Childbirth and Welfare Inequality: The Role of Bargaining Power and Intrahousehold Allocation

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Abstract

This paper investigates the impact of childbirth on wives' bargaining power and welfare by analyzing labor market responses and adjustments in intrahousehold resource allocation. Using data from the Japanese Panel Survey of Consumers (1993–2020) and employing an event study approach, we find that wives, relative to their husbands, experience a 34.9% decrease in private consumption and a 7.5% decrease in leisure following the birth of the first child. We develop a collective bargaining framework to estimate the effects of parenthood on bargaining power, preferences for consumption and leisure, and productivity in producing public goods for both spouses. Our analysis reveals that the wife's bargaining power declines by 34.3% after childbirth, while both spouses' preferences for public goods increase. As a result, the arrival of a child leads to a 12.2% decline in welfare for wives but a 7.0% increase for husbands. Our counterfactual analysis indicates that if a wife's bargaining power had remained unaffected by childbirth, her welfare would have increased by 2.6 percentage points compared to the baseline. Furthermore, if there had been no wage penalties imposed on the wife, her welfare would have increased by 7.8 percentage points.

Keywords: Child Penalty, Bargaining Power, Intrahousehold Allocation, Gender Gap, Welfare

JEL Codes: D13, J13, J16

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1 Introduction

The arrival of children significantly contributes to inequality between men and women in the labor market. Prior to parenthood, men's and women's earnings tend to follow similar trends. However, following the birth of the first child, women experience a sharp decline in their earnings, whereas men are largely unaffected. In the U.S., women experience a 20% drop in annual employment and a 31% drop in earnings after childbirth, and these negative effects persist in the long run (Kleven, 2023). Similar studies conducted in various countries highlight the decline in employment and earnings among women after having a child.[1] The effect of parenthood on women compared to men, often referred to as the child penalty (Kleven, Landais, and Leite-Mariante, 2023), constitutes a substantial proportion of the gender earnings gap.[2] Despite the well-documented negative impacts of childbirth on women's labor market outcomes, the effects of childbirth on women's bargaining power and intrahousehold resource allocation remain largely unexplored.

This paper investigates the impact of childbirth on the welfare of both wives and husbands from a household perspective, considering the combined effects of both partners' labor market responses and adjustments in intrahousehold allocation. In addition to the negative impact of childbirth on women's earnings, we examine how it affects women's bargaining power and access to household resources, such as goods and time. Specifically, we identify three key channels that demonstrate the importance of considering women as part of the family instead of as a single decision maker in evaluating their welfare.

First, couples share resources and marriage serves as a risk-sharing device (Blundell, Pistaferri, and Saporta-Eksten, 2016, 2018). Although the wife may experience a negative wage shock, it may be offset by the husband's earnings — a form of insurance mechanism. Therefore, the decline in the wife's consumption may be less pronounced due to the potential for smoothing through spousal earnings. Failing to account for this resource sharing may lead to an overestimation of the child penalty.

Secondly, the allocation of resources within a household is determined by each member's bargaining power (Calvi, 2020). Bargaining power represents the extent to which a member can influence household decision-making processes. The presence of a child can potentially diminish the wife's bargaining power by worsening her outside options in the event of divorce

[1] For instance, in the UK, women experience a 33% drop in employment relative to men (Kuziemko, Pan, Shen, and Washington, 2020). In Norway, women's earnings drop by 23% compared to men (Andresen and Nix, 2022). In the Netherlands, women's earnings drop by 46% and wages drop by 15% compared to men (Rabaté and Rellstab, 2021). In Denmark, the long-term employment penalty for having children is 13.0%, the earnings penalty is 19.4%, and the wage penalty is 9.1% (Kleven, Landais, and Søgaard, 2019). In China, earnings drop by over 20% immediately after childbirth, but return to zero from the third year after childbirth (Meng, Zhang, and Zou, 2022). Kleven, Landais, Posch, Steinhauer, and Zweimüller (2019) estimate the long-term earnings penalty for having children in Scandinavian countries (Denmark 21%, Sweden 27%), English-speaking countries (UK 44%, US 31%), and German-speaking countries (Austria 51%, Germany 61%). Kleven, Landais, and Leite-Mariante (2023) estimate employment penalties for 134 countries, ranging from 9% to 38% at the continent level.

[2] Child penalties accounted for 80% of the total gender earnings gap in Denmark in 2013 (Kleven, Landais, and Søgaard, 2019), and 70% in the U.S. in the 2010s (Cortés and Pan, 2020).

or non-cooperation through the following channels. Firstly, the wife often faces a wage penalty, leading to lower wages compared to her husband's, which has been recognized as a significant determinant of couples' bargaining power in many studies.[3] Additionally, in the event of divorce, the wife typically retains custody of the children and bears the majority of the childcare burden (Doepke and Kindermann, 2019). Moreover, the wife's attractiveness and likelihood of remarriage may decrease after childbirth, as divorced women with children are often stigmatized in the marriage market (Brandwein, Brown, and Fox, 1974). These reduced outside options lead to fewer resources being allocated to the wife, thereby exacerbating the negative impacts of childbirth. Failing to account for the decrease in the wife's bargaining power may lead to an underestimation of the child penalty.

Lastly, the shared consumption of public goods is one of the primary forces driving household formation, and children are an essential public good (Blundell, Chiappori, and Meghir, 2005, Cherchye, De Rock, and Vermeulen, 2012). Furthermore, mothers typically attach great importance to their children (Bitler, Currie, Hoynes, Ruffini, Schulkind, and Willage, 2023, Björkman Nyqvist and Jayachandran, 2017, Dizon-Ross and Jayachandran, 2023). If a wife's preference for public goods increases after childbirth, she may willingly devote more time and resources to caring for the children at home. Additionally, the arrival of children creates a significant demand for home production, often leading to changes in comparative advantage and increased specialization between market work and home production within the household (Siminski and Yetsenga, 2022). Failing to account for the shift in both the preference for public goods and the comparative advantage between market work and home production may result in a biased estimate of the effect of childbirth on women's welfare.

In this paper, we examine the effect of childbirth on the three channels discussed above and address three key questions: (1) How do children affect individual and household earnings, private and public consumption, and time use? (2) How do children impact spouses' bargaining power, preferences for private goods and public goods, and their relative productivity in home production? (3) How do changes in these dynamics affect the welfare of wives and husbands?

To answer these questions, we first document the behaviors of both wives and husbands surrounding the first birth. Our data comes from the Japanese Panel Survey of Consumers (JPSC 1993–2020). Using an event study design, we find that following the birth of a child, the wife's employment falls by 49.9% and her hourly wages fall by 18.4%. Meanwhile, the husband's employment and hourly wages are largely unaffected. Consequently, women experience a significant decline in their weekly earnings by 63.1%. However, when we consider the combined weekly earnings of wives and husbands, family earnings decrease by only 20.6%, which is much smaller than the decline in women's individual earnings.

Furthermore, we find that wives experience a substantial 40.9% decrease in private consumption and a 16.8% decrease in leisure after childbirth, whereas husbands' private consump-

[3] See, for example, Baudin, De La Croix, and Gobbi (2015), Browning, Chiappori, and Lechene (2010), Couprie (2007), Myong, Park, and Yi (2021)).

tion is not affected and their leisure only drops by 8.9%. Relative to their husbands, wives experience a 34.9% decrease in private consumption and a 7.5% decrease in leisure following the birth of the first child. The observed decline in the wife's relative private consumption and leisure suggests a reduction in her bargaining power within the household, as the family resources are tilted towards the husband after childbirth.[4] Furthermore, we observe that couples allocate more time and financial resources to public goods after the first birth, with a 189% increase in the wife's time spent on home production, a 217% increase in the husband's time spent on home production, and a 6.1% rise in expenditure on public goods, indicating a shift in preferences towards public goods.

Motivated by the facts, we develop a collective model (Chiappori, 1988, 1992) that captures the intrahousehold resource allocation. Households consist of two members, a wife and husband, both deriving utility from private goods, leisure, and public goods. Children are viewed as a public good. Public goods are produced through home production, involving time inputs from both partners and public consumption. The bargaining power of wives and husbands is measured by the Pareto weight, which is determined by factors including their relative age, relative wage, whether they have a child, and the age of the first child.[5] Fertility plays a role in our model in three ways. First, fertility shapes spouses' preferences for public goods and their relative productivity in home production. Second, fertility can directly affect the wife's bargaining power by altering her Pareto weight. Lastly, fertility affects the wife's wages, leading to several effects: (1) the substitution effect, where the wife's wage rate reflects the opportunity cost of her time, thereby affecting her time allocation; (2) the income effect, where a decline in the wife's earnings impacts the household's budget constraint; and (3) the bargaining effect, where changes in the relative wages of spouses influence the wife's Pareto weight. We estimate the model using the non-linear generalized method of moments (GMM) and intratemporal moments. This allows us to compare the Pareto weight, preferences for private goods, leisure, and public goods, and home productivity before and after childbirth without taking a stand on whether fertility is an exogenous or endogenous decision.

Our estimation reveals a significant decline of 34.3% in the wife's Pareto weight following childbirth. On average, around 28% of this decline can be attributed to the wage penalty. The remaining portion of the decline can be attributed to the direct effect of fertility, which may be driven by factors such as a decrease in the wife's outside options as she takes on more childcare responsibilities due to social norms. Furthermore, we find that the arrival of a child is accompanied by an increase in the preference for public goods, particularly among wives. The wife's preference for public goods rises by 24.6%, while the husband's preference rises by 7.5%, indicating a shift in household preferences towards public goods after the first birth. This

[4] Wataru, Hannah, Hitoshi, and Midori (2024) theoretically shows that when a wife's bargaining power drops (either driven by a decline in the Pareto weight or a decrease in the value of the outside option), her private consumption and leisure decrease relative to her husband's. Bostyn, Cherchye, De Rock, and Vermeulen (2023) uses individual private consumption data to infer unequal resource sharing between husband and wife.

[5] The cost of childcare may vary depending on the child's age, which can affect women's outside options.

increase is consistent with the observed surge in time and expenditure on public goods, which suggests that households prioritize the well-being of the child over individual consumption and leisure. Lastly, we observe that the husband's home productivity relative to that of wives increases by 37.9% after the first child's arrival.[6] This suggests that husbands' role in home production becomes more important after they become fathers.

To calculate the welfare of husbands and wives in the collective model with public good production, we employ the Money Metric Welfare Indices (MMWI) proposed by Chiappori and Meghir (2014).[7] The MMWI measures the minimum expenditure required for an individual to achieve a certain level of utility when they solely provide public goods. Our analysis reveals that on average, wives experience a decline in welfare equivalent to a 12.2% reduction in their expenditure after childbirth. In contrast, husbands' welfare increases by 7.0%, indicating an increase in intrahousehold welfare inequality following childbirth. Furthermore, the decline in welfare is more pronounced among mothers with higher levels of education and mothers who worked during pregnancy.

Our findings on welfare align with the event study analysis on the subjective well-being of women using the JPSC. We observe that after childbirth, the likelihood of women reporting good physical health status declines by 39.6%. Additionally, life satisfaction drops by 5.1%, and happiness declines by 3.7% after giving birth. Furthermore, women experience a decrease of 4.3% in their self-reported standard of living following childbirth. Overall, these results indicate that parenthood has a significant negative impact on wives' welfare. Moreover, the ratio of the wife's welfare to the husband's declines from 92% before childbirth to 75% after childbirth, suggesting an exacerbation of gender inequality in welfare within the household.

To examine the welfare implications of changes in the wife's bargaining power and wage penalty, we consider three counterfactual scenarios. In the first scenario, we remove the negative effect of fertility on the Pareto weight, including the direct fertility effect and indirect effect through a change in the relative wage between wives and husbands. In the second scenario, we eliminate the wage penalty faced by women, thereby affecting both the wife's bargaining power and labor market prospects. In the third scenario, we eliminate the wage penalty for wives as well as the fertility effect on Pareto weight, i.e., we combine the first two scenarios.

Across all scenarios, we find a positive change in the wife's welfare after childbirth compared to the baseline. In the first counterfactual, where the wife's bargaining power increases after childbirth, the wife's private consumption and leisure both increase relative to the baseline. The negative effect of childbirth on the wife's welfare is reduced from -12.16% in the baseline to -9.56% in the counterfactual. In contrast, the effect of childbirth on the husband's

[6]This helps explain why the husband's time spent on home production experiences a greater increase (in percentage) compared to the wife's after childbirth. Before the first birth, husbands' average home time is only 3.5 hours per week, much lower than the 24.6 hours for wives. After the first birth, the husband's average home time increases to 12.3 hours per week but is still lower than the 64.8 hours for wives.

[7]One caveat is that the MMWI only measures the intratemporal utility, rather than the discounted lifetime utility. In addition, it only captures the investment value of children, but not their consumption value.

welfare drops from 6.97% in the baseline to 1.79% in the counterfactual. In the second counterfactual, where the wife no longer suffers from the wage penalty, women's time spent on paid employment increases, leading to an increase in the household budget, which subsequently improves the welfare of both the wife and the husband. The effect of childbirth increases from -12.16% to -1.78% for the wife and from 6.97% to 17.89% for the husband. Finally, in the third counterfactual (which combines the two channels), the wife's welfare increases by 0.50% while the husband's welfare increases by 13.91% following the birth of the first child. At the same time, the wife's welfare relative to her husband's increases from 75% to 80%, indicating an alleviation of welfare inequality within the household.

The first contribution of this paper is to demonstrate the broader effects of childbirth beyond the labor market, particularly in the reallocation of household resources. Recent research on the child penalty has extensively documented the decline in a wife's wages, labor supply, and earnings following the birth of children.[8] Building upon these studies, we present new empirical evidence that the presence of children influences more than just women's labor market outcomes – it also changes private and public consumption, as well as spouses' time allocation between leisure and home production within households.

The second contribution is that we identify a new mechanism through which childbirth can negatively affect women: the reduction in their bargaining power. Previous studies on collective models leverage detailed household consumption or time use data to recover preferences and bargaining weights of individuals, analyzing their effects on various household outcomes.[9] Two studies are closely related to our research. Calvi (2020) reveal that women's bargaining power declines with age using cross-sectional data from India, which helps explain the excessively high poverty rates and mortality risks for older women in India. We differ from their work by showing a sharp drop in a wife's bargaining power in response to the birth of the first child using panel data from the JPSC. The second relevant study is Lise and Yamada (2019), which uses the same JPSC dataset and finds that spouses' relative wages and expected wage growths at the time of marriage, along with relative wage shocks over time, influence spousal bargaining power. We extend their work by focusing on the periods surrounding the first birth and highlighting the negative effect of fertility on the wife's bargaining power on top of the effect of fertility on relative wages.

The final contribution of this paper is to quantify the welfare effects of parenthood, revealing the asymmetric impact on wives and husbands. In addition to the gender inequality in earnings and employment, we demonstrate gender inequality in welfare brought about by children. Our welfare measure captures the values of private consumption, leisure, and public goods. Our results show that the wife's welfare relative to the husband's declines from 91.9% to 75.3%

[8] See Blau and Kahn (2017) and Cortés and Pan (2020) for comprehensive reviews in this literature.

[9] Examples of household outcomes include child poverty (Dunbar, Lewbel, and Pendakur, 2013), women's mortality risk (Calvi, 2020), consumption inequality (Lise and Seitz, 2011), spouses' adjustments in intrahousehold allocation to wages (Lise and Yamada, 2019), bride price and dowry (Zhuge, 2023), and children's schooling choices (Guerrero, 2023).

after childbirth. Moreover, ignoring the change in women's bargaining power underestimates the welfare loss experienced by women due to childbirth by 21%. These findings underscore the importance of policies aimed at improving the bargaining power of women, which can reduce intrahousehold welfare inequality.

The remainder of the paper is organized as follows. Section 2 introduces the data. Section 3 presents the empirical patterns surrounding the first birth. We introduce the collective model in Section 4 and discuss the estimation process in Section 5. The estimation results are presented in Section 6. We analyze the effect of childbirth on individual welfare and conduct counterfactual analyses in Section 7. Section 8 concludes.

2 Data

2.1 Data and sample selection

Our dataset is the Japanese Panel Survey of Consumers (JPSC), which is a longitudinal study starting from 1993 till now. The respondents include single and married women who were born between 1959 and 1989, and it offers comprehensive information on labor market outcomes, time use, and consumption for women and their husbands.

Our study focuses on married couples with at least one child between 1993 and 2020. We examine a time frame of five years before and eight years after the birth of the first child.[10] To ensure meaningful comparisons of changes experienced by these couples before and after childbirth, we limit our sample to couples who were observed for at least one year within the five years preceding the first birth and for at least one year within the eight years following the first birth.

The JPSC provides information about household consumption. The survey question posed to respondents is: *"How much expenditure did you pay this September?"* Women are required to report the total household expenditure and provide a detailed breakdown of how expenses are allocated among different household members. The breakdown consists of five categories: (1) Expenses for the entire family, (2) Expenses for the wife, (3) Expenses for the husband, (4) Expenses for the child(ren), and (5) Expenses for others. We categorize (2) as private consumption for wives, (3) as private consumption for husbands, and (1), (4), and (5) as public consumption.[11] Our definition of public consumption encompasses not only expenditures directly related to child-rearing, but also a broader range of public expenditures within the household, such as utilities and furniture. Private consumption, on the other hand, includes items such as clothing, entertainment, and healthcare.

[10] In our dataset, 89.36% women have their first child within the first five years of their marriage. Thus, we focus on this time frame.

[11] The JPSC survey collects respondents' answers from late September to October, which is why the survey only asks about household expenditure during that period. In another question, wives are asked about the total household expenditure on various items, such as food, house rent, land rent, home repair, utilities, clothing and shoes, healthcare, transportation, communication, education, culture, and entertainment. However, the survey does not specify the exact amount spent by individuals on these items.

The second key piece of information is household time use, specifically how both the wife and husband allocate their time to various activities. The JPSC records how much time is spent by each person on the following activities: 1) Commuting; 2) Work; 3) Schoolwork (studies); 4) Housekeeping and childcare; 5) Hobbies, leisure, social interactions, etc.; and 6) Other activities such as sleeping, meals, and bathing. We categorize individual time into three categories: work time, leisure, and home production time. We define activities (1), (2), and (3) as work time, activity (4) as home production time, and activities (5) and (6) as leisure. We convert time use during weekdays and days off into weekly hours spent on these activities.[12].

The final piece of information is individual labor market performance, which includes their employment status and earnings. Earnings are reported as annual income before taxes for employees during the previous year. To ensure consistency across the sample, we convert both expenditure and earnings into weekly levels, with all monetary values expressed in Japanese Yen (in units of 1000) in 2013. Household earnings are the sum of the weekly earnings of the wife and husband. Hourly wage rates are calculated by dividing annual earnings by annual working hours.

We restrict our estimation sample to married couples with information on the variables discussed, as well as data on household demographic characteristics, including the ages and education levels of the wife and husband, the number of children, and household size.[13] The sample selection criteria is explained comprehensively in Appendix A.1. Our core estimation sample consists of 748 women and their husbands, corresponding to 6,390 couple-year observations.

2.2 Summary statistics

Table 1 presents the descriptive statistics for the variables used in the analysis. In our sample, the average age at marriage is 28 for wives and 30 for husbands. The average age at the birth of the first child is 31 for wives and 33 for husbands.[14] On average, households have 1.14 children, and the average household size is 3.42. Hence, the households in our sample are mostly nuclear families.

In terms of consumption patterns, the wife's average weekly private consumption is lower than the husband's (3290 yen vs. 6520 yen). Additionally, a larger proportion of total household expenditures is allocated to public goods compared to individual expenditures. On average, Japanese households allocate nearly 80% of their expenditures to public goods.

Regarding time allocation, wives spend an average of 90.95 hours per week on leisure, 55.17 hours on home production, and 20.72 hours on work and commuting. Meanwhile, hus-

[12]Similar categorizations of time use can be found in Boerma and Karabarbounis (2021), Browning, Donni, and Gørtz (2021), and Lise and Yamada (2019)

[13]To mitigate the influence of extreme values, we winsorize the expenditure, time allocation, and wages, limiting them to observations between the 5% and 95% of the sample.

[14]In the full JPSC sample, the average age at first birth is 27 for wives, which is four years lower than the average age in our sample. This discrepancy stems from limiting our sample to households that appear both before and after the first birth. In the JPSC, 79.32% of wives entered the survey after the birth of the first child.

bands spend on average 93.47 hours per week on leisure, 10.20 hours on home production, and 63.75 hours on work and commuting. While wives and husbands allocate similar amounts of time to leisure, wives dedicate significantly more time to home production and husbands spend more time on work-related activities.

From the labor market perspective, wives generally have lower employment rates, hourly wages, and weekly earnings compared to husbands. Only 45% of women are employed compared to over 99% of men. The average hourly wage rate of wives is 1100 yen, which is only 68% of that of husbands. As a result, wives' weekly earnings amount to just 24% of husbands' weekly earnings. In Appendix A.2, we examine the representativeness of the JPSC data by comparing the summary statistics with other surveys, including STULA and FIES, published by the Statistics Bureau of Japan. While the JSPC data is reported by wives, the other two surveys are reported by individuals themselves. The consistency between the JPSC and the other two surveys suggests that the wife's reported time use and expenditure are reliable.[15]

3 Event study analysis

In this section, we present the empirical patterns regarding spousal labor market outcomes, consumption, and time use around the time of the first birth. We use the event study approach, following the methodology outlined by Kleven, Landais, and Søgaard (2019). For each individual i with gender g in age k and year s at the event time t (t years after the birth of the first child), the outcomes Y_{ist}^g are modeled as functions of event time dummies, age dummies, and year dummies:

$$Y_{ist}^g = \sum_{\substack{j=-5 \\ j\neq -2}}^{8} \alpha_j^g \cdot \mathbf{I}[j=t] + \sum_k \beta_k^g \cdot \mathbf{I}\left[k = age_{is}\right] + \sum_y \gamma_y^g \cdot \mathbf{I}[y=s] + \nu_{ist}^g$$

The reference period for comparison is set as two years before the birth of the first child, i.e., $t=-2$. We choose two years prior rather than one year prior as the reference period because women are pregnant for nine months before giving birth, and may experience changes in preferences and behavior when pregnant. Since our sample excludes couples without children, the analysis essentially compares couples with at least one child with couples who have not yet had their first child.[16] In other words, we compare women of the same age in the same year who differ in when they had their first child. We predict the counterfactual outcome of not having a baby $\widetilde{Y_{ist}^g}$ using the age dummies and year dummies:

$$\widetilde{Y_{ist}^g} = \sum_k \beta_k^g \cdot \mathbf{I}\left[k = age_{is}\right] + \sum_y \gamma_y^g \cdot \mathbf{I}[y=s]$$

[15] In Appendix A.3, we demonstrate that the wife's report of the husband's expenditure is not significantly influenced by factors such as who manages the household income or the wife's time use. The lack of correlation suggests that any potential measurement errors are unlikely to substantially impact our main findings.

[16] Due to the absence of a never-treated group, we cannot control for individual fixed effects because the event time effect would not be point identified. For further discussion, see Borusyak, Jaravel, and Spiess (2024).

Table 1: Summary Statistics (JPSC 1993-2020)

	Mean	SD
Household characteristics		
Wife's age	33.23	4.30
Husband's age	34.70	5.03
Wife's education level (years of schooling)	14.09	1.65
Husband's education level (years of schooling)	14.37	2.10
Wife's age at marriage	28.21	3.38
Husband's age at marriage	29.71	4.27
Fertility-related characteristics		
Wife's age at first birth	31.02	3.35
Husband's age at first birth	32.58	4.37
Number of children	1.14	0.82
Household size (coresident)	3.42	1.19
Household expenditure (per week)		
Wife's private expenditure	3.29	3.36
Husband's private expenditure	6.52	4.95
Public expenditure	38.55	16.12
Time use (hours per week): wife		
Wife's work time	20.72	23.19
Wife's home production time	55.17	28.34
Wife's leisure	90.95	20.86
Time use (hours per week): husband		
Husband's work time	63.75	12.10
Husband's home production time	10.20	8.45
Husband's leisure	93.47	13.77
Labor market performance: wife		
Wife's employment status	0.45	0.50
Wife's hourly wages	1.10	0.66
Wife's weekly earnings	21.91	33.62
Labor market performance: husband		
Husband's employment status	0.99	0.08
Husband's hourly wages	1.62	0.80
Husband's weekly earnings	90.23	48.51

Note: The table presents descriptive statistics for the household sample constructed from the JPSC dataset (1993-2020). The sample comprises married couples within the (-5, 8) periods relative to the year of the birth of the first child. The sample consists of 748 unique household observations, with a total of 6390 household-year observations. All monetary values are reported in 2013 Japanese 1000 Yen. Standard deviations are shown in parentheses.

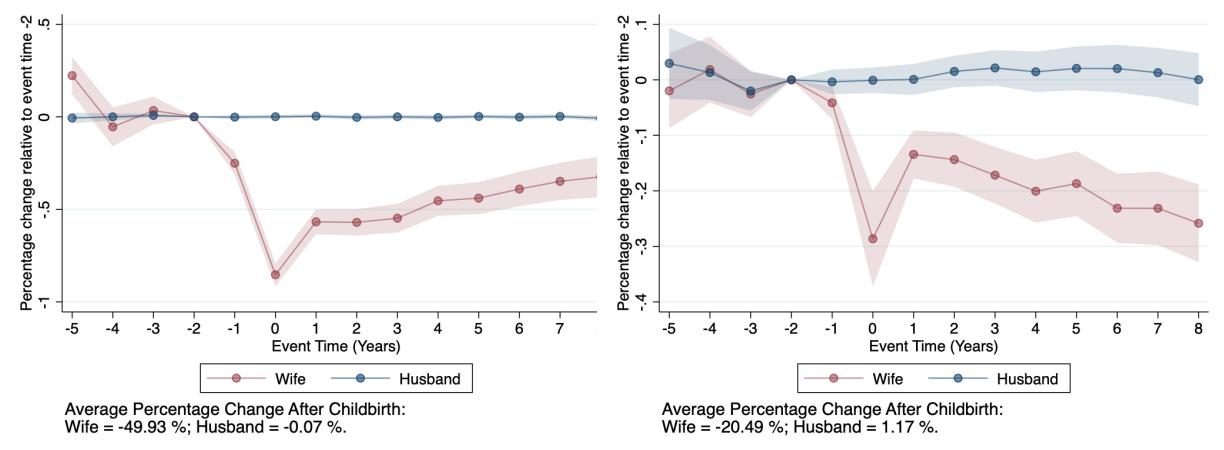
The treatment effect $P_t^g \equiv \frac{\alpha_j^g}{\widetilde{Y_{ist}^g}}$ represents the percentage change in the outcome at event time t relative to the outcome of not having a baby ($\widetilde{Y_{ist}^g}$). This scale-invariant measure of treatment effect allows for comparability across different outcomes. In Appendix B.1, we report the coefficients of the event time, which represent the change in levels.

3.1 Labor market performance

The women's earnings penalty can be attributed to three factors: (1) labor force participation, (2) hours of work, and (3) the hourly wage (Kleven, Landais, and Søgaard, 2019). Our findings indicate that women experience negative effects on all three margins, while there are no significant effects for men.

The left panel of Figure 1 illustrates that the wife's employment rate decreases by 49.93% on average following the birth of the first child. In Japan, women are predominantly employed in the non-regular sector, which is characterized by less job security and stability (Yamaguchi, 2019). Consequently, the arrival of children often leads to significant disruptions in employment. Over time, women tend to re-enter the labor force and regain employment, contributing to the observed recovery in the employment rate. However, by the eighth year after the birth of the first child, labor force participation is 40% below the pre-childbirth trend.

Furthermore, following the first birth, the wife's working hours (conditional on employment) decrease by an average of 20.49%, as shown in the right panel of Figure 1. This decline reflects the possibility that women switch their occupations and shift to sectors that offer more flexibility to accommodate their caregiving responsibilities (Cortés and Pan, 2020).



(a) Labor force participation

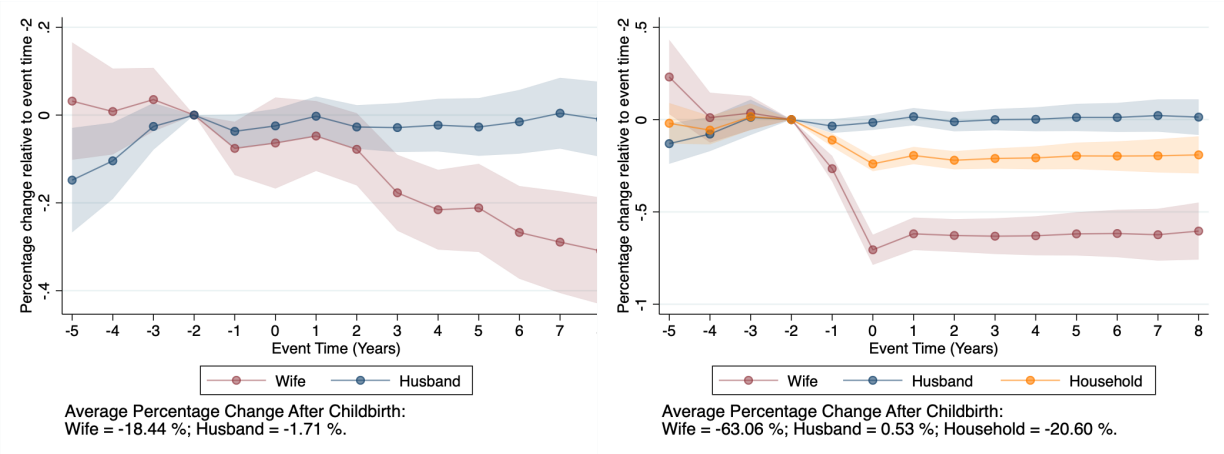
(b) Working hours (conditional on employment)

Figure 1: Labor Force Participation and Working Hours of Husbands and Wives

The left panel of Figure 2 demonstrates that the wife's hourly wages (conditional on employment) decrease by an average of 18.44% following the first birth. However, we do not observe a significant wage decrease in the first two years after childbirth. This lack of significance could be attributed to selection bias, as only women with higher wages may choose

to continue working after childbirth. However, as more women re-enter the labor market five years after childbirth, the negative effect on wages becomes more pronounced.

Due to the negative effects of childbirth on employment, working hours, and hourly wages, women experience an average decline in weekly earnings of 63.06% after childbirth, as shown in the right panel of Figure 2. Notably, our analysis of earnings includes both working and non-working women, with non-working women having zero earnings, which helps to avoid selection bias. In contrast, husbands' earnings remain unaffected by childbirth. When we combine the earnings of both spouses, we find a much smaller child penalty on family earnings. Family earnings decrease by only 20.60%, suggesting that women may experience a smaller penalty in their consumption since household earnings are shared between spouses.



(a) Hourly wage (conditional on employment)

(b) Weekly labor earnings

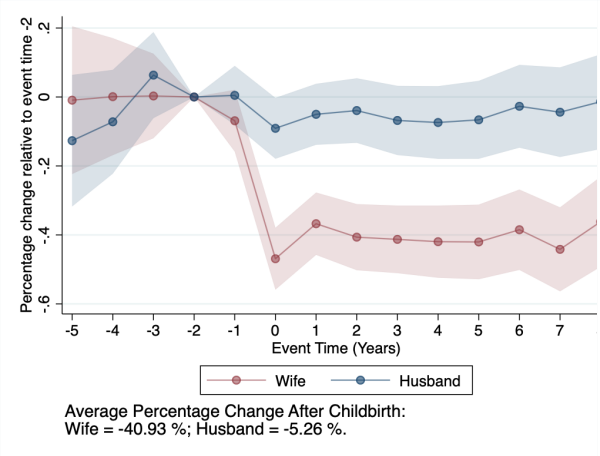
Figure 2: Wage Rates and Labor Earnings of Husbands and Wives

3.2 Individual consumption and leisure

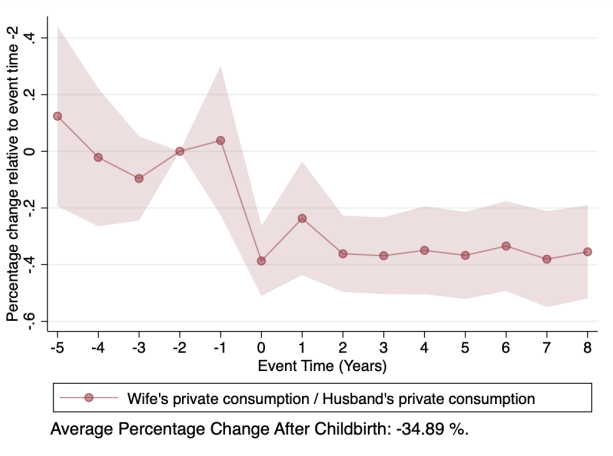
We investigate the impact of childbirth on private consumption and leisure, which are consumed by either husbands or wives. As shown in the left panel of Figure 3, wives experience a significant decline of 40.93% in private consumption following the birth of the first child, while the effect on husbands' private consumption is insignificant. The right panel of Figure 3 shows that the wife's private consumption relative to the husband's falls by 34.89% after the first birth.

Furthermore, the left panel of Figure 4 indicates that wives experience a 16.77% decrease in leisure, compared to an 8.91% decrease among husbands. The right panel of Figure 4 shows that the wife's leisure relative to her husband's leisure decreases by 7.48% following the first birth.

In Appendix B.2, we explore the heterogeneity in the response of a wife's private consumption relative to her husband's, as well as her leisure relative to her husband's, by dividing the sample based on the gender of the first child and the order of birth in the household during

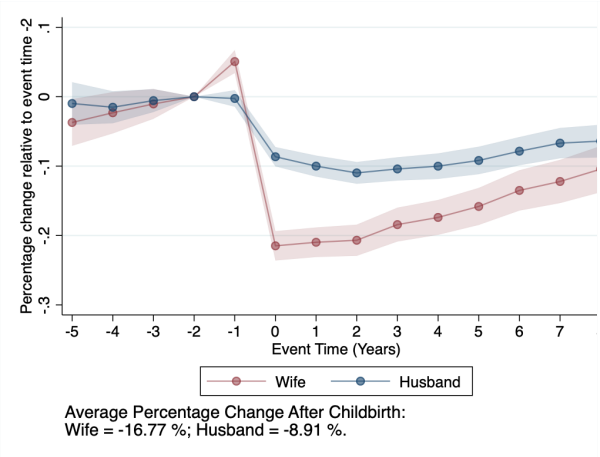


(a) Private consumption

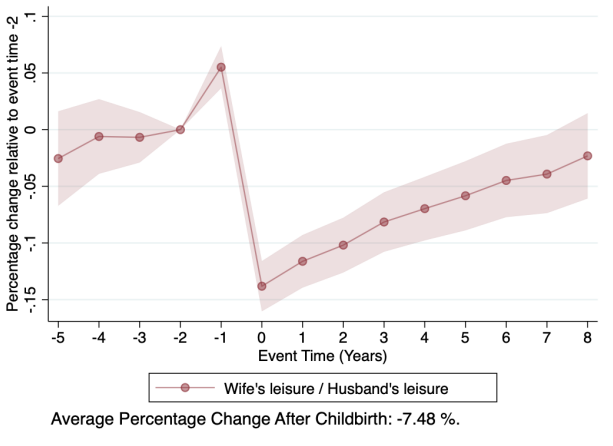


(b) Wife's private consumption (relative to husband)

Figure 3: Private Consumption of Husbands and Wives



(a) Leisure



(b) Wife's leisure (relative to husband)

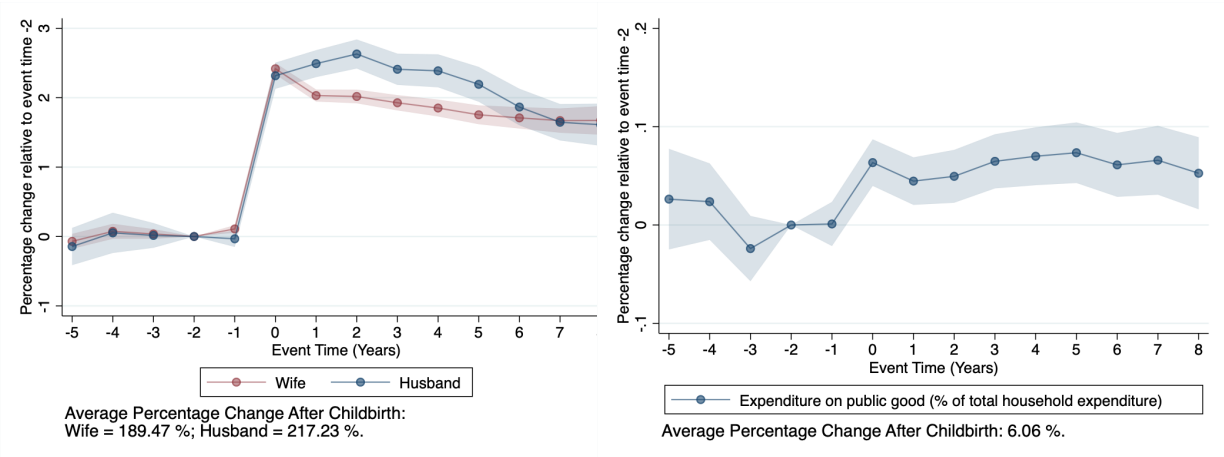
Figure 4: Leisure of Husbands and Wives

the sample periods. Our results reveal that the first birth has a similar effect on relative consumption and leisure as higher-order births. In addition, the effects on relative consumption and leisure do not vary significantly by the gender of the first child.

3.3 Public consumption and home time inputs

We also examine the impact of childbirth on time and monetary investments in public goods. As shown in the left panel of Figure 5, both wives and husbands increase their home production time following the first birth, with a percentage increase of 189% for wives and 217% for husbands. Interestingly, husbands experience a larger percentage increase in home production time than wives, likely due to their lower initial home production time compared to wives (3.5 hours vs. 24.6 hours). Figure B.5 in Appendix B.1 reveals that wives' weekly home production time increases by 41.52 hours following childbirth, which is substantially larger than the increase of 8.29 hours observed for husbands.

Moreover, the right panel of Figure 5 shows that the share of public expenditure in household total resources increases by 6.06% after the first birth. This suggests that the arrival of the first child leads to an increase in both the time and monetary inputs on public goods.



(a) Home production time (b) Public expenditures

Figure 5: Home Production Time and Public Expenditures

3.4 Summary of empirical patterns

To summarize, we have identified the following empirical patterns:

Fact 1: While women experience a wage penalty and a decrease in employment and working hours following the birth of the first child, the decline in family earnings is much smaller compared to the decline in women's earnings.

Fact 2: Following the first birth, there is a decrease in the wife's private consumption and leisure relative to the husband's.

Fact 3: Following the first birth, there is an increase in household expenditures on public goods and an increase in time spent on home production by both wives and husbands.

These patterns suggest that the arrival of a child can have a multifaceted impact on family life, including shifts in labor market outcomes and reallocation of resources between different types of goods and time allocation.

After the birth of the first child, wives tend to reallocate their time from leisure and paid employment to home production, whereas husbands primarily reallocate their time from leisure to home production, without a significant change in their working time. Additionally, wives experience a decline in private consumption, while the share of household resources allocated to public goods increases. In summary, the increase in both spouses' time and monetary contributions to public goods following childbirth indicates a stronger preference for public goods over private goods (including private consumption and leisure). Moreover, the differential increase in home production time between wives and husbands suggests a potential shift in their comparative advantage, that is, a change in the relative productivity in home production between spouses (Browning, Chiappori, and Weiss, 2014).

In addition, the decline in private consumption and leisure is more pronounced for wives compared to husbands, suggesting a reduction in the wife's bargaining power. Holding household members' preferences constant, the decrease in the wife's private consumption and leisure relative to the husband's reflects her diminished access to household resources and thus, a decline in her bargaining power.

However, the decline in private consumption and leisure following childbirth may not necessarily reflect a shift in bargaining power, as childbirth can also alter the preferences of household members for private consumption and leisure. To disentangle the effects of childbirth on husbands and wives with respect to their bargaining power, preferences for private goods versus public goods, and productivity in home production, and to investigate how these factors influence consumption and time allocation, we develop a collective model in the next section.

4 A Collective Model of Intrahousehold Allocation

We develop a collective bargaining model following Lise and Yamada (2019). The household comprises two members, the wife (W) and the husband (H). In each period t, individual $j \in \{W, H\}$ derives utility from private consumption c_{jt}, leisure ℓ_{jt}, and a public good Q_t. The wife and husband are assigned Pareto weights μ_t and $1 - \mu_t$, respectively, which reflect their bargaining power.[17] We assume that individuals have egoistic preferences. When allowing for Beckerian caring preferences, individuals care about their spouse's welfare, and thus μ_t should be interpreted as the relative importance of a household member (Lise and Seitz, 2011). The bargaining power is time-varying, and we consider the spouses bargaining in a no-commitment

[17] In a fully-fledged model, a change in bargaining power could be driven by a change in the Pareto weight or a change in the outside option. We model the Pareto weight in a reduced-form approach without directly modeling the outside option so that changes in the outside option are also reflected by changes in the Pareto weight. Therefore, we use the terms "Pareto weight" and "bargaining power" interchangeably throughout the paper.

environment.[18]

The household aims to maximize the expected, discounted, weighted sum of the spouses' utilities:

$$U_0 = E_0 \sum_{t=0}^{T} \left[\mu_t u_t^W(c_{Wt}, \ell_{Wt}, Q_t) + (1-\mu_t) u_t^H(c_{Ht}, \ell_{Ht}, Q_t) \right]$$

The public good Q_t is produced using market-purchased goods g_t and time spent on home production h_{jt} from both household members. Children enter the household utility through the public good Q_t.[19]

$$Q_t = Q(h_{Wt}, h_{Ht}, g_t)$$

Individuals allocate their time to leisure ℓ_{jt}, market work m_{jt}, and home production h_{jt}. The time constraint per period is expressed as:

$$\ell_{jt} + h_{jt} + m_{jt} = T, \quad j \in \{W, H\}$$

The budget constraint within period t is defined as:

$$c_{Wt} + c_{Ht} + g_t = w_{Wt} m_{Wt} + w_{Ht} m_{Ht} + (1+r) a_t - a_{t+1}$$

where a_t and a_{t+1} are the assets in periods t and $t+1$, respectively, while w_{Wt} and w_{Ht} are the wages of the wife and the husband, respectively.

We also have the non-negativity constraints:

$$c_{jt}, g_t, \ell_{jt}, h_{jt}, m_{jt} \geq 0.$$

and the stochastic process for wages,

$$\log w_{jt} = w(x_{jt}, \varepsilon_{jt}),$$

where x_{jt} is the observable characteristics of individual j in period t, and ε_{jt} is an i.i.d shock.

In our analysis, we focus on the household's decision-making process regarding the allocation of consumption and time after observing the wage shocks for husbands and wives before and after childbirth. Assuming interior solutions, the first-order conditions result in a set of marginal rate of substitution (MRS) relations, where the ratio of marginal utilities with re-

[18] In the literature on collective models, three common hypotheses of intra-household commitment are usually adopted: full commitment (Chiappori, Dias, and Meghir, 2018), limited commitment (Voena, 2015), and no commitment (Lise and Yamada, 2019). Previous studies have found strong evidence against the hypothesis of full commitment (Basu, 2006, Mazzocco, 2007, Theloudis, Velilla, Chiappori, Gimenez-Nadal, and Molina, 2023). Given the lower incidence of divorce in Japan (only 8.2% of women get divorced in the full sample of the JPSC), we have limited information about the binding participation constraints of both partners. Therefore, we adopt the no commitment framework.

[19] Similar settings can be found in Becker (1965) and Cherchye, De Rock, and Vermeulen (2012).

spect to two "goods" equals the ratio of prices. First, the relative marginal utilities of private consumption between wives and husbands will be proportional to the relative Pareto weights between husbands and wives.

$$\frac{\partial u_t^W / \partial c_{Wt}}{\partial u_t^H / \partial c_{Ht}} = \frac{1-\mu_t}{\mu_t} \tag{1}$$

Similarly, the relative marginal utilities of leisure between wives and husbands are determined by the relative Pareto weights and the relative wage rate.

$$\frac{\partial u_t^W / \partial \ell_{Wt}}{\partial u_t^H / \partial \ell_{Ht}} = \frac{w_{Wt}}{w_{Ht}} \frac{1-\mu_t}{\mu_t} \tag{2}$$

Moreover, the substitution pattern between private consumption and leisure for wives/husbands depends on their individual wages, which is independent of the Pareto weight.

$$\frac{\partial u_t^j / \partial c_{jt}}{\partial u_t^j / \partial l_{jt}} = \frac{1}{w_{jt}} \tag{3}$$

Lastly, the relative home production time between wives and husbands is proportional to their relative wages.

$$\frac{\partial Q_t / \partial h_{Wt}}{\partial Q_t / \partial h_{Ht}} = \frac{w_{Wt}}{w_{Ht}} \tag{4}$$

The MRSs provide insights into the empirical patterns presented in Section 2. Specifically, Equation 1 indicates that the decline in the wife's private consumption relative to her husband's, as shown in Figure 3, could be attributed to two potential factors: a decline in her bargaining power (as captured by the parameter μ_t), or a decline in her preference for private consumption relative to her husband's (as captured by the parameter $\frac{\partial u_t^W / \partial c_{Wt}}{\partial u_t^H / \partial c_{Ht}}$).

Similarly, Equation 2 reveals that the changes in the wife's leisure relative to the husband's can be attributed to three potential explanations: a change in her bargaining power (captured by the parameter μ_t), a change in her preference for leisure relative to her husband's (captured by the parameter $\frac{\partial u_t^W / \partial \ell_{Wt}}{\partial u_t^H / \partial \ell_{Ht}}$), or a change in her wages relative to her husband's ($\frac{w_{Wt}}{w_{Ht}}$). Since women's wages drop relative to their husbands' after childbirth, which suggests a decline in their opportunity cost of time, the last channel is unlikely to explain the decline in the wife's leisure relative to her husband's. Therefore, the patterns observed in Figure 4 can only be explained by a decline in her bargaining power or a decline in her preference for leisure relative to her husband's.

Equation 4 suggests that the changes in the wife's home production time relative to the husband's can be a result of a change in their relative wages ($\frac{w_{Wt}}{w_{Ht}}$) or relative home productivity ($\frac{\partial Q_t / \partial h_{Wt}}{\partial Q_t / \partial h_{Ht}}$). Since women's wages drop relative to their husbands' after childbirth, it is unlikely to explain the observed relative increase in the husband's home production time compared to the wife's, as shown in Figure 5. Therefore, the observed pattern is more likely explained by

an increase in the husband's relative home productivity after childbirth.

In the next section, we parameterize the model and introduce the estimation strategy. The MRSs discussed above serve as key moment conditions in the estimation procedure.

5 Estimation

In this section, we introduce the parametric model and discuss the two-step estimation process. We first estimate the wage function outside the model. Then, we estimate the rest of the parameters using non-linear Generalized Method of Moments (GMM).

5.1 The parametric model

We adopt the Constant Elasticity of Substitution (CES) preferences form for individual flow utilities:

$$u_t^j(c_{jt}, \ell_{jt}, Q_t) = \frac{1}{1-\sigma^j}[\alpha_{1t}^j c_{jt}^{\phi^j} + \alpha_{2t}^j \ell_{jt}^{\phi^j} + (1-\alpha_{1t}^j - \alpha_{2t}^j) Q_t^{\phi^j}]^{\frac{1-\sigma^j}{\phi^j}}$$

where α_{1t}^j, α_{2t}^j, and α_{3t}^j capture the preferences for private consumption, leisure, and public goods for individual j at time t. ϕ_j is informative about the degree of complementarity between different goods. When $1-\sigma^j < \phi_j$, private goods c_{jt}, leisure ℓ_{jt} and the public goods Q_t are direct substitutes.[20]

We adopt the following home production function:

$$Q(h_{Wt}, h_{Ht}, g_t) = [\pi_t h_{Wt}^\gamma + (1-\pi_t) h_{Ht}^\gamma]^{\frac{\rho}{\gamma}} g_t^{1-\rho}$$

where the aggregated time input and monetary input are complements. ρ is the Cobb-Douglas productivity parameter for time input. The effective time input of married couples follows a CES form in individual inputs, with an elasticity of substitution given by $\frac{1}{1-\gamma}$. A smaller value of γ indicates greater complementarity between home time inputs from the wife and husband.

We normalize the home productivities of wives and husbands such that the sum of their productivities equals one. Therefore, the wife's home productivity is $\pi_{Wt} = \pi_t$ and the husband's home productivity is $\pi_{Ht} = 1 - \pi_t$. This normalization helps us identify the preference for public goods, as an increase in a wife's home production time could be due to an increase in her preference for public goods or an increase in her home productivity in absolute terms. Therefore, changes in the preference for public goods $(1 - \alpha_{1t}^j - \alpha_{2t}^j)$ following childbirth could reflect a real change in people's preferences or simply be a result of a change in their home productivity.[21]

[20] In Appendix C.1, we consider a special case of individual utilities, a CRRA specification with separable preferences, and show that in this case, changes in relative private consumption between husband and wife have a one-to-one mapping relationship with changes in their Pareto weights.

[21] While women generally specialize in domestic work due to their comparative advantage (Becker, 1985), gender norms (Bertrand, Kamenica, and Pan, 2015), or preferences for childcare, disentangling these mechanisms empirically is challenging (Andresen and Nix, 2022).

To capture the heterogeneity across households, we model the preferences (α^j_{kt}), Pareto weights (μ_t), and relative productivity (π_t) as logistic functions of observed household characteristics. For modeling the Pareto weight at period t, we use the following specification:

$$\mu_t = \frac{\exp(x_{\mu t})}{1 + \exp(x_{\mu t})}$$

where

$$\begin{aligned} x_{\mu t} =& \beta_{\mu 1}(log(\frac{Age_W}{Age_H})) + \beta_{\mu 2}(log(\frac{w_{Wt}}{w_{Ht}})) \\ &+ \beta_{\mu 3} PostFirstBirth_{012} + \beta_{\mu 4} PostFirstBirth_{345} + \beta_{\mu 5} PostFirstBirth_{678} \end{aligned}$$

We consider the relative spousal ages and relative spousal current wages as distribution factors that can shift bargaining power. Additionally, we examine the direct effect of fertility on bargaining power. Specifically, we divide the post-birth period into three segments: 0–2 years after the first birth ($PostFirstBirth_{012}$), 3–5 years after the first birth ($PostFirstBirth_{345}$), and 6–8 years after the first birth ($PostFirstBirth_{678}$). By including these event time dummies, we can capture the impact of different stages of the post-birth period on the Pareto weights, while the pre-birth period serves as the reference period. It could also capture the potential effect of second or higher-order birth. In this specification, the Pareto weight is normalized to be one-half when spouses have the same age and wage prior to the first birth.[22]

Next, we model preference for consumption α^j_{1t} and leisure α^j_{2t} by gender using the following specification:

$$\alpha^j_{kt} = \frac{\exp(x^j_{kt})}{1 + \exp(x^j_{1t}) + \exp(x^j_{2t})} \quad \text{for } k = 1, 2$$

where

$$\begin{aligned} x^j_{kt} =& \alpha^j_{k0} + \alpha^j_{k1} Age_{jt} + \alpha^j_{k2} Edu_{jt} \\ &+ \alpha^j_{k3} PostFirstBirth_{012} + \alpha^j_{k4} PostFirstBirth_{345} + \alpha^j_{k5} PostFirstBirth_{678}. \end{aligned}$$

In this specification, x^j_{kt} includes a constant term, age, education, and three event time dummies related to the post-birth periods. Since the sum of individual preferences must equal 1, the husband's and wife's preferences for public goods, α^j_{3t}, are also functions of age, education, and the three event time dummies related to the post-birth periods.

Lastly, the relative productivity for public goods between husbands and wives is modeled

[22] We have also considered adding spousal relative education as a distribution factor affecting the Pareto weight. However, the estimation results show that spousal relative education does not significantly affect the Pareto weight after controlling for spousal relative wages. Therefore, we do not include spousal relative education in the specification of μ_t.

as a function of the three event time dummies related to the post-birth periods:

$$\pi_t = \frac{\exp(x_{\pi t})}{1 + \exp(x_{\pi t})}$$

where

$$x_{\pi t} = \beta_{\pi 0} + \beta_{\pi 1} PostFirstBirth_{012} + \beta_{\pi 2} PostFirstBirth_{345} + \beta_{\pi 3} PostFirstBirth_{678}.$$

The coefficients of $PostFirstBirth$ dummies capture whether the home productivity of husbands relative to wives changes after childbirth.

5.2 Wage process

The wages of the husband and the wife are assumed to be functions of individual fixed effects ϑ^i, potential experience exp_{jt}, and the age of the first child:[23]

$$\begin{aligned}\log w_{it} = \vartheta_i &+ \theta_1^j exp_{it} + \theta_2^j exp_{it}^2 + \theta_3^j PostFirstBirth_{012} + \theta_4^j PostFirstBirth_{345} \\ &+ \theta_5^j PostFirstBirth_{678} + \theta_6^j PostFirstBirth_{8+} + \varepsilon_{it}\end{aligned} \tag{5}$$

where the coefficients are allowed to be different across gender $j \in \{W, H\}$. ϑ^i captures the time-invariant individual skills, such as education and ability, and ε_{it} are i.i.d. shocks. Furthermore, the coefficients associated with the $PostFirstBirth$ dummies capture the wage penalty of childbirth.[24]

The relative wages of spouses are important determinants of their bargaining power. This holds true even for non-working wives, as variations in potential wages can influence their bargaining power (Blundell, Chiappori, Magnac, and Meghir, 2007). Therefore, we need to estimate the potential wages for non-working wives. Since wages are observed on the truncated working sample, we use the Heckman two-stage method (Heckman, 1979) to correct for sample selection. The method involves a two-stage model, the working decision equation, and the wage equation.

In the first-stage model, we include two sets of variables. The first set includes variables X_{it} that simultaneously affect an individual's working decision and wages; these variables include age, education, household size, and the $PostFirstBirth$ dummies. The second set Z_{it} comprises variables that exogenously shift the working decision rule but do not affect wages, such as spousal age and education. The variables Z_{it} serve as instruments to identify the parameters

[23] The differences in education result in differences in wages have already been fully reflected in the individual fixed effects ϑ^i. The potential experience a_{jt} is measured by age minus years of schooling minus 6 (i.e., the age at which formal schooling begins).

[24] To obtain a more accurate estimate of individual fixed effects, we use the entire sample observed in JPSC, rather than the (-5, +8) sample. To account for the effects of periods occurring eight or more years after the first birth, we incorporate a dummy variable, $PostFirstBirth_{8+}$.

in the two-stage model. The working decision equation is:

$$D_{it} = a_0' X_{it} + a_1' Z_{it} + v_{it}, \tag{6}$$

where (ϵ_{it}, v_{it}) are assumed to follow a joint normal distribution and ρ denotes the correlation of the two disturbances.

$$\begin{bmatrix} \epsilon_{jt} \\ v_{jt} \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_\epsilon^2 & \rho\sigma_\epsilon\sigma_v \\ \rho\sigma_\epsilon\sigma_v & \sigma_v^2 \end{bmatrix} \right)$$

We use the control function approach to estimate the wage equation, incorporating the inverse Mills ratio (IMR) as a control variable in the second stage. Our results, shown in Column (2) of Table 2, indicate that childbirth leads to a significant decline in wages for wives. The effect becomes more pronounced as children grow older, possibly due to the depreciation of the wife's human capital, the birth(s) of subsequent children, or the wife switching to more flexible occupations. Specifically, women with children experience a 6.5% wage cut compared to women without children when their children are between the ages of 0 and 2. This wage penalty increases to 19.5% when their children are between the ages of 6 and 8. In contrast, we find no significant impact of childbirth on the husband's wage rate, as shown in Column (4) of Table 2.

A comparison of Columns (1) and (2) indicates that the coefficient for the wife's potential experience becomes larger after controlling for $PostFirstBirth$ dummies. This result suggests that the estimated return to experience for women could be biased if we ignore the negative effect of the first birth on women's wages. A regression that does not control for fertility underestimates the return to experience, as shown in Column (1).

5.3 GMM

In the GMM process, the estimating equations are derived by taking the logarithm of intratemporal first-order conditions. The complete set of equations used in the estimation is outlined in Appendix C.2.

We follow the literature and adopt a parameter value of $\sigma^j = 1.5$.[25] Three sets of parameters remain to be estimated: (1) preference-related parameters, including individual preferences for private consumption (α_{1t}^j), leisure (α_{2t}^j), and the elasticity of substitution between different goods (ϕ_j); (2) home-production-related parameters, comprising relative productivity (π_t), the elasticity of substitution between different time inputs (γ), and the Cobb-Douglas productivity parameter ρ; and (3) the Pareto weight parameter (μ_t).

As in Lise and Yamada (2019), the GMM estimation incorporates two sets of instruments. First, the levels of consumption, hours, and wages from the previous year are employed as instruments for the current year's consumption, hours, and wages. Second, the preference

[25] See for example, Attanasio, Low, and Sánchez-Marcos (2008) and Knowles (2013).

Table 2: Mincer Equation Estimates

	Wife's wage rate		Husband's wage rate	
	(1)	(2)	(3)	(4)
Potential experience	0.011***	0.025***	0.046***	0.045***
	(0.002)	(0.003)	(0.001)	(0.001)
Potential experience (squared)	-0.00001	-0.00026***	-0.00084***	-0.00082***
	(0.000)	(0.000)	(0.000)	(0.000)
Post first birth (0–2 years)		-0.065*		0.011
		(0.038)		(0.009)
Post first birth (3–5 years)		-0.165***		0.015
		(0.031)		(0.010)
Post first birth (6–8 years)		-0.195***		0.011
		(0.029)		(0.011)
Post first birth (8+ years)		-0.173***		0.021
		(0.029)		(0.013)
Constant	-2.515***	-2.584***	-2.319***	-2.312***
	(0.034)	(0.042)	(0.017)	(0.021)
Individual FE	✓	✓	✓	✓
Inverse Mills Ratio	✓	✓	✓	✓
R-Squared	0.655	0.657	0.731	0.731

Note: The table presents the Mincer wage equation estimates for wives and husbands. Potential experience is measured as age minus years of schooling minus 6 (i.e., the age at which formal schooling begins). We include four 'PostFirstBirth' dummies in the equation. Standard errors are shown in parentheses. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

shifters, productivity shifters, and observable distribution factors are used as instruments. In total, there are 38 parameters to be estimated, and the estimation process involves 144 moment constraints.

Note that the MRS relationships hold true only when couples opt for interior solutions. However, when couples choose a corner solution, their relevant MRS relationships will not be used for the GMM estimation. The corner solution in work time is commonly observed in Japan where a significant proportion of women are not in paid employment. In such cases, we exclude the MRSs related to work decisions and instead focus on the MRSs of leisure, home time, private consumption, and public expenditure. We use the predicted wage (as discussed in the previous section) as the shadow price of time for non-working wives.

The main source of identification for our key parameter μ_t relies on variations in the wife's private consumption relative to the husband's, as well as the wife's leisure relative to the husband's. In the literature, there are two approaches to inferring intrahousehold sharing rules. The first approach, which uses household expenditure data, requires information on individual expenses of assignable goods to estimate resource shares (Browning, Chiappori, and Lewbel, 2013, Dunbar, Lewbel, and Pendakur, 2013). The second approach employs time use data and requires information on private leisure, which can also serve as an assignable good (Arduini, 2023, Browning, Donni, and Gørtz, 2021). Our data provide information on both private expenditure and leisure for husbands and wives, allowing us to observe the entire sharing rule.

In our model, we allow parenthood to affect not only the Pareto weight but also preferences and home productivity. Specifically, six parameters undergo changes following childbirth: μ_t, π_t, α^W_{1t}, α^W_{2t}, α^H_{1t}, and α^H_{2t}. We observe changes in six choices in the data: home production time, leisure, and private consumption for both husbands and wives.[26] Therefore, we have sufficient moments to identify these parameters, including the Pareto weight.

Empirically, we observe that both the husband's and wife's time and monetary contributions to public goods increase after childbirth, indicating an elevated preference for public goods and a decreased preference for private consumption for both individuals. However, we observe a decline in the wife's private consumption but not the husband's, which allows us to identify that childbirth reduces the wife's bargaining power.

6 Main Results

6.1 GMM estimates

Table 3 presents the GMM parameter estimates. In terms of bargaining power, we find that both a higher relative wage and a lower relative age for the wife compared to the husband contribute to an increase in her bargaining power. Furthermore, the three $PostFirstBirth$ dummies, which capture the direct impact of different stages of the post-birth period on bargaining power,

[26] We also observe work time and public expenditure, but work time can be pinned down by home production time and leisure, and public expenditure is determined by total income and private consumption.

are all negative.[27] The negative impact of parenthood on a wife's bargaining power can be due to the deterioration of outside options for women, particularly in the event of a divorce, as they would then be solely responsible for taking care of the child. According to the Vital Statistics of Japan 2019, in divorces involving minor children, the wife retains custody of the child in 84.5% of cases. Furthermore, because child-support agreements are both uncommon and unenforceable, less than 20% of divorced mothers receive any financial support from their ex-husbands (Raymo, Park, Iwasawa, and Zhou, 2014). Therefore, based on social norms, women are primarily responsible for paying the childcare costs when divorced, which leads to a significant reduction in their outside option after childbirth. Additionally, the likelihood of remarriage may decrease for divorced women with children, which further deteriorates their outside option.

In addition, fertility has a negative effect on spousal preferences for private goods and leisure. Given that preferences for private goods, leisure, and public goods sum up to one, this suggests that fertility has a positive effect on the preference for public goods for both wives and husbands. As discussed in Section 5.1, this positive effect could indicate a genuine shift in the preference for public goods or could be a result of an increase in home productivity.

Furthermore, the estimation indicates that wives with higher levels of education exhibit a stronger preference for private goods but a weaker preference for leisure. Conversely, husbands with higher levels of education have a weaker preference for private goods. Additionally, age has a positive effect on the preference for leisure for both wives and husbands, and a negative effect on the preference for private goods for husbands.

Our estimation also reveals that the coefficients of post-event time dummies in the wife's home productivity function are negative. The negative signs suggest that after childbirth, the wife's relative productivity in the home production of public goods decreases, while the husband's relative productivity in the home production of public goods increases. It is worth noting that the husband's average home production time before childbirth is only 3.5 hours per week, which increases to 12.3 hours (an increase of 250%) after childbirth. This suggests that the presence of children increases the importance of the husband's role in home production, and being a father makes husbands more productive in this domain.

Furthermore, we find that $1 - \sigma^W < \phi^W$ and $1 - \sigma^H < \phi^H$, which imply that for an individual, private consumption, leisure, and public good are viewed as direct substitutes. Additionally, the value $\gamma = 0.812$ indicates that a wife's home production time and a husband's home production time are complements.

[27] In Appendix D.1, we examine the heterogeneous effects on the decline in bargaining power associated with the three $PostFirstBirth$ dummies. Specifically, we interact these $PostFirstBirth$ dummies with dummy variables indicating whether the woman has a college degree and whether the first child is a boy. Higher education of the wife typically correlates with increased bargaining power in the literature (Ahn and Koh, 2022). Furthermore, Fan, Yi, Yuan, and Zhang (2018) find that having sons enhances the wife's bargaining power and reduces maternal time spent on household chores. Despite these insights, the interaction terms do not yield significant results. These findings suggest that the decline in bargaining power is widespread across households, regardless of these factors.

Table 3: GMM Parameter Estimates

	Estimate	
Wife's Pareto weights		
$\beta_{\mu 1} : log(\frac{Age_W}{Age_H})$	-0.702***	(0.141)
$\beta_{\mu 2} : log(\frac{logWw}{logWh})$	0.557***	(0.015)
$\beta_{\mu 4}$: post first birth (0–2 years)	-0.685***	(0.061)
$\beta_{\mu 5}$: post first birth (3–5 years)	-0.522***	(0.057)
$\beta_{\mu 6}$: post first birth (6–8 years)	-0.328***	(0.055)
Wife's preference for private goods		
α_{10}^W: constant	-0.556***	(0.186)
α_{11}^W: wife's age	0.005	(0.005)
α_{12}^W: wife's education	0.029***	(0.009)
α_{13}^W: post first birth (0–2 years)	-0.227***	(0.042)
α_{14}^W: post first birth (3–5 years)	-0.345***	(0.046)
α_{15}^W: post first birth (6–8 years)	-0.462***	(0.056)
Wife's preference for leisure		
α_{20}^W: constant	-0.838***	(0.099)
α_{21}^W: wife's age	0.016***	(0.002)
α_{22}^W: wife's education	-0.019***	(0.005)
α_{23}^W: post first birth (0–2 years)	-0.417***	(0.021)
α_{24}^W: post first birth (3–5 years)	-0.438***	(0.023)
α_{25}^W: post first birth (6–8 years)	-0.444***	(0.029)
Husband's preference for private goods		
α_{10}^H: constant	-0.277**	(0.114)
α_{11}^H: husband's age	-0.007**	(0.003)
α_{12}^H: husband's education	-0.014**	(0.006)
α_{13}^H: post first birth (0–2 years)	-0.235***	(0.028)
α_{14}^H: post first birth (3–5 years)	-0.227***	(0.032)
α_{15}^H: post first birth (6–8 years)	-0.199***	(0.041)
Husband's preference for leisure		
α_{20}^H: constant	-1.573***	(0.078)
α_{21}^H: husband's age	0.010***	(0.002)
α_{22}^H: husband's education	0.003	(0.004)
α_{23}^H: post first birth (0–2 years)	-0.154***	(0.017)
α_{24}^H: post first birth (3–5 years)	-0.130***	(0.020)
α_{25}^H: post first birth (6–8 years)	-0.075***	(0.024)
Wife's home productivity		
π_0: constant	0.340***	(0.040)
π_1: post first birth (0–2 years)	-0.641***	(0.026)
π_2: post first birth (3–5 years)	-0.638***	(0.029)
π_3: post first birth (6–8 years)	-0.628***	(0.033)
Consumptions complementaity		
ϕ^W	0.144***	(0.008)
ϕ^H	0.113***	(0.009)
Home production		
γ: home production complementaity	0.812***	(0.018)
ρ: time's output elasticity in home production	0.091***	(0.005)

To address concerns regarding the sensitivity of our estimates to functional form assumptions, we present two alternative specifications in Appendix D.4. In the first specification, we define the Pareto weight μ_t, spousal preferences α_{kt}^j, and home productivity π_t as functions of the number of children rather than the age of the first child. Specifically, we replace the post-birth event time dummies with indicators representing the number of children in the household during a specific period. The three indicators, $Children_{1t}$, $Children_{2t}$, and $Children_{3t}$ correspond to households with one child, two children, and three or more children, respectively. Households without children serve as the reference group.

In the second specification, we adopt the approach used by Lise and Yamada (2019) for the specification of μ_t by including the following distribution factors: (1) the relative wage between the husband and wife at the time of marriage; (2) the relative wage growth within 10 years between the husband and wife, which is predicted at the time of marriage; (3) the household income at the time of marriage; and (4) the relative wage shock, which is calculated by the deviations between real wages and predicted wages. We deviate from Lise and Yamada (2019) in that we additionally include the post-birth period dummies to analyze the direct effect of fertility on the Pareto weight.

The negative effects of fertility on the wife's bargaining power consistently persist across all specifications examined. Additionally, we observe enduring effects of childbirth on both husbands' and wives' preferences for private consumption and leisure, as well as on the home productivity of wives.

6.2 Model fit

Table 4 presents the goodness of fit for the estimation. We simulate household behaviors using the estimated structural parameters.[28]

The results indicate that our model fits the data well in terms of consumption allocation and time use both before and after the first birth. The model predicts that after childbirth, the wife's private consumption, work time, and leisure decrease, while her home production time increases. The model also predicts that the husband's home production time increases and leisure decreases, while there is almost no change in his private consumption or work time. In addition, the model predicts an increase in public consumption. These findings are consistent with the patterns observed in the data.

6.3 Childbirth dynamics

Using the event study approach described in Section 3, we plot the dynamics of estimated spousal bargaining power, preferences for private goods, leisure, and public goods, as well as their relative home productivity around the time of the first birth.

Figure 6 displays the dynamics of the wife's bargaining power. In the eight years after the birth of the first child, the wife's bargaining power on average decreases by 34.30%. The wife's

[28] In the simulations, we take the saving decision as $(1+r)a_t - a_{t+1}$, where r is the interest rate, as given. We directly feed in the value by using the difference between total income and total expenditure.

Table 4: Model Fit

	Before the first birth		After the first birth		Whole sample	
	(1)	(2)	(3)	(4)	(5)	(6)
	Data	Simulated	Data	Simulated	Data	Simulated
Intra-household expenditure (1000 yen per week)						
Wife's private consumption	4.41	5.92	2.94	3.55	3.29	4.12
Husband's private consumption	6.64	6.33	6.48	6.63	6.52	6.56
Public consumption	35.26	35.85	39.59	43.26	38.55	41.48
Time use (hours per week): wife						
Wife's work time	34.07	30.50	16.51	20.26	20.72	22.71
Wife's home production time	24.55	30.36	64.83	60.84	55.17	53.53
Wife's leisure	107.40	107.14	85.76	86.90	90.95	91.75
Time use (hours per week): husband						
Husband's work time	63.57	66.80	63.81	63.92	63.75	64.61
Husband's home production time	3.53	6.96	12.31	10.12	10.20	9.37
Husband's leisure	100.38	94.23	91.29	93.96	93.47	94.02
Observations	1532	1532	4858	4858	6390	6390

bargaining power recovers only a little in the long run, indicating a persistent decline in her access to household resources. On average, the estimated Pareto weight decreases significantly from 0.45 before the first birth to 0.29 afterward.[29]

The first three panels of Figure 7 depict the dynamics of spousal preferences. In terms of the preference for private goods, both the wife and husband experience a similar decline over the eight-year period after childbirth (13.11% for wives vs. 13.04% for husbands). However, wives experience a larger decline in the preference for leisure compared to husbands (18.36% vs. 4.59%). Hence, the increase in the preference for public goods is greater for wives than for husbands (24.55% vs. 7.54%). Consequently, the decrease in the wife's relative private consumption is primarily driven by the reduction in her bargaining power. The decrease in the wife's relative leisure can be attributed to both the reduction in her bargaining power and a larger decline in the preference for leisure compared to the husband. The increase in spousal home production time and public expenditure can be explained by the rise in spousal preferences for public goods.

Furthermore, the lower right panel of Figure 7 illustrates that the husband's relative productivity in home production increases by 37.90% after the arrival of the first child. This finding helps to explain the fact that husbands experience a larger percentage increase in home time compared to wives after childbirth.

[29] In Appendix D.2, we present the sample mean of the GMM parameter estimates before and after the first birth, including the Pareto weights, preferences for different goods, and husband's home productivity. Additionally, we conduct t-tests to compare these means before and after childbirth, rejecting the null hypothesis of no change in all cases.

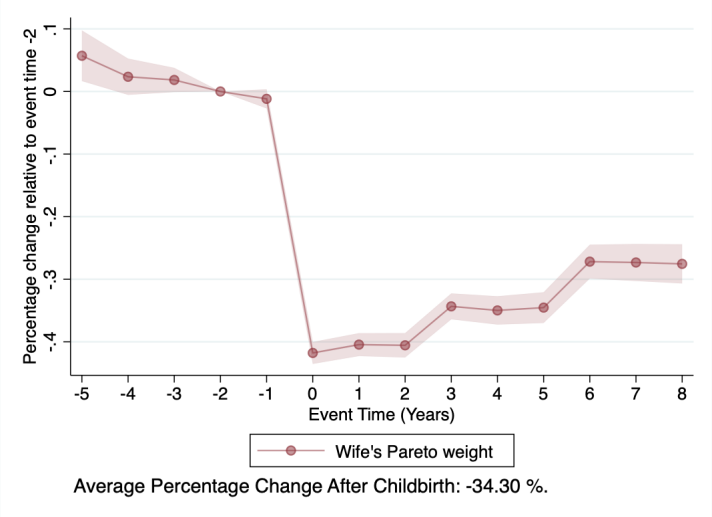
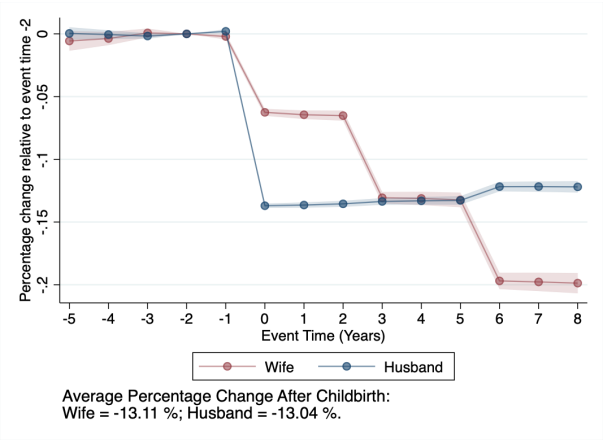
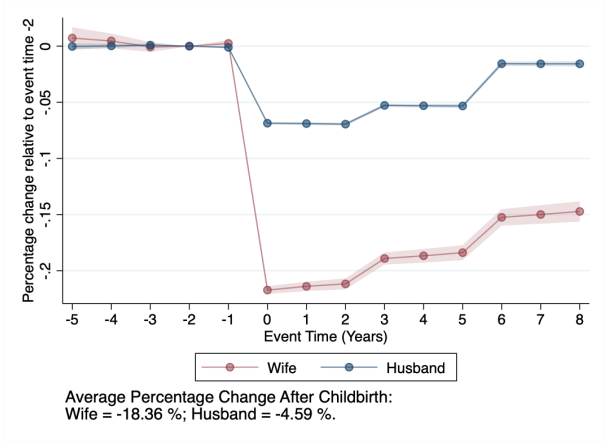


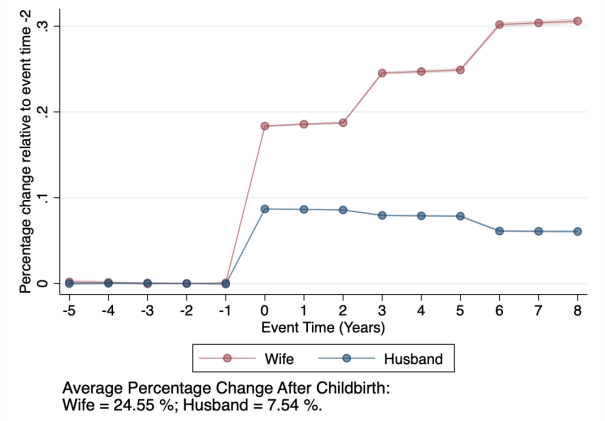
Figure 6: Childbirth Dynamics: Bargaining Power



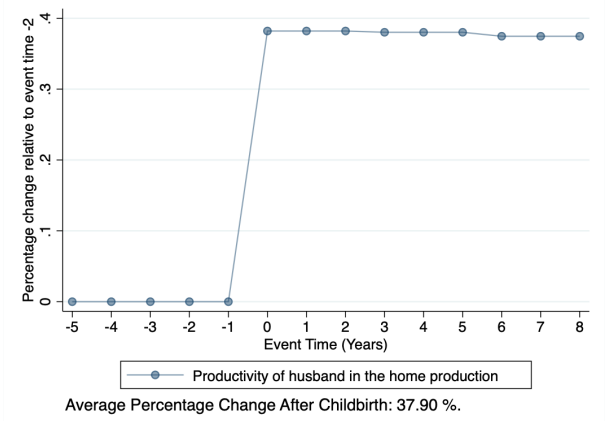
(a) Preference for private goods



(b) Preference for leisure



(c) Preference for public goods



(c) Home productivity of husband

Figure 7: Childbirth Dynamics: Preferences and Home Productivity

6.4 Decomposition of the Pareto Weight

To understand how wage penalties and fertility itself affects the wife's bargaining power after the first birth, we compare the wife's current Pareto weight μ_t and her Pareto weight μ'_t where the time-varying factors include only relative spousal age and relative spousal wage:[30]

$$\mu'_t = \frac{\exp(x'_{\mu t})}{1 + \exp(x'_{\mu t})}$$

where

$$x'_{\mu t} = \beta_{\mu 1}(log(\frac{Age_W}{Age_H})) + \beta_{\mu 2}(log(\frac{w_{Wt}}{w_{Ht}}))$$

In Figure 8, we present the dynamics of the two versions of the wife's bargaining power μ_t and μ'_t.[31] The proportion of the Pareto weight that can be explained by the relative wage ($\frac{\mu'_t}{\mu_t}$) is referred to as the relative wage effect. The remaining proportion that cannot be explained by the wage penalty ($\frac{\mu_t - \mu'_t}{\mu_t}$) is classified as the residual effect, which captures the effect of fertility itself on the wife's bargaining power. As shown in Figure 8, the relative wage effect increases gradually while the residual effect shrinks over time. On average, the relative wage effect accounts for only 28.5% of the decline in the wife's bargaining power while the residual accounts for 71.5%. These findings suggest that in addition to wage penalties, the presence of children has a direct impact on the wife's bargaining position. The two factors shift the Pareto weight in favor of the husband, thereby contributing to power inequality within the household.

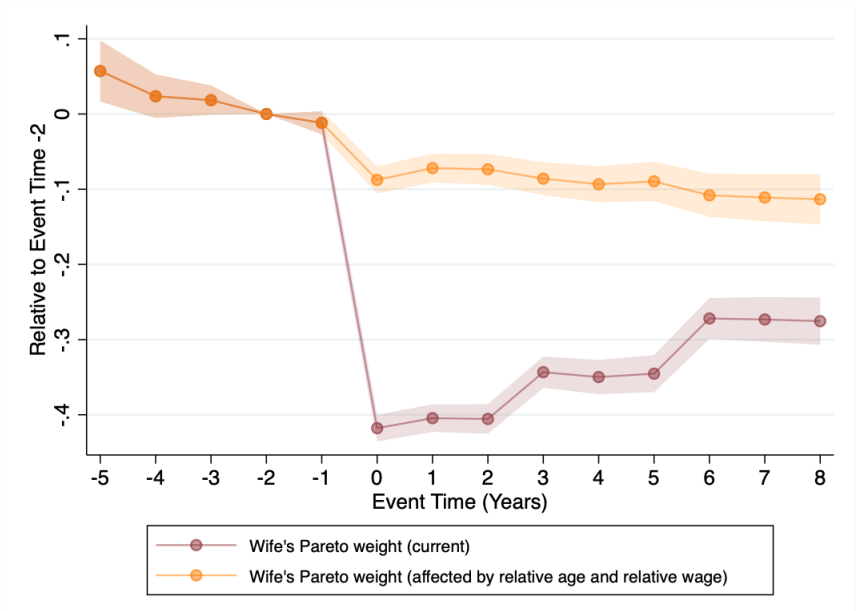


Figure 8: Decomposition of the Pareto Weight

[30] Although relative age also changes over time, the magnitude is very small.

[31] Appendix Table D.4 provides the details of the decomposition for each period after childbirth.

7 Welfare Implication and Counterfactual Analyses

7.1 Effect of Childbirth on Welfare

In the previous section, we discussed the simultaneous shifts of various factors following the birth of the first child. These factors include the bargaining power of the wife versus the husband, their preferences for private and public goods, and the productivity of home production. As a result, even for the same individual, the shape of their indifference curves may vary across different periods. Therefore, it is not appropriate to compare utility levels directly between different periods because an individual's ranking of their consumption bundles may change over time. This issue becomes particularly important when considering non-excludable public goods, as we need to account for changes in individuals' willingness to pay for the public good and the actual cost borne in producing the public good.

To address this problem, we adopt the money metric welfare indices (MMWI) developed by Chiappori and Meghir (2014). The indices measure the minimum expenditure that an individual would require to achieve the same level of utility when they are the sole producer of the public good, as they would when they are jointly producing the public good with their partner. As discussed in Cherchye, Cosaert, De Rock, Kerstens, and Vermeulen (2018), the MMWI are robust to individual environmental changes and can more consistently capture their actual welfare changes than using sharing rules. Therefore, by converting individual welfare to monetary terms, the MMWI enables us to evaluate how the welfare distribution changes at the individual level after the first birth. This measure has been widely used to evaluate individual welfare in the context of consumption inequality and individual poverty rates (Cherchye, Cosaert, De Rock, Kerstens, and Vermeulen, 2018, Cherchye, De Rock, and Vermeulen, 2012, Lewbel and Pendakur, 2024).

To compute the MMWI, we undertake the following procedure. First, based on the individual's current optimal solutions $(\tilde{c_{Wt}}, \tilde{c_{Ht}}, \tilde{g_t}, \tilde{\ell_{Wt}}, \tilde{\ell_{Ht}}, \tilde{h_{Wt}}, \tilde{h_{Ht}}, \tilde{m_{Wt}}, \tilde{m_{Ht}})$ within the household, we calculate the wife's indirect utility, $u^W_{Married}(\tilde{c_{Wt}}, \tilde{\ell_{Wt}}, Q_t(\tilde{h_{Wt}}, \tilde{h_{Ht}}, \tilde{g_t}))$, and the husband's indirect utility, $u^H_{Married}(\tilde{c_{Ht}}, \tilde{\ell_{Ht}}, Q_t(\tilde{h_{Wt}}, \tilde{h_{Ht}}, \tilde{g_t}))$.

Next, we consider a scenario where individuals live alone and produce the public good by themselves. In this scenario, we assume that the individual home production productivity, denoted as π_j, remains unchanged regardless of whether individuals produce Q_t on their own or with their partners. Hence, $\pi_W = \pi_t$ for the wife and $\pi_H = 1 - \pi_t$ for the husband. This assumption emphasizes the roles performed by both parents during childcare, which implies that their efficiency in raising children stays constant even if they are the sole childcare provider. Additionally, we assume that the home production time from their spouses are zero. Specifically, for individual $j \in \{W, H\}$, given their current wages w_{jt} and non-labor income levels

y_{jt}, we consider the following individual optimization problem:

$$\begin{aligned}
\underset{c_{jt},g_{jt},\ell_{jt},h_{jt},m_{jt}}{\text{Max}} \quad & u^j_{Singled}(c_{jt},\ell_{jt},Q_t) = \frac{1}{1-\sigma^j}(\alpha^j_{1t}c^{\phi^j}_{jt} + \alpha^j_{2t}\ell^{\phi^j}_{jt} + (1-\alpha^j_{1t}-\alpha^j_{2t})Q^{\phi^j}_t)^{\frac{1-\sigma^j}{\phi^j}} \\
\text{subject to} \quad & Q(h_{jt},g_{jt}) = (\pi_j h^{\gamma}_{jt})^{\frac{\rho}{\gamma}} g^{1-\rho}_{jt} \\
& \ell_{jt} + h_{jt} + m_{jt} = T \\
& c_{jt} + g_{jt} = w_{jt}m_{jt} + y_{jt}
\end{aligned}$$

where u^j_{Single} denotes the individual's utility function when living alone and producing the public good by themselves. The optimal solutions to this problem are denoted as $(c^*_{Wt}, g^*_{Wt}, \ell^*_{Wt}, h^*_{Wt}, m^*_{Wt})$ for the wife and $(c^*_{Ht}, g^*_{Ht}, \ell^*_{Ht}, h^*_{Ht}, m^*_{Ht})$ for the husband.

Finally, we calculate the MMWI for each individual as the minimum expenditure required to achieve the same level of utility in the single scenario as they would have in the married scenario. Specifically, for individual $j \in \{W, H\}$, the MMWI is given by:

$$\begin{aligned}
MMWI_{jt} &= \underset{c^*_{jt},g^*_{jt},\ell^*_{jt},h^*_{jt},m^*_{jt}}{\text{Min}} \left(\begin{array}{c} c^*_{jt} + g^*_{jt} + w_{jt}(\ell^*_{jt} + h^*_{jt}) \\ \text{s.t. } u^j_{Singled}(c^*_{jt},\ell^*_{jt},Q_t(h^*_{jt},g^*_{jt})) \geq u^j_{Married}(\tilde{c_{jt}},\tilde{\ell_{jt}},Q_t(\tilde{h_{Wt}},\tilde{h_{Ht}},\tilde{g_t})) \end{array} \right) \\
&= \underset{c^*_{jt},g^*_{jt},\ell^*_{jt},h^*_{jt},m^*_{jt}}{\text{Min}} \left(\begin{array}{c} w_{jt}T + y_{jt} \\ \text{s.t. } u^j_{Singled}(c^*_{jt},\ell^*_{jt},Q_t(h^*_{jt},g^*_{jt})) \geq u^j_{Married}(\tilde{c_{jt}},\tilde{\ell_{jt}},Q_t(\tilde{h_{Wt}},\tilde{h_{Ht}},\tilde{g_t})) \end{array} \right)
\end{aligned}$$

We find y_{jt} such that individuals can achieve exactly the same utility when living alone as they would when married, and $w_{jt}T + y_{jt}$ equals the MMWI.

After obtaining the MMWI, we use the event study approach discussed in Section 3 to analyze the changes in welfare following childbirth. As shown in Figure 9, there is a significant disparity in welfare changes between the husband and wife, as measured by the MMWI. On average, the wife experiences a decline of 12.16% in utility (in terms of expenditure equivalence), despite an increase in her preference for public goods. Her welfare decreases immediately after childbirth and continues to deteriorate over the first eight years. In contrast, the husband's utility shows a persistent increase of 6.97% after the birth of the first child. On average, the wife's welfare relative to the husband's declines from 91.92% to 75.28% after childbirth, indicating an increase in within-household welfare inequality.

In Appendix E.2, we examine the robustness of our welfare results with respect to the two assumptions regarding home production. We explore two alternative scenarios. First, we specify the individual home production technology to be equal to one ($\pi_W = \pi_H = 1$) when individuals produce the public good independently. In this scenario, the home production function for individuals is $Q(h_{jt}, g_{jt}) = h^{\rho}_{jt} g^{1-\rho}_{jt}$. This alternative specification helps us rule out the concern that the increase in men's welfare in the baseline specification is driven by an increase in their home productivity.

Second, we analyze the equivalent specification in Cherchye, De Rock, and Vermeulen

(2012), assuming that 30% of the spouse's home production time remains available in the new regime. Following their approach, we assume that the individual's home production time is unchanged and the spouse's home production time is at 30% of the original level. Then, we keep public goods at the same level as in the initial situation by increasing the expenditure on public goods to compensate for the decreased time input of the absent partner. The motivation for this specification is twofold: first, there is a minimum threshold of home production time required for childcare, and second, the presence of both parents is necessary and important for children's development. We then simulate the optimal private consumption and leisure arrangements that are necessary for individuals to achieve their original utility levels.

The two alternative assumptions of home production lead to consistent conclusion that parenthood leads to an increase in husband's welfare but a decline in wife's welfare. Appendix D.4 also shows that the welfare implications drawn from alternative models, as discussed in Section 6.1, are consistent with those from our baseline model.

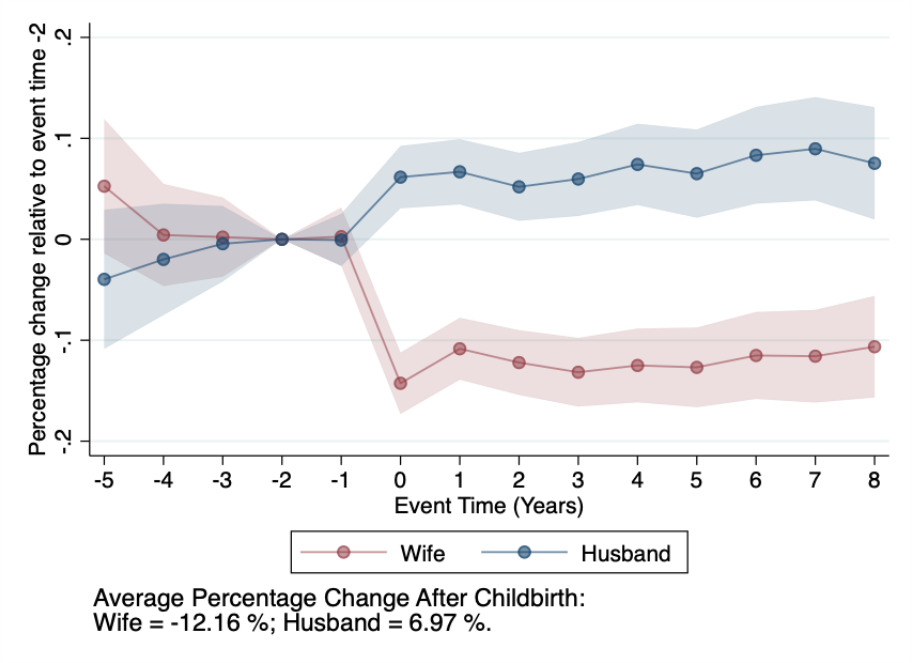
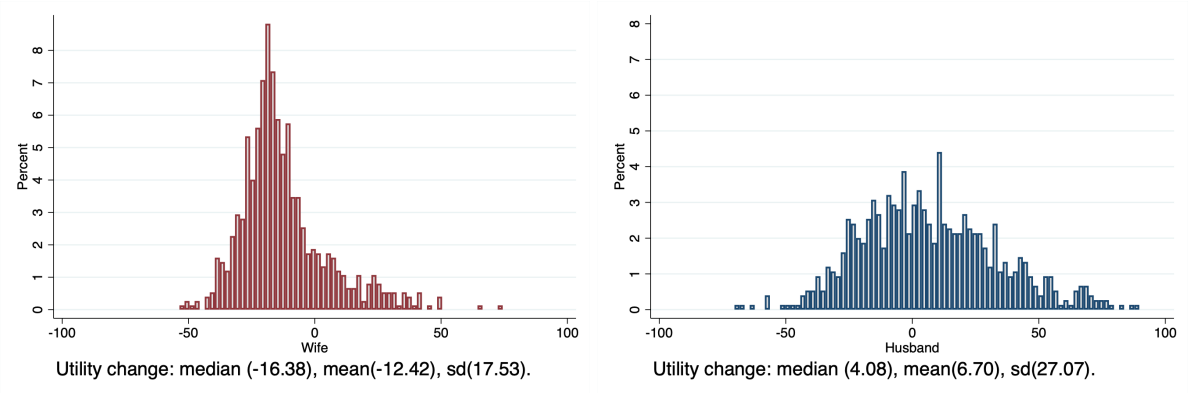


Figure 9: Money Metric Welfare Indices

To further investigate the distributions of utility changes for both the husband and wife, we use the age and year dummies to predict the counterfactual levels of MMWI for individuals not having a baby, denoted as $\widetilde{MMWI}_{jt}$. This approach enables us to compute the percentage change in the actual MMWI at event time t relative to the counterfactual MMWI of not having a baby at the same event time t. For each household, we calculate the average welfare change in their post-birth periods, i.e., event time $\in (0, 8)$. The distribution of the welfare change for our sampled households is depicted in Figure 10. The results show that 81.82% of wives experience a decline in welfare during the post-birth periods. The median wife encounters a 16.38% decrease in welfare after having a baby. In contrast, 56.68% of husbands experience

an increase in welfare after having a baby. The median husband experiences a 4.08% rise in welfare following childbirth.



(a) Wife (b) Husband

Figure 10: Distribution of Welfare Changes After Childbirth

Additionally, we examine the heterogeneity in welfare changes among wives, focusing on four characteristics: educational attainment, labor force participation before giving birth, birth cohort, and age at first birth.

First, we compare college graduates and non-college graduates. As illustrated in Figure 11, college graduates experience a larger reduction in welfare than non-college graduates, both in terms of the median (-17.86% versus -15.01%) and the mean (-14.01% versus -11.33%). The two distributions exhibit significant differences based on the Kolmogorov-Smirnov test (p-value = 0.001).

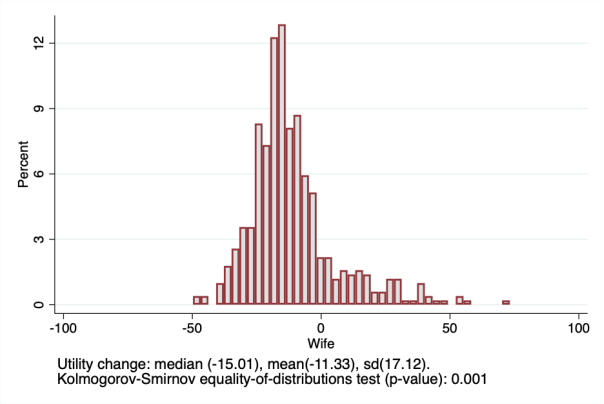
Next, we classified women based on their employment status in the year preceding the first birth.[32] Women who worked before having their first child experienced a more pronounced decline in welfare following childbirth compared to those who had not worked (mean -13.31% vs. -10.10%), as shown in Figure 12. The two distributions are significantly different according to the Kolmogorov-Smirnov test (p-value = 0.000).

We further analyze whether the welfare effects differ by birth cohort by comparing women who were born before 1976 and those who were born after 1976. As shown in Appendix Figure E.1, we do not find a significant difference in the changes in welfare between older and younger cohorts. Additionally, we examine the heterogeneous welfare effects by women's age at first birth. We find no evidence that the changes in welfare differ between women who gave birth before the age of 31 and those who gave birth after, as shown in Appendix Figure E.2.

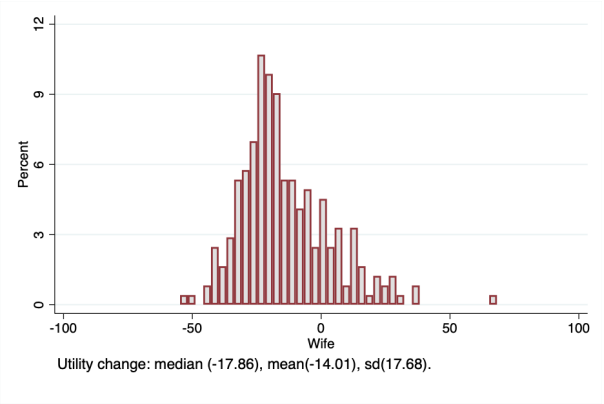
7.2 Effect of Childbirth on Wives' Health Status and Life Satisfaction

To provide further evidence in support of our welfare implications, we examine wives' life satisfaction, self-reported health status, current standard of living, and happiness using the JPSC

[32] We chose this particular event time because 96.84% of women were observed at event time = -1, whereas only 58.14% could be traced back to event time = -2.

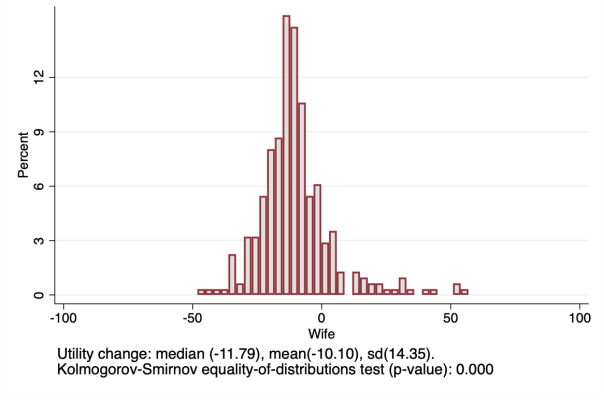


(a) Wife without a college degree

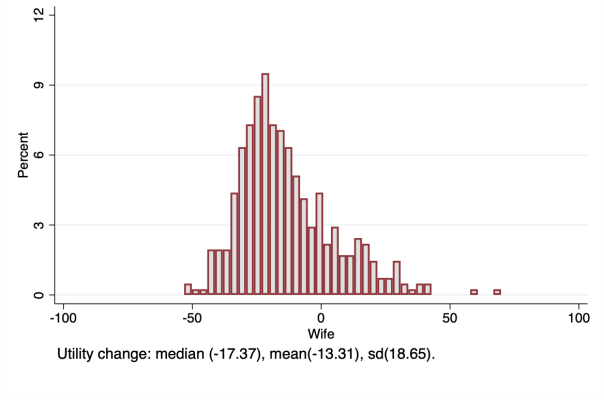


(b) Wife with a college degree

Figure 11: Heterogeneity in Welfare Changes Among Women (by Wife's Education)



(a) Unemployed wife at t = -1



(b) Employed wife at t = -1

Figure 12: Heterogeneity in Welfare Changes Among Women (by Wife's Working Status)

data. We employ the same event study specification as in Section 3 to analyze the dynamics surrounding the birth of the first child.

Regarding life satisfaction, women are asked, "Are you generally satisfied with your life?" They can choose from the options of 'Very much', 'Quite', 'Moderately', 'A little', and 'Not at all'. We classify the first three categories as indicating satisfaction. As illustrated in the upper left panel of Figure 13, the likelihood of women reporting satisfaction decreases by 5.08% after childbirth.

Concerning health status, women are asked, "Do you think you are in better physical condition than most people your age?" They can choose from the options of 'Much better than average', 'A little better than average', 'Average', 'A little below average', and 'Way below average'. The first two categories are classified as indicating good health. As shown in the upper right panel of Figure 13, the likelihood of women reporting good health decreases by 39.59% after childbirth.

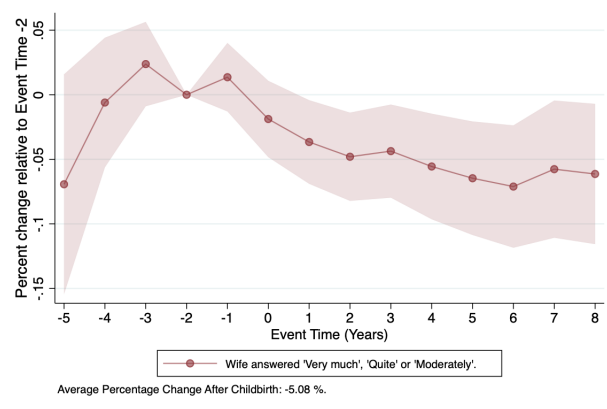
We also investigate the impact of childbirth on the current standard of living. In the JPSC survey, women are asked, "How would you classify your standard of living?" We use a continuous measure that ranges from 1 to 5, where 1 indicates that the wife answered 'Bottom' and 5 indicates the wife answered 'Top'. As depicted in the bottom left panel of Figure 13, the wife's reported standard of living experiences a decrease of 4.26% after the birth of the first child.

Lastly, we examine the effect of childbirth on happiness. In the JPSC survey, women are asked, "Do you feel that you are happy?" We employ a continuous measure that ranges from 1 to 5, where 1 indicates that the wife answered 'Very unhappy' and 5 indicates that the wife answered 'Very happy'. As illustrated in the bottom right panel of Figure 13, the birth of the first child reduces the wife's happiness by 3.70%.

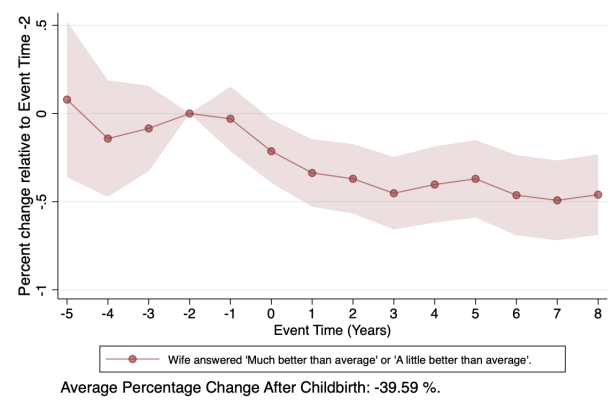
Our study consistently demonstrates a negative impact of childbirth on women's welfare using various measures of subjective well-being, which is consistent with the existing literature.[33] Note that our collective model primarily captures the investment value of children, as we use a revealed preference approach to support individuals' choices of public goods. The data does not allow us to identify the consumption value of children. Therefore, it remains uncertain whether having children brings positive or negative non-pecuniary utility. Nevertheless, our event study analysis using subjective well-being measures accounts for both the investment and consumption values of children. Interestingly, we observe that the results from these measures align with those obtained using the estimated welfare from the model.

Table 5 presents our analysis of the relationship between estimated levels of the wife's MMWI and her subjective well-being measures. Our results indicate that the wife's MMWI

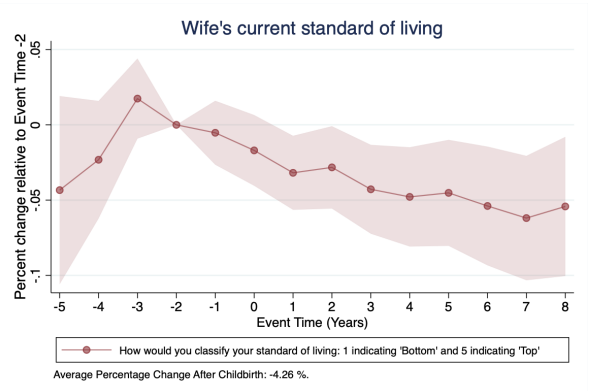
[33]Previous research has similarly documented the negative impact of parenthood on women's health and happiness. For instance, Dehos, Paul, Schäfer, and Süss (2024) found that among women in Germany, the prevalence of mental disorders and stress-related physical illnesses rises following childbirth. Moreover, the wife's reported level of happiness declines to below pre-pregnancy levels three years after giving birth to the first child. Ahammer, Glogowsky, Halla, and Hener (2024) find that women in Austria and Denmark have poorer mental health outcomes after childbirth.



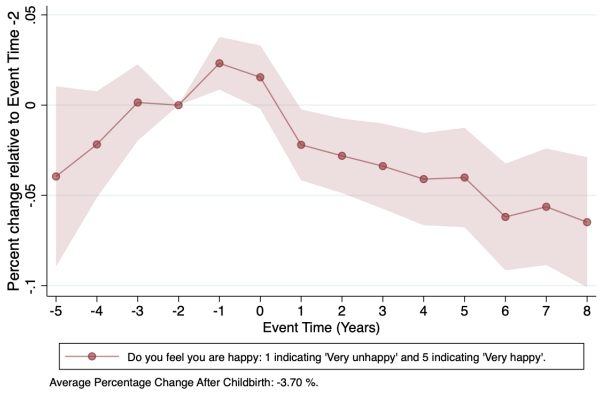
(a) Wife's life satisfaction



(b) Wife's physical health



(c) Wife's current standard of living



(d) Wife's happiness

Figure 13: Wives' Health Status and Life Satisfaction

levels are positively correlated with her reported physical health, life satisfaction, happiness, and current standard of living. This finding suggests that the consumption value of children may not significantly influence the direction of the effect of childbirth on women's welfare.

Table 5: Wives' MMWI, Health Status, and Life Satisfaction

	Wife			
	(1) Physical health	(2) Life satisfaction	(3) Feeling of happiness	(4) Current standard of living
Wife's MMWI/1000	0.766***	0.222**	0.375	2.426***
	(0.223)	(0.102)	(0.320)	(0.337)
Constant	0.097***	0.874***	4.091***	2.627***
	(0.035)	(0.019)	(0.054)	(0.054)
R-Squared	0.00767	0.00126	0.000575	0.0282

Note: The table presents the regression results between the wife's MMWI and her subjective well-being measures. The dependent variables include the wife's physical health, life satisfaction, feelings of happiness, and current standard of living. Standard errors are in parentheses. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

7.3 Counterfactual Analyses

We examine three hypothetical scenarios to investigate the welfare consequences of changes in the wife's bargaining power and wage penalty.

In the first scenario, we eliminate the impact of childbirth on bargaining power. Specifically, bargaining power varies only with changes in the relative age between spouses, and is unaffected by fertility or wage effects.[34] In the second scenario, we eliminate the wage penalty for wives, which affects their labor market opportunities and bargaining power through spousal relative wages. In the third scenario, we combine the first two counterfactuals by eliminating the wage penalty for wives and the fertility effect on bargaining power. We then analyze how intrahousehold allocation of consumption and time, as well as the welfare of both the husband and wife, differ in these counterfactual scenarios compared to our baseline model.

The results of the counterfactual analysis on intrahousehold allocation are presented in Table 6. Column (1) displays the simulation outcomes before childbirth while Column (2) shows the results after childbirth, serving as the baseline for our counterfactual comparisons. Columns (3) to (5) correspond to the three scenarios explained above.

Column (3) shows that in the first counterfactual scenario, as the wife's bargaining power increases after childbirth compared to the baseline, there is an increase in the wife's private consumption and leisure. Compared to the baseline, the wife's private consumption increases from 3,550 to 4,340 yen per week, and her leisure increases from 86.90 to 96.12 hours per week. On the other hand, the husband's private consumption decreases from 6,630 yen to 5,630 yen

[34] Although in reality, the age difference between husband and wife within a couple does not change, in our model, the relative age could vary over time due to the functional form we have chosen. Nevertheless, the effect of relative age on the wife's bargaining power is pretty small.

per week while his leisure decreases from 93.96 hours to 89.57 hours per week. These results suggest that empowering women can reduce the inequality in household resource allocation. Moreover, the wife's home production time decreases from 60.84 hours to 53.73 hours per week, while the husband's home production time increases from 10.12 hours to 13.59 hours per week, indicating that an increase in bargaining power can alleviate the heavy burden of housework and childcare among wives, and enhance the husband's role in home production.

In the second counterfactual scenario where the wife does not experience wage penalties after childbirth, there is an increase in the wife's work time, as depicted in Column (4). This increase in work time is primarily driven by an increase in her wage rate, which dominates the effect of an increase in her bargaining power. As observed in the first counterfactual, an increase in the wife's bargaining power would typically lead to a reduction in her work time. The higher wages and increased working hours for the wife result in higher household earnings. Consequently, both the wife and the husband experience an increase in private consumption compared to the baseline. Public consumption also increases in this scenario. Additionally, the relative increase in the wife's wages compared to husband's implies an increase in the husband's comparative advantage in home production, leading to an increase in the husband's home production time.

As shown in Column (5), in the third counterfactual scenario where the wife experiences neither a wage penalty nor a decrease in bargaining power due to childbirth, the wife's private consumption further increases to 5,930 yen per week. This increase in consumption reflects the combined effect of her greater bargaining power and the larger household budget. Additionally, the wife spends less time on home production and more time on leisure. On the other hand, the husband spends more time on home production and less time on leisure. The responses in home production time and leisure are the largest in the third counterfactual scenarios for both spouses.

Next, we analyze the welfare change for both wives and husbands before and after childbirth in the baseline model and three counterfactual scenarios. The results are presented in Figure 14. In the baseline model, the wife's welfare, as measured by the MMWI, decreases by 12.16%. When we eliminate the effect of childbirth on the wife's bargaining power, the wife still experiences a drop in welfare, but the magnitude shrinks to -9.56%. This increase in welfare is primarily driven by an increase in private consumption and leisure for the wife. Conversely, the effect of childbirth on the husband's welfare declines from 6.97% in the baseline to 1.79% in the first counterfactual scenario.

In the second scenario where the wife does not experience a wage penalty, the drop in her welfare after childbirth shrinks from -12.16% to -1.78%. Since the wage penalty plays a more important role in the mid and late stages of the post-birth periods, the effect of removing the wage penalty on welfare gradually increases as the children grow older. Additionally, the effect of childbirth on the husband's welfare increases from 6.97% to 17.89%, which is the highest among all three scenarios. The increase in the wife's wages and labor supply rises the

Table 6: Counterfactual Analysis: Intrahousehold Allocation

	(1) Before	(2) After (Baseline)	(3) After (No effect on μ)	(4) After (No wage penalty)	(5) After (No effect on μ + No wage penalty)
Intra-household expenditure (1000 yen per week)					
Wife's private consumption	5.92	3.55	4.34	5.05	5.93
Husband's private consumption	6.33	6.63	5.63	8.08	7.10
Public consumption	35.85	43.26	42.29	46.01	44.65
Time use (hours per week): wife					
Wife's work time	30.50	20.26	18.15	27.77	24.75
Wife's home production time	30.36	60.84	53.73	57.49	49.92
Wife's leisure	107.14	86.90	96.12	82.74	93.33
Time use (hours per week): husband					
Husband's work time	66.80	63.92	64.84	61.09	62.18
Husband's home production time	6.96	10.12	13.59	15.40	19.21
Husband's leisure	94.23	93.96	89.57	91.50	86.61
Relative terms					
Wife's private consumption / Husband's private consumption	0.87	0.41	0.65	0.63	0.87
Wife's leisure / Husband's leisure	1.16	0.94	1.10	0.93	1.11
Money metric welfare indices (1000 yen per week)					
Wife's MMWI	161.92	153.38	157.88	171.43	175.61
Husband's MMWI	189.31	222.29	209.75	244.49	234.46
Wife's MMWI/Husband's MMWI	0.92	0.75	0.82	0.75	0.80
Observations	1532	4858	4858	4858	4858

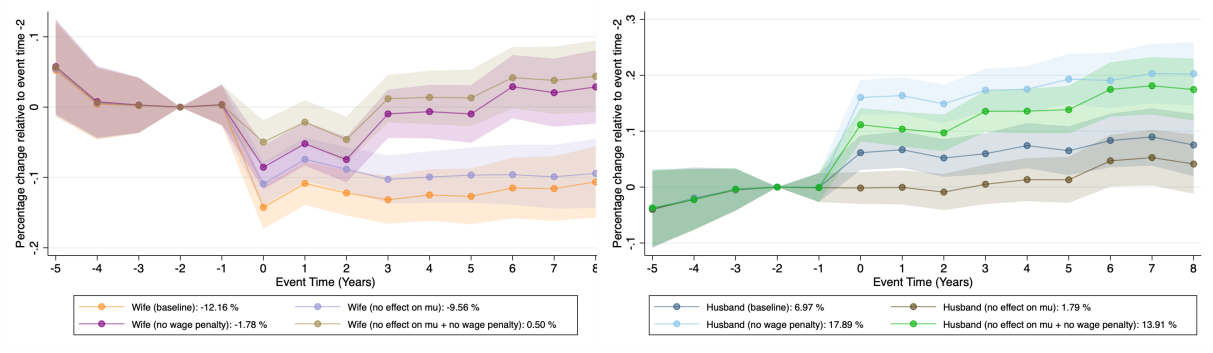
household budget, hence benefiting the husband as well. These findings suggest that policies aimed at mitigating the wage penalty associated with childbirth may have positive welfare implications for the entire household.

In the third scenario where the wife experiences neither a wage penalty nor a reduction in her bargaining power, the effect of childbirth on the wife's welfare changes from negative to a positive 0.50%. Meanwhile, the effect of childbirth on the husband's welfare increases to 13.91%. These results indicate that both the wage penalty and a reduction in bargaining power are crucial factors in explaining the negative effect of childbirth on women's welfare. Ignoring the change in women's bargaining power underestimates the welfare loss of childbirth by 21%.[35]

In the last three rows of Table 6, we present the MMWI levels for both wives and husbands, as well as the ratio of the wife's MMWI to the husband's MMWI. This ratio is a measure of welfare inequality within the household. Prior to the first birth, the wife's MMWI is 92% of her husband's, indicating a slight disadvantage for wives. However, following the first birth, the wife's MMWI drops to 75% of her husband's in the baseline scenario, which exacerbates gender inequality in welfare within the household.

In the first counterfactual scenario where the wife's bargaining power remains unaffected by childbirth, her MMWI increases from 75% to 82% due to enhanced bargaining power. In the second scenario, the wage penalties have a minimal impact on welfare inequality. Although

[35] 21%=1-9.56%/12.16%.



(a) Wife (b) Husband

Figure 14: Counterfactual Analyses Depicting Welfare Changes After Childbirth

wages can influence Pareto weights, this influence is marginal, as the relative wage effect only explains 28.5% of the decrease in the wife's bargaining power, as shown in Section 6.4. In the third counterfactual scenario, which combines the effects of the previous two scenarios, the wife's MMWI reaches 80% of her husband's MMWI. This suggests that the absence of negative effects on women's wages and bargaining power could potentially alleviate welfare inequality within the household.

8 Conclusion

This paper examines the impact of childbirth on labor market outcomes, intrahousehold resource allocation, bargaining power, and welfare for both husbands and wives. The empirical analysis reveals a significant decrease in women's employment, working hours, hourly wage rates, and labor earnings following childbirth. Additionally, wives' private consumption and leisure decrease relative to their husbands', while both spousal home production time and the share of household expenditure on public goods increase after the birth of the first child.

We develop a collective model and estimate it using GMM, and discover that the arrival of a child results in a 34% decline in the wife's bargaining power. Additionally, there is an increase in the preference for public goods among both wives and husbands; this increase is particularly potent among wives. Using money metric welfare indices, we find that the arrival of the first child leads to a 12% decrease in welfare for the wife and a 7% increase in welfare for the husband.

Our findings have several important implications. First, we highlight the role of the wife's bargaining power in influencing her consumption, time use, and overall welfare within the household. Our counterfactual experiments show that failing to account for the impact of childbirth on the wife's bargaining power may result in an underestimation of the negative effects of childbirth on women's welfare by 21%. Second, novel policies that aim to empower women can mitigate the adverse effects of childbirth on women's welfare. While existing studies explore policy interventions such as parental leave policies that directly encourage women's re-entry into the labor market (Blair and Posmanick, 2023, Wang, 2022, Yamaguchi, 2019), we suggest

that policies could focus on enhancing the wife's bargaining power after childbirth. For example, enacting laws to increase alimony payments provided by men to women in divorce would ensure the rights of divorced women with children and improve their outside options within marriage. By empowering women within the household, such policies can promote greater gender equality and improve the well-being of women during the post-childbirth period.

However, it remains a puzzle why women still want a child if parenthood lowers their welfare. Note that the current welfare measure in our model does not capture either the consumption value of children or their long-term benefits. Moreover, it remains unclear whether women can anticipate the decrease in bargaining power that comes with childbirth. If women are unable to foresee this shift, their welfare loss may also come as a surprise. Kuziemko, Pan, Shen, and Washington (2020) have shown that women may underestimate the likelihood of becoming stay-at-home mothers, indicating a potential lack of foresight regarding the effects of having children. More research is needed to better understand women's anticipation of fertility-related changes in bargaining power within the household. The ability to accurately anticipate these shifts could potentially influence a woman's decision on employment and fertility, and has significant implications for policies aimed at supporting new mothers.

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APPENDIX

A Data Appendix

A.1 Sample Selection Criteria

The Japanese Panel Survey of Consumers (JPSC) dataset is a longitudinal study that began in 1993 and continues to the present day. Our study uses data collected from 1993 to 2020 and includes 4,120 women with 52,144 individual-year observations.

Table A.1 provides an overview of the procedures used to obtain the final study sample. First, we restrict the data to married women, resulting in a sample of 35,657 observations. Next, we remove observations with missing values for variables such as wives' private expenditure and time allocation, husbands' private expenditure and time allocation, and public expenditure, leaving us with 32,200 observations.

Subsequently, we excluded cases where the age of the woman's first child was missing, including women without children, leaving us with 29,654 remaining observations. We then further eliminated women who entered the survey after the birth of their first child, resulting in the removal of 20,526 observations and leaving us with 9,128 observations. The substantial loss of observations is due to the fact that 79.3% of married women entered the survey after the birth of their first child.

Additionally, we drop women without any observations after the first birth, resulting in the removal of five observations and leaving us with 9,123 observations. Finally, we restrict our sample to five years before and eight years after the birth of the first child. This final selection process yields a sample of 748 women with 6,390 observations.

Table A.1: Sample Selection Criteria in JPSC

	Number of women	Number of observations
Original sample	4120	52144
Married women	2910	35657
Non-missing expenditure and time use	2849	32200
First birth related:		
(1) Non-missing first-birth age	2464	29654
(2) Women with pre-birth information	753	9128
(3) Women with post-birth information	748	9123
(4) Women in the (-5,8) periods	748	6390

In our GMM estimation, because we use the one-year lagged levels of consumption, hours, and wages as instruments for their respective logged variables, we lose 980 observations lacking the required lagged data. Consequently, our GMM estimation comprises 5,410 observations.

A.2 Data Comparability

To assess the representativeness of the JPSC data for the Japanese population, we conducted a comparative analysis with two prominent surveys published by the Statistics Bureau of Japan:

the Survey on Time Use and Leisure Activities (STULA) and the Family Income and Expenditure Survey (FIES).

The STULA survey, a nationally representative survey focusing on time use, has been conducted every five years since 1976. Respondents include all persons aged 10 and older in the sampled households.[36] For direct comparison, we selected one specific year, 2011, within our sample period. Our analysis focused on the average weekly time allocation of married women and married men aged 25–49. The STULA survey provides more detailed activity breakdowns than the JPSC dataset. Consequently, we categorized all activities into three main categories: work time, home production time, and leisure. To categorize the activities, we first calculated the number of hours spent per week on each activity. Then, we categorized the following activities as leisure: sleeping, personal care, meals, watching TV, listening to the radio, reading newspapers or magazines, resting and relaxing, hobbies and amusements, sports, volunteer and social activities, and social life. Similarly, we categorized the following activities as work time: work, schoolwork, commuting to and from school or work, learning, self-education, and training. Finally, we categorized the following activities as home production time: housework, caring or nursing, childcare, shopping, medical examinations or treatments, and other miscellaneous tasks.

As shown in Table A.2, the distribution of weekly time spent on work, home production, and leisure exhibits remarkable similarities between the two surveys. For example, in the JPSC 2011 dataset, married women allocated 15% of their time to work-related activities, 28% to home production, and 56% to leisure. Similarly, in the STULA 2011 survey, married women devoted 16% of their time to work-related activities, 26% to home production, and 59% to leisure. Additionally, we observe that the work time, home production time, and leisure of husbands in the JPSC closely align with those in the STULA. While the JSPC data is reported by wives, the STULA data is reported by individuals themselves. The consistency between the two surveys suggests that the wife's reported time use of the husband is reliable.

Table A.2: Time Allocation of Married Men and Women (aged 25-49)

	Married Women		Married Men	
	STULA	JPSC	STULA	JPSC
Work time	15.52%	15.35%	38.72%	37.71%
Home production time	25.62%	28.18%	4.07%	4.82%
Leisure	58.87%	56.47%	57.21%	57.47%

Note: The table reports the time use among married men and women aged 25–49 from the Survey on Time Use and Leisure Activities (STULA) and the Japanese Panel Survey of Consumers (JPSC) in 2011. We categorize time use into three main categories: work time, home production time, and leisure. The reported values represent the share of total time spent in each category. Since the three categories account for the entire 168 hours available in a week, there is no remaining time for other activities.

The Family Income and Expenditure Survey (FIES) is a comprehensive and nationally rep-

[36]The STULA survey has been used to analyze individual time allocation in some studies, such as Kitao and Nakakuni (2024).

resentative monthly survey that provides valuable information on income and expenditure. To compare the FIES with the JPSC, we again selected the year of 2011. As shown in Table A.3, the 2011 FIES data indicates that the average monthly earnings and consumption expenditure are 473,115 and 236,031 yen, respectively. In the 2011 JPSC data, the average monthly earnings and consumption expenditure are 507,392 and 209,932 yen, respectively. These statistics suggest that the JPSC sample provides a reasonable representation of income and expenditure in Japan during the selected period.

Table A.3: Income and Expenditure of Households with Workers

	FIES	JPSC
Monthly wages and salaries (yen)	473,115	507,392
Monthly total consumption expenditures (yen)	236,031	209,932

Note: The table reports the income and Expenditure of households with workers from the Family Income and Expenditure Survey (FIES) and the Japanese Panel Survey of Consumers (JPSC) in 2011. The Japanese currency unit is the yen.

A.3 Potential Measurement Errors of Husbands' Private Consumption Reported by Wives

In Section 2, we mention potential measurement errors in the data, as the husband's consumption and time use are reported by the wife. In Appendix Section A.2, we show that the time use of husbands reported by their wives in the JPSC is comparable to that reported by household heads (i.e., husbands) in the STULA. In this section, we focus on discussing the measurement errors of husbands' private consumption.

Note that the measurement errors of the level of husband's consumption would not directly threaten our identification as the event study compares the changes in private consumption before and after childbirth. The concern is whether the change in the husband's consumption before and after the birth is systematically affected by this potential measurement error.

We consider two possible channels through which the wife's report may affect the change in the husband's consumption. First, after childbirth, a wife may be occupied with childcare and have less time to monitor her husband's spending, leading to less accurate measures of her husband's expenditure. Second, we observe that post-childbirth, the wife becomes more responsible for managing the household expenses, as shown in the first column of Table A.4. A wife managing the household expenses may have more accurate information regarding her husband's expenditure than if her husband were managing the household expenses.

In the second column of Table A.4, we investigate how the wife's time allocation affects her reported weekly consumption of her husband. We find that the wife's home production time and work time are uncorrelated with the husband's reported private consumption, indicating that the first channel is unlikely to cause a systematic measurement problem. In the third column of Table A.4, we further analyze whether the wife's management of household expenses affects her reports of her husband's consumption, and find no significant correlation, suggesting that

the second channel is not a concern either. These two pieces of evidence jointly imply that any potential measurement errors are unlikely to significantly impact our main findings.

Table A.4: Management of Household Expenses

	Wife manages household expenses (dummy)	Husband's weekly private consumption (1000 yen)		
	(1)	(2)	(3)	(4)
After Childbirth (dummy)	0.102***			
	(0.014)			
Wife manages household expenses (dummy)			0.081	0.147
			(0.272)	(0.276)
Wife's weekly home production time (hours)		0.000		-0.000
		(0.003)		(0.003)
Wife's weekly work time (hours)		0.005		0.006
		(0.005)		(0.005)
Household weekly labor earnings (1000 yen)	-0.001***	0.008***	0.009***	0.008***
	(0.000)	(0.003)	(0.002)	(0.003)
Constant	0.859***	5.476***	5.415***	5.339***
	(0.023)	(0.364)	(0.384)	(0.450)
Individual FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
R-Squared	0.511	0.480	0.480	0.481

Note: Standard errors are in parentheses. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

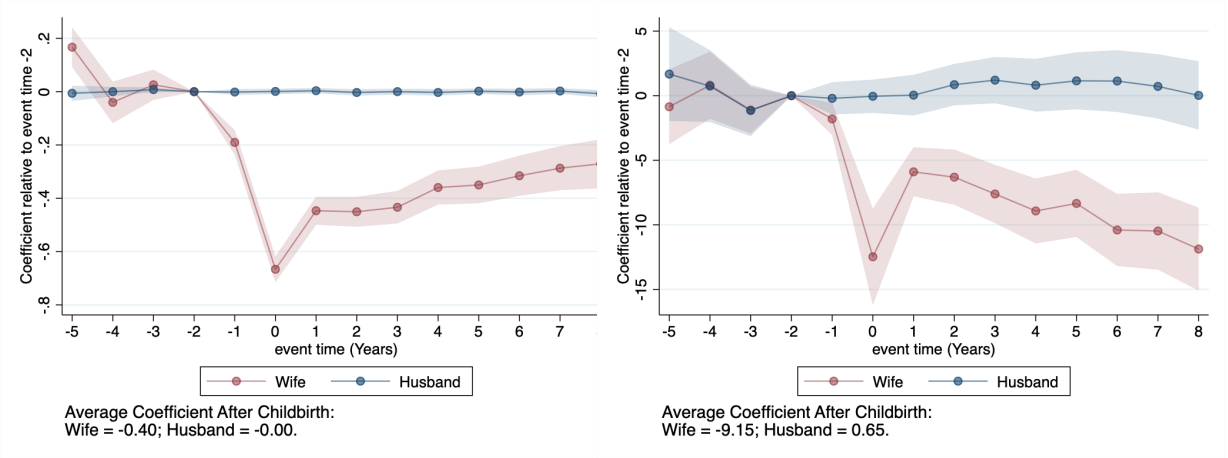
B Event Study Appendix

B.1 Event Time Coefficients in the Event Study Analysis

The main analysis in Section 3 reports $P_t^g \equiv \frac{\alpha_j^g}{\widetilde{Y_{ist}^g}}$, the percentage change in the outcome of having a child at event time t relative to the outcome of not having a child $\widetilde{Y_{ist}^g}$. In this section, we report the level change, i.e., the event time coefficients α_j^g from the event study analysis to demonstrate the robustness of our results. These coefficients are interpreted as the impact of having children relative to event time $t = -2$.

The left panel of Figure B.1 shows that the wife's employment rate drops by an average of 40 percentage points relative to the rate two years prior to childbirth, while the husband's employment rate is largely unchanged. The right panel of the same figure indicates that the wife's working hours (conditional on employment) decrease by an average of 9.15 hours per week after childbirth, whereas the husband's working hours do not experience a significant change.

The left panel of Figure B.2 shows that the wife's hourly wage decreases by an average of 250 yen after childbirth, while the husband's wage remains constant. The right panel reveals

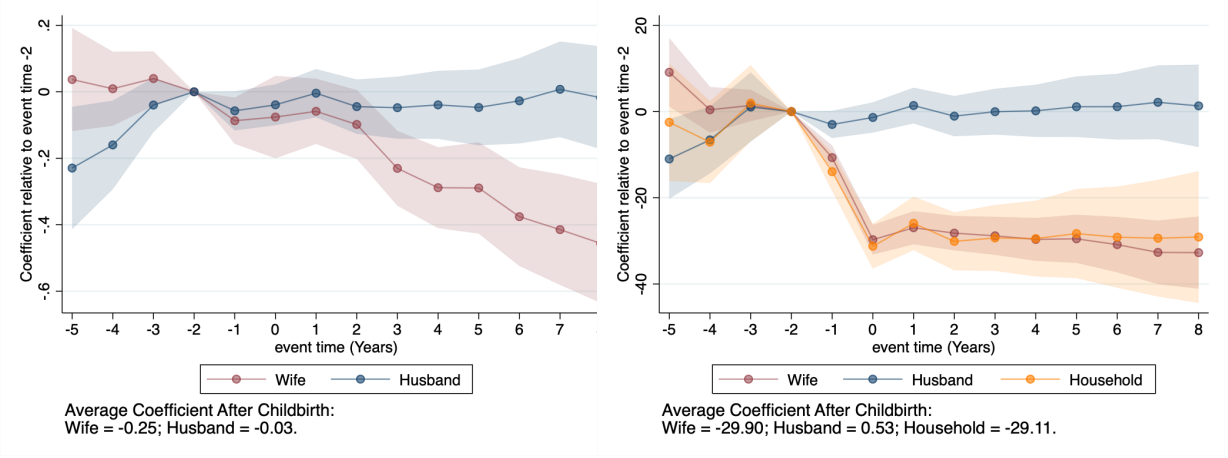


(a) Labor force participation

(b) Weekly working hours (conditional on employment)

Figure B.1: Labor Force Participation and Working Hours of Husbands and Wives

that the wife's weekly labor earnings decrease by 29,900 yen after childbirth, which drives a similar fall of 29,110 yen in weekly household earnings.



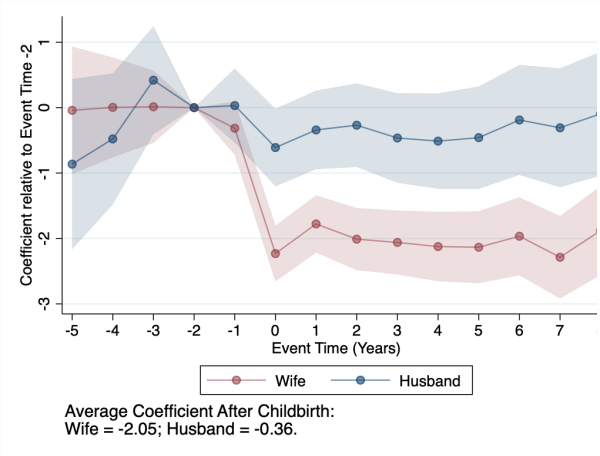
(a) Hourly wage (conditional on employment)

(b) Weekly labor earnings

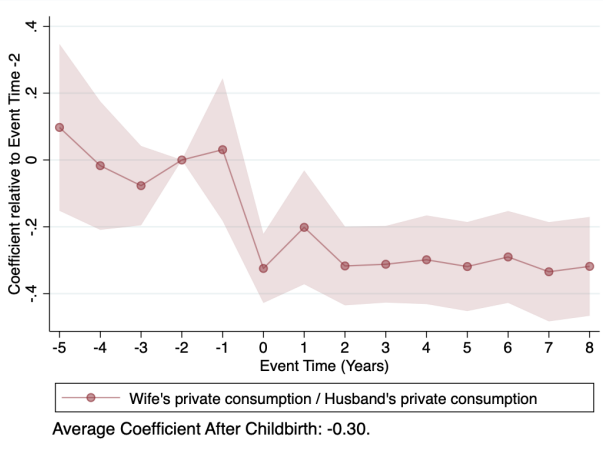
Figure B.2: Wage Rates and Labor Earnings of Husbands and Wives

The left panel of Figure B.3 shows that following childbirth, weekly private consumption falls by 2,050 yen for the wife and by 360 yen for the husband. Relative to the husband, the wife's weekly private consumption decreases by 30 percentage points, as depicted in the right panel.

The left panel of Figure B.4 shows that the wife's weekly leisure decreases by 17.44 hours after having a child, while the husband's leisure decreases by 8.95 hours per week. Furthermore, there is a significant increase in the wife's leisure at event time = -1, reflecting her need for rest and preparation for pregnancy before child- birth. The wife's leisure relative to the husband's drops by eight percentage points after childbirth, as shown in the right panel.

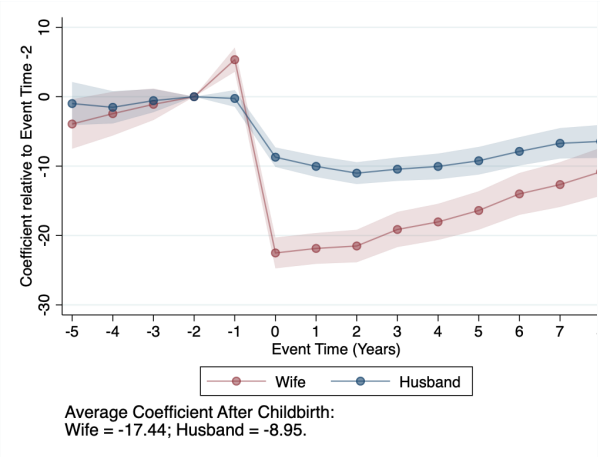


(a) Weekly private consumption



(b) Wife's weekly private consumption (relative to husband)

Figure B.3: Private Consumption of Husbands and Wives

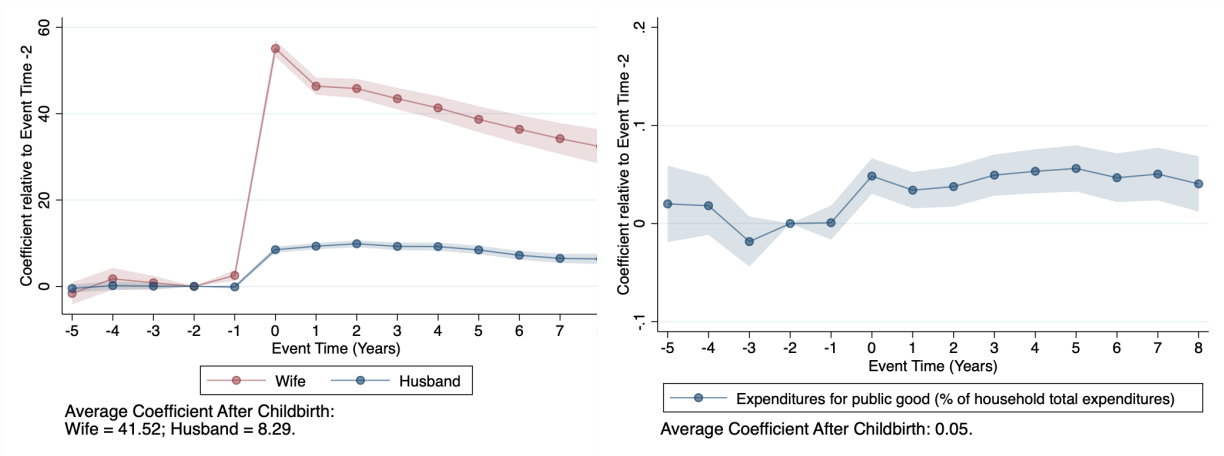


(a) Weekly leisure

(b) Wife's weekly leisure (relative to husband)

Figure B.4: Leisure of Husbands and Wives

The left panel of Figure B.5 shows that following childbirth, the wife's weekly home production time increases by 41.52 hours while the husband's weekly home time increases by only 8.29 hours. The right panel shows that the household's public expenditure as a share of total expenditure increases by five percentage points after childbirth.



(a) Weekly home production time (b) Expenditure on public good

Figure B.5: Home Production Time and Public Expenditure

B.2 Heterogeneous Effects in Relative Private Consumption and Leisure

We investigated the heterogeneity in the response of a wife's private consumption relative to her husband's, as well as her leisure relative to her husband's, by examining the order of birth and gender of the first child. Figure B.6 illustrates that the effects of the first child on relative private consumption and leisure are similar to the effects of second and higher-order births. Moreover, Figure B.7 shows that the effects are similar between families whose first child is a boy and those whose first child is a girl.

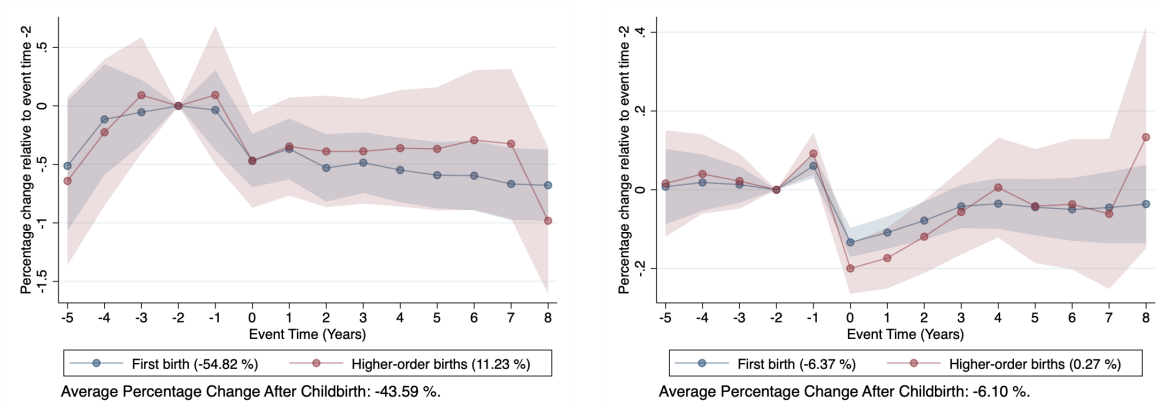


Figure B.6: Relative Private Consumption and Leisure by the Birth Order

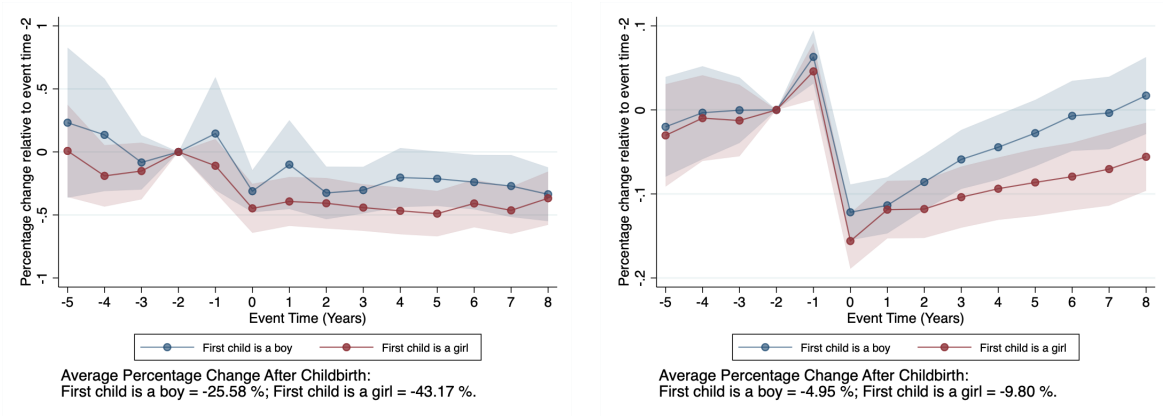


Figure B.7: Relative Private Consumption and Leisure by the Gender of First Child

C Model Appendix

C.1 Alternative Functional Forms

In this section, we consider an alternative functional form for individual utilities, a CRRA specification with separable preferences, which is used in Gayle and Shephard (2019). We show that in this case, the relative consumption between wives and husbands only depends on their Pareto weights.

The individual utilities are given by:

$$u(c,\ell,Q)=\frac{c^{1-\sigma_c}-1}{1-\sigma_c}+\beta_\ell\frac{\ell^{1-\sigma_\ell}-1}{1-\sigma_\ell}+\beta_Q\frac{Q^{1-\sigma_Q}-1}{1-\sigma_Q}.$$

Here the time subscript t is omitted for simplicity.

The household jointly determines the private consumption c_j, market purchased goods g, and leisure l_j, home production time h_j and working time m_j, where $j\in\{W,H\}$ and y is non-labor income.

$$\begin{aligned}\underset{g,\{c_j,l_j,h_j,m_j\}_{j=W,H}}{max}\quad & (1-\mu)\left[\frac{c_H^{1-\sigma_c^H}-1}{1-\sigma_c^H}+\beta_\ell^H\frac{\ell_H^{1-\sigma_\ell^H}-1}{1-\sigma_\ell^H}+\beta_Q^H\frac{Q^{1-\sigma_Q^H}-1}{1-\sigma_Q^H}\right]\\ & +\mu\left[\frac{c_W^{1-\sigma_c^W}-1}{1-\sigma_c^W}+\beta_\ell^W\frac{\ell^{1-\sigma_\ell^W}-1}{1-\sigma_\ell^W}+\beta_Q^W\frac{Q^{1-\sigma_Q^W}-1}{1-\sigma_Q^W}\right]\end{aligned}$$

subject to

$$Q=Q(h_H,h_W,g)$$

$$\ell_j+h_j+m_j=T$$

$$c_H+c_W+g=w_Hm_H+w_Wm_W+y$$

Based on Equation (1) and Equation (2) derived in Section 4, we derive the MRS between the wife's and the husband's private consumption (c_{Wt} and c_{Ht}) in Equation (C.1) and the MRS

between the wife's and the husband's leisure (ℓ_{Wt} and ℓ_{Ht}) in Equation (C.2):

$$\frac{(c_W)^{\sigma_c^W}}{(c_H)^{\sigma_c^H}} = \frac{\mu}{1-\mu} \tag{C.1}$$

$$\frac{(\ell_W)^{\sigma_\ell^W}}{(\ell_H)^{\sigma_\ell^H}} = \frac{\mu}{1-\mu}\frac{w_H}{w_W}\frac{\beta_l^W}{\beta_l^H} \tag{C.2}$$

There are two important implications: first, when the Pareto weight μ increases, the wife's private consumption relative to the husband's increases, given fixed σ_c^W and σ_c^H. Second, the wife's leisure l_W increases with the Pareto weight μ, as well as with the relative preference for leisure $\frac{\beta_l^W}{\beta_l^H}$ and the relative wage $\frac{w_W}{w_H}$.

C.2 Estimating Equations in GMM

The estimating equations are constructed based on the marginal rate of substitution (MRS) equations in Section 4. Following Lise and Yamada (2019), given the CES functional form assumptions, we derive the moment conditions.

C.2.1 Home production technology

Moment condition (C.3) is the MRS between the wife's and the husband's home production time (h_{Wt} and h_{Ht}). The relative home production time is governed solely by the home production technology (π and γ) and the relative wage.

$$(\frac{\pi_t}{1-\pi_t})(\frac{h_{Wt}}{h_{Ht}})^{\gamma-1} = \frac{w_{Wt}}{w_{Ht}} \tag{C.3}$$

Moment conditions (C.4) and (C.5) are the MRS between individual home production time (h_{jt}) and market-purchased inputs (g).

$$\pi_t(\frac{\rho}{1-\rho})(\frac{h_{Wt}^{\gamma-1}}{G_t})g_t = w_{Wt} \tag{C.4}$$

$$(1-\pi_t)(\frac{\rho}{1-\rho})(\frac{h_{Ht}^{\gamma-1}}{G_t})g_t = w_{Ht} \tag{C.5}$$

where $G_t = \pi_t h_{Wt}^\gamma + (1-\pi_t)h_{Ht}^\gamma$.

C.2.2 Private consumption and leisure

Moment conditions (C.6) and (C.7) are the MRSs between individual private consumption (c_{jt}) and leisure (ℓ_{jt}).

$$\frac{\alpha_{1t}^W}{\alpha_{2t}^W}(\frac{c_{Wt}}{\ell_{Wt}})^{\phi^W-1} = \frac{1}{w_{Wt}} \tag{C.6}$$

$$\frac{\alpha_{1t}^H}{\alpha_{2t}^H}(\frac{c_{Ht}}{\ell_{Ht}})^{\phi^H-1} = \frac{1}{w_{Ht}} \tag{C.7}$$

Moment condition (C.8) is the MRS between the wife's and the husband's leisure (ℓ_{Wt} and ℓ_{Ht}).

$$(\frac{\mu_t}{1-\mu_t})(\frac{A_{Wt}\alpha_{2t}^W \ell_{Wt}^{\phi^W-1}}{A_{Ht}\alpha_{2t}^H \ell_{Ht}^{\phi^H-1}}) = \frac{w_{Wt}}{w_{Ht}} \tag{C.8}$$

where $A_{jt} = [\alpha_{1t}^j c_{jt}^{\phi^j} + \alpha_{2t}^j \ell_{jt}^{\phi^j} + (1-\alpha_{1t}^j - \alpha_{2t}^j) q_t^{\phi^j}]^{\frac{1-\sigma^j-\phi^j}{\phi^j}}$.

Moment condition (C.9) is the MRS between the wife's and the husband's private consumption (c_{Wt} and c_{Ht}).

$$(\frac{\mu_t}{1-\mu_t})(\frac{A_{Wt}\alpha_{1t}^W c_{Wt}^{\phi^W-1}}{A_{Ht}\alpha_{1t}^H c_{Ht}^{\phi^H-1}}) = 1 \tag{C.9}$$

In general, the relative marginal utility of consumption between the wife and the husband depends on the entire allocation of hours and expenditure (A_{jt}), and is thus not independent of leisure and expenditure on public goods.

C.2.3 Public consumption

Moment conditions (C.10) and (C.11) are the MRS between individual leisure (ℓ_{jt}) and home production time (h_{jt}).

$$\mu_t A_{Wt}\alpha_{2t}^W \ell_{Wt}^{\phi^W-1} = \pi_t \rho h_{Wt}^{\gamma-1} G_t^{\frac{\rho-\gamma}{\gamma}} g_t^{1-\rho} D_t \tag{C.10}$$

$$(1-\mu_t) A_{Ht}\alpha_{2t}^H \ell_{Ht}^{\phi^H-1} = (1-\pi_t) \rho h_{Ht}^{\gamma-1} G_t^{\frac{\rho-\gamma}{\gamma}} g_t^{1-\rho} D_t \tag{C.11}$$

where the household's marginal value of public consumption is $D_t = \mu_t A_{Wt}\alpha_{3t}^W q_t^{\phi^W-1} + (1-\mu_t) A_{Ht}\alpha_{3t}^H q_t^{\phi^H-1}$ and $\alpha_{3t}^j = 1-\alpha_{1t}^j - \alpha_{2t}^j$.

Moment conditions (C.12) and (C.13) are the MRS between individual private consumption (c_{jt}) and market purchased inputs (g).

$$\mu_t A_{Wt}\alpha_{1t}^W c_{Wt}^{\phi^W-1} = (1-\rho) G_t^{\frac{\rho}{\gamma}} g_t^{-\rho} D_t \tag{C.12}$$

$$(1-\mu_t) A_{Ht}\alpha_{1t}^H c_{Ht}^{\phi^H-1} = (1-\rho) G_t^{\frac{\rho}{\gamma}} g_t^{-\rho} D_t \tag{C.13}$$

In Equations (C.3), (C.4), (C.5), (C.6), (C.7), and (C.8), if an individual's wage is not observed, we predict their potential wages using Equation 5, as discussed in Section 5.2. Consequently, the predicted wage serves as a measurement of the shadow price of time for non-working wives. Thus, we include both working and non-working individuals when estimating all the equations.[37]

[37] However, due to the fact that individuals may report their private consumption as zero, we drop the relevant MRSs for individuals with zero private consumption.

D Estimation Results Appendix

D.1 Heterogeneous Effects in Bargaining Power

In this section, we analyze whether the effect of childbirth on women's bargaining power varies by women's education and the gender of the first child. First, we interact the $PostFirstBirth$ dummies with a dummy variable indicating whether women have a college degree. This interaction term captures whether childbirth has a differential impact among high- and low-skilled women. The results in Table D.1 indicate that there is no significant difference in the drop of bargaining power between women with and without a college degree.

Second, we interact the $PostFirstBirth$ dummies with a dummy variable indicating whether the first child is a boy. The results in Table D.2 indicate that women with a boy and those with a girl experience a similar decline in their bargaining power.

Table D.1: GMM Parameter Estimates (By Wife's Education)

	Estimate	
Wife's Pareto weights		
$\beta_{\mu 1} : log(\frac{Age_W}{Age_H})$	-0.709***	(0.143)
$\beta_{\mu 2} : log(\frac{logWw}{logWh})$	0.559***	(0.015)
$\beta_{\mu 4}$: post first birth (0–2 years)	-0.732***	(0.135)
$\beta_{\mu 5}$: post first birth (3–5 years)	-0.587***	(0.181)
$\beta_{\mu 6}$: post first birth (6–8 years)	-0.373***	(0.135)
$\beta_{\mu 7}$: post first birth (0–2 years)*Wife with a college degree	0.136	(0.388)
$\beta_{\mu 8}$: post first birth (3–5 years)*Wife with a college degree	0.215	(0.589)
$\beta_{\mu 9}$: post first birth (6–8 years)*Wife with a college degree	0.165	(0.544)
Wife's preference for private goods		
α_{10}^W: constant	-0.165	(0.164)
α_{11}^W: wife's age	0.006	(0.005)
α_{12}^W: wife's education	-0.000	(0.004)
α_{13}^W: post first birth (0–2 years)	-0.228***	(0.045)
α_{14}^W: post first birth (3–5 years)	-0.353***	(0.048)
α_{15}^W: post first birth (6–8 years)	-0.474***	(0.058)
Wife's preference for leisure		
α_{20}^W: constant	-0.668***	(0.108)
α_{21}^W: wife's age	0.017***	(0.002)
α_{22}^W: wife's education	-0.031***	(0.005)
α_{23}^W: post first birth (0–2 years)	-0.420***	(0.021)
α_{24}^W: post first birth (3–5 years)	-0.443***	(0.023)
α_{25}^W: post first birth (6–8 years)	-0.451***	(0.029)
Husband's preference for private goods		
α_{10}^H: constant	-0.310***	(0.114)
α_{11}^H: husband's age	-0.007**	(0.003)
α_{12}^H: husband's education	-0.012**	(0.006)
α_{13}^H: post first birth (0–2 years)	-0.235***	(0.027)
α_{14}^H: post first birth (3–5 years)	-0.226***	(0.033)
α_{15}^H: post first birth (6–8 years)	-0.199***	(0.043)
Husband's preference for leisure		
α_{20}^H: constant	-1.598***	(0.080)
α_{21}^H: husband's age	0.010***	(0.002)
α_{22}^H: husband's education	0.004	(0.004)
α_{23}^H: post first birth (0–2 years)	-0.154***	(0.016)
α_{24}^H: post first birth (3–5 years)	-0.131***	(0.020)
α_{25}^H: post first birth (6–8 years)	-0.075***	(0.024)
Wife's home productivity		
π_0: constant	0.347***	(0.040)
π_1: post first birth (0–2 years)	-0.641***	(0.026)
π_2: post first birth (3–5 years)	-0.638***	(0.029)
π_3: post first birth (6–8 years)	-0.630***	(0.034)
Consumptions complementaity		
ϕ^W	0.144***	(0.008)
ϕ^H	0.113***	(0.009)
Home production		
γ: home production complementaity	0.808***	(0.019)
ρ: time's output elasticity in home production	0.091***	(0.005)

Table D.2: GMM Parameter Estimates (By the Gender of First Child)

	Estimate	
Wife's Pareto weights		
$\beta_{\mu 1} : log(\frac{Age_W}{Age_H})$	-0.705***	(0.146)
$\beta_{\mu 2} : log(\frac{logW_w}{logW_h})$	0.558***	(0.015)
$\beta_{\mu 4}$: post first birth (0–2 years)	-0.701***	(0.203)
$\beta_{\mu 5}$: post first birth (3–5 years)	-0.482**	(0.237)
$\beta_{\mu 6}$: post first birth (6–8 years)	-0.317*	(0.181)
$\beta_{\mu 7}$: post first birth (0–2 years)*First child is a boy	0.031	(0.361)
$\beta_{\mu 8}$: post first birth (3–5 years)*First child is a boy	-0.081	(0.445)
$\beta_{\mu 9}$: post first birth (6–8 years)*First child is a boy	-0.022	(0.312)
Wife's preference for private goods		
α_{10}^W: constant	-0.569***	(0.192)
α_{11}^W: wife's age	0.006	(0.005)
α_{12}^W: wife's education	0.029***	(0.009)
α_{13}^W: post first birth (0–2 years)	-0.226***	(0.044)
α_{14}^W: post first birth (3–5 years)	-0.346***	(0.047)
α_{15}^W: post first birth (6–8 years)	-0.462***	(0.057)
Wife's preference for leisure		
α_{20}^W: constant	-0.840***	(0.099)
α_{21}^W: wife's age	0.016***	(0.002)
α_{22}^W: wife's education	-0.019***	(0.005)
α_{23}^W: post first birth (0–2 years)	-0.418***	(0.021)
α_{24}^W: post first birth (3–5 years)	-0.438***	(0.023)
α_{25}^W: post first birth (6–8 years)	-0.442***	(0.029)
Husband's preference for private goods		
α_{10}^H: constant	-0.278**	(0.117)
α_{11}^H: husband's age	-0.007**	(0.003)
α_{12}^H: husband's education	-0.014**	(0.006)
α_{13}^H: post first birth (0–2 years)	-0.234***	(0.027)
α_{14}^H: post first birth (3–5 years)	-0.228***	(0.032)
α_{15}^H: post first birth (6–8 years)	-0.199***	(0.041)
Husband's preference for leisure		
α_{20}^H: constant	-1.573***	(0.080)
α_{21}^H: husband's age	0.010***	(0.002)
α_{22}^H: husband's education	0.003	(0.004)
α_{23}^H: post first birth (0–2 years)	-0.154***	(0.017)
α_{24}^H: post first birth (3–5 years)	-0.131***	(0.020)
α_{25}^H: post first birth (6–8 years)	-0.076***	(0.024)
Wife's home productivity		
π_0: constant	0.340***	(0.040)
π_1: post first birth (0–2 years)	-0.642***	(0.026)
π_2: post first birth (3–5 years)	-0.639***	(0.029)
π_3: post first birth (6–8 years)	-0.629***	(0.033)
Consumptions complementaity		
ϕ^W	0.144***	(0.008)
ϕ^H	0.113***	(0.009)
Home production		
γ: home production complementaity	0.813***	(0.019)
ρ: time's output elasticity in home production	0.091***	(0.005)

D.2 Sample Mean of GMM Estimates

Table D.3 presents the sample mean of the GMM parameter estimates before and after the first birth, including the wife's Pareto weight, preferences for various goods, and the husband's relative home productivity. Additionally, we perform t-tests to compare these means before and after childbirth. Note that the parameter estimates reported in the first column may differ slightly from those in Table 2 of Lise and Yamada (2019) because our analysis focuses specifically on the periods surrounding the first birth, and the sample restrictions differ accordingly.

Table D.3: GMM Parameter Estimates (Sample Mean)

	Event study sample	Before the first birth	After the first birth	Diff. (t-test)
Wife's Pareto weight				
μ	0.33	0.45	0.29	-0.16***
	(0.10)	(0.07)	(0.07)	(0.00)
Relative home productivity				
husband: π^H	0.54	0.42	0.57	0.16***
	(0.07)	(0.00)	(0.00)	(0.00)
Wife' preferences				
α_1^W: private goods	0.36	0.40	0.35	-0.05***
	(0.03)	(0.01)	(0.02)	(0.00)
α_2^W: leisure	0.19	0.21	0.18	-0.03***
	(0.02)	(0.01)	(0.01)	(0.00)
α_3^W: public goods	0.45	0.39	0.47	0.08***
	(0.04)	(0.01)	(0.02)	(0.00)
Husband' preferences				
α_1^H: private goods	0.24	0.27	0.23	-0.04***
	(0.02)	(0.01)	(0.01)	(0.00)
α_2^H: leisure	0.1669	0.1674	0.1667	-0.0007**
	(0.01)	(0.01)	(0.01)	(0.00)
α_3^H: public goods	0.59	0.56	0.60	0.04***
	(0.02)	(0.00)	(0.01)	(0.00)
Observations	6390	1532	4858	6390

Note: The estimates are evaluated at the sample mean. Standard deviation are reported in the parenthesis.

D.3 The Decomposition of the Pareto Weight

In Section 6.4, we evaluate the relative importance of the wage effect and the fertility effect in shaping the intertemporal dynamics of the wife's Pareto weight by comparing two versions of the wife's Pareto weight: (1) the wife's current Pareto weight μ_t; (2) the wife's Pareto weight $\mu_t' = \frac{\exp(x_{\mu t}')}{1+\exp(x_{\mu t}')}$ where the time-varying factors $x_{\mu t}'$ include relative spousal age and wage, defined as $x_{\mu t}' = \beta_{\mu 1}(log(\frac{Age_W}{Age_H})) + \beta_{\mu 2}(log(\frac{w_{Wt}}{w_{Ht}}))$.

In Table D.4, we present the relative wage effect and fertility effect across various post-

birth periods. In the early stages of the post-birth periods, the fertility effect plays a significant role in reducing the wife's bargaining power, accounting for 79.02% – 81.86% of the decrease. However, as the first child grows older, the fertility effect becomes less significant, and the wage penalty becomes more prominent. When the first child reaches eight years old, the wage effect accounts for 41.15% of the decrease in bargaining power.

Table D.4: Relative Wage Effect and Fertility Effect

	Relative wage effect (%)	Fertility effect (%)
Event time = 0	20.98	79.02
Event time = 1	17.78	82.22
Event time = 2	18.14	81.86
Event time = 3	25.02	74.98
Event time = 4	26.71	73.29
Event time = 5	25.94	74.06
Event time = 6	39.76	60.24
Event time = 7	40.64	59.36
Event time = 8	41.15	58.85
Mean	28.46	71.54

Note: The estimates are evaluated at the sample mean.

D.4 Robustness check of GMM estimates

To address concerns regarding the robustness of our estimations against varying functional form assumptions, we propose two alternative specifications. In the first specification, we define the Pareto weight μ_t, spousal preferences α_{kt}^j, and the home productivity π_t as functions of the number of children rather than the age of the first child. In the second specification, we adopt Lise and Yamada (2019) approach in defining μ_t. Under both specifications, the negative effects of fertility on the wife's bargaining power persist. Additionally, we observe consistent effects of childbirth on both husbands' and wives' preferences for private consumption and leisure, as well as on their respective home productivities. The welfare implications drawn from the two alternatives are consistent as well, bolstering confidence in our main findings.

D.4.1 Specification 1: Number of children

In this specification, we replace the post-birth event time dummies with indicators representing the number of children in the household during a specific period; $Children_{1t}$, $Children_{2t}$ and $Children_{3t}$ indicate that the household has one child, two children, and three or more children, respectively, in a certain period t. Households without children at t are used as the reference group.

The number of children is treated as a discrete variable to capture the potential changes in the parameters associated with different family sizes. Specifically, we can capture the effect of children along two margins, i.e., the extensive margin (the presence of children) as well as

the intensive margin (the number of children). Treating the number of children as a continuous variable would require assumptions about the linearity of effects, which may not hold in practice.

First, we model the Pareto weight at period t as $\mu_t = \frac{\exp(x_{\mu t})}{1+\exp(x_{\mu t})}$ where

$$\begin{aligned} x_{\mu t} =& \beta_{\mu 1}(log(\frac{Age_W}{Age_H})) + \beta_{\mu 2}(log(\frac{w_{Wt}}{w_{Ht}})) \\ &+ \beta_{\mu 3} Children_{1t} + \beta_{\mu 4} Children_{2t} + \beta_{\mu 5} Children_{3t} \end{aligned}$$

Second, we model preference for consumption and leisure by gender as

$$\alpha_{kt}^j = \frac{\exp(x_{kt}^j)}{1 + \exp(x_{1t}^j) + \exp(x_{2t}^j)} \quad \text{for } k = 1, 2$$

where x_{kt}^j includes a constant term, age, education, and three indicators of the number of children in the household (one child, two children, and three or more children).

Third, we model productivity in the production of public goods as

$$\pi_t = \frac{\exp(x_{\pi t})}{1 + \exp(x_{\pi t})}$$

where $x_{\pi t}$ includes three indicators of the number of children in the household (one child, two children, and three or more children)

The GMM results are shown in Table D.5 and the childbirth dynamics of bargaining power are shown in Figure D.1. The estimates of the wife's Pareto weights, the preferences for private goods and leisure for husbands and wives, and the wife's home productivity remain robust in this alternative specification. Compared to wives without children, wives with children have less bargaining power. The wife's bargaining power decreases by 38.29% after the first birth. The marginal effect of having an additional child exhibits an increasing trend; with each additional child, the wife's bargaining power further diminishes.

The welfare results, as estimated using the money metric welfare index, are presented in Figure D.2. Following the birth of the first child, the wife's welfare decreases by 13.38% while the husband's welfare increases by 7.43%. These estimates are similar to those generated by our baseline estimation of welfare changes (-12.16% versus 6.97%).

D.4.2 Specification 2: Lise and Yamada (2019)

In this specification, to facilitate comparisons of the results of our Pareto weight with those obtained by Lise and Yamada (2019), we define the Pareto weight in period t as follows:

$$\mu_t = \frac{\exp(x_{\mu t})}{1 + \exp(x_{\mu t})}$$

Table D.5: GMM Parameter Estimates (Alternative Specification: Number of Children)

	Estimate	
Wife's Pareto weights		
$\beta_{\mu 1}$: $log(\frac{age_W}{age_H})$	-0.611***	(0.129)
$\beta_{\mu 2}$: log(Ww)	0.526***	(0.016)
$\beta_{\mu 3}$: log(Wh)	-0.598***	(0.020)
$\beta_{\mu 4}$: Number of children = 1	-0.621***	(0.055)
$\beta_{\mu 5}$: Number of children = 2	-0.655***	(0.057)
$\beta_{\mu 6}$: Number of children $\geq$ 3	-0.730***	(0.125)
Wife's preference for private goods		
α_{10}^W: constant	-0.567***	(0.171)
α_{11}^W: wife's age	0.004	(0.004)
α_{12}^W: wife's education	0.030***	(0.009)
α_{13}^W: Number of children = 1	-0.228***	(0.043)
α_{14}^W: Number of children = 2	-0.331***	(0.047)
α_{15}^W: Number of children $\geq$ 3	-0.332***	(0.104)
Wife's preference for leisure		
α_{20}^W: constant	-1.020***	(0.095)
α_{21}^W: wife's age	0.022***	(0.002)
α_{22}^W: wife's education	-0.020***	(0.005)
α_{23}^W: Number of children = 1	-0.407***	(0.021)
α_{24}^W: Number of children = 2	-0.445***	(0.025)
α_{25}^W: Number of children $\geq$ 3	-0.591***	(0.053)
Husband's preference for private goods		
α_{10}^H: constant	-0.109	(0.107)
α_{11}^H: husband's age	-0.011***	(0.003)
α_{12}^H: husband's education	-0.014***	(0.006)
α_{13}^H: Number of children = 1	-0.224***	(0.029)
α_{14}^H: Number of children = 2	-0.290***	(0.035)
α_{15}^H: Number of children $\geq$ 3	-0.323***	(0.056)
Husband's preference for leisure		
α_{20}^H: constant	-1.533***	(0.072)
α_{21}^H: husband's age	0.010***	(0.002)
α_{22}^H: husband's education	0.002	(0.004)
α_{23}^H: Number of children = 1	-0.156***	(0.017)
α_{24}^H: Number of children = 2	-0.168***	(0.020)
α_{25}^H: Number of children $\geq$ 3	-0.215***	(0.037)
Wife's home productivity		
$\beta_{\pi 0}$: constant	0.329***	(0.039)
$\beta_{\pi 1}$: Number of children = 1	-0.596***	(0.029)
$\beta_{\pi 2}$: Number of children = 2	-0.668***	(0.032)
$\beta_{\pi 3}$: Number of children $\geq$ 3	-0.738***	(0.048)
Consumptions complementaity		
ϕ^W	0.144***	(0.010)
ϕ^H	0.119***	(0.011)
Home production		
γ: home production complementaity	0.816***	(0.018)
ρ: time's output elasticity in home production	0.092***	(0.004)

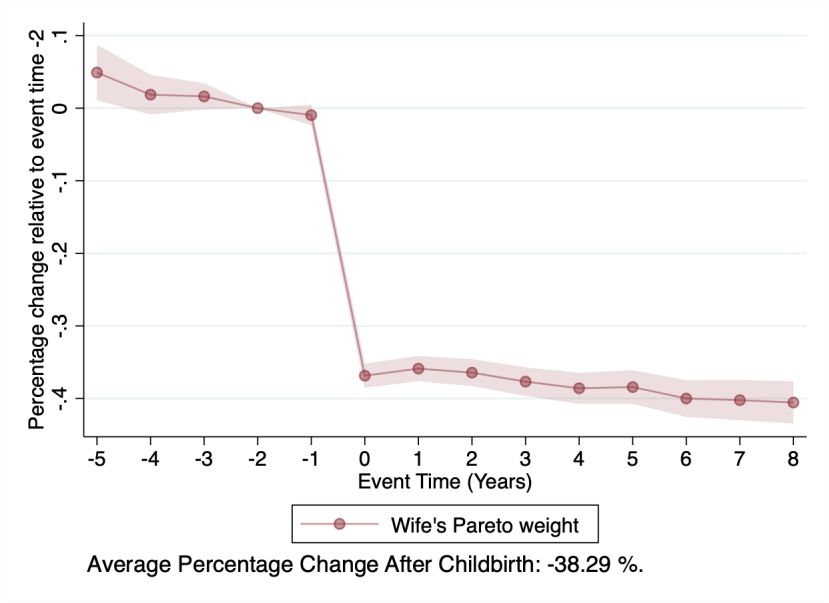


Figure D.1: The Dynamics of Bargaining Power (Alternative Specification: Number of Children)

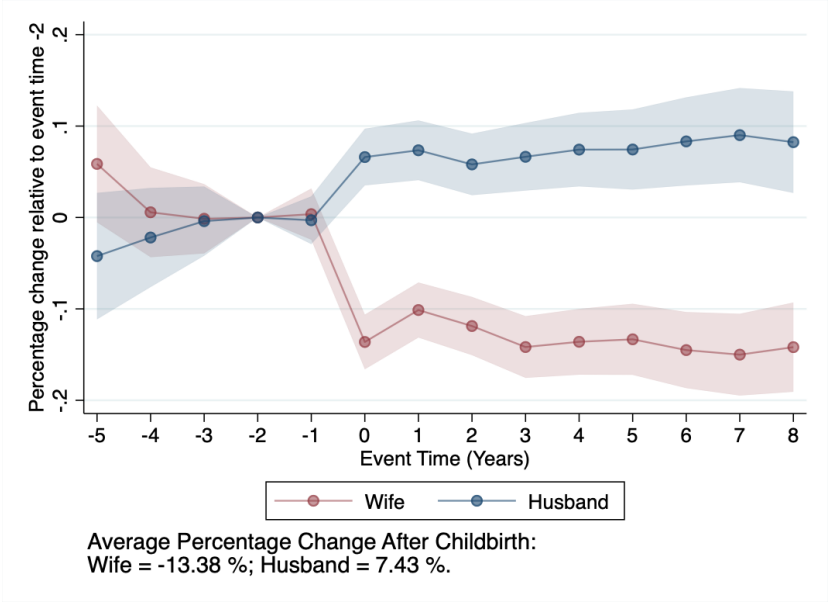


Figure D.2: Money Metric Welfare Indices (Alternative Specification: Number of Children)

where

$$x_{\mu t} = \beta_{\mu 1} log(\frac{w_{\hat{W}0}}{w_{\hat{H}0}}) + \beta_{\mu 2}(log(\frac{w_{\hat{W}10}}{w_{\hat{H}10}}) - log(\frac{w_{\hat{W}0}}{w_{\hat{H}0}})) + \beta_{\mu 3} log(Y_0) + \beta_{\mu 4}(log(\frac{w_{Wt}}{w_{Ht}}) - log(\frac{w_{\hat{W}t}}{w_{\hat{H}t}}))$$
$$+ \beta_{\mu 5} PostFirstBirth_{012} + \beta_{\mu 6} PostFirstBirth_{345} + \beta_{\mu 7} PostFirstBirth_{678}$$

We incorporate the following distribution factors: (1) the predicted relative wage between the wife and the husband at the time of marriage, denoted by $log(\frac{w_{\hat{W}0}}{w_{\hat{H}0}})$; (2) the predicted relative wage growth within 10 years between the wife and the husband, $log(\frac{w_{\hat{W}10}}{w_{\hat{H}10}}) - log(\frac{w_{\hat{W}0}}{w_{\hat{H}0}})$; (3) the logarithm of household income at the time of marriage, $log(Y_0)$; (4) the relative wage shock $\varepsilon_{Wt} - \varepsilon_{Ht} = log(\frac{w_{Wt}}{w_{Ht}}) - log(\frac{w_{\hat{W}t}}{w_{\hat{H}t}})$, where the individual wage shock $\varepsilon_{jt} = logw_{jt} - log\hat{w}_{jt}$ is calculated by the deviations between real wages and predicted wages in period t; and (5) the post-birth period dummies $PostFirstBirth_{012}$, $PostFirstBirth_{345}$ and $PostFirstBirth_{678}$. The first four factors align precisely with Lise and Yamada (2019), and the fifth factor is introduced to account for the impact of fertility on bargaining power.

We assume that the wage penalty cannot be anticipated at the time of marriage. Wage growth, $log(\frac{w_{\hat{W}10}}{w_{\hat{H}10}}) - log(\frac{w_{\hat{W}0}}{w_{\hat{H}0}})$, is computed based only on the return to potential experience. In the Mincer equation, the $PostFirstBirth$ dummies in the wage equation are considered as wage shocks observable in period t. Women face two types of wage shocks at period t. One is the normal wage shock, and the other is the wage penalty from having a child, which is reflected in the three $PostFirstBirth$ dummies.

For non-working wives, as their realized wages ($\log w_t$) and the associated wage shocks ($\varepsilon_{Wt} = logw_{Wt} - log\hat{w}_{Wt}$) are not directly observable, we employ the Heckman two-stage method to estimate their expected wage shock, ε_{Wt}. Conditional on the wife's working status, their wage shock can be computed as follows:

$$IMR = E(\epsilon_{jt} \mid D_t) = \begin{cases} \rho\sigma_\epsilon \frac{\varphi((\hat{a}_0' X_{it} + \hat{a}_1' Z_{it})/\sigma_v)}{\Phi((\hat{a}_0' X_{it} + \hat{a}_1' Z_{it})/\sigma_v)} & \text{if } D_t = 1 \\ -\rho\sigma_\epsilon \frac{\varphi((\hat{a}_0' X_{it} + \hat{a}_1' Z_{it})/\sigma_v)}{1 - \Phi((\hat{a}_0' X_{it} + \hat{a}_1' Z_{it})/\sigma_v)} & \text{if } D_t = 0 \end{cases}$$

where $D_t = 1$ means that wives are working and $D_t = 0$ means that wives are not working. The definitions of $\rho, \sigma_\epsilon, \sigma_v, X_{it}, Z_{it}$ follow the descriptions in Section 5.2. Therefore, non-working wives will experience a wage shock of $E(\varepsilon_{Wt} \mid D_t = 0)$. This approach enables us to account for the wage shock effect experienced by non-working wives.

The GMM results are shown in Table D.6. Both the wage, $log(\frac{w_{\hat{W}0}}{w_{\hat{H}0}})$, and the wage growth within 10 years, $log(\frac{w_{\hat{W}10}}{w_{\hat{H}10}}) - log(\frac{w_{\hat{W}0}}{w_{\hat{H}0}})$, predicted at the time of marriage play a significant role in determining the initial Pareto weight. A higher wage and a higher wage growth for the wife relative to the husband correspond to increased bargaining power for the wife. The relative spousal wage shock, $log(\frac{w_{Wt}}{w_{Ht}}) - log(\frac{w_{\hat{W}t}}{w_{\hat{H}t}})$, also affect the wife's bargaining power. If the wife experiences a relatively positive wage shock compared to her husband, her bargaining power will increase. These findings replicate the main conclusions of Lise and Yamada (2019). More-

over, the post-birth relative event dummies are negatively correlated with the wife's bargaining power. The dynamics of bargaining power following childbirth are illustrated in Figure D.3. After the first birth, the wife's bargaining power decreases by 36.84%, which aligns with our baseline estimate of -34.30%.

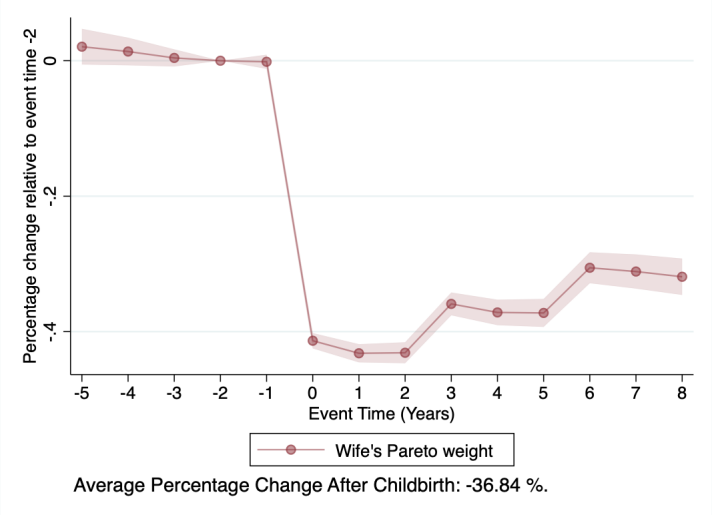


Figure D.3: The Dynamics of Bargaining Power (Alternative Specification: Lise and Yamada (2019))

The welfare results, estimated using the money metric welfare index, are depicted in Figure D.4. Following the birth of the first child, the wife's welfare decreases by 11.35% while the husband's welfare increases by 8.27%. These estimates closely resemble those obtained from our baseline estimation of welfare changes (-12.16% versus 6.97%).

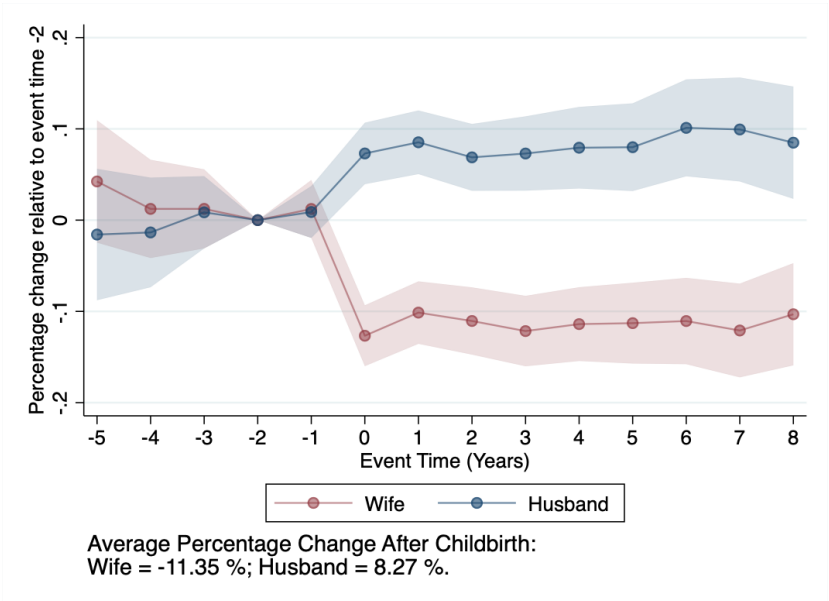


Figure D.4: Money Metric Welfare Indices (Alternative Specification: Lise and Yamada (2019))

Table D.6: GMM Parameter Estimates (Alternative Specification: Lise and Yamada (2019))

	Estimate	
Wife's Pareto weights		
$\beta_{\mu 1}: \omega_0^W - \omega_0^H$	0.372***	(0.021)
$\beta_{\mu 2}: \Delta\omega_{10}^W - \Delta\omega_{10}^H$	0.621**	(0.295)
$\beta_{\mu 3}: v_0$	0.058***	(0.016)
$\beta_{\mu 4}: \epsilon^W - \epsilon^H$	0.332***	(0.023)
$\beta_{\mu 5}$: post first birth (0–2 years)	-0.889***	(0.075)
$\beta_{\mu 6}$: post first birth (3–5 years)	-0.686***	(0.068)
$\beta_{\mu 7}$: post first birth (6–8 years)	-0.506***	(0.068)
Wife's preference for private goods		
α_{10}^W: constant	-0.004	(0.059)
α_{11}^W: wife's age	-0.005	(0.004)
α_{12}^W: wife's education	0.008	(0.008)
α_{13}^W: post first birth (0–2 years)	-0.161***	(0.048)
α_{14}^W: post first birth (3–5 years)	-0.266***	(0.049)
α_{15}^W: post first birth (6–8 years)	-0.358***	(0.057)
Wife's preference for leisure		
α_{20}^W: constant	-0.748***	(0.109)
α_{21}^W: wife's age	0.016***	(0.003)
α_{22}^W: wife's education	-0.027***	(0.006)
α_{23}^W: post first birth (0–2 years)	-0.370***	(0.022)
α_{24}^W: post first birth (3–5 years)	-0.401***	(0.026)
α_{25}^W: post first birth (6–8 years)	-0.403***	(0.032)
Husband's preference for private goods		
α_{10}^H: constant	-0.077	(0.104)
α_{11}^H: husband's age	-0.011***	(0.003)
α_{12}^H: husband's education	-0.015**	(0.006)
α_{13}^H: post first birth (0–2 years)	-0.280***	(0.030)
α_{14}^H: post first birth (3–5 years)	-0.259***	(0.035)
α_{15}^H: post first birth (6–8 years)	-0.232***	(0.043)
Husband's preference for leisure		
α_{20}^H: constant	-1.460***	(0.093)
α_{21}^H: husband's age	0.007***	(0.002)
α_{22}^H: husband's education	0.004	(0.004)
α_{23}^H: post first birth (0–2 years)	-0.165***	(0.018)
α_{24}^H: post first birth (3–5 years)	-0.134***	(0.021)
α_{25}^H: post first birth (6–8 years)	-0.077***	(0.026)
Wife's home productivity		
$\beta_{\pi 0}$: constant	0.538***	(0.042)
$\beta_{\pi 1}$: post first birth (0–2 years)	-0.667***	(0.028)
$\beta_{\pi 2}$: post first birth (3–5 years)	-0.674***	(0.031)
$\beta_{\pi 3}$: post first birth (6–8 years)	-0.659***	(0.036)
Consumptions complementaity		
ϕ^W	0.137***	(0.011)
ϕ^H	0.119***	(0.015)
Home production		
γ: home production complementaity	0.706***	(0.020)
ρ: time's output elasticity in home production	0.093***	(0.006)

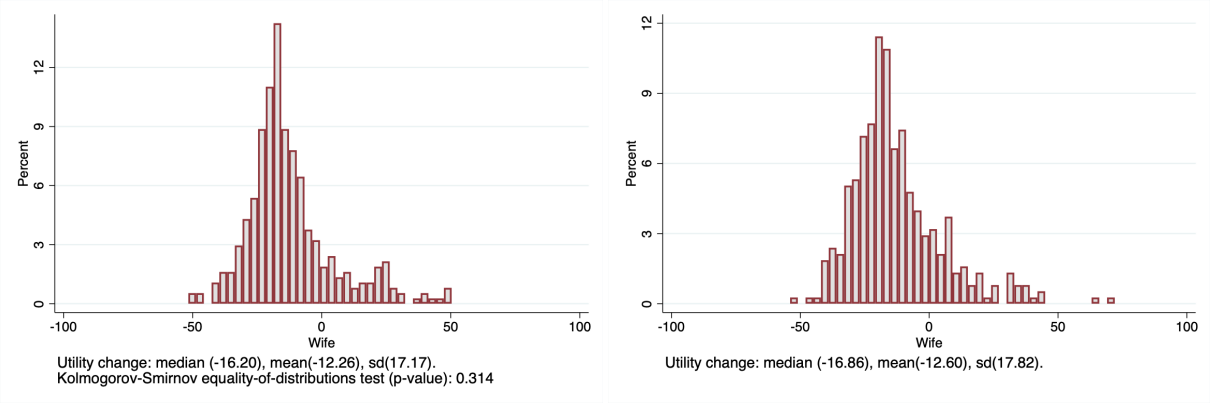
E Welfare Analysis Appendix

E.1 Heterogeneity in the Welfare Effect of Childbirth

We provide additional analyses to complement the heterogeneity analysis presented in Section 7.

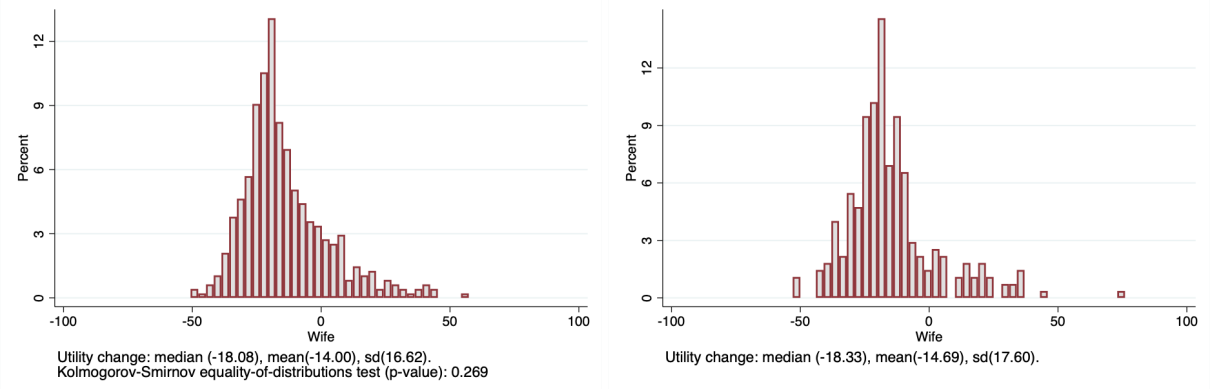
Figure E.1 categorizes women into two groups based on their birth cohorts, using the median year of 1976 as the reference point. On average, women born before 1976 experience a 12.26% reduction in their welfare following childbirth while women born in or after 1976 experience a decrease of 12.60%. There is no statistically significant difference between the two distributions of welfare changes (Kolmogorov-Smirnov test: p-value = 0.314).

In Figure E.2, we categorize women based on their age at first birth, using the median age of 31 as the reference point. We find that women who give birth before or at the age of 31 experience an average decline in welfare of 14.00% while women who give birth after the age of 31 experience a decline of 14.69%. The differences between the two distributions of welfare changes are not statistically significant (Kolmogorov-Smirnov test: p-value = 0.269).



(a) Wife born $<$ 1976 (b) Wife born $\geq$ 1976

Figure E.1: Heterogeneity in Welfare Change Among Women (by Birth Cohort)



(a) Wife's age at the first birth $\leq$ 31 (b) Wife's age at the first birth $>$ 31

Figure E.2: Heterogeneity in Welfare Change Among Women (by Age at First Birth)

E.2 Robustness check of MMWI

In Section 7, when computing the money metric welfare indices (MMWI), we make two assumptions regarding home production. Firstly, we assume that individual home production productivity, denoted as π_j, remains unchanged regardless of whether individuals produce Q_t on their own or with their partners. Hence, $\pi_W = \pi_t$ for the wife and $\pi_H = 1 - \pi_t$ for the husband. Second, we assume that the home production time input of the spouse is zero.

To examine whether our welfare results are sensitive to the two assumptions, we consider two alternative assumptions regarding home production. First, we specify the individual home production technology to be one ($\pi_W = \pi_H = 1$). Second, we analyze the analogous specification in Cherchye, De Rock, and Vermeulen (2012). All the welfare results in the baseline and the counterfactuals are shown in Table E.1. Panel A shows the results for the wife and Panel B shows the results for the husband. The first column shows the main measure used in Section 7, the second column shows the alternative measure using specification 1, and the third column shows the alternative measure using specification 2.

E.2.1 Specification 1: individual home productivity $\pi_j = 1$

In this specification, we assume that the individual home production technology $\pi_W = \pi_H = 1$ when the individual is the sole producer of the public good. Thus, the home production function for individuals can be represented as $Q(h_{jt}, g_{jt}) = h_{jt}^{\rho} g_{jt}^{1-\rho}$. This alternative specification helps us rule out the concern that the increase in men's welfare in the baseline specification is driven by an increase in their home productivity.

Using this alternative specification, we found that the wife's welfare declines by 12.89%, while the husband's welfare increases by 7.98% during the post-birth periods. These estimates align with those obtained from our baseline estimation (-12.16% vs. 6.97%).

In the first counterfactual analysis, which assumes no fertility or wage effects on the wife's bargaining power, the effect of childbirth on women's welfare increases from -12.89% in the baseline to -10.30%, while the welfare effect for husbands declines from 7.98% in the baseline to 3.01%. In the second counterfactual, when the wife does not encounter a wage penalty, the welfare effect for wives increases from -12.89% in the baseline to -4.80%. Meanwhile, the welfare effect for husbands also increases, from 7.98% in the baseline to 13.61%. Lastly, in the absence of both wage penalties for wives and any adverse fertility impact on bargaining power, the welfare effect increases to -1.83% for wives and 8.35% for husbands. These results are consistent with the findings using the baseline specification.

E.2.2 Specification 2: Cherchye, De Rock, and Vermeulen (2012)

We analyze an equivalent specification examined in Cherchye, De Rock, and Vermeulen (2012), where each individual maintains an identical home production time allocation as observed within the household, with 30% of the partner's allotted home production time remaining available for the production of public goods. This specification also requires the public goods to

maintain the same level, so individuals need to increase public expenditure when they produce the public goods alone. Thereafter, we simulate the optimal private consumption and leisure required to match the individual utility level.

The main motivation behind considering this specification is to highlight the role of home production time for both wives and husbands in child-rearing. The reallocation of time is not entirely flexible due to two reasons: first, home production time, especially the time spent on childcare, cannot be perfectly substituted by public expenditure to achieve the same level of public goods — there is a minimum threshold of home production time required for childcare. Second, the presence of both parents is necessary and important for children's development. This specification captures these two key aspects and investigates how welfare implications change when the home production time of both spouses is taken into consideration.

To substantiate the individual optimization problem, let us consider the wife ($j = W$) as an example. At period t, the current optimal solutions within the household are denoted as $(\tilde{c_{Wt}}, \tilde{c_{Ht}}, \tilde{g}_t, \tilde{\ell_{Wt}}, \tilde{\ell_{Ht}}, \tilde{h_{Wt}}, \tilde{h_{Ht}}, \tilde{m_{Wt}}, \tilde{m_{Ht}})$. The original level of public goods are represented as $\tilde{Q}_t(\tilde{h_{Wt}}, \tilde{h_{Ht}}, \tilde{g}_t)$. When the wife is living alone and responsible for producing the public goods, her home production time is fixed at $\tilde{h_{Wt}}$. Furthermore, she could gain home production time support from her husband due to co-parenting, while only 30% of her husband's home time can be used for home production. To maintain the same level of public goods as before, she needs to increase the public expenditure g^*_{Wt} such that $Q_t(\tilde{h_{Wt}}, 0.3\tilde{h_{Ht}}, g^*_{Wt}) = \tilde{Q}_t(\tilde{h_{Wt}}, \tilde{h_{Ht}}, \tilde{g}_t)$. Then, given the fixed levels of g^*_{Wt}, $\tilde{h_{Wt}}$, $\tilde{h_{Ht}}$, and $\tilde{Q}_t$, the wife's optimization problem can be expressed as follows:

$$
\begin{aligned}
\underset{c_{Wt},\ell_{Wt},m_{Wt}}{\text{Max}} \quad & u^W_{Singled}(c_{Wt}, \ell_{Wt}, \tilde{Q}_t) = \frac{1}{1-\sigma^W}(\alpha^W_{1t} c^{\phi^W}_{Wt} + \alpha^W_{2t} \ell^{\phi^W}_{Wt} + (1-\alpha^W_{1t}-\alpha^W_{2t})\tilde{Q}^{\phi^W}_t)^{\frac{1-\sigma^W}{\phi^W}} \\
\text{subject to} \quad & \tilde{Q}_t = (\pi_W \tilde{h}^\gamma_{Wt} + \pi_H (0.3\tilde{h}_{Ht})^\gamma)^{\frac{\rho}{\gamma}} (g^*_{Wt})^{1-\rho} \\
& \ell_{Wt} + \tilde{h}_{Wt} + m_{Wt} = T \\
& c_{Wt} + g^*_{Wt} = w_{Wt} m_{Wt} + y_{Wt}
\end{aligned}
$$

where the wife chooses the optimal $c^*_{Wt}, \ell^*_{Wt}, m^*_{Wt}$ to maximize her utility. The MMWI will be calculated as the minimum expenditure required to achieve the same level of utility in the single scenario as she would have achieved in the married scenario. Specifically, for the wife ($j = W$), the MMWI is given by:

$$
MMWI_{Wt} = \underset{c^*_{Wt},\ell^*_{Wt},m^*_{Wt}}{\text{Min}} \left(\begin{array}{c} c^*_{Wt} + g^*_{Wt} + w_{Wt}(\ell^*_{Wt} + \tilde{h}_{Wt}) + 0.3 w_{Ht} \tilde{h}_{Ht} \\ \text{s.t. } u^W_{Singled}(c^*_{Wt}, \ell^*_{Wt}, \tilde{Q}_t) \geq u^W_{Married}(\tilde{c_{Wt}}, \tilde{\ell_{Wt}}, \tilde{Q}_t) \end{array} \right)
$$

The optimization problem for the husband is identical.

Note that the MMWI includes the value of spousal home production time, $0.3 w_{Ht} \tilde{h}_{Ht}$. Therefore, the welfare of wives estimated using this approach will be higher than that in the baseline model. We focus more on the changes in welfare when we shut down the effect of

having a child on bargaining power or the wage penalty.

The last column of Table E.1 illustrates the welfare results following the specification in Cherchye, De Rock, and Vermeulen (2012). We find that the wife encounters a reduction in welfare of -6.15% after childbirth, in contrast to a 14.02% improvement in welfare experienced by the husband. Notably, these values of welfare effects are higher than our previous welfare assessments. A possible explanation is that we now include spousal time when calculating the MMWI in all periods. For wives, the home production time of the husband is increasing after childbirth while his wages are largely unchanged. Therefore, when we add the amount of $0.3w_{Ht}h_{Ht}$ to calculate the minimum expenditure for wives to maintain the same individual utility level, we get a larger welfare effect for wives.

We apply this alternative specification to evaluate changes in welfare across three hypothetical scenarios. In the first scenario, where there is no effect on bargaining power, the effect of childbirth on wives' welfare increases from -6.15% in the baseline to -1.02%, while the effect of childbirth on husbands' welfare declines from 14.02% in the baseline to 10.39%. In the second scenario, where there are no wage penalties for women, the arrival of the first child leads to an increase in welfare by 3.02% for wives and 21.48% for husbands. Lastly, in the third scenario, where there is neither a wage penalty nor a drop in the wife's bargaining power, the welfare effect is 8.92% for wives and 16.37% for husbands. In sum, the changes in welfare effect in the three counterfactuals are consistent with what we found in the baseline specification.

Table E.1: Welfare Changes After Childbirth: Alternative Specifications of MMWI

	Main Measure	$\pi_j = 1$	Cherchye et al. (2012)
Panel A: Wife			
Baseline	-12.16%	-12.89%	-6.15%
No effect on μ	-9.56%	-10.30%	-1.02%
No wage penalty	-1.78%	-4.80%	3.02%
No wage penalty + No effect on μ	0.50%	-1.83%	8.92%
Panel B: Husband			
Baseline	6.97%	7.98%	14.02%
No effect on μ	1.79%	3.01%	10.39%
No wage penalty	17.89%	13.61%	21.48%
No wage penalty + No effect on μ	13.91%	8.35%	16.37%

Note: The Table presents the welfare results using the alternative specifications of MMWI. In Specification 1, we assume that the individual home production technology $\pi_W = \pi_H = 1$ when the individual is the sole producer of the public good. In Specification 2, we assume that each individual maintains identical home time as observed within the household, with 30% of the partner's home time remaining available for home production.