Empowerment Effects and Intertemporal Commitment of Married Couples: Evidence from Japanese Pension Reform*

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Abstract

This study investigates a household's commitment to a resource allocation by exploiting a 2007 Japanese pension reform allowing divorced women to claim a portion of their husband's pension benefits while keeping the household's total benefits unchanged. Although the reform should not affect a couple's decision-making under full commitment, we find that it increased wives' leisure and decreased their market and domestic work. This suggests that wives were able to increase their welfare by exploiting an improved outside option, and thus commitment to resource allocation is less than complete.

Keywords: family; bargaining power; risk sharing; pension; divorce law
JEL codes: D13, D91, H31, J12, K36

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1 Introduction

Economists have long been interested in the extensive economic gains from marriage, including the joint use of public goods, specialization, and self-insurance of household members. The self-insurance is especially important for the personal security of household members, as the effects of business cycles can be severe when job displacement risks are not completely insured (Krebs, 2007). While these risks can be mitigated by conventional unemployment insurance, they can also be hedged by income pooling through marriage, although inter- and intra-family insurance would not completely absorb income shocks (Altonji et al., 1992; Hayashi et al., 1996). In addition, marriage also allows an individual to insure other risks such as longevity risks through the heritage of his/her partner (Kotlikoff and Spivak, 1981).

To realize these economic gains, however, marriage partners must be able to commit to their initial resource allocation plan, and the traditional unitary model of household decision-making implicitly requires this by assuming the household is a single decision maker. However, when marriage partners have distinct preferences, this introduces a potential conflict in their incentives that can lead to a "hold-up" problem whereby one partner might deviate from the initial allocation plan by exploiting a changed situation to improve his or her welfare. Should this occur, a couple cannot fully enjoy the fruits of marriage, as Dufwenberg (2002) theoretically finds that a couple's failure to commit to a resource plan leads to a failure to specialize and an under-accumulation of human capital. Further, Voena (2015) finds that divorce and property division laws can affect both asset allocation and female labor force participation. From these studies, we see that a couple's lack of commitment can make it difficult for a household to achieve the first-best resource allocation, or *ex-ante* efficiency. Economic gains from family formation thus depend on the degree of commitment.

Since the seminal work of Chiappori (1988), research in household decision making has shifted from the unitary model to the collective one in which household members have individual preferences and the resource allocation of the household is obtained through bargaining.[1] However, studies of bargaining in family decision-making have typically adopted a static collective framework that is silent about dynamic issues such as divorce or changes in the viability of an outside option for each household member. In adapting the collective model to a dynamic setting, Mazzocco (2007) argues that differing preferences among household members could result in a lack of commitment because one has an incentive to deviate from the initial plan when it is favorable for that member. Since bargaining position is fixed under full commitment but is allowed to fluctuate under limited commitment so that household members may attempt

[1] Apps and Rees (1997), Browning and Chiappori (1998), Chiappori (1992), Chiappori (1997), and Blundell et al. (2005) developed the collective model, while others such as Angrist (2002), Attanasio and Lechene (2014), Aura (2005), Cherchye et al. (2012), Duflo (2003), Francis (2011), Ponczek (2011) have tested and rejected the unitary model. Aronsson et al. (2001) is one of the few studies that has not rejected the unitary model.

to improve their situation when outside options change, the degree of commitment is testable by examining within-household variation in a bargaining position.

These empirical tests of the degree of commitment are of interest not only concerning the economic benefits of marriage but also for their practical implications in the specification of life-cycle models. While the limited commitment model is more general than the full commitment model, its complexity leads to a computational burden in obtaining a solution (Chiappori and Mazzocco, 2017). Consequently, studies typically attempt to limit this burden through simplifying assumptions such as full commitment (Casanova, 2010), a single agent (Adda et al., 2017), or functional form impositions on the Pareto weight (van der Klaauw and Wolpin, 2008).[2] While full commitment may be a good approximation of reality if any resource allocation distortions associated with hold-up problems are relatively minor, researchers need to consider the extent to which the full commitment assumption drives their results. If distortions exist, the model should allow for the possibility of incomplete commitment.

Another reason why limited commitment should be considered is that full commitment has not been supported by some recent empirical studies. For example, in their studies of dynamic models nesting the full-commitment case, Mazzocco (2007) and Lise and Yamada (2018) both find the evidence inconsistent with full commitment, with Lise and Yamada (2018) finding that household members do update their bargaining position, but only when the participation condition for marriage is binding. In another study, Blau and Goodstein (2016) test degree of commitment by examining whether an unexpected inheritance affects the relative bargaining position and household behavior, controlling for household budget and any expected inheritance. Since a couple under full commitment fixes its bargaining position at marriage, it should not be affected by any unexpected shock when preferences and budget constraint are held constant. However, they find mixed results, with full commitment rejected in some specifications but not others.[3] Notwithstanding the mixed results, an advantage of the Blau and Goodstein (2016) approach, compared to the above two studies, is the identification strategy not relying on functional form assumption on preferences or household technology. For example, Mazzocco (2007) assumes the bargaining position to be independent of the level of assets, and Lise and Yamada (2018) assume an interior solution for time-allocation to estimate their structural model. In contrast, if unexpected shocks only affect bargaining position, it is not necessary to specify the forms of the household objective function or home production technology.

This study contributes to the literature on household decision-making by testing the degree of commitment without relying on any *a priori* assumptions about functional form and by using

[2] Studies that do allow for incomplete commitment include Voena (2015) and Low et al. (2018)

[3] These mixed results are attributed to a lack of statistical power, as inheritance is a rare event. Because inheritance amount has been shown to suffer from serious measurement error (Laitner and Sonnega, 2010), the receipt of an inheritance is used instead, which lowers the statistical power. Additionally, as the study examines several full commitment null hypotheses one-by-one under various specifications, the statistical inference seems difficult to interpret.

a Japanese dataset that allows us to exploit a major pension reform as a natural experiment using a difference-in-differences (DD) estimation methodology. The Japanese pension reform of 2007 allowed a couple to divide their pension benefits upon divorce. Before the reform, since the bulk of public pension benefits in Japan are proportional to labor earnings, a dependent spouse specializing in home production would have found it difficult to live only on her own pension benefits after divorce. The reform addressed this issue by allowing the spouse with fewer pension records to claim a portion of the partner's pension records tracked during the marital period. For our purposes, several features of the reform are beneficial for testing the degree of commitment of a household. Firstly, the reform allows for sharing of pension benefits while keeping the total amount of the benefits unaffected. The unexpected shock thus does not change the household budget, which facilitates our identification of the degree of commitment. Secondly, the pension division applies only to the public pension insurance that covers permanent employees, which leaves a dependent wife of a self-employed spouse unaffected. Thirdly, the maximum share of pension benefits after division is 50 percent, which means that if both spouses are permanently employed and of a similar age, there is very little room for pension balancing. This allows us to use these households as a control group for the counterfactual inference required for our difference-in-differences (DD) estimation strategy.

Following the framework of Mazzocco (2007), we first constructed a dynamic collective model to investigate the effect of the pension reform under both full and limited commitment, finding that only couples without full commitment were affected. We tested several of the model's predictions. First, as the reform is expected to mostly affect couples in which the husband's pension benefits are large, and since most young couples have not yet accumulated substantial benefits, the reform is most likely to affect elderly couples.[4] Second, low net worth households are more likely to respond to the reform because pension benefits comprise only a small share of the total assets of high net worth households that would be divided upon divorce. Third, as noted by Chiappori and Mazzocco (2017), the dynamic collective model implies that household members re-bargain their resource allocation only when one member's participation condition is binding. We tested this prediction using young couples, whose current period participation condition is unlikely to bind because they cannot receive pension benefits for several decades.

We then conducted empirical analysis by using DD estimation with the *Keio Household Panel Survey* (KHPS), a household panel survey in Japan. The treatment group consists of households in which the husband was a permanent employee and the wife was not, the control group consists of all other households. The results of our DD estimation do not support the full-commitment model. Consistent with the model's prediction, we did not find any significant

[4]In a study of the reform using relatively young couples of 48 years and younger, Sakamoto (2008) finds no policy impact.

impact on young couples, but elderly wives aged 50–59 increased their leisure time by 5 hours per week (or 5 percent) by decreasing equally their market and domestic work. The elasticities of those outcomes to the lifetime pension benefits received upon divorce are 0.05, 0.20, and 0.05, respectively. A subsample analysis of homeownership as a proxy for individual assets showed that those wives who were most affected by the reform were those who did not own a home, which is also consistent with the model's prediction. Finally, the model passed several tests of the parallel trend assumption of our identification strategy including a placebo test, a specification with a group-specific linear trend, and a triple-differences estimation using young households as an additional comparison group.

A limitation of the study is that the test of full commitment relies on the assumption that couples do not eventually divorce. This limitation is not unique to this study, however, and is typically imposed throughout the literature either explicitly or implicitly (Blau and Goodstein, 2016; Lise and Yamada, 2018; Mazzocco, 2007). When divorce is possible and seems on the horizon, spouses have an incentive to prepare for this future divorce (Mazzocco et al., 2006), which means that the household allocation plan can be contingent on the post-divorce economic situation even under full commitment. This concern would appear to be negligible for elderly couples in Japan, however, due to the low annual and lifetime divorce rates of 0.3 and 3.0 percent, respectively, for Japanese wives aged 55. Therefore, we believe that this assumption cannot be the main driver of our findings.

Additionally, when we take the rejection of the full commitment model as a given, this study highlights the difficulty in making a commitment, as couples fail to achieve full commitment even within a stable marital relationship. This limited commitment implies that *ex-ante* efficient allocation is not necessarily *ex post* efficient and, as a result of this inconsistency, a hold-up problem may occur. The resulting inefficiency could be more serious among young couples because their relatively higher divorce rates indicate that the participation condition is likely to bind. If this is the case, then household behavior including human capital accumulation and investment in children may be distorted by a fluctuation in the bargaining position, and this also makes risk-sharing among household members difficult.

Finally, this study is related to the large literature on divorce law reforms. The majority of the studies evaluate the impact of transition from mutual-consent regime to unilateral regime (Gray 1998; Gruber 2004; Stevenson and Wolfers 2006; Wolfers 2006; Stevenson 2007; Caceres-Delpiano and Giolito 2012; Brassiolo 2016; Garcia-Ramos 2021, for example). However, relatively scarce is the assessment of property division law upon divorce. It is particularly relevant for a homemaker since her welfare upon divorce is deeply rely on the amount of alimony and asset division. To the best of our knowledge, the study on the property division law focusing on a homemaker is limited to Wong (2014, 2016). Since the Japanese pension reform of 2007 mainly targets a homemaker, our study adds new evidence to this scarce literature.

2 Institutional Background

2.1 Japanese Pension System and the Reform of 2007

In order to better understand the context of the study, this section describes the Japanese public pension system and the reform of 2007. The Japanese public pension system consists of three insurance policies, the Employee pension (*kosei nenkin*), the Mutual Aid pension (*kyosai nenkin*), and the National pension (*kokumin nenkin*). The first two policies cover permanent employees (i.e., full-time workers not hired under a time-limited contract) in the private and public sectors, respectively,[5] but are otherwise identical, so we hereafter refer to them collectively as the Employee pension insurance. Within the Employee pension insurance, participants aged under 70 pay pension premiums as long as they earn labor income, with the amount of the premium proportional to their labor income. The age of eligibility for benefits is around 60, depending on sex and birth cohort, with the age of eligibility for men higher than women and for a recent cohort higher than an earlier cohort (for details, see Table 8). The pension benefits consist of two parts: a basic part and a proportional part, with the basic part depending only on the number of years for which the participant paid premiums, and the proportional part depending on earnings and duration of premium payments prior to retirement. The National pension covers those who are not covered by the Employee pension, which includes mainly the self-employed, part-time employees, and dependent wives, all of whom pay premiums until they turn 60 and become eligible for benefits at age 65. The National pension is similar to the basic component of the Employee pension, except for the age of eligibility and the participants in each respective plan.

Before the pension reform of 2007, the Japanese pension system was thought to be inequitable because spouses were not allowed to claim any fraction of the pension benefits of their partners should they divorce. While a homemaker wife played an important role in enabling her husband to specialize in market work, she previously had no access to his pension benefits. As the average monthly National pension benefit in 2007 was only about 540 U.S. dollars,[6] a homemaker would have difficulty living only on her own pension benefits after divorce.

In order to address this issue, a reform was approved in 2004 and enacted on April 1st, 2007 to permit divorcing spouses to divide the proportional part of the household's Employee pension records tracked during the marital period.[7] Although the proportion of the household pension record claimed by either party is determined by agreement between the spouses, the division

[5]In addition to permanent employees, the pension plans cover part-time employees who work more than three-quarters of the hours per day and days per month worked by a full-time employee. For example, if a full-time employee works eight hours per day and twenty days per month, then a part-time employee working more than six hours per day and fifteen days per month participates in either the Employee or Mutual Aid pension.

[6]The Employee pension paid out about 1,610 U.S. dollars per month on average. Source: Japanese Ministry of Health, Labour and Welfare: `http://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000106808_1.html`

[7]The basic part of the pension is not based on income and so it is not divisible.

must range between 0-50 percent, as the spouse with the smaller pension cannot claim more than half of the total and there is no room for the division if the records of both spouses are equal.[8] If the spouses fail to agree on division, a rate is provided by the courts. In 99 percent of cases in 2007, this rate was 50 percent[9], consistent with the asset division rule which divides assets accumulated during the marital period equally.[10] Since a divorced homemaker is now assured of at least some income beyond her basic pension, the post-divorce situation is said to have improved.

Several features of the 2007 pension reform help to facilitate our analysis. Firstly, as the reform does not change the total amount of pension benefits received by a household, it does not affect the household budget under marriage, which allows us to isolate changes in allocations due to bargaining. Secondly, as the reform provides a better outside option to dependent wives, we can investigate whether this change affects commitment. Thirdly, as the pension reform leaves some households unaffected, the policy design allows us to create treatment and control households for the counterfactual inferences required for our DD estimation. Since the pension reform applies only to Employee pension records, it does not affect the self-employed, who are covered by the National pension. Additionally, when both spouses are permanent employees, they each have their own Employee pension record and so the pension splitting opportunities are marginal. Hereafter, we refer to this latter type of household as a "dual-permanent" household.[11] As discussed below, households either "dual-permanent" or with one self-employed spouse were used to control for the economic trend in absence of the reform.

[8]Each household member can claim, to the Japan Pension Service, an estimate of the pension benefits before or after divorce if he or she is 50 years old or older. Although this system potentially makes information gap between elderly households and young households, I suspect that it does not play an essential role for two reasons. First, since the rate of the pension contribution is public information, the wife would make a good estimate of the husband's pension benefits from his earnings, or if not available, from the level of consumption. Second, even if the amount of pension benefits is private information of the husband, he has an incentive to reveal the true value, or at least, the value close to the true value, as the pension benefits are the main income source after retirement and lying about the pension benefits would result in inefficient intertemporal resource allocation.

[9]Source: Supreme Court of Japan; `http://www.courts.go.jp/vcms_lf/20513001.pdf`.

[10]A second pension reform was implemented in 2008 that allows a dependent wife (or husband) to claim half of the total household Employee pension records tracked after May 1st, 2008 should they divorce. This reform, which applies to households in which the wife's annual income is less than about 13,000 U.S. dollars, has a fixed division ratio of 50 percent. However, considering that the first pension reform applies to the entire Employee pension records tracked during the marital period, the function of this second reform is, at most, supplementary, as it does not apply to pension records before May 1st, 2008. As its impact on household behavior is likely to be negligible, our analysis focused only on the impact of the first reform.

[11]Explicitly excluded are those households in which the husband is a permanent employee and the wife works part-time, as part-time employees are typically not covered by the employee pension. Even if a wife working part-time is covered by the employee pension, however, the amount of her pension records is likely to be much less than that of a husband who is a permanent employee.

2.2 Divorce Law in Japan

Although Japanese divorce law in principle requires mutual consent before a couple may divorce, enforcement is not strict and so in practice, it may operate similar to unilateral divorce. Under Article 770 of the Japanese Civil Code, a judicial divorce is permitted if a spouse: (i) has committed an act of unchastity; (ii) has been abandoned in bad faith; (iii) is of unknown whereabouts and for at least three years it has not been clear whether s/he is dead or alive; (iv) is suffering from severe mental illness and there is no prospect of recovery; or (v) has any other grave concern making it difficult to continue the marriage. While the fifth point is ambiguous, the Ministry of Justice has issued a guideline that allows a couple to divorce after five years of separation. As a result, a spouse who wishes to the divorce may simply end cohabitation with his/her partner and file a suit for divorce after the required time has elapsed.

As for the distribution of assets upon divorce, the property division rule in Japan assures divorcees equal division of those assets for which they both "contributed" in obtaining, but it is not necessary for this contribution to be monetary, whereas other assets are divided on basis of the title. For example, if a wife specializes in home production and has no earnings, her domestic work is regarded as a contribution to purchasing housing. On the other hand, the asset division does not apply to assets accumulated before marriage or obtained via inheritance. Since asset division is implemented based on holdings at the time of divorce or the end of cohabitation if a couple separates prior to divorce, separation can be an effective strategy to divorce without mutual consent, as a spouse can file for divorce several years after the end of cohabitation but asset division is implemented as if the couple had divorced at the beginning of the separation.

2.3 Identification of the Policy Impact

We identify the policy impact via parallel trend assumption, and estimate it by DD estimation, with the treatment group consisting of households in which the husband was a permanent employee and the wife was not, and the control group consisting of all other households. As noted earlier, since the Employee pension insurance covers a permanent employee but not non-permanent employees or the self-employed, the treatment group is a typical household targeted by the reform. On the other hand, the majority of the households in the control group consists of a self-employed husband and a wife without permanent employment, and this type of households is unaffected by the reform. The key identification assumption is that the time trend in the wife's time allocation is the same between the treatment group and the control group.

One concern is that the control group includes some dual-earner households whose husband and wife both have permanent employment, and the time allocation of the wife working for full-time at the market is different from that of the wife not working or working for part-time at the market. While this is a reasonable concern, our main empirical finding is robust to excluding those households from the control group. Another concern is that the employment status itself is endogenous and thus affected by the policy. In order to avoid this issue, we define the treatment status by the employment status in 2003, one year before the approval of the policy change. Thus, the treatment status is not confounded by the change in the employment status in response to the policy change.

Finally, since the amount of the pension benefits is determined by a history of the contribution, we admit that defining the treatment status by the employment status at a certain point is inadequate. Some husbands in the treatment group may recently switch from the self-employed to the employed while some husbands in the control group may recently switch from the employed to the self-employed. In other words, it is possible that those who are untreated are included in the treatment group and those who are treated are included in the control group. Since this measurement error would result in the bias toward zero, our estimation results would be regarded as the lower bound of the policy impact. Furthermore, the switching between the employed and the self-employed seems relatively rare. According to the Employment Status Survey 2007, 94 percent (94 percent) of men who entered the labor market as an employee (self-employed) work as an employee (self-employed) when they are 45–54 years old. Therefore, we believe that the potential bias from the misclassification would be marginal.

3 Theoretical Model of Household Decision Making

In this section, we provide a model to describe how a couple responds to the pension reform under full and limited commitment. In particular, we consider a household in which a husband and wife have distinct preferences and bargain over resource allocation. The resulting household resource allocation is in favor of a member whose outside option, namely, welfare upon divorce, is better. While this is the standard collective model setting (Chiappori, 1988, 1992), another problem arises when dynamic decision making is concerned, that is, commitment to resource allocation plan (Mazzocco, 2007). Although both members benefit from the household initial allocation plan given all information available at marriage, some shock to one's outside option could induce him/her to divorce even if it does not affect the household budget under marriage. In such a case, a household needs to modify the initial allocation plan to persuade that member to stay married. Since a lack of commitment makes household resource allocation sensitive to shocks that have nothing to do with household budget or preferences, the household decision becomes time-inconsistent and inefficient. On the other hand, the household may be somehow able to fully commit the initial allocation plan, so that household behavior is contingent on the household budget but not contingent on the realization of uncertainty to the outside option. For example, as a commitment device, Dufwenberg (2002) incorporates guilty into the model.

If we look at the pension reform through the lens of this household model, it is regarded as a shock to the outside option of the wife and husband. Since it does not affect the amount of pension benefits that the household can receive, the household with full commitment does not change its resource allocation plan. However, in the case of limited commitment, the pension reform increases (decreases) the wife's (husband's) pension benefits upon divorce, and thus, the wife would threaten her husband to divorce unless the consumption plan is modified in her favor. Therefore, we can infer if the household has the full commitment or not by investigating the household response to the pension reform. Furthermore, whether the wife's threat to divorce is empty or not depends on the extent to which her outside option is improved by the policy. For example, if she has a large asset and the value of pension benefits is marginal compared with that asset, her value of divorce after the reform is similar to the value of divorce before reform. Also, a young wife is unlikely to be affected, because her husband's pension benefits are still small and because she needs to wait for decades until she becomes eligible for the pension benefits. In both cases, the pension reform has, at best, a marginal impact on her value of divorce, and thus, her threat to divorce is likely to be an empty threat.

To formally illustrate how the pension reform affects the household decision making, consider the following 3-period problem for a 2-member household ($j = 1, 2$) in which the couple marries in the 1st period and may or may not choose to divorce in the 2nd or 3rd period. The household members supply market and domestic labor in the 1st and 2nd periods and retire in the 3rd period. A fraction τ of labor earnings is collected as a pension premium, and the couple receives the pension benefits b_{j3} in the 3rd period. Each spouse derives his or her welfare from private consumption c_{jt} and leisure l_{jt}, where the consumption good is produced by domestic labor h_{jt} and there is a market good g_t. We assume unilateral divorce, so divorce is possible without mutual consent. We denote member j's asset and pension benefits upon divorce as a^D_{jt} and b^D_{jt}, respectively.

We now define full and limited commitment. A couple achieves "full commitment" if the *participation condition* that the value of the marriage for each member is greater than or equal to the value of divorce is required only at the initial period, whereas the degree of commitment is said to be "limited" if the participation condition must be satisfied at each period. Thus, under limited commitment, both members must be satisfied with the marriage at each period; otherwise, an unsatisfied member may threaten to divorce to increase his/her consumption or leisure, even if that member does not intend to carry through with the divorce. Here, we assume that the couple does not ever divorce. The case of actual divorce is discussed in Appendix B.

The household problem under full commitment is

$$\max_{(c_{jt},l_{jt},b_{jt},g_t,a_{t+1})} \mu E_1\left[\sum_{t=1}^{3}\beta^{t-1}u_1(c_{1t},l_{1t},\theta_{1t})\right]+(1-\mu)E_1\left[\sum_{t=1}^{3}\beta^{t-1}u_2(c_{2t},l_{2t},\theta_{2t})\right], \quad (1)$$

$$\begin{aligned}\text{s.t. } & c_{1t}+c_{2t}=F(h_{1t},h_{2t},g_t),\\ & a_{t+1}=(1+r_t)a_t+\sum_{j=1}^{2}(1-\tau_{1t})(1-l_{jt}-h_{jt})w_{jt}-g_t \quad (t=1,2),\\ & b_{j,t+1}=(1+r_t)b_{jt}+\tau_{1t}(1-l_{jt}-h_{jt})w_{jt},\\ & 0\le l_{jt}+h_{jt}\le 1, \quad l_{j3}+h_{j3}=1,\end{aligned}$$

where θ_{jt} is match-specific utility, w_{jt} is j's market wage, r_t is the risk-free interest rate,[12] and the total time is normalized to one. Since the couple marries in the 1st period, the initial-period participation condition is summarized in the Pareto weight μ. Solving this problem backwardly, we observe that the household allocation plan is contingent on total assets $a_t+b_{1t}+b_{2t}$ but not on the assets and pension benefits divided upon divorce, $(a_t^D, b_{1t}^D, b_{2t}^D)$. Hence, the solution to the problem is

$$x_{jt}(\Omega_t)=\tilde{x}_{jt}(a_t+b_{1t}+b_{2t},\theta_{1t},\theta_{2t},w_{1t},w_{2t}) \quad (x\in\{c,l,h\}; j\in\{1,2\}), \quad (2)$$

where $\Omega_t=(a_t,a_{1t}^D,a_{2t}^D,b_{1t},b_{2t},b_{1t}^D,b_{2t}^D,\theta_{1t},\theta_{2t},w_{1t},w_{2t})$ is the set of state variables.

The household problem under limited commitment is similar to the full commitment household problem (1), but additionally requires the participation conditions in periods 2 and 3:

$$u_j(c_{j2},l_{j2},\theta_{j2})+\beta u_j(c_{j3},l_{j3},\theta_{j3})\ge V_{j2}^D\left(a_{j2}^D+b_{j2}^D,w_{j2}\right), \quad (3)$$

$$u_j(c_{j3},l_{j3},\theta_{j3})\ge V_{j3}^D\left(a_{j3}^D+b_{j3}^D\right) \quad (j\in\{1,2\}), \quad (4)$$

where $b_{jt}^D=b_{jt}$ under the pre-reform regime and $b_{jt}^D=\frac{b_{1t}+b_{2t}}{2}$ under the post-reform regime. The 3rd-period problem is

$$\begin{aligned}V_3(\Omega_3)=\max\ & \mu u_1(c_{13},l_{13},\theta_{13})+(1-\mu)u_2(c_{23},l_{23},\theta_{23}),\\ \text{s.t. } & c_{13}+c_{23}=F(h_{13},h_{23},g_3),\\ & g_3=a_3+b_{13}+b_{23}; \quad l_{j3}+h_{j3}=1 \quad (j\in\{1,2\}),\\ & u_j(c_{j3},l_{j3},\theta_{j3})\ge V_{j3}^D\left(a_{j3}^D+b_{j3}^D\right) \quad (j\in\{1,2\}).\end{aligned}$$

Denoting the Lagrange multiplier on the participation conditions by λ_j (≥ 0), this problem is

[12] Although, for simplicity, the amount of pension benefits is assumed to be accumulated in the same way as savings, the model identification result does not rely on this assumption.

rewritten as

$$
\begin{aligned}
&\max\ (\mu+\lambda_1)u_1(c_{13},l_{13},\theta_{13})+(1-\mu+\lambda_2)u_2(c_{23},l_{23},\theta_{23}),\\
&\text{s.t. } c_{13}+c_{23}=F(h_{13},h_{23},g_3),\\
&\qquad g_3=a_3+b_{13}+b_{23};\quad l_{j3}+h_{j3}=1\quad (j\in\{1,2\}),
\end{aligned}
$$

where the $\lambda_j = 0$ if member j's participation condition is not binding. Thus, the couple re-bargains only when the participation condition of one member binds.

The main difference from the full commitment case is that the pension division rule upon divorce, b^D_{j3}, matters, and this, in turn, implies that so does asset composition (b_{1t}, b_{2t}). Indeed, we observe in general that

$$
\lambda_j=\lambda_j(a^D_{13},a^D_{23},b_{13},b_{23},\theta_{13},\theta_{23})\neq\lambda_j(a^D_{13},a^D_{23},b_{13}+b_{23},\theta_{13},\theta_{23}).
$$

Since a similar argument applies to the 1st- and 2nd-period problems, the household allocation plan cannot be written as a function of total assets:

$$
\begin{aligned}
x_{jt}(\Omega_t)&=x(a_t,a^D_{1t},a^D_{2t},b_{1t},b_{2t},b^D_{1t},b^D_{2t},\theta_{1t},\theta_{2t},w_{1t},w_{2t})\\
&\neq\tilde{x}_{j,t}(a_t+b_{1t}+b_{2t},\theta_{1t},\theta_{2t},w_{1t},w_{2t})\quad (x\in\{c,l,h\};j\in\{1,2\}).
\end{aligned}
\tag{5}
$$

Equations (2) and (5) give the test of the full commitment model using the variation in the amount of pension benefits divided upon divorce. In particular, the household consumption plan is not contingent on it under the full commitment model, $\frac{\partial x_{jt}}{\partial b^D_{jt}}=0$, while the household consumption plan is not contingent on it, $\frac{\partial x_{jt}}{\partial b^D_{jt}}\neq 0$. Since the pension reform of 2007 affects the amount of pension benefits upon divorce, it is used to identify the model. In order to see the impact of the pension reform in detail, suppose that the reform is unexpectedly implemented at the beginning of the 2nd period. Under limited commitment, the initial allocation plan satisfies

$$
\begin{aligned}
&u_j(c_{j2},l_{j2},\theta_{j2})+\beta u_j(c_{j3},l_{j3},\theta_{j3})\geq V^D_{j2}\left(a^D_{j2}+b_{j2},w_{j2}\right),\\
&u_j(c_{j3},l_{j3},\theta_{j3})\geq V^D_{j3}\left(a^D_{j3}+b_{j3}\right)\quad (j\in\{1,2\}),
\end{aligned}
$$

but due to the change in pension division rule, the new participation conditions are

$$
\begin{aligned}
&u_j(c_{j2},l_{j2},\theta_{j2})+\beta u_j(c_{j3},l_{j3},\theta_{j3})\geq V^D_{j2}\left(a^D_{j2}+\frac{b_{12}+b_{22}}{2},w_{j2}\right),\\
&u_j(c_{j3},l_{j3},\theta_{j,3})\geq V^D_{j3}\left(a^D_{j3}+\frac{b_{13}+b_{23}}{2}\right)\quad (j\in\{1,2\}),
\end{aligned}
$$

and the 2nd-period participation condition is now more restrictive for member 2 if $b_{12} > b_{22}$.

Taking this into consideration, other things being equal, the greater is $(b_{12} - b_{22})$, the more likely the participation condition for member 2 will bind. Since the pension division upon divorce applies only to the pension records during the marital period, a young couple does not have many divisible pension benefits (i.e. b_{12} is small), suggesting that elderly households are more likely to be affected by the reform. On the other hand, suppose that the initial allocation plan satisfies the 2nd-period participation condition but does not satisfy the 3rd period one. In this case, the main impact is on the 3rd-period allocation because the 3rd-period participation constraint cannot hold without adjusting the allocation at that period. The 2nd-period allocation is then affected due to consumption smoothing.

The above discussion implies that the main impact of the pension reform should be observed after the reform is implemented, and young households are unlikely to show a substantial change in allocation in the reform year even if they re-bargain their future resource allocation. Furthermore, given the concavity of the value function, the value of divorce is sensitive to the amount of pension benefits when the amount of other assets available upon divorce is small. This suggests that a couple with few assets other than pension benefits will be most affected by the reform. In Appendix A, we conduct some numerical exercises to illustrate how the policy impact varies depending on the value of the husband's pension benefits and household assets, and it indeed gives the results consistent with the above argument. See Appendix A for details.

4 Data and Identification Strategy

4.1 Data

This study utilized data from the *Keio Household Panel Survey* (KHPS) provided by the Keio University Panel Data Research Center. The KHPS is an annual household-level panel survey of households beginning in 2004 and consisting of 4,000 households (3,000 married and 1,000 single). Each year, the survey is conducted at the end of January, and respondents are asked about their usual time allocation as well as background information such as age, sex, family composition, and employment status. As Japan's fiscal year begins in April, each implementation of the survey inquires about the previous fiscal year, with KHPS 2004, for example, asking about respondent behavior in 2003. Accordingly, KHPS 2004 includes data on the socio-economic status of respondents before the 2004 pension reform approval, and KHPS 2008 and succeeding waves represent household behavior after the enactment of the reform.

Although ten waves (KHPS 2004 through 2013) were available, we restricted our main sample to KHPS 2005 through 2008. As KHPS 2004 does not include information about time spent on childcare, the domestic labor supply in this wave is inconsistent with other waves, so we used this first wave only to obtain background information. We also excluded KHPS 2009 through 2013 from our sample because of two external events: the global financial crisis of 2008, the impact of which seems difficult to distinguish from that of the 2007 pension reform, and the Great East Japan Earthquake of 2011, which very likely caused heterogeneous effects across households. The set of households chosen for the analysis sample was selected according to the following criteria: (1) spouses who married before 2004[13], who live together, and who were both aged 30–59 in 2007; (2) a time allocation that meets the constraint of 168 hours; and (3) the lack of any missing key variables for our analysis.[14] In empirical studies, we used family size, the number of children, and an indicator variable for children aged less than or equal to six to control for household heterogeneity. The variables of interest are time allocation, leisure, market labor supply, and domestic labor supply[15], which were measured as the average hours per week.

DD estimation, which separates the impact of a specific policy from the counterfactual time trend that would have been faced by the treatment group had there not been any treatment, requires that the analysis sample of households be divided into a treatment group and a control group. We defined the treatment group as households in which the husband was permanently employed but the wife was not because those households would have been most affected by the pension reform. The control group consisted of the remaining households; that is, "dual-permanent" households and households in which the husband was self-employed.[16] The "dual-permanent" households consist of households in which both members are permanent employees, so households in which the wife works for part-time jobs are excluded. The treatment status of each household was fixed throughout the sample period by using the employment status in 2003, one year before the approval of the reform.[17]

4.2 Sample and Treatment Group Validity Checks

From the sample descriptive statistics shown in Table 1, we can see that there are some differences between the treatment and control households, with the average treatment household slightly younger and having more children than the control household. Further, while leisure time is similar, wives in treatment households work less in the market and longer in domestic production

[13]We did not include newly married couples in our sample because in 2004, these couples may have known about the pension reform at the time of their marriage and so within-household variation in bargaining position is not identifiable for those households.

[14]The 2nd condition for the sample restriction drops about 10 percent of observations while the 3rd condition has little impact on the sample.

[15]Domestic labor supply consisted mainly of meal preparation, laundry, grocery shopping, cleaning, and child-care.

[16]Households in which the wife was a permanent employee and the husband was not would also have been affected by the pension reform, but as the impact would be in the opposite direction of that of our treatment group, and since the size of this subset was very small, we included this type of household in the control group.

[17]The change in employment status is relatively rare. Indeed, nearly 90 percent of observations would be assigned the same treatment status if the current employment status were used instead of the employment status in 2003.

Table 1: Descriptive statistics of KHPS sample

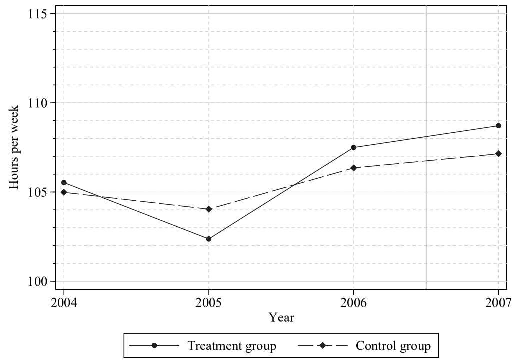
	Wife		Husband		Household	
	Treatment (1)	Control (2)	Treatment (3)	Control (4)	Treatment (5)	Control (6)
Leisure	105.86	105.51	118.46	120.59		
	(32.63)	(29.02)	(19.14)	(21.96)		
Market labor supply	12.49	27.65	46.72	43.85		
	(15.30)	(21.71)	18.41	(20.79)		
Domestic labor supply	49.65	34.84	2.82	3.56		
	(35.23)	(29.22)	(5.82)	(7.16)		
Age	42.87	44.72	45.06	47.24		
	(7.64)	(7.67)	(8.01)	(7.83)		
Family size					4.04	4.07
					(1.21)	(1.39)
Number of children					1.72	1.52
					(0.96)	(1.00)
Children under 6 years old					0.24	0.17
					(0.43)	(0.38)
Marital period					15.77 [i]	17.53 [ii]
					(8.25)	(8.66)
Observations	2,868	1,812	2,868	1,812	2,868	1,812

Note: The table shows means and standard deviations, with the latter in parentheses. Time allocation was measured as the average hours per week. i) Sample size was 2836. ii) Sample size was 1776.

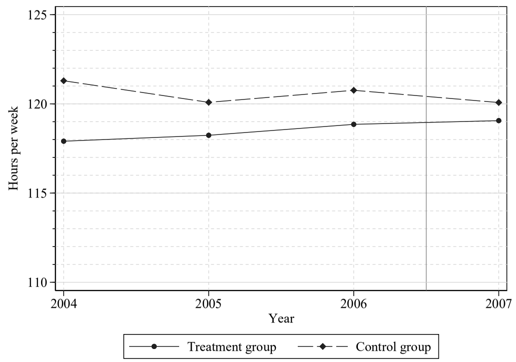
than those in control households, while husbands in treatment households work longer in the market and less in domestic production.[18] Although these differences may signal potential heterogeneity between the two groups, our identification strategy is robust to this heterogeneity, for DD estimation with household fixed effects controls for heterogeneity in preferences as long as the differences demonstrate the same trend over time. In addition, we also implemented a triple differences (DDD) estimation (discussed in Section 6.4) that is robust to a violation of this parallel trend assumption.

Before implementing our difference-in-differences (DD) estimation strategy, we graphically checked if the parallel trend assumption required to identify the average treatment effect on treated (ATT) is likely to hold by comparing the trend in the pre-treatment period. Figure 1 shows trends in the time allocation of each spouse and highlights several points relevant to our analysis. First, as is also seen in the descriptive statistics, the amount of time allocated to various activities differs between the treatment and control groups. In particular, there are relatively large differences between the two groups in the market and domestic labor supplies of wives, with the typical wife in the treatment group working more hours in the household and fewer in the market than a typical wife in the control group. With control variables and fixed effects,

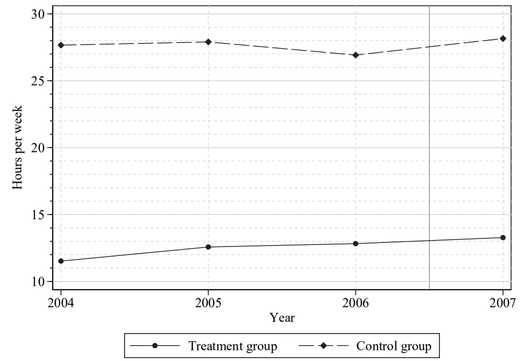
[18] See Table 10 for descriptive statistics of time-allocation before and after the reform.



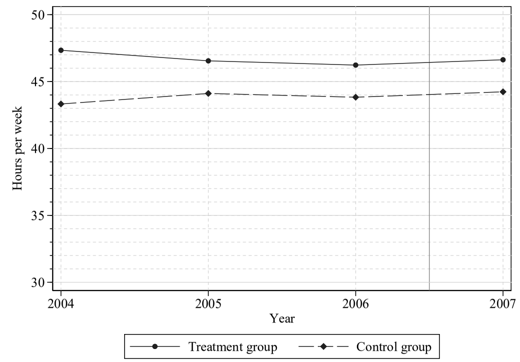
(a) Leisure: Wife



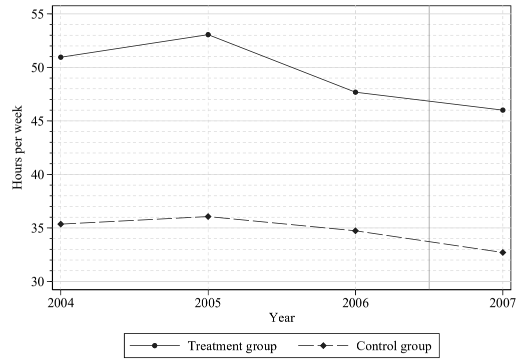
(b) Leisure: Husband



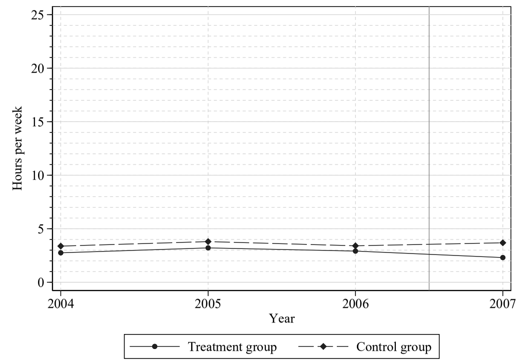
(c) Market Labor Supply: Wife



(d) Market Labor Supply: Husband



(e) Domestic Labor Supply: Wife



(f) Domestic Labor Supply: Husband

Figure 1: Time trend in market labor supply, domestic labor supply, and leisure

Data Source: The *Keio Household Panel Survey*
Note: This figure shows the yearly trend in the time allocation of wives and husbands. The solid lines represent the time allocation of individuals in the treatment group while the dotted lines represent individuals in the control group. The vertical lines highlight 2006, one year before the pension reform was enacted.

DD estimation can account for these differences in the absolute levels of time allocation as long as the parallel trend assumption holds. Second, and more importantly, the treatment and control groups show a similar trend before the pension reform, which supports the parallel trend assumption required for our DD estimation.

While it is difficult to see any large impact of the pension reform from Figure 1, the policy impact becomes clear when heterogeneity in the age of the wife is considered. In particular, the impact of the reform on a wife's allocation to leisure is striking (Figure 2). In the most elderly group (wives aged 50-59), the time allocated to leisure increases by about 5 hours in the treatment group, while showing a pre-reform trend similar to the control group (Figure 2a). In contrast, in the other age groups, the treatment and control groups both show a similar time trend before and after the pension reform (Figures 2b and 2c). These observations support our contention that the pension reform appears to have had a substantial impact on elderly households but a limited impact on younger households.

4.3 Regression Framework for Difference-in-Differences Analysis

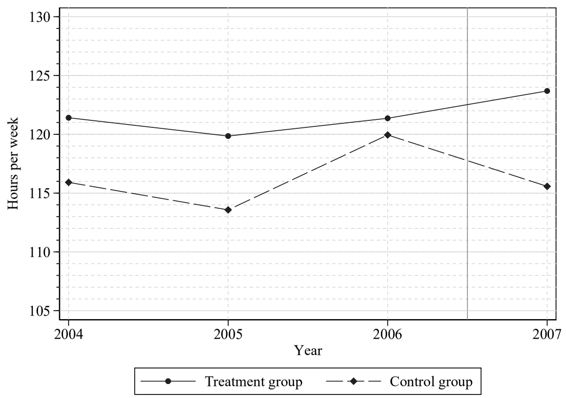
We applied a difference-in-differences (DD) estimation strategy to investigate the causal impact of the 2007 Japanese pension reform. The treatment group consisted of households in which the husband was a permanent employee in 2003 and the wife was not, whereas the control group consisted of all other households. The estimation equation was specified as

$$y_{it}^j = \delta_1^j After_t \cdot Treatment_i + x_{it}'\beta^j + \pi_t^j + c_i^j + u_{it}^j, \tag{6}$$

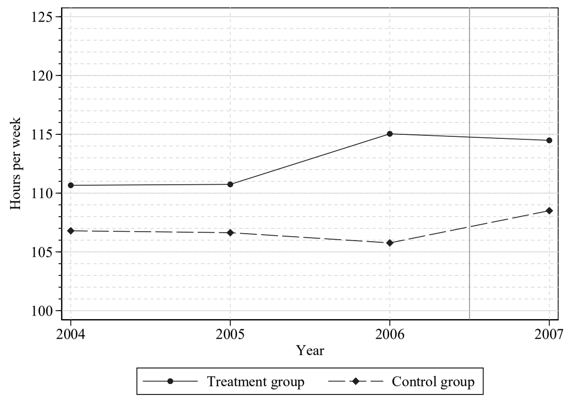
where i, j and t denote each household, each household member, and the year, respectively. Dummy variables include $After_t$, which takes one if $t = 2007$, and $Treatment_i$, which takes one if household i is in the treatment group. The control variables x_{it} are a constant and household characteristics, which include the squared ages of both spouses, family size, the number of children, and a dummy variable indicating whether the household has children aged 6 or younger.[19] π_i^j is year fixed effects, and c_i^j is household fixed effects. Note that $After_t$ is equivalent to d_{2007}, and household fixed effects absorb the treatment dummy variable, $Treatment_i$, which was fixed according to employment status in 2003. The dependent variable, y_{it}^j, is the allocation to leisure, market labor supply, and domestic labor supply of spouse j of household i in year t.

The coefficient of interest is δ_1^j, which represents the household time allocation response

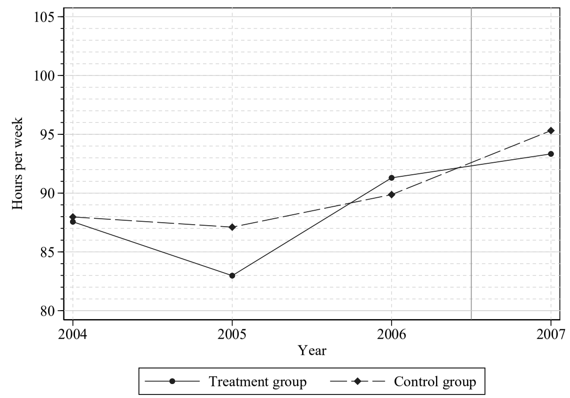
[19]Although we did not include wage rates in the empirical model since those of non-labor participants are unobserved, our estimates do not suffer from any bias as long as the (potential) wage rates are uncorrelated with the treatment status, conditional on household fixed effects, year dummy variables and other control variables. Since the treatment status was fixed over the period, we believe that this conditional independence assumption is not restrictive.



(a) Wife Aged 50-59



(b) Wife Aged 40-49



(c) Wife Aged 30-39

Figure 2: Time trend in time allocated to leisure by age of wife

Data Source: The *Keio Household Panel Survey*
Note: Yearly trend in the time allocated to leisure by wives are presented for each age group. Solid lines represent the treatment group and dotted lines represent the control group. The vertical lines indicate 2006, one year before the pension reform was enacted.

to the pension reform and is key to test the degree of commitment. Under full commitment, a couple's consumption plan is contingent on its total assets and, given that amount, asset composition is irrelevant. As the couple does not respond to the reform, δ_1^j is expected to be zero. Under limited commitment, however, the couple's consumption plan is contingent on each member's asset share upon divorce, so δ_1^j is not equal to zero, assuming that the participation conditions are violated in some households due to the reform. Hence, if δ_1^j is different from zero, we reject the full commitment model. Since the theoretical model suggests that the pension reform will have heterogeneous effects according to the wife's age, we, therefore, estimated equation (6) by dividing the sample into three groups: an elderly group of households with wives aged 50–59 in 2007, a middle-aged group with wives aged 40–49, and a young group with wives aged 30–39.[20]

By estimating by the age of the wife, it allows us to investigate how spouses might update their bargaining positions. For example, if we find no policy impact on the time allocation of younger households, this suggests that those households display some degree of commitment, which is consistent with the model in which the re-bargaining occurs only when the participation condition is binding. We must remember, however, that this specific test may lack statistical power, for even if the younger household does re-bargain its resource allocation plan, the effect may be too small to detect due to the small policy impact on the outside option of a young wife.

5 Results

5.1 Baseline Results

Table 2 reports the empirical results of the DD estimation showing the household response to the reform by age group. In the most elderly group, consisting of households with wives aged 50–59, the wife's allocation to leisure increased by 5.0 hours per week, or 4.8 percent. This increase in leisure was associated with a roughly equal decrease in market labor supply and domestic labor supply. Although the effect on labor supply was not statistically significant here, we found that this effect was statistically significant and the size of the estimates was similar in the triple-differences (DDD) estimation discussed in Section 6.4. Furthermore, the estimates in this age group were jointly different from zero at 10 percent significance level, so our statistical inference is not a consequence of testing multiple hypotheses one by one.

These estimation results imply that the elderly spouses fail to completely commit to their initial allocation plan due to conflicting incentives, which leads us to reject the full commitment

[20]Another approach would have been to categorize households by marriage duration instead of age, as the amount of divisible pension records depends on marriage duration, but this would have been problematic because the marital period is likely to be correlated with match quality. Indeed, in equations (3) and (4), we see that the higher the match-specific utility $\theta_{j,t}$, the less likely the participation conditions are to be binding.

Table 2: The effect of pension reform: Difference-in-differences estimation

		Wife		
Age Group	Leisure (1)	Market Labor Supply (2)	Domestic Labor Supply (3)	Observations [Households]
50–59	4.976**	-2.363	-2.613*	1,333
	(2.509)	(2.136)	(1.435)	[442]
40–49	-0.322	2.166	-1.844	1,804
	(1.878)	(1.491)	(1.578)	[575]
30–39	-3.265	1.475	1.790	1,543
	(3.445)	(1.637)	(3.153)	[490]
All	0.797	0.695	-1.492	4,680
	(1.530)	(0.997)	(1.288)	[1,507]

		Husband		
Age group	Leisure (4)	Market labor supply (5)	Domestic labor supply (6)	Observations [Households]
50–59	1.014	-0.171	-0.842	1,333
	(2.180)	(2.109)	(0.567)	[442
40–49	-0.935	1.259	-0.324	1,804
	(2.056)	(2.004)	(0.504)	[575]
30–39	1.615	-0.811	-0.805	1,543
	(2.361)	(2.293)	(0.874)	[490]
All	0.376	0.312	-0.688*	4,680
	(1.281)	(1.243)	(0.371)	[1,507]

Note: The table shows the estimation results of equation (6) by the age group of the wife. Only the estimated values of δ_1^j are reported, with standard errors clustered by each household in parentheses.
$*** \ p < 0.01$, $** \ p < 0.05$, $* \ p < 0.1$.

model of household behavior. While one might consider complete commitment as a good approximation if re-bargaining effects were negligible, we found substantial re-bargaining in the form of a 5-percent change in the wife's leisure. We thus conclude that the model with limited commitment is a better approximation of actual household behavior. Additionally, we found that home production played a non-negligible role in re-bargaining. Specifically, if we had instead defined leisure as non-market hours, we would have missed about half of the change in the wife's time allocation. As shown in Blundell et al. (2005), the level of home production depends on the marginal willingness of each spouse to pay, and thus, contribution to home production is an important bargaining domain.[21]

[21] Blundell et al. (2005) discuss the public good provision under a cooperative framework. Although we specified the home production good as a private good, we can easily modify our model so that both private and public goods are produced at home without changing the main predictions.

In order to gauge the magnitude of the policy impact, we consider the amount of pension benefits that a wife can access from her husband upon divorce. Suppose that the annual value of the divisible pension benefits for a wife aged 55 is 4.8 thousand U.S. dollars, which was the average amount among those who were eligible for benefits in 2014 (i.e., wives who were older than 53 when the pension reform was enacted)[22], the wife's age of eligibility for pension benefits is 60, and she marries at 28 and dies at 86, which reflects the average lifespan of women in Japan.[23] Setting the interest rate $r = 0.01$, the present value of benefits for a wife aged 55 is 90.5 thousand U.S. dollars. Given that the annual amount of her National pension benefits is 6.5 thousand US dollars beginning at age 65, this pension reform changes the present value of her total pension benefits from 92.0 thousand to 182.6 thousand US dollars, which is almost a 100 percent increase. This back-of-the-envelope calculation indicates that the wife's leisure, market work, and domestic work elasticities to the lifetime pension benefits upon divorce are 0.05, 0.20, and 0.05, respectively. Since the reform does not change total benefits, these effects are not due to any wealth effect but can be attributed solely to the re-bargaining effect. Furthermore, since the wife may have other assets at her disposal, the elasticity to the assets at her disposal upon divorce could be even larger.

Unlike elderly couples, we did not find any statistically significant changes in time-allocation among the younger households, and the estimates for the two younger groups were also jointly insignificant (Table 2). It is worth noting that these two younger groups correspond to the households in the Sakamoto (2008) study, which does not find any policy impact of the reform. This is consistent with the model's prediction that the current-period participation condition is unlikely to bind for younger households. Firstly, the pension division applies only to the records tracked during marriage, which is short for young households. Secondly, as the pension benefits do not count as collateral, a divorcing wife is not able to immediately receive the present value of any future pension benefits but must wait until retirement.[24] Thirdly, the discounted future value of the divorce receipts for a young wife would be low, which again makes the current-period participation condition unlikely to bind. For all these reasons, the possible division of pension benefits is less relevant to a younger wife, resulting in almost no impact of the reform on her household resource allocation. Even if the participation conditions at future periods bind under the current allocation, the impact on the current-period resource allocation is only through consumption-smoothing, not through the direct impact of the re-bargaining. As a result, the resource allocation would be gradually adjusted to minimize the deviation from the *ex-ante*

[22]Source: Japanese Ministry of Health, Labour and Welfare; `http://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000106808_1.html`.

[23]Data Source: `http://www.mhlw.go.jp/toukei/saikin/hw/jinkou/geppo/nengai07/` and `http://www.mhlw.go.jp/toukei/saikin/hw/life/life07/index.html`.

[24]Exceptions to this include borrowing against future benefits through the Welfare and Medical Service Agency and the Japan Finance Corporation. For more detail, see `http://hp.wam.go.jp/home/tabid/36/Default.aspx` and `https://www.jfc.go.jp`.

efficient allocation.

This discussion is in line with Lise and Yamada (2018), who argue that small shocks do not trigger re-bargaining. Since any possible improvement in welfare is too small for a young wife to initiate divorce, her bargaining position is not updated. Consequently, the reform has virtually no impact on young households, for it affects neither the budget set nor the utility weight on each member. We must recall, however, that this view of the way to update bargaining power should be treated with caution since it can possibly be due to a lack of statistical power in testing minute changes in time allocation.

5.2 Home Ownership and Net Housing Value

Another prediction from our model is that the impact of the reform depends on the amount of household assets other than pension benefits because the assets obtained through pension division would be negligible for high net worth households. In Japan, the property division rule assures divorcing spouses equal division of assets for which they both contributed in obtaining, and one of the most important non-financial household assets is the family home. The interpretation of the law is that a home purchased during the marital period would be divided among the spouses if they divorced, but if it was acquired either before marriage or through an inheritance or gift, it would belong to a single spouse and would not be divided.

The impact of the pension reform on a dependent wife's option outside of marriage is therefore likely to also depend on the value of any property that she would obtain upon divorce. If the value of a property is high, the pension benefits divided from her husband would be only of marginal importance to her. As a result, the pension reform would be expected to have a negligible impact on a wife with other real assets and a substantial impact on a wife with no property. Another possible interpretation is that homeownership could also work as a commitment device that makes divorce undesirable relative to staying married. In such cases, a household with homeownership would likely have a higher degree of commitment than one without.

To test this prediction, we divided the most elderly age group into two subgroups according to the household's net housing value and home-ownership.[25] To this end, we first calculated the net value of all houses and plots of land using the self-evaluated value of these properties less the remaining debt from acquiring them.[26] We then assigned a property value to each spouse according to the property rights from housing and land, and then divided the most elderly group into two subgroups: wives with positive property values and those without. Given the above

[25]Although it would have been possible to conduct this subsample analysis based on household assets or savings, we chose homeownership because the title to properties other than housing was not available in our dataset. Consequently, we could not distinguish the fraction of savings divided upon divorce from the fraction of savings accumulated before marriage or accumulated through inheritance.

[26]We omitted the top and bottom two percent of the property values to alleviate any influence of outliers.

Table 3: Subsample analysis by housing value and property rights (Wives aged 50–59)

	Housing ≤ 0	Housing > 0
	(1)	(2)
Dependent variable		
Leisure	9.116**	-0.593
	(4.342)	(4.487)
Market work	-4.083	-0.314
	(3.319)	(4.200)
Domestic work	-5.033*	0.906
	(2.753)	(2.006)
p-value of joint test	0.086	0.900
p-value of H_0: same impact in (1) and (2)	0.156	
Observations	495	500
Households	165	164

Note: The table shows the estimation results of equation (6) for the most elderly age group of the wife, by subsamples defined by net housing value, where the top and bottom two percents of the property values of wives are excluded to eliminate outliers. Only the estimated value of δ_1^j is reported. Standard errors clustered by each household are in parentheses. The p-value for the joint test against the null hypothesis that the response to the reform is, in terms of time allocation, the same across two groups is less than 0.1.
$*** p < 0.01$, $** p < 0.05$, $* p < 0.1$.

discussion, we would expect the reform to have a substantial impact only on wives without a positive property value.

Table 3 highlights the heterogeneous effects of the pension reform on wives according to the value of the property they own. The leisure of wives whose net housing value was non-positive substantially increased by 9 hours per week while their market and domestic labor supply decreased by 4 and 5 hours, and these estimates were jointly significantly different from zero. In contrast, the hours allocated to both leisure and production by wives with positive property value were not affected in any statistically significant way and, furthermore, the point estimates were almost zero. Although we could not reject the null hypothesis that the response to the reform was the same across the two groups in terms of time allocation at the 10 percent level (with p-value 0.16), we believe that this is due to the relatively small sample size. These estimation results thus seem to suggest that those who were mainly affected by the reform were wives with poor options outside of marriage, which is well explained by the collective model with limited commitment. To sum up, this subsample analysis further supports the rejection of the full commitment model.

6 Validity Check of the Identification Assumption

6.1 Placebo Test

While the parallel trend assumption required for DD estimation to identify the ATT is not directly testable, it is worth considering what might occur if this assumption was violated. For example, if the results in Table 2 were driven entirely by a business cycle unique to the treatment group, we would observe its impact throughout all age groups. However, we found significant changes in the time allocation in the most elderly age group while not in the other groups, so our results are unlikely to be explained by an economic shock that would have influenced only the treatment group.

In order to further confirm the validity of the parallel trend assumption, we estimated the placebo effects of the policy by counterfactually assuming that the reform was enacted in 2005 and 2006 as well as in 2007. Specifically, we estimated the following equation for each age group:

$$y_{it}^{j} = \sum_{t=2005}^{2007} \delta_{1t}^{j} d_t \cdot Treatment_i + x_{it}'\beta^j + \pi_t^j + c_i^j + u_{it}^j. \tag{7}$$

Since $\delta_{1,2005}^{j}$ and $\delta_{1,2006}^{j}$ represent placebo policy effects, they should be zero when time trends are common across the groups. If they are different from zero, the parallel trend assumption may be violated. In the following analysis, we focus on the time allocation of the wife since we found close to null effects for the husband in our DD analysis (Columns 4–6 in Table 2).[27]

Table 4 shows the estimates of δ_{1t}^{j} in equation (7) for the wives. Consistent with our baseline results, we found a significant impact on the most elderly age group but a smaller impact on the other age groups.[28] In terms of the coefficients on the placebo years, the estimates of these coefficients were not statistically different from zero in the most elderly and youngest households, supporting the parallel trend assumption. Although the leisure of the wife significantly increased and the domestic labor supply decreased in 2006, which could potentially indicate a violation of our identification assumption, we need to carefully interpret it as we are testing multiple hypotheses one by one. If we tested a total of 12 hypotheses that each placebo coefficient is zero, it is not unlikely that one of them might be rejected at a 5 or 10 percent significance level

[27] As the husband in the treatment group was typically a full-time employee, it appears to have been difficult for him to have changed his hours worked. Furthermore, there were many households in which the husband did not engage in any household production. As a result, changes in bargaining power caused by the pension reform may not have been substantial enough for these husbands to deviate from the corner solution. However, our estimation results do not immediately suggest that the pension reform had no impact on husbands, as their levels of consumption may have declined, both in terms of private and public goods.

[28] The estimates were jointly significant in the most elderly group. Moreover, we rejected the null hypothesis that the 9 coefficients on $Treatment \times d_{2007}$ are all zero, where the three restrictions are redundant since the time allocation sums up to 168.

even in the case that all of them are true.[29] In fact, we could not reject the null hypothesis that the placebo coefficients are all zero, with p-value of 0.36.

However, we still cannot completely negate the possibility of the violation of the parallel trend assumption, so to further address this issue, we explicitly allowed for a linear time trend specific to the treatment group. The first column in Table 5 shows the estimation results. We see that the estimate for leisure is quantitatively similar to the baseline result and although the market and domestic labor supply estimates differ from the baseline, the standard errors tend to be large and the signs are the same as the baseline. Considering that we have only one treatment year out of the four sample periods, it seems natural that the estimates would become imprecise, and so the robust result for leisure thus supports our contention that our estimation result is not driven by a violation of the identification assumption.

6.2 Sensitivity to Specification and Sample Restriction

One potential cause of differing time trends between the treatment and control groups would be a change in family structure. In particular, the typical treatment household tends to have a larger family and younger children than the control household (Table 1). Although in the baseline specification we controlled for family size, the number of children, whether households had a child under 6, and household fixed effects, it is possible that these were insufficient to completely remove the impact of changes in family structure. Thus, we controlled for family structure by using fourth-order polynomials of family size and the number of children, dummy variables indicating whether or not the household had a child aged 0–6, 7–12, and 13–18, and interaction terms between these polynomials and the dummy variables. Despite this flexible specification, we obtained estimation results that were qualitatively and quantitatively identical to the baseline results (Column 2 in Table 5). Therefore, any potential changes in family structure seem not to be a concern for our identification strategy.

A second potential violation of the parallel trend assumption could occur because in the baseline estimation the control group included wives who were permanent employees in 2003 whereas the treatment group did not. Since it is conceivable that the time allocation trend of wives with permanent employment differs from those with part-time or no employment, as an additional confirmation of our baseline results, we excluded wives with permanent employment from our sample and re-estimated the baseline DD equation (6). The third column of Table 5 shows that the leisure time of the wife in the most elderly age group increased while her market hours and domestic work hours decreased in response to the pension reform. Furthermore, the magnitude of the estimates is comparable with those from the baseline result. As before, none of the estimates for the younger two groups are statistically significant. These findings suggest

[29] While we have 18 placebo estimates (3 outcomes $\times$ 2 placebo years $\times$ 3 age group), 6 estimates are redundant in terms of hypothesis testing due to the identity, $\hat{\delta}_{\text{Leisure}} + \hat{\delta}_{\text{Market work}} + \hat{\delta}_{\text{Domestic work}} = 0$.

that differences in time-use were not the main driver of our baseline results.

As discussed in Section 3, the key to identifying the degree of commitment of spouses to an initial resource allocation plan is intra-household variation in bargaining position caused by the pension reform. Though approved in 2004 and enacted into law in 2007, discussion of the reform began several years earlier, with published newspaper articles about the reform appearing as early as 1998. It is thus possible that some people aware of the potential reform before 2000 (Figure 8) may have married in the early 2000's already anticipating that the division of pension records upon divorce might be allowed in the future. If this were the case, then the pension reform of 2007 would be unsuitable as an identification strategy, as it would be difficult to separate the changes in bargaining position after marriage from the bargaining position at marriage. Consequently, as couples that potentially anticipated the pension division reform would need to be excluded from the analysis, we implemented a subsample analysis that limited the estimation sample to wives in the most elderly group who married in 1997 or earlier. As the results (Column 6 in Table 5) are identical to the baseline, the issue of couples anticipating the pension reform at the time of their marriage appears to be inconsequential to our analysis.

On the other hand, it is possible that a couple married without knowing the pension reform of 2007 but, getting aware of it in 2004, when the policy was announced, changed the household resource allocation before 2007. In this case, we would observe change in household behavior before 2007, but a first-order policy impact is expected to be the resource allocation after the reform and change in the resource allocation before the reform is likely to be second order. To see why this is the case, we note first that the only channel with which the pension reform affects household behavior is the participation condition to marriage, which is reflected in the Pareto weight in the household objective function. Since the new pension division rule does not apply if the couple divorces before the reform, the value of divorce does not change until the reform is implemented. It implies that even with the information on the reform, the wife cannot threaten her husband to divorce before the reform. As a result, the bargaining position does not change before the reform but it changes after the reform. Therefore, the first-order policy impact is observed after the reform period. On the other hand, since the household behavior before the reform affects the participation condition after the reform through the accumulation of asset and pension records, the household resource allocation before the reform is modified due to this intertemporal consideration. Although this is an informal argument, we refer to Appendix A.3 which confirms this intuition via numerical exercise.

Finally, in order to check if our estimates on the heterogeneous policy impact across the age of the wife are not an artifact of idiosyncratic errors, we re-estimation equation (6) by starting with 10-year age bin of "50–59" and sequentially changing the age bin to "49–58," "48–57," and so on, as well as 5-year age bin.[30] If the heterogeneity that we found is not idiosyncratic

[30]We thank the anonymous referee for suggesting this robustness check.

but systematic, the size of the estimates is expected to become gradually smaller as we shift to a younger group. The estimation result, in fact, shows a systematic pattern of the estimates (Tables 11 and 12). The policy impact on the leisure is the largest in the most elderly age group, and roughly speaking, it becomes monotonically smaller as the estimation sample becomes younger. We also found a similar tendency for market and domestic labor supply, though the pattern for the market labor supply is somewhat noisy. Therefore, this exercise indicates that the heterogeneity in the policy effect is systematic and consistent with the prediction that the older the household, the larger the policy impact.

6.3 Other Policy Changes

6.3.1 Pension Reforms in 2004

A series of pension reforms legislated in 2004, and the pension division rule upon divorce is a part of it. The main purpose of the pension reform in 2004 is to make the pension system sustainable under the rapid population aging in Japan. From the viewpoint of households, the pension reforms in 2004 mainly consist of (1) an increase in pension premium and (2) a decrease in income replacement rate. First, the monthly pension premiums of the National pension insurance was increased by about 2.5 USD (280 JPY) in each year from 2005 to 2017, and the contribution to the Employee pension insurance is increased by 0.354 percentage points in each year from 2004 to 2017 so the rate of the Employee pension premium increased gradually from 13.58 percent to 18.30 percent. Second, the income replacement rate of the pension benefits was planned to decrease from 60 percent to 50 percent depending on economic growth and population growth. However, due to sluggish economic growth, the adjustment of the income replacement was not implemented until 2014. As a result, the income replacement rate was still around 60 percent even in 2019.

Although these pension reforms potentially affect our treatment group and control group differently, they are unlikely to be the main driver of our empirical results for three reasons. First, the increase in pension premium started in 2004 and 2005, but we did not find policy impacts in 2005 or 2006 but only in 2007. Furthermore, if the change in pension premium mattered, we would observe change in household behavior among young households as well as elderly households since the payment of pension premium does not depend on age. Second, the increase in Employee pension premium has a negative income effect on the wife in the treatment group, and thus, the policy impact on her leisure would, if any, be negative as long as leisure is a normal good. However, we found a positive impact on the wife's leisure. Finally, one might argue that though the income replacement rate did not change eventually, the policy announcement changed the household expectation of their future pension benefits downwardly, resulting in change in household resource allocation. This explanation is again inconsistent with our empirical results as it leads to the negative income effect.

6.3.2 The Mandatory Retirement Age

Another consideration in interpreting our estimation results is the enactment in 2006 of the Elderly Employment Stabilization Law (EESL) affecting the mandatory retirement system in Japan. From 2006, the Japanese government through the enactment of the EESL has required firms to comply with a scheme to raise the mandatory retirement age to 65 in order to fill the gap between the existing mandatory retirement age of 60 and the pension eligibility age of 65. Specifically, the EESL allows those born in 1946 to remain employed until age 63, those born in 1947 or 1948 until age 64, and those born in 1949 or later until age 65. The new law did not force firms to raise the mandatory retirement age but instead provided them with three options to continue to employ workers who would otherwise need to retire: (1) raise the mandatory retirement age; (2) extend or renew employment contracts; or (3) abolish mandatory retirement. According to the Ministry of Health, Labour and Welfare, more than 80 percent of firms chose option 2 rather than either raising or abolishing the mandatory retirement age.[31]

It is expected that the EESL would increase the labor force participation rate of elderly people hired as full-time employees. Kondo and Shigeoka (2017) show that it has indeed increased the ratio of salaried workers aged over 60, but the impact is rather small at only 3 percentage points and is seen only in large firms (≥ 500 employees), perhaps because small and medium firms had already abolished or raised the retirement age. Additionally, they find that contract renewals tend to be associated with a substantial decline in wages, which discourages employees from continuing to participate in the labor force. Despite the apparent limited impact of the EESL, it could nevertheless bias our estimates due to the similarity of the target populations. Those born in 1946 became 60 years old in 2006, and a main target of the EESL was full-time employees, so the pension reform enacted in 2007 presumably affected the same employees. Given that the effect of the EESL was to increase the future earnings of the husband, this wealth effect could potentially decrease the current market labor supply of the wife and increase her leisure. Since those affected by the EESL are employees at large firms, we excluded them from the sample and re-estimated the baseline empirical model (6). As this subsample analysis (Column 4 in Table 5) replicated the baseline results, the EESL also does not seem to be the main driver of our findings.

One further possibility is that the EESL may potentially have an indirect effect on younger employees. Since the EESL requires firms to continue to employ workers who would otherwise retire at age 60, it is conceivable that firms might accommodate this new requirement by decreasing the number of young employees, either by not hiring new graduates or by letting go of part-time employees. Conversely, if elderly workers and young workers are viewed as

[31] Data Source: `http://www.mhlw.go.jp/toukei/list/11-23c.html`.

complementary, then firms could increase the number of young employees as a result of the EESL. Ohta (2012) and Kondo (2016) report negative correlations between the proportions of employees aged over 60 and of female part-time workers, potentially suggesting that the EESL has created a crowding-out effect. However, since our control group includes part-time employees, such an indirect impact of the EESL is controlled by our DD estimation to a certain degree. Furthermore, as long as the EESL affects young and old female part-time employees in a similar manner, DDD estimation (described next) partials out any potential indirect impact of the EESL so that potential biases caused by the EESL are likely to be small.

6.4 Triple Differences Estimation

As the characteristics of the 2007 pension reform suggest that it had little effect on anyone other than elderly households, this is an opportunity to implement triple differences (DDD) estimation, which is more robust than DD estimation since the third difference can partial out any time trend specific to the treatment group. We must be careful in interpreting DDD estimates, however, as DDD estimation removes any policy impact that is common across the young and elderly households in the treatment group. In particular, as some estimates for the oldest and middle-aged group were similar (Table 2), DDD estimation could underestimate the policy impact. Thus, the biases in DDD estimation would make the null hypothesis of full commitment difficult to reject, and so, the resulting hypothesis test would be rather conservative.

For DDD estimation, we introduced two younger age groups as additional controls and introduced a dummy variable, Old_i, which takes one if the wife was over 50 in 2007. Then, we estimated

$$y_{it}^j = \delta_1^j DDD_{it} + \delta_2^j After_t \cdot Treatment_i + \delta_3^j After_t \cdot Old_i + x_{it}'\beta^j + \pi_t^j + c_i^j + u_{it}^j, \quad (8)$$

where $DDD_{it} = After_t \cdot Treatment_i \cdot Old_i$, and δ_1^j represents the impact of the pension reform. In order to accommodate any arbitrariness in the choice of the control group, we estimated equation (8) by using two subsamples as well as the entire sample, with one subsample consisting of the most elderly group and the second youngest group and the other consisting of the most elderly group and the youngest group.

In estimating equation (8), we found that the leisure of the wife increased more than 5 hours per week, which was statistically significant irrespective of the choice of the control group (Table 6). While the estimate using wives aged 30–39 as the control group is relatively larger (Column 7), the size of the other two estimates is comparable to the results of the DD estimation (Columns 1 and 4). Hence, we are confident that the results from both DDD and DD estimation provide sufficient evidence to reject the full commitment model. Meanwhile, the market labor supply of the typical wife decreased by 4–4.5 hours, a result that was robust to change in control groups.

Moreover, the sign of the DDD estimate is in line with those of the baseline DD estimates, though its magnitude is somewhat greater than the baseline and similar to the DD estimate which allowed for a linear time trend specific to the treatment group. All in all, considering the robustness of our findings, it appears that the wives' market hours decreased due to the changes in the value of divorce to her.

In contrast to market work, we observed relatively large variation in the DDD estimates of the impact on domestic work, and the estimates were not statistically significant. However, the sign of the coefficient was still negative in all three cases, as it was with the DD estimate. Furthermore, the estimate became smaller when we used the second most elderly age group as the control group, and this is consistent with our earlier discussion that DDD estimation possibly underestimates the policy impact by filtering out effects common among elderly and younger households.

While we maintained the identification assumption that there was no time trend specific to the treatment group in the most elderly age group, the DDD estimates would fail to recover the ATT if this assumption did not hold. Thus, to check the sensitivity of our estimates, we implemented a further DDD estimation while allowing for a linear time trend specific to the most elderly age group and also to the treatment group. Under the identification assumption, the resulting estimates would likely be similar to the DDD estimates obtained from the empirical model without those group-specific time trends and, indeed, we found an almost identical result with this specification (Column 7 in Table 5). To sum up the above discussion, a comprehensive series of the robustness checks further supports our rejection of the full commitment model.

7 Conclusion

It appears that couples have difficulty committing to an initial resource allocation plan. By using a pension reform in Japan to create a natural experiment, we filled a gap in the literature by testing a full commitment model of household decision-making without imposing any specific functional form assumptions on preferences or home production technology. The results led us to reject the full commitment model, as elderly wives exploited their improved outside option to enjoy more leisure by reducing market and domestic labor. Consistent with the model's prediction, this impact was most striking among low net worth couples. Incomplete commitment, however, does not mean no commitment, and we found suggestive evidence that a couple does not respond to small shocks unless the participation condition binds. A lack of commitment thus seems to distort resource allocation and typically makes the first-best allocation difficult, if not impossible, to achieve. Therefore, future work should address the size of distortion in long-term decision making such as human capital accumulation and investment in children as well as risk sharing. Finally, given the non-negligible impact of re-bargaining, we believe that model-based studies need to incorporate this feature of family decision making.

Table 4: Placebo test for the wives

Age group: 50–59	Leisure	Market labor supply	Domestic labor supply
	(1)	(2)	(3)
$Treatment \times d_{2007}$	5.733*	-1.659	-4.074**
	(2.998)	(2.527)	(1.882)
$Treatment \times d_{2006}$	-0.992	2.957	-1.965
	(2.587)	(1.944)	(2.009)
$Treatment \times d_{2005}$	3.199	-0.832	-2.367
	(2.656)	(2.158)	(1.890)
Observations	1333	1333	1333
Households	442	442	442
Age group: 40–49	**Leisure**	**Market labor supply**	**Domestic labor supply**
	(4)	(5)	(6)
$Treatment \times d_{2007}$	1.138	3.103	-4.240*
	(2.641)	(1.894)	(2.193)
$Treatment \times d_{2006}$	4.705*	0.378	-5.084**
	(2.751)	(1.729)	(2.376)
$Treatment \times d_{2005}$	-0.431	2.412	-1.981
	(2.546)	(1.718)	(2.109)
Observations	1804	1804	1804
Households	575	575	575
Age group: 30–39	**Leisure**	**Market labor supply**	**Domestic labor supply**
	(7)	(8)	(9)
$Treatment \times d_{2007}$	-3.809	2.032	1.777
	(4.623)	(2.201)	(4.135)
$Treatment \times d_{2006}$	0.902	0.745	-1.647
	(4.342)	(2.109)	(4.022)
$Treatment \times d_{2005}$	-2.635	0.882	1.753
	(3.887)	(1.895)	(3.679)
Observations	1543	1543	1543
Households	490	490	490

Note: The table shows the estimation results of equation (7), checking the pre-time trend for the wives. Standard errors clustered by each household are in parentheses. Only the estimated values of the interaction terms between the treatment dummy variable and year dummy variables are reported.
$*** \ p < 0.01$, $** \ p < 0.05$, $* \ p < 0.1$.

Table 5: Robustness checks using households with wives aged 50–59

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable							
Leisure	5.837*	5.198**	5.833*	4.930*	4.976**	5.890**	5.654*
	(3.531)	(2.530)	(3.052)	(2.574)	(2.509)	(2.509)	(3.162)
Market work	-5.229*	-2.608	-2.524	-2.164	-2.363	-2.935	-4.361*
	(2.863)	(2.201)	(2.697)	(2.225)	(2.136)	(2.180)	(2.400)
Domestic work	-0.608	-2.590*	-3.309**	-2.767*	-2.613*	-2.955**	-1.293
	(2.223)	(1.378)	(1.681)	(1.464)	(1.435)	(1.411)	(2.280)
p-value of joint test	0.173	0.069	0.076	0.088	0.090	0.035	0.146
Method	DD	DD	DD	DD	DD	DD	DDD
Group-specific linear trend	X						X
Flexible family structure		X					
Wives with permanent employment	X	X		X	X	X	X
Wives with husbands in large firms	X	X	X		X	X	X
Couples divorced btw. 2005 and 2012	X	X	X	X		X	X
Couples married before 1998	X	X	X	X	X		X
Observations	1333	1333	1104	1219	1328	1287	4680
Households	442	442	364	413	439	426	1507

Note: The table shows the estimation results of equation (6) and (8) with various specifications and sample restrictions, for the most elderly age group. Only the estimated value of δ_1^j is reported. Standard errors clustered by household are in parentheses. In the DDD analysis, the two young groups were used as the control. $*** \ p < 0.01$, $** \ p < 0.05$, $* \ p < 0.1$.

Table 6: The effect of the pension reform on the wives: Triple differences estimation

Control group: Wife aged 30–49			
Dep. Var	Leisure (1)	Market labor supply (2)	Domestic labor supply (3)
DDD	5.658*	-4.278*	-1.380
	(3.147)	(2.399)	(2.265)
Observations	4,680	4,680	4,680
Households	1,507	1,507	1,507
Control group: Wife aged 40–49			
Dep. Var	Leisure (4)	Market labor supply (5)	Domestic labor supply (6)
DDD	5.233*	-4.565*	-0.669
	(3.113)	(2.597)	(2.117)
Observations	3,137	3,137	3,137
Households	1,017	1,017	1,017
Control group: Wife aged 30–39			
Dep. Var	Leisure (7)	Market labor supply (8)	Domestic labor supply (9)
DDD	7.636*	-3.911	-3.725
	(4.380)	(2.701)	(3.665)
Observations	2,876	2,876	2,876
Households	932	932	932

Note: The table shows the estimated values of δ_1^j in equation (8) for wives, with standard errors clustered by each household in parentheses.
$*** \ p < 0.01$, $** \ p < 0.05$, $* \ p < 0.1$.

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A Numerical Example

A.1 Household Decision Problem

In order to illustrate the effect of the pension reform on the wife's time allocation in the household decision model, this section provides some numerical examples. The model considered in this section is a two-period model without home production, and thus, it is much simpler than the model in Section 3, but we believe that the following model is sufficient to describe the response of the leisure time of the wife to the pension reform. Each household member works at market at the 1st period, and retires at the 2nd period. The household problem is

$$
\begin{aligned}
\max \mu \left[u_1^M(c_{11}, l_{11}; \theta_1) + u_1^M(c_{12}, l_{12}; \theta_1)\right] &+ (1-\mu)\left[u_2^M(c_{21}, l_{21}; \theta_2) + u_2^M(c_{22}, l_{22}; \theta_2)\right] \\
\text{s.t.} \quad & a_2 = a_1 + \sum_{j=1}^{2}(1-\tau)(1-l_{j1})w_j - c_{11} - c_{12} \\
& b_{j2} = b_{j1} + \tau(1-l_{j1})w_j \\
& a_2 + b_{12} + b_{22} = c_{12} + c_{22} \\
& 0 \le l_{j1} \le 1, \quad l_{j2} = 1 \\
& u j^M(c_{j1}, l_{j1}; \theta_j) + u_j^M(c_{j2}, l_{j2}; \theta_j) \ge DV_{j1}(a_1, b_{11}, b_{21}, w_j; \phi), \\
& u_j^M(c_{j2}, l_{j2}; \theta_j) \ge DV_{j2}(a_2, b_{12}, b_{22}, w_j; \phi),
\end{aligned}
$$

where $u_j^M(c, l; \theta) = u_j(c, l) + \theta$, $u_j(c, l) = \ln c + \gamma_j \ln l$, θ_j is the match quality for member j, and $\phi(a_t, b_{1t}, b_{2t}, j)$ is the asset division rule for member j, given the household asset a and each member's accumulated pension benefits b_{jt}. In particular, the asset division rule before the pension reform is $\phi_0(a_t, b_{1t}, b_{2t}) = \frac{a_t}{2} + b_{jt}$, and the asset division rule after the pension reform is $\phi_1(a_t, b_{1t}, b_{2t}) = \frac{a_t + b_{1t} + b_{2t}}{2}$. Since the pension reform increases (decreases) the value of divorce of the wife (husband), we consider only the participation conditions of the wife.

Denoting the Lagrange multipliers on the intertemporal budget constraint, the initial-period participation condition and the 2nd-period participation condition as λ_0, λ_1 and λ_2, respectively, the above maximization problem can be written as

$$
\begin{aligned}
\max \mu \left[u_1^M(c_{11}, l_{11}) + u_1^M(c_{12}, l_{12})\right] + (1-\mu)\left[u_2^M(c_{21}, l_{21}) + u_2^M(c_{22}, l_{22})\right] & \\
+ \lambda_0 \left[a_1 + b_{11} + b_{21} + w_1 + w_2 - \sum_{j=1}^{2}\sum_{t=1}^{2} c_{jt} - \sum_{j=1}^{2} w_j l_j\right] & \\
+ \lambda_1 \left[u_2^M(c_{21}, l_{21}) + u_2^M(c_{22}, l_{22}) - DV_{21}(a_1, b_{11}, b_{21}, w_2; \phi)\right] & \\
+ \lambda_2 \left[u_2^M(c_{22}, l_{22}) - DV_{22}(a_2, b_{12}, b_{22}, w_2; \phi)\right], &
\end{aligned}
$$

with the pension accumulation rule $b_{j2} = b_{j1} + \tau(1 - l_{j1})w_j$ and the complementary slackness conditions,

$$\lambda_0 \left[a_1 + b_{11} + b_{21} + w_1 + w_2 - \sum_{j=1}^{2} \sum_{t=1}^{2} c_{jt} - \sum_{j=1}^{2} w_j l_j \right] = 0,$$
$$\lambda_1 \left[u_2^M(c_{21}, l_{21}) + u_2^M(c_{22}, l_{22}) - DV_{21}(a_1, b_{11}, b_{21}, w_2; \phi) \right] = 0,$$
$$\lambda_2 \left[u_2^M(c_{22}, l_{22}) - DV_{22}(a_2, b_{12}, b_{22}, w_2; \phi) \right] = 0.$$

Given the Lagrange multipliers λ_1 and λ_2, the first order conditions and intertemporal budget constraint implies that the solution to this problem, $x(\lambda_1, \lambda_2)$, is given by the following system of equations:

$$0 = \frac{\mu}{c_{11}(\lambda_1, \lambda_2)} - \frac{\mu}{c_{12}(\lambda_1, \lambda_2)} + \frac{\lambda_2}{A_2(\lambda_1, \lambda_2)},$$
$$0 = \frac{\mu \gamma_1}{l_1(\lambda_1, \lambda_2)} - \frac{\mu w_1}{c_{12}(\lambda_1, \lambda_2)} + \frac{\lambda_2 w_1}{A_2(\lambda_1, \lambda_2)},$$
$$0 = \frac{(1 - \mu) + \lambda_1}{c_{21}(\lambda_1, \lambda_2)} - \frac{\mu}{c_{12}(\lambda_1, \lambda_2)} + \frac{\lambda_2}{A_2(\lambda_1, \lambda_2)},$$
$$0 = \frac{(1 - \mu) + \lambda_1 \gamma_2}{l_2(\lambda_1, \lambda_2)} - \frac{\mu w_2}{c_{12}(\lambda_1, \lambda_2)} + \frac{\lambda_2 w_2}{A_2(\lambda_1, \lambda_2)},$$
$$0 = \frac{[(1 - \mu) + \lambda_1 + \lambda_2]\, \gamma_2}{c_{22}(\lambda_1, \lambda_2)} - \frac{\mu_1}{c_{12}(\lambda_1, \lambda_2)},$$
$$0 = A_2(\lambda_1, \lambda_2) - c_{12}(\lambda_1, \lambda_2) - c_{22}(\lambda_1, \lambda_2),$$

where $A_2(\lambda_1, \lambda_2) = a_0 + b_{11} + b_{21} + w_1 + w_2 - c_{11}(\lambda_1, \lambda_2) - c_{21}(\lambda_1, \lambda_2) - w_1 l_1(\lambda_1, \lambda_2) - w_2 l_2(\lambda_1, \lambda_2)$. Then, denoting the value of the 2nd-period asset and pension benefits derived from this solution by $a_2(\lambda_1, \lambda_2)$, $b_{12}(\lambda_1, \lambda_2)$ and $b_{22}(\lambda_1, \lambda_2)$, respectively, the Lagrange multipliers $\lambda_1 and \lambda_2$ solves

$$0 = \lambda_1 \left[u_2^M \left(c_{21}(\lambda_1, \lambda_2), l_{21}(\lambda_1, \lambda_2) \right) + u_2^M \left(c_{22}(\lambda_1, \lambda_2), l_{22}(\lambda_1, \lambda_2) \right) - DV_{21}(a_1, b_{11}, b_{21}, w_2; \phi) \right],$$
$$0 = \lambda_2 \left[u_2^M \left(c_{22}(\lambda_1, \lambda_2), l_{22}(\lambda_1, \lambda_2) \right) - DV_{22} \left(a_2(\lambda_1, \lambda_2), b_{12}(\lambda_1, \lambda_2), b_{22}(\lambda_1, \lambda_2), w_2; \phi \right) \right],$$

with $\lambda_1 \geq 0$ and $\lambda_2 \geq 0$.

A.2 Comparative Statics

In order to analyze the effect of the pension reform on household behavior, we numerically solve this model, and investigate the heterogeneity of the policy impact across the husband pension benefits and household assets. Throughout the simulation analysis, we normalize the Pareto weight μ so that the wife is indifferent between marriage and divorce under the pre-reform

Table 7: Parameter values in simulation analysis

Comparative statics	Husband's pension benefits (1)	Asset (2)
(γ_1, γ_2)	$(0.2, 0.8)$	$(0.2, 0.8)$
(θ_1, θ_2)	$(\ln 2, \ln 2)$	$(\ln 2, \ln 2)$
(w_1, w_2)	$(1, 0.5)$	$(1, 0.5)$
τ	0.18	0.18
a_1	2	$\in [0.5, 4.0]$
b_{11}	$\in [0.5, 2.5]$	1
b_{21}	0	0

regime, ϕ_0. Other parameters used in the simulation are given in Table 7. We admit that the preference parameter was chosen somewhat arbitrarily to achieve high labor supply of the husband and low labor supply of the wife, and relatively high match quality is required to induce both members into marriage, for this model does not have any other channels to make family formation attractive such as specialization and economies of scale in home production. The rate of the pension premium, τ, was set to the actual rate.[32] The range of comparative statics of the husband's pension benefits and household asset was chosen so that a couple stays married before and after the policy reform, given other parameters.

Figure 3 summarizes the result of the comparative statics with respect to the husband's pension benefits b_{11}. Intuitively, the Pareto weight on the wife is decreasing in the husband's pension benefits as it suggests that her value of divorce is low relative to her husband's before the pension reform. However, since the pension reform gives access to her husband's pension benefits upon divorce, she would choose to divorce under the current consumption plan, and as a result, she can threaten her husband to modify the household resource allocation in her favor. In fact, her value of marriage is less than the value of divorce with a pre-reform allocation plan (Figure 3c), while the husband has a large gain from the marriage (Figure 3b). The adjustment of the resource allocation is made through the Pareto weight, the positive value of λ_1 and λ_2 (Figure 3a). Furthermore, the 1st-period Lagrange multiplier is increasing in the husband pension benefits, which is consistent with the discussion in Section 3; the more the pension benefits of her husband, the more the wife can benefit from the reform. Although the 2nd-period Lagrange multiplier is insensitive to the husband's pension benefits, we note that the change in the 2nd-period Pareto weight is $\lambda_1 + \lambda_2$ and it is increasing in the husband's pension benefits.

As a result of change in the Pareto weight, the consumption and leisure of the wife increase while those of the husband decrease after the reform (Figures 3d–3f). Due to the log utility assumption, the 1st-period consumption is proportional to the 1st-period leisure, and so, the

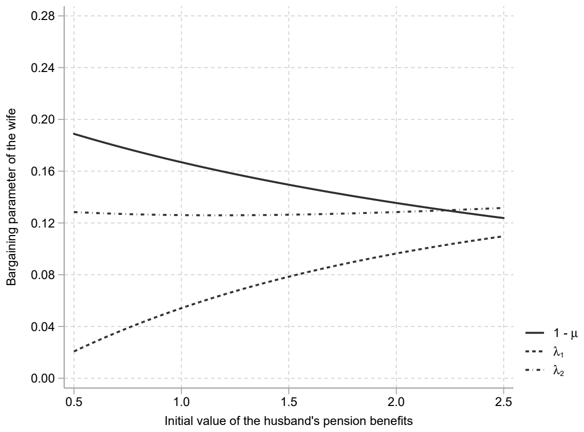
[32]In reality, half of the pension premium is paid by the employer, but we ignore this feature for simplicity. Changing this parameter does not affect the qualitative result of our simulation analysis.

policy impacts on them are the same in terms of percent change. Since the change in the Pareto weight is increasing in the husband's pension benefits, so are the impacts of the pension reform. Consistent with the discussion in Section 3, the policy impacts on a household with large pension benefits are larger than those on a household with small pension benefits. Although this model is a 2-period model, an elderly household can be regarded as the former type of household while a young household as the latter type of household. In this sense, our empirical result on heterogeneous policy impact across the wife's age (Table 2) is consistent with the prediction from the simulation analysis.

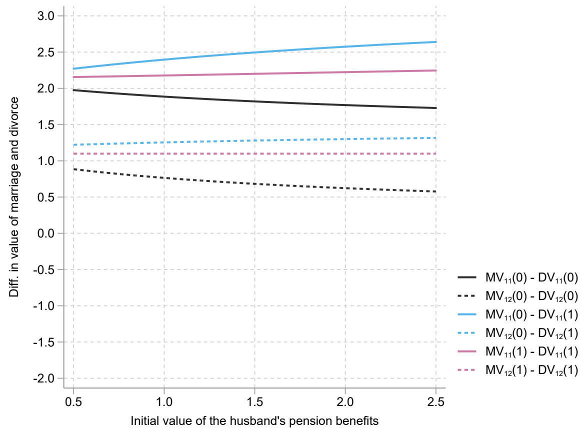
We next conducted the comparative statics with respect to the household initial asset, a_1 (Figure 4). In this case, a large household asset indicates a better outside option of the wife even before the pension reform, as the asset is divided equally upon divorce and the pension reform does not affect this asset division rule. Consequently, the Pareto weight of the wife, $1 - \mu$, is increasing in the initial asset. On the other hand, the change in the Pareto weight after the reform is decreasing in the initial asset because the pension benefits divided from the husband is marginal to her if she has a large asset, and thus, change in her value of divorce after the reform is marginal as well. As a result, her threat to divorce is so weak that a small adjustment in resource allocation is sufficient for her to stay married. As a result, the simulation analysis shows that the policy impacts are larger for the household with small assets than for the household with large assets. Therefore, this validates our empirical results on the heterogeneity across housing values (Table 3).

A.3 Anticipation of the Reform

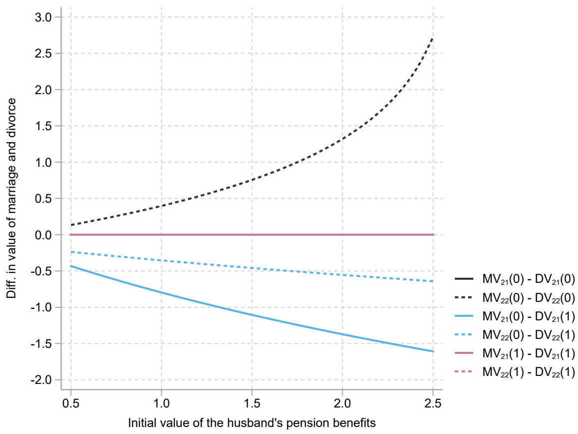
We next demonstrate how the anticipation of the policy affects the policy impact. To that end, we consider the case in which the policy is announced in the 1st period but the new policy applies only to the couple that divorces at the 2nd period. In this case, while the reform affects the participation condition at the 2nd period as in the above exercise, the reform does not affect the participation condition at the 1st period since the old pension division rule is applied if a couple divorces at the 1st period. We numerically solve the model in a similar way above, and the results are shown in Figures 5 and 6. An important difference from the previous exercise is that the 1st-period participation condition is not binding (i.e., $MV_{21}(1) - DV_{21}(1) > 0$), and thus, the Lagrange multiplier on the 1st-period participation condition is zero. Instead, the 2nd-period participation condition is more binding, and thus, the Lagrange multiplier on the 2nd-period participation condition becomes larger. As a result, we observe a large increase in the wife's consumption at the 2nd period. Interestingly, the 1st-period consumption and leisure of both members slightly increase: The information on the future reform gives the husband the incentive to reduce the accumulation of asset and pension benefits because they increase the value of divorce of the wife in the next period. Consequently, more household resource is consumed at the 1st period compared with the baseline case without the reform. Nonetheless, this anticipation effect is, at most, the second order, and the main policy impact is observed after the policy implementation.



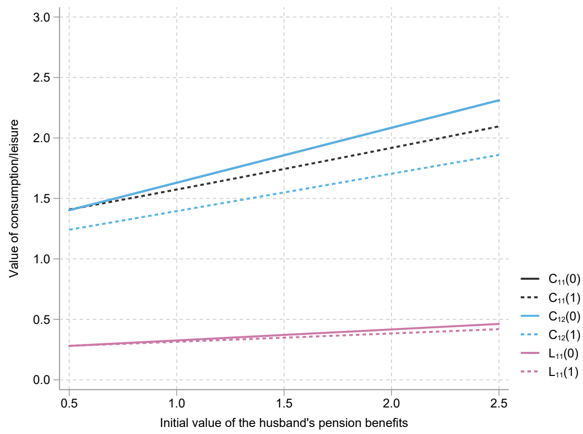
(a) Bargaining parameters



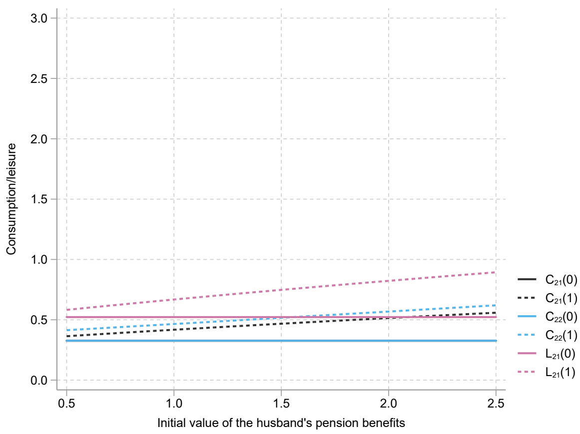
(b) Relative value of marriage: Husband



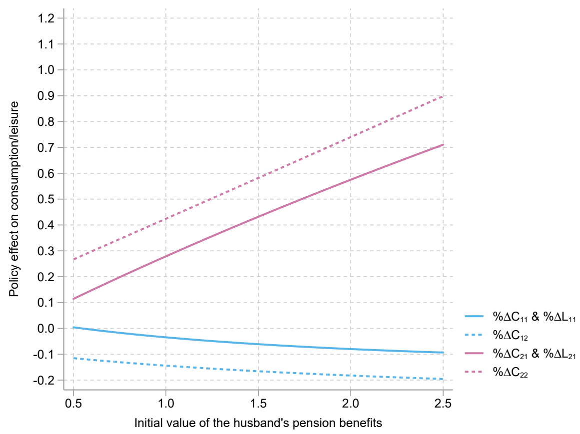
(c) Relative value of marriage: Wife



(d) Consumption and leisure: Husband

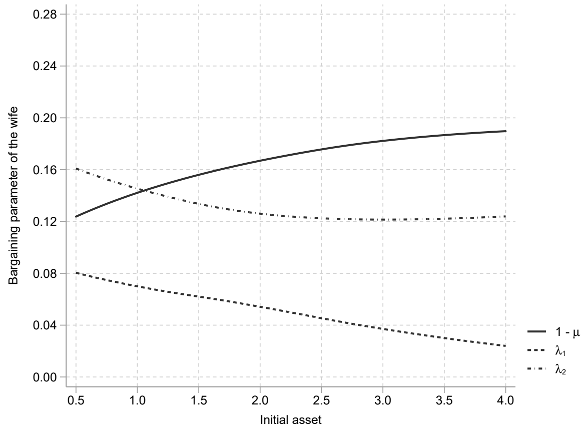


(e) Consumption and leisure: Wife

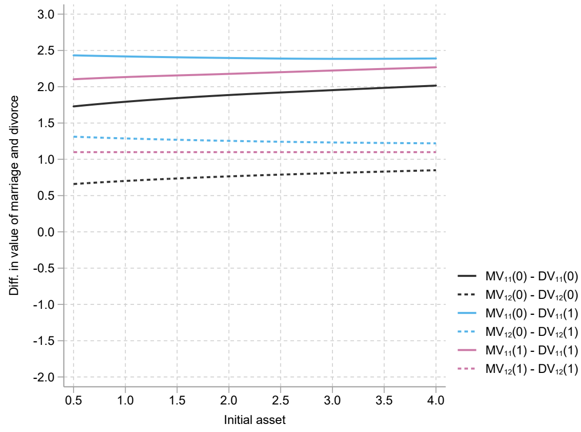


(f) Policy effects on consumption and leisure

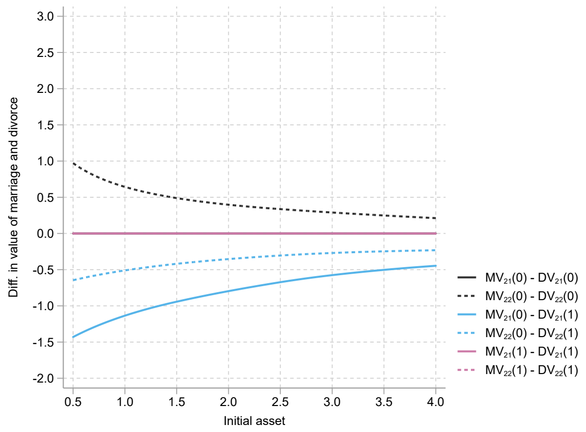
Figure 3: Comparative statics with respect to the pension benefits of the husband



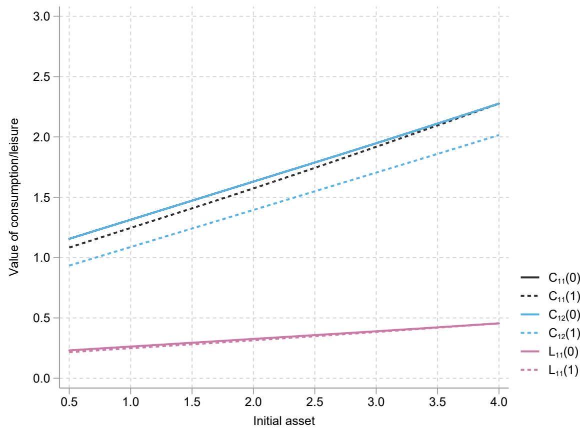
(a) Bargaining parameters



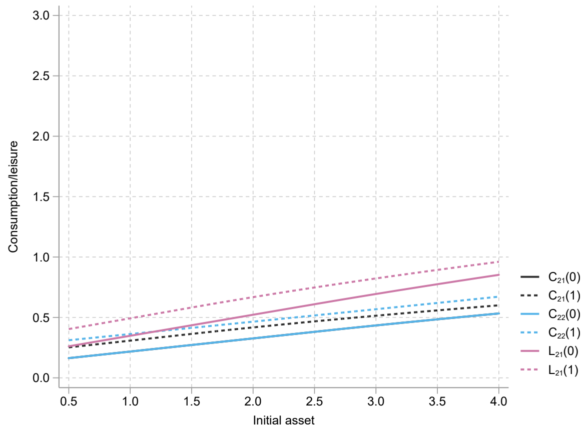
(b) Relative value of marriage: Husband



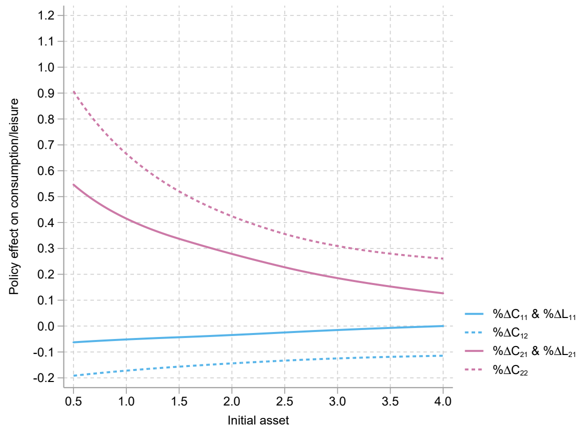
(c) Relative value of marriage: Wife



(d) Consumption and leisure: Husband

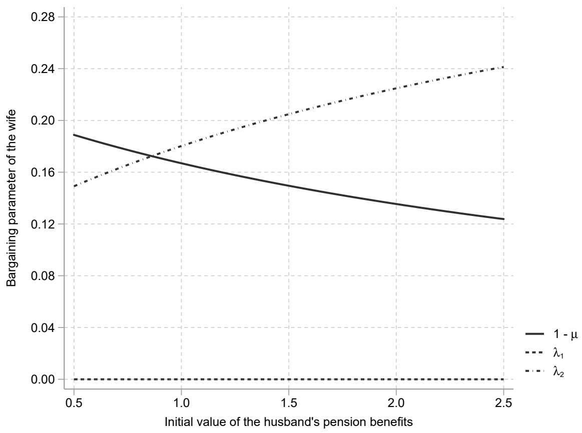


(e) Consumption and leisure: Wife

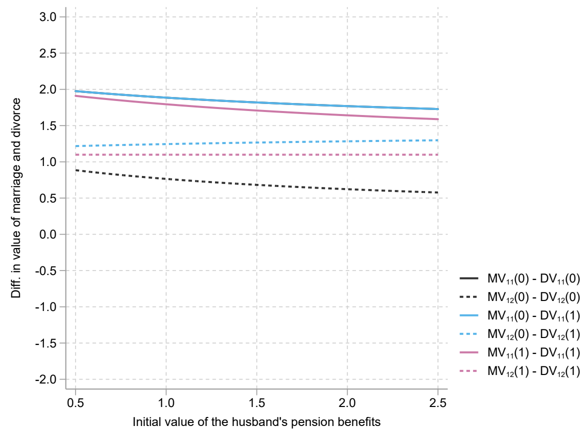


(f) Policy effects on consumption and leisure

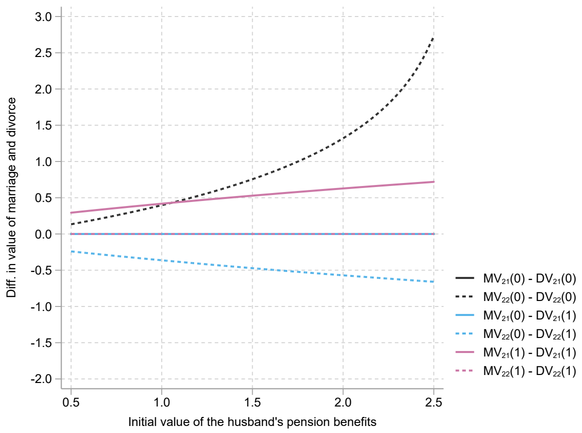
Figure 4: Comparative statics with respect to the initial household asset



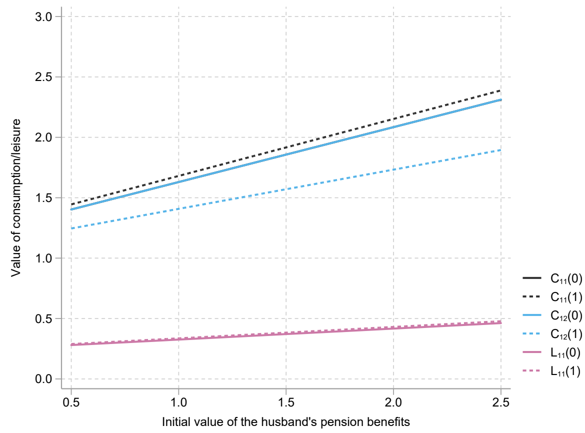
(a) Bargaining parameters



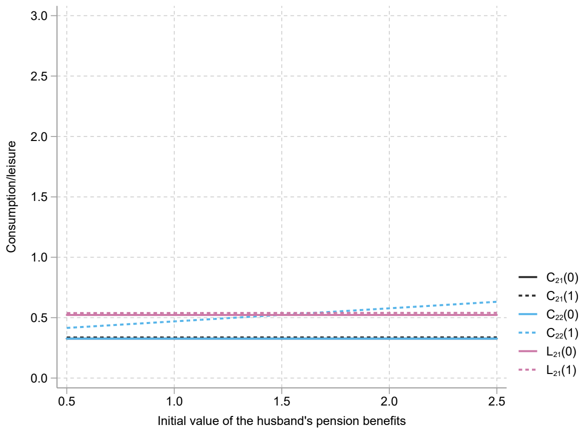
(b) Relative value of marriage: Husband



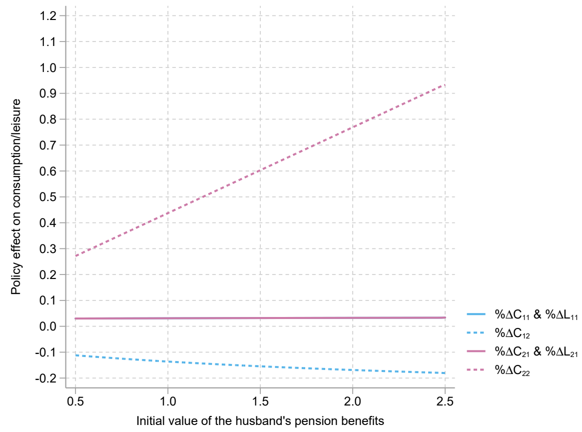
(c) Relative value of marriage: Wife



(d) Consumption and leisure: Husband

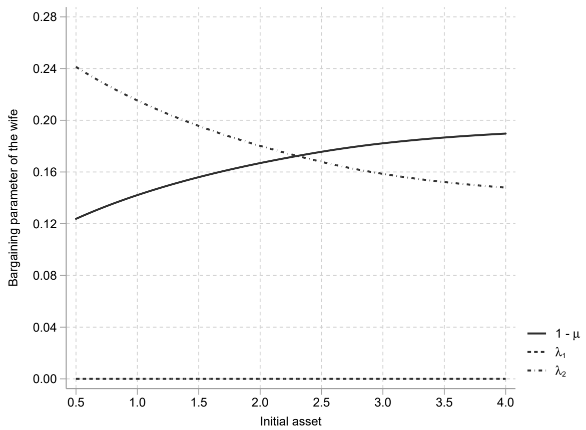


(e) Consumption and leisure: Wife

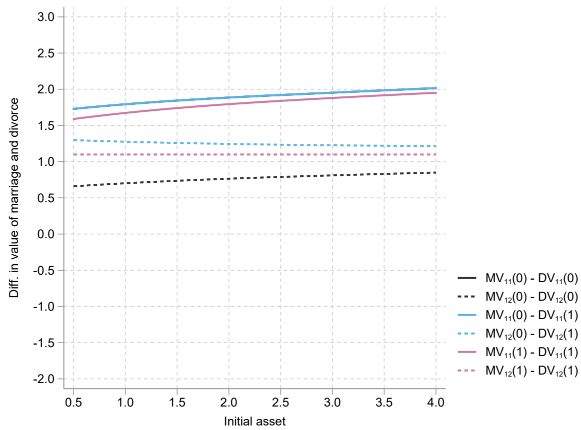


(f) Policy effects on consumption and leisure

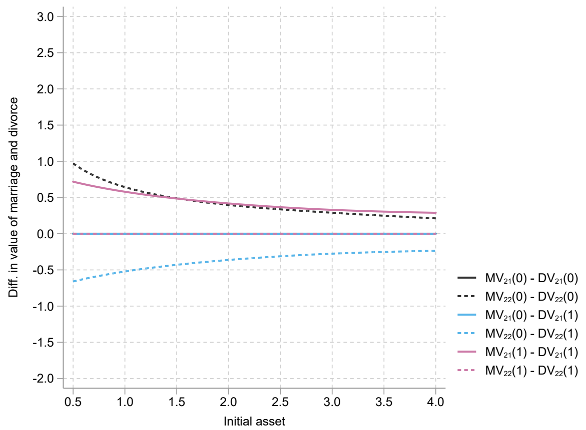
Figure 5: Anticipation of the policy: Comparative statics with respect to the pension benefits of the husband



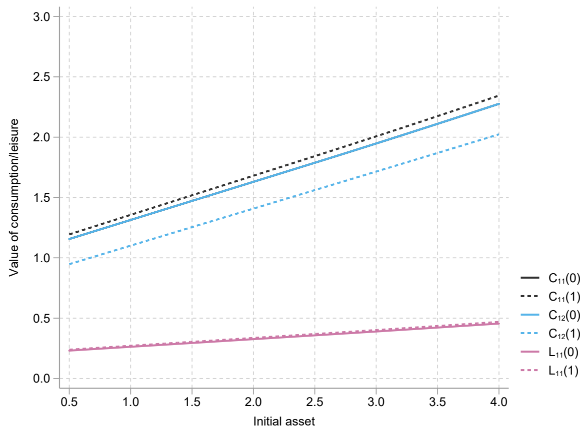
(a) Bargaining parameters



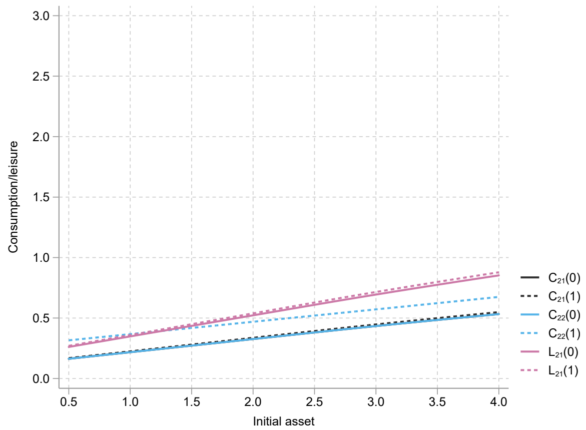
(b) Relative value of marriage: Husband



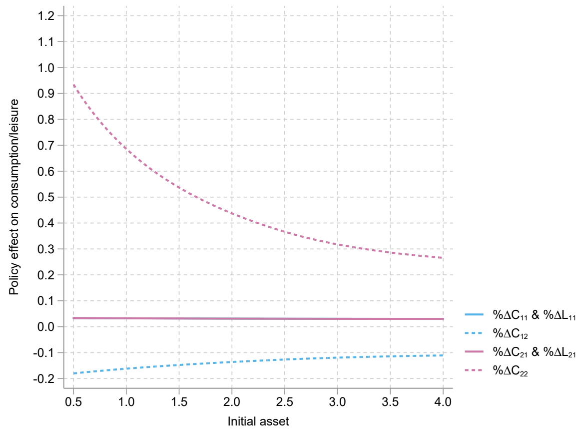
(c) Relative value of marriage: Wife



(d) Consumption and leisure: Husband



(e) Consumption and leisure: Wife



(f) Policy effects on consumption and leisure

Figure 6: Anticipation of the policy: Comparative statics with respect to the initial household asset

B Household Decision Model with Divorce

In Section 3, we assumed that a couple does not eventually divorce, and the identification result indeed relies on that assumption. In this section, we thus examine the case when divorce does occur. With a positive probability of divorce, the household objective function becomes

$$\mu E\left[\sum_{t=1}^{3}\beta^{t-1}\left\{(1-D_t)u_1(c_{1t},l_{1t};\theta_{1t})+D_tV_{1t}^{D}\left(a_{1t}^{D}+b_{1t}^{D}\right)\right\}\right]$$
$$+(1-\mu)E\left[\sum_{t=1}^{3}\beta^{t-1}\left\{(1-D_t)u_2(c_{2t},l_{2t};\theta_{2t})+D_tV_{2t}^{D}\left(a_{2t}^{D}+b_{2t}^{D}\right)\right\}\right],$$

where D_t is a decision to divorce, which is an absorbing state, and $D_1 = 0$ as we focus on a married couple. In this case, each spouse cares about their welfare after potential divorce even under full commitment, and consequently, this concern about divorce makes the household behavior contingent on the share of assets upon divorce. Note that this caveat is not unique to this study but is typical in the literature.[33]

One possible interpretation of our results is that the pension division system might have affected the wife's actions prior to divorce and thus our estimates reflect that rather than the effects of re-bargaining. For example, it seems plausible that a housewife planning to the divorce may begin working in order to prepare for her life after divorce, and Mazzocco et al. (2006) suggest that wives in the United States tend to start working about two years before the divorce so as to accumulate human capital. Since the Japanese pension reform provided an additional income source after divorce, this might eliminate the need for a wife to work before (and possibly after) the divorce. In this scenario, her market hours would decline after the reform and her leisure would increase, which is compatible with our estimation results but unrelated to changes in her bargaining position.

Reflecting on the above situation, however, it seems difficult to explain our findings entirely by such "divorce-concern" behavior due to the low probability of divorce in Japan, particularly among elderly households. Figure 7a illustrates the annual divorce rate of elderly households before and after the reform and shows, for example, that 3 in 1000 couples with wives aged 55 divorced the next year. This probability declines rapidly as the age of the couples rises, becoming less than 0.1 percent at age 70. Although we are referring here to cross-sectional data, from this we calculated a lifetime divorce rate at each age of the wife (Figure 7b). While the lifetime probability of divorce is relatively high for young wives because both the annual divorce rate and life expectancy are high, this is not true of elderly wives, whose lifetime divorce rate at age

[33] Our limitation is the same as that of Blau and Goodstein (2016), while Mazzocco (2007) does not allow assets to be used for bargaining, and Lise and Yamada (2018) do not incorporate endogenous divorce behavior or human capital accumulation in their structural model so the "divorce-concern" behavior discussed by Mazzocco et al. (2006) is not addressed.

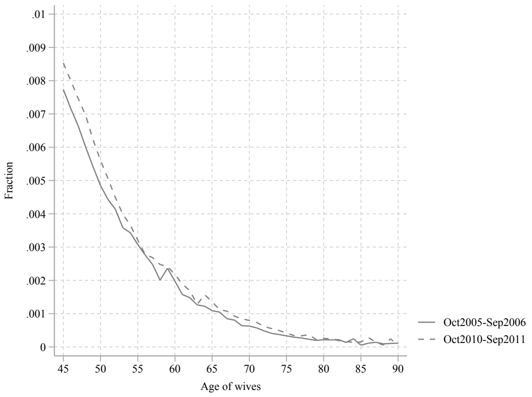
55 is only about 3 percent. Since the value of divorce under full commitment affects household behavior only through the decision to divorce, these low probabilities of divorce suggest that our baseline model without divorce approximates reality well and our estimation results do not seem to be driven entirely by "divorce-concern" behavior.

We also calculated the weight ω_2^D put on the divorce value in the wife's value function. The weight of the wife aged t would be approximated by

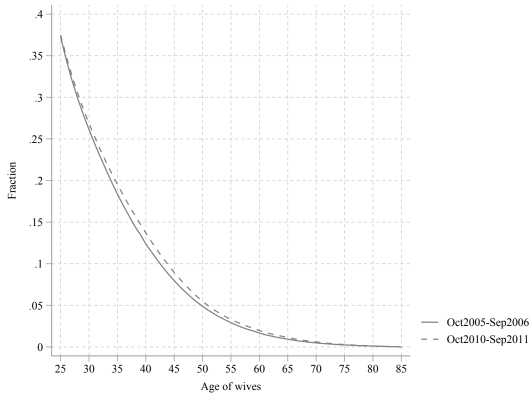
$$\begin{aligned}\omega_2^D(t) &= \frac{\sum_{s=t}^{T} \beta^{s-1} \Pr(D_s = 1|D_{s-1} = 0)}{\sum_{s=t}^{T} \beta^{s-1} \Pr(D_s = 1|D_{s-1} = 0) + \sum_{s=t}^{T} \beta^{s-1} \Pr(D_s = 0|D_{s-1} = 0)} \\ &= \frac{\sum_{s=t}^{T} \beta^{s-1} \Pr(D_s = 1|D_{s-1} = 0)}{\sum_{s=t}^{T} \beta^{s-1}},\end{aligned}$$

with the imprecision due to the decision to divorce depending on a distribution of uncertainties. Figure 7c plots ω_2^D at each age, showing that this weight is minute at all age points. It is still possible, however, that the weight on the divorce state could be large particularly among couples on the verge of divorce. To partially check if those couples are the driving force of our estimation results, we re-estimated our baseline regression excluding couples that divorced between 2005 and 2012, but the results were unchanged (Column 5 in Table 5). Hence, our results seem difficult to be explained by divorce concern behavior.

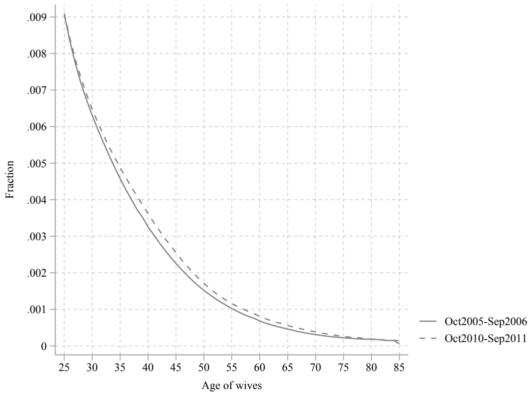
If we can accept that the full commitment model is rejected, our findings underline how difficult it is to make a commitment. Although the marital relationship of elderly couples in Japan tends to be stable and divorce is rare, even they fail to achieve full commitment. While a lack of substantial exogenous variation did not allow us to test the degree of commitment of young couples, we suspect that their comparatively less stable marital relationships would make a commitment even more difficult. In fact, a high divorce rate may suggest that the participation conditions are likely to bind, so a young couple may have more opportunities to threaten divorce or to bring about a hold-up problem. We thus believe that a lack of commitment is a key feature of family decision making, and its economic consequences are worth considering in future empirical studies.



(a) Yearly divorce probability



(b) Life-time divorce probability



(c) Utility weight on the divorce state

Figure 7: Divorce probability and utility weight put on the divorce value

Source: *Vital Statistics* and *Census*.

C Supplementary Figures and Tables

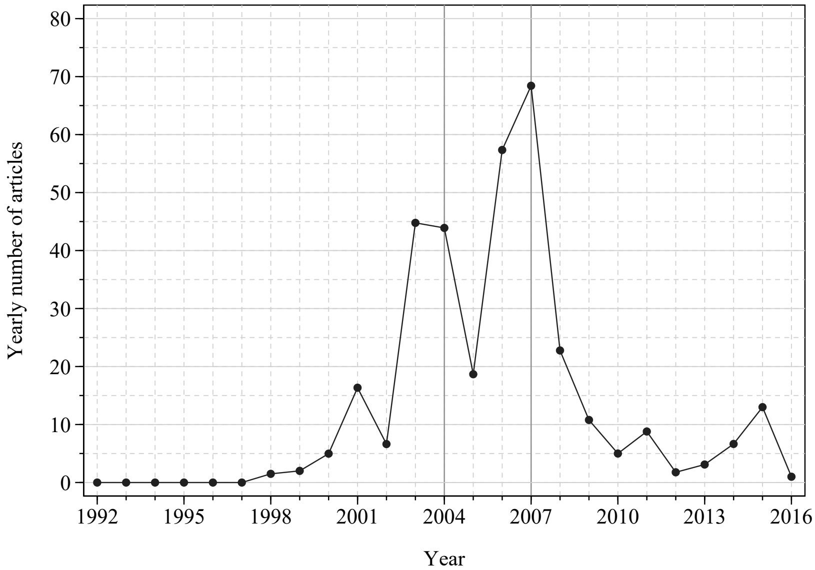


Figure 8: The yearly number of newspaper articles about pension division

Data Source: *Kikuzo II Visual*, *Maisaku*, *Semi-Annual Newspaper Issuer Report*, *Nikkei Telecom* and *Yomidasu Rekishikan*
Note: This figure shows the yearly number of newspaper articles about pension division on divorce published in the *Asahi*, *Mainichi*, *Nikkei* and *Yomiuri* newspapers, which are the prime national newspapers in Japan. The vertical axis shows the weighted sum of the number of the articles, where the annual yearly circulation of each newspaper was used as the weight and the weight on the number of the articles of the *Yomiuri* newspaper was normalized to one. Due to data availability, the total number of articles in 2015 and 2016 was not weighted. The pension reform was voted in 2004 and enacted in 2007.

Table 8: Age of eligibility for Employee pension benefits

Birth cohort	Basic part		Proportional part	
	Men	Women	Men	Women
1940	60	60	60	60
1941	61	60	60	60
1942	61	60	60	60
1943	62	60	60	60
1944	62	60	60	60
1945	63	60	60	60
1946	63	61	60	60
1947	64	61	60	60
1948	64	62	60	60
1949	65	62	60	60
1950	65	63	60	60
1951	65	63	60	60
1952	65	64	60	60
1953	65	64	61	60
1954	65	65	61	60
1955	65	65	62	60
1956	65	65	62	60
1957	65	65	63	60
1958	65	65	63	61
1959	65	65	64	61
1960	65	65	64	62
1961	65	65	65	62
1962	65	65	65	63
1963	65	65	65	63
1964	65	65	65	64
1965	65	65	65	64
1966	65	65	65	65

Table 9: Summary of the pension reform in 2007

Date of approval	June 2004
Date of enactment	April 2007
Apply to	Employee pension insurance (*kosei nenkin*)
	Mutual Aid pension insurance (*kyosai nenkin*)
Not apply to	National pension insurance (*kokumin nenkin*)
Maximum division rate	50% of household total pension benefits

Table 10: Changes in the time allocation of the treatment group and the control group

	Wife				Husband			
Leisure	Before (1)	After (2)	D (3)	DD (4)	Before (1)	After (2)	D (3)	DD (4)
Treatment group	105.09	108.71	3.63**	1.57	118.3	119.06	0.76	1.41
	[33.48]	[29.10]	(1.49)	(2.30)	[19.41]	[18.09]	(0.87)	(1.49)
Control group	105.09	107.14	2.06		120.73	120.08	-0.65	
	[29.60]	[26.70]	(1.68)		[22.10]	[21.45]	(1.27)	
Market labor supply	Before (5)	After (6)	D (7)	DD (8)	Before (5)	After (6)	D (7)	DD (8)
Treatment group	12.27	13.28	1.01	0.37	46.74	46.63	-0.11	-0.60
	[15.34]	[15.15]	(0.70)	(1.33)	[18.55]	[17.89]	(0.84)	(1.43)
Control group	27.51	28.15	0.64		43.74	44.23	0.49	
	[21.57]	[22.22]	(1.25)		[20.84]	[20.61]	(1.20)	
Domestic labor supply	Before (9)	After (10)	D (11)	DD (12)	Before (9)	After (10)	D (11)	DD (12)
Treatment group	50.64	46.01	-4.64***	-1.94	2.96	2.31	-0.65**	-0.81*
	[36.26]	[30.92]	(1.60)	(2.43)	[6.16]	[4.26]	(0.27)	(0.47)
Control Group	35.4	32.71	-2.70		3.53	3.69	0.16	
	[30.06]	[25.74]	(1.69)		[7.19]	[7.05]	(0.41)	

Note: The table shows the means of leisure before and after the pension reform, their difference within each group, and a DD estimate, with standard deviations in brackets and standard errors in parentheses.
$*** \ p < 0.01$, $** \ p < 0.05$, $* \ p < 0.1$.

Table 11: Robustness check to the heterogeneity of the policy impact by the wife's age (10-year bin)

Age	Leisure (1)	Market labor supply (2)	Domestic Labor supply (3)	Observations [Households]
50–59	4.976**	-2.363	-2.613*	1333
	(2.509)	(2.136)	(1.435)	[442]
49–58	3.939*	-1.498	-2.441*	1468
	(2.308)	(1.978)	(1.322)	[481]
48–57	2.395	0.085	-2.481*	1643
	(2.078)	(1.795)	(1.288)	[533]
47–56	1.842	0.020	-1.862	1748
	(1.932)	(1.652)	(1.233)	[564]
46–55	0.786	1.121	-1.908	1803
	(1.871)	(1.624)	(1.208)	[584]
45–54	0.907	0.701	-1.608	1845
	(1.849)	(1.622)	(1.150)	[595]
44–53	0.866	0.208	-1.075	1852
	(1.807)	(1.545)	(1.226)	[596]
43–52	-0.513	1.270	-0.757	1849
	(1.805)	(1.544)	(1.264)	[595]
42–51	0.256	0.674	-0.931	1823
	(1.798)	(1.518)	(1.386)	[585]
41–50	0.957	1.517	-2.474	1836
	(1.851)	(1.482)	(1.555)	[587]

Note: The table shows the estimation results of equation (6) by the age group of the wife. Only the estimated values of δ_1^j are reported, with standard errors clustered by each household in parentheses.
$*** \; p < 0.01$, $** \; p < 0.05$, $* \; p < 0.1$.

Table 12: Robustness check to the heterogeneity of the policy impact by the wife's age (5-year bin)

Age	Leisure (1)	Market labor supply (2)	Domestic Labor supply (3)	Observations [Households]
55–59	7.863*	-1.999	-5.864*	490
	(4.364)	(3.406)	(2.996)	[169]
54–58	8.079*	-3.343	-4.736**	625
	(4.319)	(3.714)	(2.340)	[207]
53–57	7.953**	-4.397	-3.556*	736
	(3.581)	(3.070)	(2.002)	[242]
52–56	5.417	-2.928	-2.489	794
	(3.383)	(2.854)	(1.753)	[258]
51–55	3.425	-1.612	-1.813	845
	(3.162)	(2.713)	(1.681)	[275]
50–54	4.195	-2.760	-1.434	843
	(3.049)	(2.722)	(1.548)	[273]
49–53	1.417	-0.453	-0.964	843
	(2.629)	(2.293)	(1.573)	[274]
48–52	-1.897	3.521	-1.624	907
	(2.450)	(2.145)	(1.707)	[291]
47–51	-1.213	2.424	-1.211	954
	(2.213)	(1.916)	(1.741)	[306]
46–50	-1.922	3.610**	-1.688	958
	(2.101)	(1.812)	(1.776)	[309]

Note: The table shows the estimation results of equation (6) by the age group of the wife. Only the estimated values of δ_1^j are reported, with standard errors clustered by each household in parentheses.
$*** \; p < 0.01$, $** \; p < 0.05$, $* \; p < 0.1$.