiving is necessary, enabling experts to identify what is deemed inappropriate or excessive for each young carer. Based on a web-based questionnaire survey conducted in 2016, the National Institution for Youth Education (2018) showed how childhood experiences of an appropriate level of support (e.g., helping with shopping, helping with cooking, helping clean the house and taking out the trash, and helping with laundry) are related to the ability to make a dent, increase motivation, and improve communication skills among men and women in their 20s to 60s. However, the National Institution for Youth Education (2018) did not ask the children how long it would take me to help them. In addition, Joseph et al. (2020) highlighted that small-scale studies with selected groups of young carers could not conclusively show the extent and nature of the problems faced by young carers as one homogeneous group. They emphasized that research on the scope and nature of young carers' problems (e.g., responsible for extreme care) had reached saturation. Hence, larger-scale studies with representative samples are needed to determine the extent and nature of young carers' difficulties. They stated that the challenge in studying young carers is accumulating generalizable studies showing the causality of variables and longer-term perspective effects. Thus, we use the national data of the survey on time use and leisure activities conducted by the Statistics Bureau, MIAC.

Related studies on the division of household chores and child-rearing between parents

The following studies analyzed the correlation between fathers' household chores/child-rearing time and mothers' work-life balance: Matsuda and Suzuki (2002) targeted 1,200 parents to investigate the factors contributing to the division of household chores time in Japan using the survey on time use and leisure activities conducted by MIAC. They show a positive correlation between fathers' household chores time and mothers' working time. Tsuru and Kume (2018) empirically analyzed the impact of fathers' participation in household chores and child-rearing on mothers' employment using individual data from the 2014 Web Survey on Diverse Work Styles and Attitudes of Full-Time and Non-Formal Employees. They found that the father's household chores and child-rearing time positively correlated with the mother's probability of employment.

Next, the following studies analyzed parents' or married couples' time use. Fujino and Kawata (2009) showed a negative correlation between fathers' household chores/child-rearing time

and their working time. Furthermore, they showed that fathers' commuting time negatively correlates with fathers' child-rearing time. Thus, they suggest that fathers' involvement in household chores and child-rearing can increase by streamlining their work tasks and reducing total working time. Hook (2010) showed that wives spend more time on household chores when husbands work longer hours. In addition, when husbands take longer parental leave, their cooking time becomes shorter, while for wives, it becomes longer. Iwata and Tamada (2014) revealed that married women tend to commute longer distances as their incomes increase, and in cases of higher incomes, their commuting time tends to be shorter. Furthermore, they showed that married women's leisure time is increased by not cutting down on household chores but rather by reducing their commuting time.

Some previous studies discussed the impact of the COVID-19 pandemic on the division of household chores among family members. Ishibashi et al. (2021) assessed the impact of the COVID-19 pandemic on the division of household chores among parents and their children under the age of 12 using activity time surveys and attribute information from the New Corona Lifestyle Behaviour Survey by the Urban Planning Research Office, Urban Planning Division, Urban Planning Bureau, Ministry of Land, Infrastructure and Transport, and Tourism before/during/after the first declaration of a state of emergency from April 16 to May 13. The average household chores rate for men between 8:00 and 10:00 increased by 1.1% from before to during/after the declaration. From 18:00 to 20:00, the rates were 2.6% before, 3.7% during, and 2.8% after the declaration. Furthermore, the average child-rearing rate for men from 8:00 to 21:00 increased by 2% from before to during the declaration. Nishimura et al. (2022) showed that whether fathers work from home positively correlates with the frequency of household chores and child-rearing for fathers. This result reveals that the time availability for household chores and child-rearing was increased by reducing fathers' commuting time.

Related studies on the division of elderly/nursing care for family members between parents

Szinovacz and Davey (2008) analyzed that the data were drawn from Waves 1–5 (1992, 1994, 1996, 1998, 2000) of the US Health and Retirement Survey, which is a longitudinal bi-annual survey of households based on interviews with a primary respondent aged 51–61 years at Wave 1 and his/her spouse of any age. They showed that wives provided care more than their husbands in nearly two-thirds of the care occasions. Furthermore, they discussed a tendency for same-gender caregiving, which signifies that husbands are not heavily involved in caring for female parents, and revealed that husbands tend to be the primary caregivers for their parents.

2.3. Novelties of this study

Based on Section 2.2, the previous studies have two limitations: First, most previous studies focused only on young (adult) carers with caregiving responsibilities and single-parent households. Thus, they did not consider young (adult) carers in terms of imbalances in the division of time within their

household. Second, to identify young (adult) carers in terms of imbalances in the division of home duties in their household, it is necessary to analyze whether they engage in home duties during the times when they should be sleeping, particularly when they are in an imbalance in the division of time in two-parent households. However, no previous study, except for Craig and Powell (2018), conducted a simultaneous analysis of the presence of home duties division, including children. Craig and Powell (2018) found that mothers took on a more significant share of routine tasks (meal preparation, laundry/cleaning, grocery shopping), fathers contributed to routine tasks when mothers' working time increased, and children made a slight contribution to non-routine tasks (outdoor work, household maintenance, household management).[11]

This study focuses on children's participation in home duties, particularly their late-night household responsibilities, examining the possibility that a decrease in mothers' home-duty time leads to children being burdened with home duties when they should be sleeping. Furthermore, this study considers the issue of young (adult) carers not only in single-parent households but also in two-parent households.

3. Methodologies

3.1. The two-stage least model

We analyze changes in children's home-duty time in response to changes in the mother's home-duty time. Suppose that y_i is the continuous dependent variable, and $x_1, \dots, x_k$ are the independent variables. Then, the ordinary least squared (OLS) model is written as

$$y = \beta_0 + \beta_1 x_1 + \cdots + \beta_{k-1} x_{k-1} + \beta_k x_k + u,$$

where u is the error term with $\mathrm{E}(u) = 0$. Suppose that x_k is an endogenous variable; therefore, we assume that $\mathrm{Cov}(x_k, u) \neq 0$. We should not use the OLS model to avoid biased and inconsistent estimates if endogenous variables exist. Let $z_1, \dots, z_l$ $(l > 1)$ be the IVs. We assume that $\mathrm{Cov}(z_m, u) = 0$, and $\mathrm{Cov}(z_m, x_k) \neq 0$ for any $m \in \{1, \dots, l\}$. Then, the 2SLS model estimates the following equations:

$$x_k = \gamma_0 + \gamma_1 x_1 + \cdots + \gamma_{k-1} x_{k-1} + \delta_1 z_1 + \cdots + \delta_l z_l + \nu \quad \text{(the first stage)},$$
$$y = \theta_0 + \theta_1 x_1 + \cdots + \theta_{k-1} x_{k-1} + \theta_k \hat{x}_k + \varepsilon \quad \text{(the second stage)},$$

Where ν is the error term in the first stage, $\hat{x}_k$ is the fitted value in the first stage, and ε is the error term in the second stage.

Following Baum and Schaffer (2007), we conduct the following three tests: (i) the

[11] Craig and Powell (2018) analyze data from the Australian Bureau of Statistics 2006 time-use survey, a nationally representative sample of Australian households. All individuals aged 15 years and over in sampled households must provide time-use information.

Kleibergen-Paap rk Wald F test, which assesses whether the excluded instruments are weak. The null hypothesis is that the instruments are weak. (ii) the under-identification test, where the null hypothesis states that the model is not identified. (iii) the Hansen J test, which examines whether the overidentifying restrictions are valid. The test which confirms whether the IVs are uncorrelated with the error term u in the structural model. If (i) is rejected, (ii) is rejected, and (iii) is accepted, then the 2SLS model with the IVs is considered valid[12].

3.2. The instrumental variable probit model

We analyze changes in children's home-duty time in response to the changes in the mother's home-duty time. Suppose that y_i is the continuous dependent variable, and $X_1, \dots, X_k$ are the independent variables. We employ the Instrumental Variables probit (IV-probit) model, which allows for endogenous regressors in a probit framework (Finlay and Magnusson, 2009).

Since it is difficult to directly derive marginal effects from the IV-Probit model, an alternative approach involves first using OLS in the first stage to estimate the predicted values of the endogenous variable and then substituting these predicted values into a Probit model in the second stage to obtain the marginal effects. However, the manual two-stage probit estimation results may differ slightly from those obtained using the IV-Probit model. The main reason for this discrepancy is that the IV-Probit model estimates the entire system simultaneously. In contrast, the manual two-stage probit estimation does not fully account for the error structure, and the predicted values of the endogenous variable obtained in the first stage may differ from the actual endogenous variable.

Following Newey (1987), the structural model is specified as follows:

$$y_i^* = \beta_0 Y_i + \gamma_1 X_{i1} + \cdots \gamma_k X_{ik} + u_i = \delta_0 Z_i + u_i, \quad i = 1, \dots, n,$$

$$y_i = \begin{cases} 1 & if \ y_i^* \geq 0, \\ 0 & if \ y_i^* < 0. \end{cases}$$

where y_{1i}^* is a latent endogenous variable, Y_i is endogenous explanatory variable, $\delta_0 = [\beta_0, \gamma_1, \dots, \gamma_k]$, and $Z_i = [Y_i, X_{i1}, \dots, X_{ik}]$.

In this context, the first regression model is written as:

$$Y_i = \pi_0 x_i + \upsilon_i = \pi_{10} X_{1i} + \pi_{20} X_{2i} + \upsilon_i$$

where υ_i is an error term. π_{10} is a coefficient of instrumental variables that are included in the second stage regression, π_{20} is a coefficient of instrumental variables that are exclude in the second stage regression, and $\pi_0 = [\pi_{10}, \ \pi_{20}]$ (Newey, 1987).

$$\begin{aligned} y_{1i}^* &= \beta_0(\pi_0 x_i + \upsilon_i) + \gamma_0 X_{1i} + u_i \\ &= X_{1i}(\pi_{10}\beta_0 + \gamma_0) + \pi_{20} X_{2i} + \upsilon_i \\ &= X_{1i}\alpha_{10} + X_{2i}\alpha_{20} + \upsilon_i \end{aligned}$$

[12] For further details, see Baum and Schaffer (2007).

$$= X_i\alpha_0 + \upsilon_i,$$

Newey (1987) estimates the regression coefficients by maximizing the following log likelihood function.

$$\ln L_i = w_i\left[y_{1i} ln\Phi(m_i) + (1 - y_{1i})\ln\{1 - n\Phi(m_i)\} + ln\phi\left(\frac{y_{2i} - \pi_0 x_i}{\sigma}\right) - ln\sigma\right],$$

where

$$m_i = \frac{\delta Z_i + \rho(y_{2i} - \pi_0 x_i)/\sigma}{(1-\rho^2)^{\frac{1}{2}}},$$

$\Phi(\cdot)$ and $\phi(\cdot)$ are the standard normal distribution and density functions, respectively; σ is the standard deviation of υ_i; ρ is the correlation coefficient between u_i and υ_i; and w_i is the weight for observation i or one if no weights were specified.

Next, we explain the reason why the manual two-stage probit estimation slightly differs from the IV-Probit model.

In this context, the first regression model is written as:

$$Y_i \;=\; \pi_0 x_i + \upsilon_i = \;\pi_{10}X_{1i} + \pi_{20}X_{2i} + \upsilon_i,$$

We substitute the predicted values of the endogenous variable estimated in the first stage into the second-stage Probit model, where the dependent variable is a latent endogenous variable.

$$y_{1i}^{*} \;= \beta_0\widehat{Y}_i + \gamma_0 X_{1i} + u_i,\;\; i = 1, \dots, n,$$

We estimate the regression coefficients by maximizing the following log likelihood function.

$$L(\boldsymbol{\beta}) = \Pi_{i=1}^{N}\left[\left(\int_{-\infty}^{\beta_0\widehat{Y}_i+\gamma_0 X_{1i}} \frac{1}{\sqrt{2\pi}}\exp\left(-\frac{z^2}{2}\right)dz\right)^{y_i}\left(\int_{\beta_0\widehat{Y}_i+\gamma_0 X_{1i}}^{\infty} \frac{1}{\sqrt{2\pi}}\exp\left(-\frac{z^2}{2}\right)dz\right)^{1-y_i}\right]$$

IV-Probit includes the term $ln\,\phi\left(\frac{y_{2i}-\pi_0 x_i}{\sigma}\right) - ln\sigma$, whereas the manual two-stage probit estimation does not have the term, resulting in slight differences in the calculation results.

Following the framework outlined by Finlay and Magnusson (2009), we conduct six tests to guarantee that the IV-probit model is valid: (i) Conditional Likelihood Ratio (CLR) test, which confirms whether the coefficient of an endogenous explanatory variable equals a specific value (e.g., $\beta = 0$ or $\beta = \beta_0$). Unlike standard Wald tests, the CLR test is robust to weak instruments and remains valid under weak identification; (ii) the Anderson-Rubin (AR) test, which simultaneously tests whether he coefficient of the endogenous explanatory variable equals a specified value (e.g., $\beta = 0$) and whether the instrumental variables (IVs) are valid (i.e., satisfy overidentification restrictions); (iii) Lagrange Multiplier (LM) test, which, unlike the CLR test, indicates whether the coefficient of the endogenous variable is statistically significant but does not guarantee the validity of the IVs; (iv) over-identification (J) test, which verifies whether the instrumental variables are exogenous by testing their correlation with the error term in the structural model; (v) the LM-J test combines the Lagrange Multiplier Minimum Distance (LM) test and the Joint Minimum Distance (J) test to jointly assess

whether the coefficient of the endogenous variable equals β_0 and whether the overidentification restrictions hold; (vi) for robustness, we also conducted the Wald test to examine whether the coefficient of the endogenous variable differs significantly from zero. In this study, if (i) is rejected, (ii) is rejected, (iii) is rejected, (iv) is accepted, (v) is accepted, and (vi) is rejected then the IV-probit model with the IVs is valid[13].

4. Data

4.1. Data overview

We use anonymous data from Sheet A[14] of the survey on time use and leisure activities conducted by the Statistics Bureau, MIAC, from October 15 to 23, 2011, and October 15 to 23, 2016.[15] Each survey area was allocated two consecutive days from the above nine days. Sheet A includes data from approximately 200,000 individuals aged ten and above residing in the designated survey areas (about 6,900 regions nationwide in 2011; about 7,300 regions nationwide in 2016). In the 2011 and 2016 surveys, the two-stage sampling method was adopted with the Enumeration Districts (ED) of the 2005 and the 2010 Population Census as the first-stage sampling unit and households as the second-stage sampling unit. Some sample EDs in Iwate, Miyagi, and Fukushima Prefecture were excluded from the survey because those EDs were devastated by the Great East Japan Earthquake on March 11, 2011. In addition, some sample EDs in Kumamoto Prefecture were excluded from the survey because those EDs were devastated by the 2016 Kumamoto Earthquake in April 2016. The sample EDs were selected by systematic sampling with unequal probabilities based on population.

Sheet A reports the average time for each daily activity, the status of daily activities by time zone, and the average time of major daily activities. Specifically, Sheet A contains family ID, relation, age, marital status, education, caregiving responsibilities, employment status, household income, implementation time of daily activities during the two consecutive days, and others. We use the data on the first day of the two consecutive days because the sample size on the first day is larger than that on the second day: e.g., there are 72 missing observations for a variable of household annual income and 59 for a variable of education status.

In our data, the observations cover children aged 10–24 in two-parent households who responded regarding their spent on home-duty time (unit: hours). The main aim of our analysis is to clarify that the unfair division of home duties between parents leads to children becoming young

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[13] For further details, see Finlay and Magnusson (2009).

[14] The survey also includes another sheet, B, but we use only Sheet A in this study. There are two reasons: First, the sentences of questions we used in this study slightly differ between Sheets A and B, making simultaneous analysis impractical. Second, Sheet B has a small sample size according to the number of children aged 10–24: Sheet A includes 23,964 children aged 10–24, while Sheet B includes 1,448 children aged 10–24.

[15] The data used in this study's descriptions are based on the Statistics Bureau, MIAC website: Statistica Bureau of Japan, Survey on Time Use and Leisure Activities. https://www.stat.go.jp/english/data/shakai/index.html (accessed on July 31, 2023).

(adult) carers. Thus, we exclude single-parent children in households. To use the data of parental daily time-use answers as explanatory variables, we add copies of the parent's information to their children's information based on family ID and relation. Next, we prepare two indicators: Indicator (I), the daily time children spend on home duties, and Indicator (II), children who do home duties at night. MURC (2021) showed that young carers are 5.7% of eighth graders and 4.1% of full-time high school sophomores in Japan. Statistically speaking, these rates are low. Thus, we analyze indicators (I) and (II) to compare the results in the indicator's potentially high and fundamental household burdens.

Finally, the sample size of the 2011 survey was 12,502, and that of the 2016 survey was 11,462. We use both data as cross-sectional data; therefore, the sample size is 23,964 (the rates of males and females are 50.15% and 49.85%, respectively). We drop two observations from the data because their fathers' working time is over 22.5 hours (1,350 minutes).

4.2. Variables

Table 3 in Appendix A summarizes the following variables' fundamental statistics. Regarding terminology specifics, home duties include household chores, child-rearing, and elderly/nursing care.[16] As discussed in Section 1, we do not focus on specific home duties but instead evaluate their burden using the total home-duty time.

We use two dependent variables to analyze the impact of home duties on children. The first dependent variable, $c\_homeduty\_time_i$, is a continuous variable representing the total time (in hours) that children spend on home duties, including those who report zero hours. The second dependent variable, $c\_latenight\_homeduty_i$, is a binary variable indicating whether an individual engages in home duties during specific late-night times, defined by age group: between 9:00 p.m. and 6:00 a.m. for those aged 10 to 14; between 10:00 p.m. and 6:00 a.m. for those aged 15 to 19; and between 11:00 p.m. and 6:00 a.m. for those aged 20 to 24.

These time intervals are based on the minimum recommended sleep durations by age group provided by the Ministry of Health, Labour and Welfare (MHLW, 2024): 9 hours for elementary school students, 8 hours for junior and senior high school students, and 7 hours for adults. However, this study adopts an age-based classification for two main reasons. First, the governmental guidelines assume that individuals are enrolled in school at standard ages. In contrast, the dataset used in this study does not allow us to identify each respondent's schooling status accurately. Second, even if a respondent's highest level of education is high school, it is not possible to determine from the data whether their age corresponds to that of a typical university student.

There are three primary reasons for focusing on late-night home duties. First, these times

[16] These variables used in this study's descriptions are based on the Statistics Bureau, MIAC website: Statistics Bureau of Japan, 2011. Explanation of Terms (Questionnaire A). https://www.stat.go.jp/english/data/shakai/2011/yogo.html (accessed on July 31, 2023).

correspond to the periods during which individuals are expected to be asleep based on the recommended sleep durations. Second, reflecting typical wake-up times for school or work and the need for morning preparations. Third, examining not only the total amount of home-duty time but also the specific time of day allows for a more analysis of daily life patterns. Home duties conducted at night may be associated with reduced sleep and increased psychological stress.

There is a reason for using the above dependent variable: First, we observe that mothers are primarily responsible for home duties, with an average daily home-duty time of approximately 4.36 hours (approximately 261 minutes). In contrast, fathers spend an average of only 0.35 hours (approximately 21 minutes) on home duties. Children report an average daily home-duty time of approximately 0.1 hours (approximately 6 minutes). Therefore, we consider it essential to analyze the effect of children performing home duties during hours when they should be asleep, particularly about changes in mothers' home-duty time.

Second, this analysis allows us to clarify whether the structure of home-duty allocation affects not only the total amount of time children spend on home duties but also the specific times of day at which they take on these responsibilities.

The independent variables, which may correlate with $c\_latenight\_homeduty_i$ and $c\_homeduty\_time_i$, are $m\_hduties_i$, which indicates home-duty time of i's mother, $f\_hduties_i$, which indicates home-duty time of i's father, $m\_commutetime_i$, which indicates commuting time of i 's mother, similarly $f\_commutetime_i$, $male_i$ (takes 1 if i is male; otherwise, 0), $num\_members\_under10_i$ (the number of i 's household members under 10 years old), $dual\_income_i$ (takes 1 if i 's parents are both working; otherwise, 0), $hincome200\_299_i$, $hincome300\_399_i$, $hincome400\_499_i$, $hincome500\_599_i$, $hincome600\_699_i$, $hincome700\_799_i$, $hincome800\_899_i$, $hincome900\_999_i$, $hincome1000\_1499_i$ ($hincome[x]\_[y]_i$ takes 1 if i's household income is from $[x]$ to $[y]$ millions yen; otherwise, 0), $hincome1500_i$ (takes 1 if i's household income is 1,500 million yen and over ; otherwise, 0), $f\_highsch_i$ (takes 1 if i's father graduated a high school; otherwise, 0), f_univ_i (takes 1 if i's father graduated a university; otherwise, 0), f_grad_i (takes 1 if i's father graduated a graduate school; otherwise, 0), similarly, $m\_highsch_i$, and m_univ_i. The category "mother's highest education: graduate school" was automatically omitted in the IV-Probit model due to the perfect prediction of the dependent variable. Furthermore, $f\_working\_la_i$ (takes 1 if the father is working during the child's recommended sleep hours; otherwise, 0), similarly, $m\_working\_la_i$, $f\_regular_i$ (takes 1 if the father is employed as a regular (full-time) worker; otherwise, 0), $f\_nonregular_i$ (takes 1 if the father is employed as a non-regular (part-time, casual, fixed-term, rehired, or temporary agency worker) worker; otherwise, 0), $f\_executive_i$ (takes 1 if the father holds an executive or managerial position; otherwise, 0), $f\_housemaker_i$ (takes 1 if the father is not in the labor force and primarily engaged in housework; otherwise, 0), $f\_self\_employed_i$ (takes 1 if the father is self-employed; otherwise, 0),

$f\_otherstatus_i$ (takes 1 if the father was not working for an extended period during the past year due to reasons such as childcare leave, nursing care, illness, or being newly employed with less than one year of tenure; otherwise, 0), similarly, $m\_regular_i$, $m\_nonregular_i$, $m\_executive_i$, $m\_housemaker_i$, and $m\_otherstatus_i$.

Additionally, we add the following control variables: $worktime_i$, which indicates home-duty time of i, $three\_major_i$ (takes 1 if i lives in the greater areas of Tokyo, Osaka, and Nagoya[17]; otherwise, 0), $grad\_high_i$ (takes 1 if i has completed high school; otherwise, 0), $grad\_junior\_college_i$ (takes 1 if i has completed junior/technical College student[18]; otherwise, 0), $grad\_univ_i$ (takes 1 if i has completed university; otherwise, 0), $grad\_univ_i$ (takes 1 if i has completed university; otherwise, 0), $student_i$ (takes 1 if the individual is currently enrolled in school; otherwise, 0), and $holiday_i$ (takes 1 if i's household answered the survey on Saturday or Sunday; otherwise, 0). The referenced enrollment status is "completed junior high school."

Since we consider that $m\_homeduty_i$ is an endogenous variable, we use the following three IVs: $f\_paleave\_dummy_i$ (takes 1 if the father took paid leave during the past year; otherwise, 0), similarly $m\_paleave\_dummy$, and $year\_2016_i$ (takes 1 if i answered in 2016; otherwise, 0).

Since the analysis is based on data from only two survey years—2011 and 2016—we use the $year\_2016_i$ dummy as an instrumental variable to capture exogenous changes between these two-time points. These changes include major policy initiatives such as the Act on Promotion of Preventive Measures against Karoshi (2014) and the Act on Promotion of Women's Participation and Advancement in the Workplace (2016). Although non-binding, these policies may have influenced household behaviors by affecting corporate practices and societal expectations regarding gender roles and work–life balance.

In addition, since unobserved family decisions may endogenously determine a mother's home-duty time, we also use whether the parents took paid leave in the past year and year dummies as instrumental variables. These variables are assumed to influence the mother's home-duty time without directly affecting the father's home-duty time. These exogenous variables allow us to identify whether a mother's home-duty time increases or decreases.

5. Results

5.1 Results of the first-stage regressions of 2SLS and IV probit model

Table 1 reports the results of the first-stage regressions. As with Section 5.1, we summarize the robust

[17] Due to the limitations of the data from the survey with Sheet A, information on individuals' places of residence is unavailable. Thus, the residential area data will be based on whether they reside within the three major metropolitan areas: Kanto Major Metropolitan Area (Saitama-shi, Chiba-shi, Ku-area of Tokyo, Yokohama-shi, Kawasaki-shi, and Sagamihara-shi), Chukyo Major Metropolitan Area (Nagoya-shi), and Kinki Major Metropolitan Area (Kyoto-shi, Osaka-shi, Sakai-shi, and Kobe-shi).

[18] Kōsen (Technical Colleges) are Japanese five-year institutions that provide specialized education in engineering and technology from the age of 15.

results with respect to CI: therefore, we do not report all results at 10% or more significance level because their confidence intervals cross zero. Furthermore, since the endogenous and instrumental variables used in the 2SLS and IV-Probit models are identical, the first-stage estimates are also the same. Therefore, instead of reporting the first-stage results separately for each model, we present them as a single unified result to avoid redundancy.

From Table 1, $f\_paleave\_dummy$ positively correlates with $m\_hduties$ at 5 % significance level. In contrast, $m\_paleave\_dummy$ positively correlates with $m\_hduties$ at 1 % significance level.

In the 2SLS model, we report the first-stage F statistic derived from the standard Wald test, which evaluates the strength of the instruments for each endogenous regressor. The Kleibergen-Paap rk Wald F statistic is 6.83 ($p < 0.01$), exceeding the conventional threshold of 5.0 for identifying weak instruments. Additionally, the under-identification test strongly rejects the null hypothesis that the model is under-identified (Kleibergen-Paap rk LM = 20.46, $p < 0.001$).

In contrast, we report the Sanderson-Windmeijer multivariate F statistic for the IV-Probit estimation, which tests the joint relevance of excluded instruments in the presence of multiple endogenous regressors. The test yields a value of 111.42 ($p < 0.01$), indicating strong instrument relevance.

These diagnostic results suggest that the model is well-identified and that the excluded instruments are sufficiently strong, mitigating concerns about weak identification in both estimation frameworks (For a detailed explanation of each diagnostic test, see Section 3.2.).

Table 1. Results of the first-stage regressions with the OLS model (dep. var. is $m\_hduties$)

	Indicator (I)	Indicator (II)
Instrumental variables		
$f\_paleave\_dummy$	0.112**	0.112**
	[0.046]	[0.046]
$m\_paleave\_dummy$	-0.157***	-0.157***
	[0.042]	[0.043]
$year\_2016$	0.023	0.023
	[0.036]	[0.037]
Home duty [h]		
$f\_hduties$	0.141***	0.141***
	[0.019]	[0.015]
Parents' commute time [h]		
$f\_commutetime$	0.225***	0.225***
	[0.020]	[0.020]
$m\_commutetime$	-1.133***	-1.133***
	[0.033]	[0.034]
Parents' working timing		
$f\_working\_la$	0.072	0.072
	[0.050]	[0.049]
$m\_working\_la$	-0.696***	-0.696***

	[0.081]	[0.084]
Enrollment Status		
$grad\_highsch$	-0.181***	-0.181***
	[0.050]	[0.051]
$grad\_junior/college$	-0.145	-0.145
	[0.099]	[0.104]
$grad\_univ$	-0.245**	-0.245**
	[0.103]	[0.105]
$students$	0.069	0.069
	[0.068]	[0.069]
$holiday$	-0.344***	-0.344***
	[0.037]	[0.037]
$there\_major$	0.133***	0.133***
	[0.036]	[0.036]
$male$	0.130***	0.130***
	[0.033]	[0.033]
$num\_members\_under10$	0.449***	0.449***
	[0.042]	[0.038]
$dual\_income$	-0.039	-0.039
	[0.087]	[0.080]
$children\_worktime$ [h]	-0.003	-0.003
	[0.007]	[0.007]
Parents final education		
Father		
$f\_highsch$	0.048	0.048
	[0.072]	[0.072]
$f\_junior/tech\_college$	0.161*	0.160*
	[0.084]	[0.084]
f_univ	0.231***	0.231***
	[0.078]	[0.078]
f_grad	0.424***	0.424***
	[0.121]	[0.121]
Mother		
$m\_highsch$	-0.052	-0.052
	[0.089]	[0.089]
$m\_junior/tech\_college$	0.112	0.112
	[0.091]	[0.091]
m_univ	0.238**	0.238**
	[0.110]	[0.101]
Parents' employment status		
$f\_regular$	-0.106	-0.106
	[0.149]	[0.146]
$f\_nonregular$	-0.047	-0.047
	[0.164]	[0.162]
$f\_executive$	0.388**	0.388**
	[0.162]	[0.157]
$f\_self\_employed$	0.296**	0.296**
	[0.152]	[0.148]
$f\_otherstatus$	-0.079	-0.079
	[0.290]	[0.273]
$f\_housemaker$	-0.840***	-0.840***
	[0.284]	[0.283]

$m\_regular$	0.128	0.128
	[0.363]	[0.278]
$m\_nonregular$	0.926***	0.926***
	[0.360]	[0.274]
$m\_executive$	0.764**	0.764**
	[0.388]	[0.307]
$m\_self\_employed$	0.923***	0.923***
	[0.366]	[0.282]
$m\_otherstatus$	1.189***	1.188***
	[0.385]	[0.306]
$m\_housemaker$	2.151***	2.151***
	[0.357]	[0.273]
Household income	Yes	Yes
Constant	3.091***	3.091***
	[0.400]	[0.323]
N	23,964	23,964
Robust F test	6.83***	111.42***
R- square		0.180

Notes: clustered robust standard errors in brackets,
*** p<.010, ** p<.050, * p<.100

5.2 Results of the second-stage regressions

Table 2 reports the results of the second-stage regressions. As with Section 5.1, we summarize the robust results with respect to CI: therefore, we do not report all results at 10% or more significance level because their confidence intervals cross zero.

In Indicator (I), f_hduty and $grad\_highsch$ positively correlate with c_homedy_time at 1 % significance level. Furthermore, $male$, $students$, and $worktime$ negatively correlate with c_homedy_time at 1 % significance level; and $f\_regular$ negatively with c_homedy_time at 5 % significance level.

In Indicator (II), m_hduty and $m\_commutetime$ positively correlate with $c\_latenight\_homedy$ at 1 % significance level. Furthermore, $male$, $num\_members\_under10$ and f_univ positively correlate with $c\_latenight\_homedy$ at 1 % significance level; and $m\_working\_la$ and $holiday$ positively correlate with $c\_latenight\_homeduty$ at 5 %; and f_hduty, $f\_commutetime$, and f_grad negatively correlate with $c\_latenight\_homeduty$ at 5 % significance level. From column 3, the 2SLS and IV probit results were broadly consistent, indicating that the estimated effects are robust to model selection.

A comparison with the 2SLS model was conducted to assess the robustness of the model (column 3 in Table 2). The 2SLS is a standard regression method used to address the issue of endogenous variables, assuming a linear relationship between the dependent and independent variables. The results from both models were generally consistent, with no significant differences in the effects of the key variables. This confirms that the estimates from the IV-Probit model are reliable.

For the 2SLS model, the Kleibergen-Paap rk Wald F statistic is 6.83, exceeding the conventional threshold of 5.0, and the under-identification test is strongly rejected (LM = 20.46, p <

0.001), suggesting that the instruments are relevant, and the model is properly identified. The Hansen J test yields a p-value of 0.047, indicating a marginal rejection of the overidentifying restrictions at the 5% level. While this may raise concerns regarding the exogeneity of the instruments, the result is borderline and does not definitively undermine the validity of the IV approach.

For the IV-Probit model, the weak-instrument robust inference results indicate that the CLR (p = 0.002), AR (p = 0.011), and LM (p = 0.002) tests all reject the null hypothesis, suggesting statistical significance even under potential weak instrument conditions. The Hansen J test is not rejected (p = 0.609), supporting the validity of the instruments in this nonlinear framework.

In addition, since the IV probit model does not directly provide marginal effects, this study estimates the endogenous variable using OLS in the first stage, substitutes the predicted values into a probit model, and calculates the marginal effects. We then examine whether there are significant differences in the sign and significance levels of the coefficients. According to the results presented in Appendix B, the estimated results from the IV probit model and the marginal effects are consistent, indicating that the estimation results are robust to model selection.

Table 2. Results of the second stage with the 2SLS model

Indicator	(I)	(II)	
	2SLS	IV-Probit	2SLS
Home duty [h]			
f_hduty	0.020***	-0.213**	-0.003**
	[0.007]	[0.089]	[0.001]
m_hduty	-0.029	1.475***	0.021**
	[0.044]	[0.571]	[0.008]
Parents' commute time [h]			
$f\_commutetime$	0.007	-0.331**	-0.005**
	[0.010]	[0.136]	[0.002]
$m\_commutetime$	-0.010	1.740***	0.025***
	[0.050]	[0.655]	[0.009]
Parents' working timing			
$f\_working\_la$	0.006	0.040	0.001
	[0.010]	[0.116]	[0.002]
$m\_working\_la$	-0.024	1.012**	0.014**
	[0.035]	[0.441]	[0.006]
Enrollment Status			
$grad\_highsch$	0.059***	0.235	0.003
	[0.014]	[0.158]	[0.003]
$grad\_junior/college$	0.040	-0.176	-0.001
	[0.028]	[0.312]	[0.004]
$grad\_univ$	0.010	0.124	0.002
	[0.030]	[0.306]	[0.004]
$students$	-0.153***	-0.018	0.000
	[0.023]	[0.170]	[0.003]

$holiday$	0.015	0.552**	0.008***
	[0.017]	[0.217]	[0.003]
$three\_major$	-0.007	-0.153	-0.002
	[0.009]	[0.115]	[0.002]
$male$	-0.069***	-0.306***	-0.005***
	[0.008]	[0.108]	[0.002]
$num\_members\_under10$	0.027	-0.873***	-0.012***
	[0.022]	[0.279]	[0.004]
$dual\_income$	-0.008	0.068	0.001
	[0.015]	[0.161]	[0.003]
$children\_worktime$ [h]	-0.022***	0.006	0.000
	[0.002]	[0.018]	[0.000]
Parents final education			
$f\_highsch$	0.018	-0.299*	-0.005*
	[0.013]	[0.165]	[0.003]
$f\_junior/tech\_college$	0.033*	-0.407*	-0.006*
	[0.017]	[0.213]	[0.004]
f_univ	0.027	-0.627***	-0.010***
	[0.017]	[0.228]	[0.004]
f_grad	0.000	-0.946**	-0.014**
	[0.027]	[0.378]	[0.006]
$m\_highsch$	-0.008	0.510*	0.006**
	[0.017]	[0.275]	[0.003]
$m\_junior/tech\_college$	-0.010	0.184	0.001
	[0.017]	[0.285]	[0.003]
m_univ	0.006	0.290	0.004
	[0.022]	[0.321]	[0.004]
Parents' employment status			
$f\_regular$	-0.075**	-0.149	-0.003
	[0.038]	[0.308]	[0.006]
$f\_nonregular$	-0.062	-0.141	-0.003
	[0.042]	[0.347]	[0.006]
$f\_executive$	-0.062	-0.690*	-0.010
	[0.045]	[0.405]	[0.007]
$f\_self\_employed$	-0.072*	-0.684*	-0.011*
	[0.042]	[0.364]	[0.006]
$f\_otherstatus$	-0.015	0.089	-0.001
	[0.078]	[0.585]	[0.011]
$f\_housemaker$	-0.052	1.289*	0.018
	[0.100]	[0.767]	[0.014]
$m\_regular$	0.018	3.047	0.006
	[0.056]	[148.024]	[0.008]
$m\_nonregular$	0.039	1.704	-0.013
	[0.066]	[148.025]	[0.010]
$m\_executive$	0.078	1.949	-0.010
	[0.070]	[148.025]	[0.011]
$m\_self\_employed$	0.069	1.643	-0.014
	[0.069]	[148.025]	[0.011]
$m\_otherstatus$	0.055	1.321	-0.019
	[0.078]	[148.026]	[0.013]
$m\_housemaker$	0.078	-0.028	-0.037**
	[0.110]	[148.029]	[0.019]

Household income	Yes	Yes	Yes
Constant	0.435***	-10.191	-0.063**
	[0.155]	[148.035]	[0.028]
N	23,964	23,964	23,964
R-square	0.004	-	-0.464

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In addition, Appendix C summarizes the diagnostic test results for both the 2SLS and IV-Probit estimations including assessments of instrument strength, model identification, and exogeneity for the three instruments: $f\_paleave\_dummy$, $m\_paleave\_dummy$, and $year\_2016$. These instrumental variables largely support the validity and robustness of this study.

6. Discussions

6.1 Discussions for the results of Indicator (I)

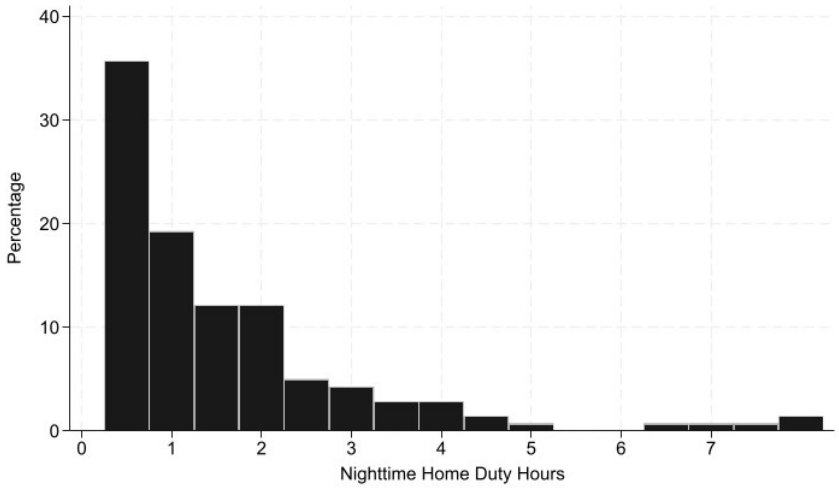
We provide interpretations for the above estimates of Indicate (I) in the following order: (i) household time allocation, (ii) the father's social status in the household, and (iii) individual attributes in terms of gender.

First, $f\_hduties$ positively correlates with $c\_homedytime$. This may suggest that, as seen in the data, the relative scarcity of the father's home-duty time leads children to take on household responsibilities more actively, resulting in their engaging in home-duty.

Second, we find that $f\_regular$ negatively correlates with $c\_homedytime$ when the referenced father's employment status is "unemployed." This implies that in households with stable income from regular employment, parents may assume more home duties or use external services without their dependence on children. However, the survey did not ask about household consumption behavior, so we cannot confirm our hypothesis in this study.

Third, focusing on individual attributes, we find that the $male$ negatively correlates with $c\_latenight\_homedy$. This result is consistent with Di Gessa et al. (2022), who report that women tend to bear a disproportionate share of household responsibilities and caregiving duties. Additionally, $students$ negatively correlate with $c\_homedytime$. The result may show that the children allocate time to study, do club activities, and do other things. Conversely, $grad\_highsch$ positively correlates with $c\_homedytime$. Furthermore, $worktime$ negatively correlates with $c\_homedytime$, suggesting that, in terms of the quantitative aspect (i.e., time spent on home duties), household responsibilities tend to increase depending on the child's schooling status advances.

Figure 1. Distribution of Nighttime Home Duty Hours



Source: Created by the author based on data provide by MICA

Lastly, from Table 1, $m\_paleave\_dummy$ negatively correlates with $m\_hduties$ in Indicators (I) and (II). This result shows that when the mother took paid leave during the past year, it her home-duty time decreased. The result suggests that mothers working in environments where paid leave is accessible tend to have greater time flexibility in managing their daily responsibilities. Furthermore, $f\_paleave\_dummy$ positively correlates with $m\_hduties$ in Indicators (I) and (II). This result suggests that when the father took paid leave during the past year, it was associated with an increase in the mother's home-duty time. This may indicate that while fathers assumed more household responsibilities, the overall expectations or standards for home duties also increased, increasing mother's burden. This result shows a similar pattern to Hook (2010) in terms of taking longer husbands' parental leave, their cooking time becomes shorter, while for wives, it becomes longer. From the results of the second-stage regressions, an increase in the father's home-duty time, particularly in households where the father's responsibilities are relatively low, tends to be associated with an increase in the child's home-duty time.

6.2 Discussions for the results of Indicator (II)

There are three difference points between the results of Indicators (I) and (II). First, in Indicator (II), we have significant results for $m\_hduties$, $m\_commutetime$, $f\_commutetime$, $m\_working\_la$, and $holiday$ in terms of household time allocation. Second, significant results are found for f_univ and f_grad in terms of household time allocation. Third, we have a significant result for$num_members_under10$ in terms of the household environment.

First, $m\_hduties$ positively correlates with $c\_latenight\_homedy$. The result shows that in households where mothers bear a heavy home duty, children may be compelled to shift their

domestic responsibilities to late-night times to balance them with their school commitments. In contract, $f\_hduties$ negatively correlates with $c\_latenight\_homedy$. The results suggest that when fathers are not actively involved in housework, the uneven distribution of domestic responsibilities may prompt children to complete household tasks within more irregular hours.

$m\_commutetime$ positively correlates with $c\_latenight\_homedy$. The result shows that the available time to bear in home duties becomes limited, increasing the likelihood that children will bear home duties during late-night times as a substitute. In contrast, $f\_commutetime$ negatively correlates with $c\_latenight\_homedy$. The result suggests that their father may not be a burden in domestic labor at home. In particular, $m\_working\_la$ negatively correlates with $c\_latenight\_homedy$. The result indicates that children may bear additional home duties during late at night.

Furthermore, $holiday$ positively correlate with $c\_latenight\_homedy$. The result suggests that the possible existence of a certain number of children who engage in irregular patterns of domestic labor is particularly limited to weekends. To supplement this analysis, we compare the average children's home-duty time late at night on weekdays and weekends, respectively, to approximately 1.7 hours and 1.4 hours, indicating that home-duty time late at night tends to be slightly longer on weekdays.

Second, f_univ and f_grad positively correlate with $c\_latenight\_homedy$. This result may reflect differences in household economic capacity, access to stable employment, or, more broadly, the work–life balance structure. This study interprets educational attainment as a proxy for the father's social status. Households with highly educated fathers are likely to have time and financial flexibility, reducing the necessity for children to engage when they should be sleeping (Indicator (I)).

Fourth, $num\_members\_under10$ negatively correlates with $c\_latenight\_homedy$. This result may suggest that childrearing responsibilities for younger siblings are being assumed earlier, particularly.

Notably, children who engage in home duties during their usual sleeping hours spend significant time on these tasks throughout the day. Among them, the top 10% spend over 3.38 hours on late-night home duties, with the maximum reaching 8.25 hours.

Based on the above, the results suggest that domestic responsibilities may be unevenly distributed within the household in cases of doing home-duty during times when they should be sleeping. These findings provide important insights into capturing the often-invisible burden of young (adult) carers.

As stated in Section 5.1, we obtain the same results of IVs in the first-stage regressions for both Groups (I) and (II).

7. Conclusion

This study aims to clarify that imbalances in the division of time within their household may lead to children becoming young (adult) carers using the survey on time use and leisure activities conducted by the Statistics Bureau, MIAC, in 2011 and 2016. To achieve the above goal, we focus on children residing in households with parents and aim at those aged 10–24.

We found the following four factors leading the children to be young (adult) carers: (i) the household time allocation, (ii) the father's social status in the household, (iii) the individual attributes in terms of gender, and (iv) the household environment.

Regarding household time allocation, children tend to engage in home duties when they should be sleeping, which is associated with longer home-duty and commuting times for mothers, and shorter ones for fathers.

Furthermore, in households where the father's social status (educational attainment) is lower, children are statistically more likely to engage in household duties when sleeping. However, this observed relationship may be influenced by other factors, necessitating further investigation. Regarding individual attributes such as gender, the observation that children engage in household responsibilities when they should be sleeping highlights the persistent inequality in the distribution of female' home-duty time. In addition, household environment, such as the number of siblings under the age of 10, plays significant role in shaping the timing of home duties. It is important to note that an increase in fathers' time spent at home—due to access to paid leave (IVs)—does not necessarily reduce mothers' home duties. In contrast, mothers' home-duty time may increase, potentially driven by factors such as elevated standards of home production or the persistence of gendered social norms.

We have the following three limitations in our analyses: First, as for residential data, there is no information about the prefecture of each household. Second, we do not have information about the health conditions of unemployed fathers. Third, we do not have IVs highly correlated with endogenous variables.

These findings of this study have practical policy implications aimed at the early identification and intervention of young (adult) carers. In particular, by considering both the overall household labor and any distortions in time-use patterns—such as the engagement of home duties during late-night times and experiencing reductions in time for personal activities—this approach enables the identification of individuals who may require support but are not easily captured by conventional indicators.

These findings the need for a comprehensive screening framework that considers more than just the quantity of household labor. This may include strengthening daily monitoring and support systems through collaboration among schools, local communities, and social welfare agencies. Additionally, early monitoring mechanisms using time-use records could provide valuable insights.

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Appendix

A. Summaries of fundamental statistics

Table 3. Group (I): #obs.=23,964

Variables	N	mean	s.d.	min	max
latenight_homeduty	23964	.006	.076	0	1
c_hduties_time [h]	23964	.103	.504	0	12.5
f_hduties [h]	23964	.352	1.115	0	15
m_hduties [h]	23964	4.364	2.786	0	16.75
f_commutetime [h]	23964	.689	.914	0	8
m_commutetime[h]	23964	.296	.538	0	5
f_paleave_dummy	23964	.619	.486	0	1
m_paleave_dummy	23964	.412	.492	0	1
*year*_2016	23964	.478	.5	0	1
f_working_la	23964	.13	.337	0	1
m_working_la	23964	.041	.198	0	1
grad_highsch	23964	.213	.409	0	1
grad_junior_college	23964	.046	.21	0	1
grad_univ	23964	.04	.197	0	1
student	23964	.815	.388	0	1
holiday	23964	.616	.486	0	1
three_major	23964	.355	.479	0	1
male	23964	.502	.5	0	1
*num_members_under*10	23964	.197	.455	0	2
dual_income	23964	.859	.348	0	1
*hincome*200_299	23964	.031	.173	0	1
*hincome*300_399	23964	.07	.256	0	1
*hincome*400_499	23964	.111	.315	0	1
*hincome*500_599	23964	.131	.338	0	1
*hincome*600_699	23964	.127	.333	0	1
*hincome*700_799	23964	.119	.324	0	1
*hincome*800_899	23964	.103	.305	0	1
*hincome*900_999	23964	.081	.272	0	1
*hincome*1000_1499	23964	.164	.37	0	1
*hincome*1500	23964	.039	.195	0	1
f_highsch	23964	.454	.498	0	1
f_junior/tech_college	23964	.123	.329	0	1
f_univ	23964	.328	.469	0	1
f_grad	23964	.032	.175	0	1
m_highsch	23964	.462	.499	0	1
m_junior/tech_college	23964	.372	.483	0	1
m_univ	23964	.126	.332	0	1
f_regular	23964	.748	.434	0	1
f_nonregular	23964	.042	.2	0	1
f_executive	23964	.067	.25	0	1

$f\_self\_employed$	23964	.116	.32	0	1
$f\_otherstatus$	23964	.005	.069	0	1
$f\_housemaker$	23964	.004	.064	0	1
$m\_regular$	23964	.209	.406	0	1
$m\_nonregular$	23964	.481	.5	0	1
$m\_executive$	23964	.016	.125	0	1
$m\_self\_employed$	23964	.064	.244	0	1
$m\_otherstatus$	23964	.015	.12	0	1
$m\_housemaker$	23964	.212	.409	0	1

B. Results of manual two-stage probit estimation

We report the marginal effect of the endogenous variable using OLS in the first stage, substitute the predicted values into a probit model, and calculate the marginal effects because the IV probit does not allow us to calculate the marginal effects. These results indicate that there is no significant difference from the results of the IV probit model.

Table 4. Results of the first-stage regressions

Indicator	(I) OLS First-stage	(I) Probit Second-stage
Instrumental variables		
$f\_paleave\_dummy$	0.112**	
	[0.046]	
$m\_paleave\_dummy$	-0.157***	
	[0.042]	
$year\_2016$	0.023	
	[0.036]	
Home duty [h]		
f_hduty	0.141***	-0.004***
	[0.019]	[0.001]
m_hduty		0.024***
		[0.007]
Parents' commute time [h]		
$f\_commutetime$	0.225***	-0.005***
	[0.020]	[0.002]
$m\_commutetime$	-1.133***	0.028***
	[0.033]	[0.008]
Parents' working timing		
$f\_working\_la$	0.072	0.001
	[0.050]	[0.001]
$m\_working\_la$	-0.696***	0.016***
	[0.081]	[0.006]
Enrollment Status		
$grad\_highsch$	-0.181***	0.004*
	[0.050]	[0.002]
$grad\_junior/college$	-0.145	-0.003
	[0.099]	[0.005]

$grad\_univ$	-0.245**	0.002
	[0.103]	[0.004]
$students$	0.069	-0.000
	[0.068]	[0.002]
$holiday$	-0.344***	0.009***
	[0.037]	[0.003]
$three\_major$	0.133***	-0.002*
	[0.036]	[0.001]
$male$	0.130***	-0.005***
	[0.033]	[0.001]
$num\_members\_under10$	0.449***	-0.014***
	[0.042]	[0.004]
$dual\_income$	-0.039	0.001
	[0.087]	[0.002]
$children\_worktime$ [h]	-0.003	0.000
	[0.007]	[0.000]
Parents final education		
$f\_highsch$	0.048	-0.005**
	[0.072]	[0.002]
$f\_junior/tech\_college$	0.161*	-0.007***
	[0.085]	[0.002]
f_univ	0.231***	-0.010***
	[0.079]	[0.003]
f_grad	0.424***	-0.015***
	[0.128]	[0.005]
$m\_highsch$	-0.052	0.007*
	[0.098]	[0.004]
$m\_junior/tech\_college$	0.112	0.001
	[0.101]	[0.004]
m_univ	0.238**	0.003
	[0.110]	[0.005]
Parents' employment status		
$f\_regular$	-0.106	-0.002
	[0.149]	[0.004]
$f\_nonregular$	-0.047	-0.002
	[0.164]	[0.004]
$f\_executive$	0.388**	-0.011**
	[0.162]	[0.005]
$f\_self\_employed$	0.296*	-0.011**
	[0.152]	[0.004]
$f\_otherstatus$	-0.079	0.001
	[0.290]	[0.007]
$f\_housemaker$	-0.840***	0.021**
	[0.284]	[0.010]
$m\_regular$	0.128	0.050***
	[0.363]	[0.008]
$m\_nonregular$	0.926**	0.028***
	[0.360]	[0.007]
$m\_executive$	0.764**	0.032***
	[0.388]	[0.007]
$m\_self\_employed$	0.923**	0.027***

	[0.366]	[0.007]
$m\_otherstatus$	1.189***	0.021
	[0.385]	[0.009]
$m\_housemaker$	2.151***	-0.001
	[0.357]	[0.015]
Household income	Yes	Yes
N	23,964	23,964
R-square	0.180	-

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1