# When Economic Shocks Reduce Divorce but Increase Intra-Household Inequality*

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**Abstract**

Using unique panel data containing individual-level consumption and time use, we provide new evidence that an earthquake shock reduces divorce probability and reallocates both consumption and leisure from wives to husbands. We argue that a key driver is a gender-specific labor-market shock induced by the earthquake, which worsened women's conditions relative to men's. This lowers the value of divorce for wives, whereas the value of marriage remains high due to family insurance through husbands' income compensation. We formalize these findings in a collective household model with limited commitment and show that wives incur disproportionately larger welfare losses than husbands.

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# 1 Introduction

How do adverse economic shocks affect family structure and intra-household allocation? These responses matter for the extent of family insurance, welfare, and intra-household inequality. Despite substantial theoretical progress since Becker et al. (1977), compelling empirical evidence on how families react to unexpected shocks remains scarce. We provide new evidence on the effect of an economic shock on divorce and intra-household allocation, examine the underlying mechanisms empirically, and rationalize the findings using a collective household model with limited commitment.

Studying these responses is challenging for two reasons. First, truly exogenous and unexpected shocks are rare, and families often adjust their behavior in anticipation. Many studies instead use idiosyncratic income shocks or policy reforms, which can be endogenous or expected. An ideal research design would exploit a large, purely exogenous, unexpected shock that affects many individuals and exhibits substantial variation in intensity. Second, most datasets measure welfare-relevant outcomes (e.g., consumption) only at the household level. Individual-level consumption panel data are scarce and often limited to narrow items such as clothing. An ideal dataset would provide comprehensive panel measures of personal consumption and time use.

We address these challenges by exploiting the Great East Japan Earthquake of 2011, a natural experiment that was both exogenous and unexpected. The earthquake was the largest ever recorded in Japan and the fourth largest worldwide, with substantial cross-regional variation in intensity. To study its effects on families, we use two unique datasets: the Longitudinal Survey of Newborns in the 21st Century 2001 (LSN2001) and the Japanese Panel Survey of Consumers (JPSC). The LSN2001 is national birth cohort data with a large sample of married couples with a child born in 2001. The JPSC is, to our knowledge, the only comprehensive panel data on both personal consumption and time use within households. Confidential geographic identifiers allow us to link households to municipality-level seismic intensity, which measures actual ground shaking. We estimate difference-in-differences models that exploit cross-regional variation in seismic intensity as treatment intensity. Observing households before and after the earthquake allows us to control for time-invariant family characteristics via household fixed effects. Our main analysis focuses on married couples with a young child prior to the earthquake.

In a first step, we examine the effect of the earthquake shock on divorce and intra-household allocation. These extensive- and intensive-margin responses are interrelated and jointly determine family insurance and welfare. We find that the probability of divorce decreases in both the short and long run, which we call the *divorce effect*.

An increase in seismic intensity by one reduces divorce by 0.5 and 0.9 percentage points, or 9.3 and 16.7 percent, up to three and seven years after the earthquake. Dynamic difference-in-differences estimates show persistent effects and support parallel trends. We also find that, relative to wives in the same household, husbands' private consumption and leisure increase, whereas childcare and housework decline, implying reallocation of resources from wives to husbands. This provides causal evidence that families reallocate resources within households in response to economic shocks, a key assumption in many structural models.

In a second step, we investigate the mechanism empirically. We focus on the gender-specific labor-market shock induced by the earthquake: conditions for female workers deteriorated sharply, with large demand contractions in female-intensive services (e.g., sales, hotels, restaurants) and in temporary employment, whereas conditions for male workers did not necessarily worsen and in some cases improved owing to reconstruction-related demand (Higuchi et al., 2012; Ministry of Health, Labour and Welfare, 2012; Ohta, 2015). Difference-in-differences estimates show that the earthquake reduces married women's labor income in municipalities with higher seismic intensity in both the short and long run. It also increases non-employed wives' job search, consistent with a negative labor-demand shock. In contrast, effects for husbands depend on pre-earthquake couple type: labor income rises in dual-earner couples, fully offsetting wives' losses, but not in single-earner couples. The gains among men are driven by sectoral migration from the tertiary to the secondary sector.

How does the gender-specific labor-market shock generate the divorce effect and intra-household reallocation? As women's labor-market conditions deteriorate and wives' earnings fall, their value of divorce declines because post-divorce resources are limited for single mothers. In contrast, the value of marriage remains high due to family insurance provided by the husband's income compensation. The relative decline in the value of divorce explains the decrease in the probability of divorce, in the spirit of Becker (1974) and Becker et al. (1977). In other words, wives who would otherwise divorce become more financially dependent after an income loss and thus remain married to avoid a costly divorce. They are also in a weaker bargaining position over household resource division than before, leading to a shift of resources toward husbands.

We provide several pieces of evidence consistent with this mechanism. First, to establish a link between labor-market conditions and family responses, we examine wives' pre-earthquake occupations. If our proposed channel is causal, effects should be limited for households where the wife worked in a less-affected occupation. Using the JPSC occupational data, we split the sample by whether the wife worked in the

secondary or tertiary sector in 2010. Reassuringly, we find a statistically significant divorce effect and intra-household reallocation for the latter households, but not for the former. Second, in single-earner families, wives typically have no market income before the earthquake, so their value of divorce falls only through worsened future job prospects. Consistent with this, the divorce effect is larger in dual-earner couples, where wives experience actual income losses, than in single-earner couples. Third, low-income households tend to accumulate less wealth during marriage, leaving wives with little upon divorce and increasing their financial dependence on their husbands' income. In line with this, we find a statistically significant divorce effect for low-income households but not for high-income households. Lastly, we find a statistically significant divorce effect for couples with a young child, but not for those without, consistent with our mechanism that single-parenting is particularly costly when children are young. These patterns provide strong support for a mechanism operating through a gender-specific labor-market shock.

We then examine alternative channels that could account for parts of the results. Leading candidates are a preference shock that strengthens family ties in more-affected areas, a social-norm shock that increases the value placed on traditional family roles and discourages divorce, a higher value of insurance after the realization of a previously unknown event (Knightian uncertainty), and declines in housing wealth caused by the earthquake. Although these forces are not mutually exclusive with the labor-market channel and may play some role, none alone is fully consistent with all of our findings.

In a third step, we formalize our empirical findings in a collective household model with limited commitment. In the model, a dual-earner couple with a young child chooses whether to divorce. If they remain married, they seek an efficient allocation by solving a Pareto problem associated with a Pareto weight summarizing decision power. If they divorce, each spouse selects an allocation separately. The tractable setup yields a closed-form expression for the probability of divorce.

In this environment, we consider a situation in which a wife loses her job due to an unexpected, exogenous shock, with re-employment requiring large time costs. With concave utility and weak labor demand, divorce becomes costly: a newly single mother must search for work while caring for a young child under poor earnings prospects. In contrast, the value of marriage remains high because the husband, whose labor-market conditions improve, secures a higher-paying job that offsets the tighter household budget and provides family insurance. The relative decline in the value of divorce induces wives facing a low realization of match quality, who would otherwise divorce, to remain married. The model also predicts weaker divorce effects for single-earner couples,

high-income couples, and couples without young children, consistent with the empirical evidence.

The theory is also useful for understanding intra-household reallocation. As a form of family insurance, the husband switches jobs and raises his income to offset the wife's income loss. In a collective framework with limited commitment, this income change can shift Pareto weights (decision power) through two channels. First, if decision power is a function of relative income (Browning et al., 2014), a change in spouses' earnings alters decision power. Second, if the husband's higher income raises his value of divorce enough to violate his participation constraint, the couple renegotiates the Pareto weights so that he remains married, restoring individual rationality (Mazzocco, 2007). In both cases, Pareto weights tilt toward the husband, resulting in reallocation of consumption and leisure from wife to husband. This mechanism also explains why improved male labor-market conditions do not necessarily reverse the decline in divorce; instead of separating, husbands remain married and, through renegotiation, obtain higher consumption and leisure. Importantly, under a unitary model that predicts income pooling, only total household income matters for choices, not the income source. Because total household income does not change significantly after the earthquake, the observed reallocation provides strong evidence against this model.

Finally, we conduct a simple welfare analysis of the labor-market shock using an extended collective model with public goods and preference heterogeneity, following Chiappori et al. (2025). We find that the earthquake-induced labor-market shock disproportionately lowers wives' welfare: wives' welfare falls by 3.6%, whereas husbands' welfare rises by 0.4%. This gain reflects intra-household reallocation driven by improved outside options for husbands and subsequent renegotiation. Because married women already consume less and have fewer leisure hours before the shock, the reallocation further increases inequality within affected households.

Our main contribution is to provide, to our knowledge, the first clean causal evidence that a large exogenous shock reallocates resources within households from wives to husbands, thereby exacerbating intra-household inequality. Many papers study the effects of shocks on variables related to intra-household allocation, such as clothing expenditures (e.g., Lundberg et al., 1997), food expenditures (e.g., Attanasio and Lechene, 2014), labor-force participation (e.g., Voena, 2015; García, forthcoming), childcare time (e.g., Grönqvist et al., 2025), and educational investments for children (e.g., Rangel, 2006). Our study makes a distinct contribution by providing direct evidence of reallocation across both consumption and leisure in response to an unexpected, exogenous economic shock. Observing both margins is essential for welfare; it reveals whether resources

shift simultaneously from one spouse to the other or whether losses in one domain (e.g., consumption) are offset by gains in another (e.g., leisure). This enables direct welfare implications of the redistribution and shows that the shock exacerbates intra-household inequality.[1]

Numerous studies examine how economic factors affect divorce. The shocks studied include idiosyncratic income shocks (e.g., Weiss and Willis, 1997), plant closures (e.g., Charles and Stephens, 2004; Eliason, 2012), welfare reforms (e.g., Hu, 2003; Bitler et al., 2004), house-price changes (e.g., Rainer and Smith, 2010; Farnham et al., 2011), and trade shocks (e.g., Autor et al., 2019; Keller and Utar, 2022; Irastorza-Fadrique et al., 2023). Compared with these studies, a natural-disaster shock has a key advantage: it is exogenous and unexpected.[2,3] Unlike the shocks above, it is unrelated to contemporaneous local economic trends and arrives without advance signaling.[4] Recent studies use lottery winnings—another clean source of identification—to estimate effects on divorce conditional on lottery participation (Hankins and Hoekstra, 2011; Bulman et al., 2022; Cesarini et al., 2023; Golosov et al., 2023). Lottery shocks are one-time positive wealth shocks, useful for estimating income effects. In contrast, the earthquake induced a sudden deterioration in economic conditions, which is more relevant for family insurance and welfare.

We also conduct a comprehensive empirical investigation of the underlying mechanisms. We argue that a key driver is a gender-specific labor-market shock induced by the earthquake. Consistent with our mechanism, many studies find that the probability of divorce is positively related to the wife's income (e.g., Becker et al.,

[1]Research on intra-household inequality typically relies on structural estimation of the collective model. Key contributions include Browning et al. (1994), Chiappori and Ekeland (2009), Browning et al. (2013), Dunbar et al. (2013), and Voena (2015); see Browning et al. (2014) and Chiappori and Meghir (2015) for reviews. Due to the lack of comprehensive individual-level data, the literature often estimates Pareto weights using household-level data alongside partial individual consumption measures such as clothing. Cherchye et al. (2012) and Browning et al. (2024) use cross-sectional data on time use and personal expenditures to estimate the collective model. Using the JPSC panel dataset, which contains individual-level consumption and leisure over time, Lise and Yamada (2019) and Guo and Xie (2024) estimate dynamic collective models to study how Pareto weights respond to wage shocks or childbirth.

[2]Sen (1983) argues that famine causes divorce. Cohan and Cole (2002) and Deryugina et al. (2018) study the impacts of hurricanes, including effects on divorce.

[3]The Seattle and Denver Negative Income Tax experiments were long viewed as ideal for this question. However, the analysis and findings were later challenged on methodological and experimental design grounds; see Cain and Wissoker (1990).

[4]For example, Keller and Utar (2022) use China's WTO entry as a quasi-natural experiment but define treatment years before the actual entry and interpret a pre-entry decline in women's earnings as anticipation effects. Welfare reforms also tend to be anticipated before they occur. For example, the Personal Responsibility and Work Opportunity Reconciliation Act of 1996, a major welfare reform designed to reduce the number of single mothers in the United States, was enacted two years after Congress passed the major welfare reform bills.

1977; Weiss and Willis, 1997; Folke and Rickne, 2020; Keller and Utar, 2022; Irastorza-Fadrique et al., 2023). Our paper complements this literature by showing that wives' increased financial dependence on their partners likely drives the divorce effect, rather than psychological factors—a mechanism relevant in other contexts with gender-specific labor-market shocks, including trade liberalization, structural transformation, automation, and pandemics. An important implication of our results is that individuals may avoid family dissolution to take advantage of family insurance, similar in spirit to Kaplan (2012), who shows that co-residence with parents is an important insurance channel against labor-market risks.

Our paper also contributes to the literature on how spouses share resources in a collective framework (see Browning et al., 2014 and Chiappori and Mazzocco, 2017 for reviews). Structural estimations using microdata show evidence more consistent with limited commitment than full commitment and with collective decision-making than the unitary model (Mazzocco, 2007; Lise and Yamada, 2019). Our empirical analysis directly tests the predictions of a collective model with limited commitment for divorce and for resource reallocation across consumption and leisure, thereby reinforcing the model's validity without estimating it.

# 2 Empirical Strategy

## 2.1 Earthquake Shock

We exploit the Great East Japan Earthquake of March 11, 2011 as an exogenous shock to the economy. Its magnitude was the largest ever recorded in Japan and the fourth largest globally since 1900. The damage was unprecedented: 18,425 people were dead or missing, and 404,893 buildings were destroyed or damaged (National Police Agency, 2021). The estimated economic loss ($285 billion) is the highest for any natural disaster worldwide since 1900 (Aon, 2021).

The earthquake's intensity varied substantially across regions. The Japan Meteorological Agency's Seismic Intensity Scale, measured at over 4,000 observation stations nationwide, captures this variation. The scale quantifies ground shaking from accelerometer records, reflecting peak acceleration and duration. Table A.1 summarizes how each intensity level maps to human perception, conditions, and damage.[5] Figure 1 maps average municipal seismic intensity, with darker shading indicating higher

[5] We do not use distance from the epicenter because earthquake damage depends heavily on local ground conditions.

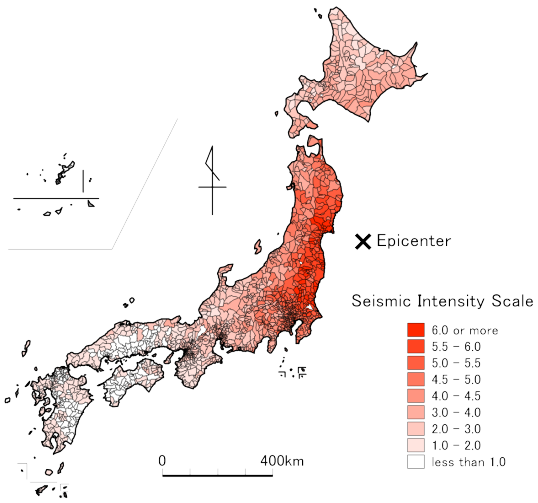



**Figure 1:** Regional Variation in Earthquake Intensities. The map displays average municipal seismic intensity on March 11, 2011, measured using the Japan Meteorological Agency's Seismic Intensity Scale.

values, and shows wide nationwide variation. We define high-intensity areas using a seismic-intensity cutoff of 4.5, the level at which real economic damage begins to appear according to the Japan Meteorological Agency, which roughly corresponds to Level VII ("Very Strong") on the Modified Mercalli Intensity Scale.

Large earthquakes can occur across Japan, but their timing, location, and intensity are unpredictable. Figure A.1 shows that strong earthquakes occurred in many regions between 1980 and 2010 and that, as of 2010, the estimated probability of significant earthquakes over the following 30 years was high nationwide. Between 1995 and 2010, 40 of 47 prefectures experienced at least one high-intensity earthquake (seismic intensity$\geq$4.5). Overall, the area affected by the Great East Japan Earthquake was not unusually prone to such events.

## 2.2 Data

Our empirical analysis draws on two main datasets: the Longitudinal Survey of Newborns in the 21st Century 2001 (LSN2001) and the Japanese Panel Survey of Consumers (JPSC).

**LSN2001.** The LSN2001 is a national birth cohort study conducted by Japan's Ministry of Health, Labour and Welfare and Ministry of Education, Culture, Sports, Science and Technology. The survey is an annual panel of children born during January 10-17 or July 10-17, 2001, and their families. Nearly 90% of all children born in these windows

**Table 1:** Summary Statistics of the LSN2001 (Pre-Treatment)

| Variable | mean | s.d. | Earthquake Intensity | |
|---|---|---|---|---|
| | | | High | Low |
| Divorce (%) | 5.8 | 23.4 | 5.4 | 6.1 |
| Number of children | 2.2 | 0.8 | 2.1 | 2.2 |
| Grandparent(s) co-residence (%) | 24.6 | 43.1 | 24.3 | 24.8 |
| Employment, wives (%) | 55.4 | 49.7 | 52.4 | 57.1 |
| Employment, husbands (%) | 99.0 | 10.2 | 99.1 | 98.9 |
| Earnings, wives (m yen) | 0.84 | 1.72 | 0.87 | 0.83 |
| Earnings, husbands (m yen) | 5.32 | 5.20 | 5.78 | 5.06 |
| Dual-earner couples (%) | 51.7 | 49.9 | 50.1 | 52.6 |
| Observations | 165,456 | | 58,358 | 107,098 |

Note: The table reports summary statistics for the LSN2001 sample. High-intensity areas are municipalities with seismic intensity$\geq$4.5. Earnings are annual pre-tax labor income (millions of yen). Dual-earner couples are those with a full-time employed husband and an employed wife in 2010.

participated in the first wave, yielding 47,015 households.[6] Since only about 2% of children in Japan are born out of wedlock, the initial sample consists predominantly of married households. The LSN2001 provides annual panel data from 2001 to 2018 on a wide range of socioeconomic characteristics. Confidential geographic identifiers record each household's municipality of residence at every wave, allowing us to merge household data with municipality-level earthquake intensity.

The survey runs twice a year so that January- and July-born children are the same age at interview, except in 2007, when only the July cohort was surveyed due to a timing change. We exclude 2011 from the baseline sample because one wave was conducted before and the other after the earthquake.[7] Each year we observe all members living in the household. Marital status is not directly observed. Reflecting the Japanese context where virtually no married couples with children live apart (ISSP Research Group, 2017), we classify a couple as divorced when they no longer co-reside for non-work reasons.[8] Our main analysis focuses on years after 2005, when the survey began recording whether a household member lives separately for work.

[6]The average annual attrition rate is low at about 2.6% and is similar in high- and low-intensity areas. Because the survey maintains contact with respondents, movers remain in sample. From 2010 to 2012, 1.6% of households moved to another prefecture each year. This rate is comparable to that between 2009 and 2010 (1.3%) and in the low-intensity area (1.1%). Excluding these movers does not materially affect the results.

[7]We include 2011 in a robustness check and find that the results hardly change.

[8]This tendency for married couples to live together is particularly pronounced in Japan. Figure A.2 shows an international comparison. We also show the divorce rate across countries in Figure A.3.

We restrict the sample to households with non-missing variables for co-residence with grandparents and the number of children in the same household. These variables enter as controls in our main specification. The resulting sample comprises 383,318 observations and 35,275 households. Table 1 presents pre-treatment summary statistics.

The LSN2001 offers several key advantages for analyzing divorce: its large sample of married couples yields sufficient divorce cases, and its long panel allows us to track families for many years before and after the earthquake.

**JPSC.** The JPSC is an annual household survey of women, with new cohorts added approximately every five years. Although the sample is not large, it is, to our knowledge, the only nationwide panel that provides comprehensive individual-level data on time use and personal consumption within households, making it well suited to studying intra-household allocation. The JPSC also reports marital status and detailed job information, and covers diverse family types, including couples with children of different ages and couples without children. We use confidential geographic identifiers to merge the survey data with municipality-level earthquake intensity.

For time use, the JPSC records, for each spouse, typical daily minutes in six activity categories: (i) commuting, (ii) work, (iii) study, (iv) housework and childcare, (v) hobby, recreation, socializing, and (vi) other activities (sleeping, eating, bathing). Following Lise and Yamada (2019), we aggregate these into three groups: market work time (i-iii), childcare and housework time (iv), and leisure time (v-vi). The survey distinguishes workdays and days off, and we construct weekly hours by weighting daily minutes for workdays by five and for days off by two and converting minutes to hours.

For consumption, the JPSC collects household expenditures for September of each year, covering payments made by cash, credit/loan, or direct deposit. It then asks for a breakdown into five categories: (i) expenses for family, (ii) expenses for the wife, (iii) expenses for the husband, (iv) expenses for the child(ren), and (v) other expenses. Following Chiappori et al. (2025), we treat (ii) as the wife's private consumption and (iii) as the husband's private consumption, and classify public goods into child-related expenditures (iv) and other general public goods (i) and (v).

We use data from 2008 to 2018 and restrict the sample to couples already married in 2008 to avoid endogenous entry into the sample after the earthquake. We exclude the cohort added in 2013 because their marital status in 2008 is unknown. As in the LSN2001, our main sample comprises families with at least one young child (under age ten in 2011), and we drop households with missing information on co-residence with grandparents or on the number of children in the same household. We also drop the 2011 wave. The resulting sample consists of 3,749 observations and 661 households. Table 2 provides

**Table 2:** Summary Statistics of the JPSC (Pre-Treatment)

| Variable | mean | s.d. | Earthquake Intensity High | Earthquake Intensity Low |
|---|---|---|---|---|
| **Time Use** (weekly hours) | | | | |
| Wives | | | | |
| Market work | 17.58 | 20.64 | 17.54 | 17.61 |
| Childcare/Housework | 63.45 | 27.03 | 63.28 | 63.53 |
| Leisure | 86.82 | 20.97 | 87.07 | 86.70 |
| Husbands | | | | |
| Market work | 59.00 | 14.30 | 60.30 | 58.39 |
| Childcare/Housework | 15.03 | 11.86 | 15.43 | 14.84 |
| Leisure | 93.89 | 155.55 | 92.16 | 94.69 |
| **Consumption** (monthly, thousands JPY) | | | | |
| Private consumption, wives | 12.39 | 18.24 | 13.65 | 11.79 |
| Private consumption, husbands | 29.68 | 27.16 | 31.55 | 28.81 |
| Child-related | 33.62 | 45.04 | 35.46 | 32.76 |
| General public goods | 149.95 | 83.32 | 155.28 | 147.48 |
| Divorce (%) | 1.1 | 10.7 | 1.2 | 1.1 |
| Number of children | 1.9 | 0.8 | 1.9 | 1.9 |
| Grandparent(s) co-residence (%) | 20.2 | 40.2 | 22.3 | 19.1 |
| Sectoral distribution, female workers (%) | | | | |
| Primary | 1.6 | 12.6 | 1.8 | 1.7 |
| Secondary | 19.6 | 39.7 | 27.1 | 16.6 |
| Tertiary | 78.7 | 40.9 | 71.2 | 81.8 |
| Sectoral distribution, male workers (%) | | | | |
| Primary | 1.8 | 13.3 | 1.8 | 1.9 |
| Secondary | 43.1 | 49.5 | 34.8 | 46.5 |
| Tertiary | 54.9 | 49.7 | 62.9 | 51.5 |
| Observations | 1,686 | | 534 | 1,152 |

Note: The table reports summary statistics for the JPSC sample. High-intensity areas are municipalities with seismic intensity$\geq$4.5.

pre-treatment summary statistics.

## 2.3 Estimation

We use a difference-in-differences design to estimate the effects of the earthquake on marital dissolution, intra-household allocation, and labor-market outcomes. We exploit regional variation in seismic intensity to measure the extent of the treatment. Observing households before and after the shock allows us to control for time-invariant family characteristics with household fixed effects. Formally, we estimate

$$D_{irt} = \alpha_t + \alpha_i + \beta Treat_r \times Post_t + X'_{irt}\gamma + u_{irt}, \tag{1}$$

where $D_{irt}$ is the outcome variable for household $i$ residing in municipality $r$ (defined by pre-earthquake residence) in year $t$. $\alpha_t$ and $\alpha_i$ are year and household fixed effects; the latter accounts for all time-invariant observed and unobserved family characteristics, such as parents' education, child's gender, and initial match quality. $Treat_r$ measures seismic intensity in municipality $r$ based on the household's residence immediately before the earthquake. Thus, treatment is predetermined and held fixed even if the household later relocates. To account for potential nonlinear effects, following Hanaoka et al. (2018) we use a kinked treatment, $\mathbb{I}\{T_r \geq 4.5\}(T_r - 4.5)$, where $\mathbb{I}$ denotes an indicator function equal to one when the condition is satisfied and zero otherwise, and $T_r$ denotes seismic intensity. As a robustness, we also use a cutoff of 5 in analyses with the LSN2001. $Post_t$ is a post-earthquake indicator. $X_{irt}$ includes time-varying controls, such as the number of children and co-residence with grandparents. Standard errors are clustered at the municipality level (Bertrand et al., 2004). The coefficient of interest $\beta$ captures the effect of earthquake intensity on the outcome. For divorce, we use a linear probability model as the baseline to facilitate interpretation and estimate a logit model for robustness.

# 3 Main Results: Causal Effects of the Earthquake Shock

We document the effects of the earthquake shock on divorce and intra-household allocation using the difference-in-differences design outlined in Section 2.3.

## 3.1 Evidence for Decline in Divorce

First, we present striking descriptive evidence at the aggregate level. Figure 2 plots crude divorce rates (new divorces per 1,000 population) at the prefecture level, grouped into high- and low-seismic-intensity areas, relative to 2010. The two groups track each other closely before the earthquake, but after the shock, the high-intensity area exhibits a markedly lower divorce rate than the low-intensity area, and the gap persists for many years. These aggregate patterns provide strong motivation for our individual-level causal analysis.

Table 3 reports the short- and long-run effects of the earthquake on divorce, up to three and seven years post-event, using the difference-in-differences estimation (1) based on the LSN2001 dataset.[9] We use two different intensity cutoffs, 4.5 and 5, to define the treatment group. Columns (1) and (4) include household and year fixed effects only. We

[9]The results are robust to estimating a logit model and to specifying treatment as a dummy rather than a kinked variable (Table A.2). The result is also robust in the JPSC sample (Table A.7, column 1).

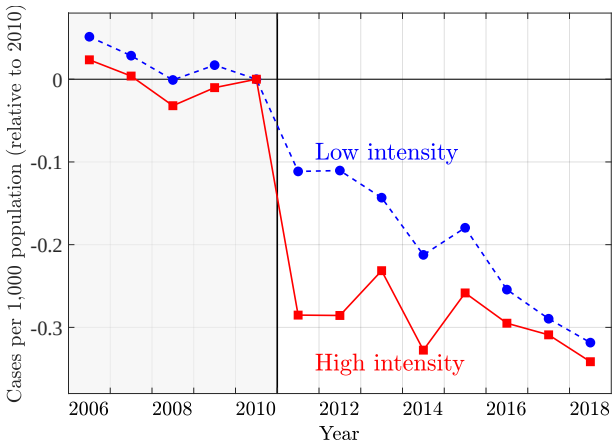



**Figure 2:** Crude Divorce Rates at the Prefecture Level. The figure plots the crude divorce rates (new divorces per 1,000 population), relative to 2010. The high-intensity prefectures are Fukushima, Iwate, and Miyagi. The vertical line indicates the timing of the earthquake. Source: Vital Statistics (Ministry of Health, Labour and Welfare); population estimates (Statistics Bureau, Ministry of Internal Affairs and Communications).

find a negative and statistically significant effect on divorce: couples in more-affected areas are less likely to divorce in both the short and long run, and the effect grows in magnitude over time. In Japan, divorce is based on mutual consent; if spouses disagree, they face a lengthy legal process that can take several years, which partly explains the long-lasting impact.[10] Adding controls for the number of children (columns 2, 5) and for co-residence with grandparents (columns 3, 6) leaves the coefficient size and significance largely unchanged. In our preferred specification (column 3), an increase in seismic intensity by one reduces the long-run probability of divorce by 0.9 percentage points, which corresponds to a 16.7 percent reduction relative to the pre-earthquake divorce rate of 0.054 in the treatment sample.[11]

Wolfers (2006) finds that the introduction of unilateral divorce laws in the United States had only short-lived effects on divorce rates. Because the formation of new marriages is likely influenced by the reform, his long-run state-level estimates can partly reflect compositional changes. In contrast, our individual-level analysis follows the same households over time, isolating the effect for couples already married when the shock occurred.

[10] There are four legal routes to divorce without the spouse's consent: collaborative divorce, divorce by court mediation, divorce by court order, and divorce by court decree. Post-earthquake disruptions to local government institutions that might have hindered filings were limited, and procedures returned to normal within a month even in the most affected areas (Local Authorities Systems Development Center, 2012).

[11] With a standard deviation of seismic intensity of 0.334, a one-standard-deviation increase reduces the probability of divorce by 0.3 percentage points, or 5.6 percent.

**Table 3:** Effect of the Earthquake on Divorce

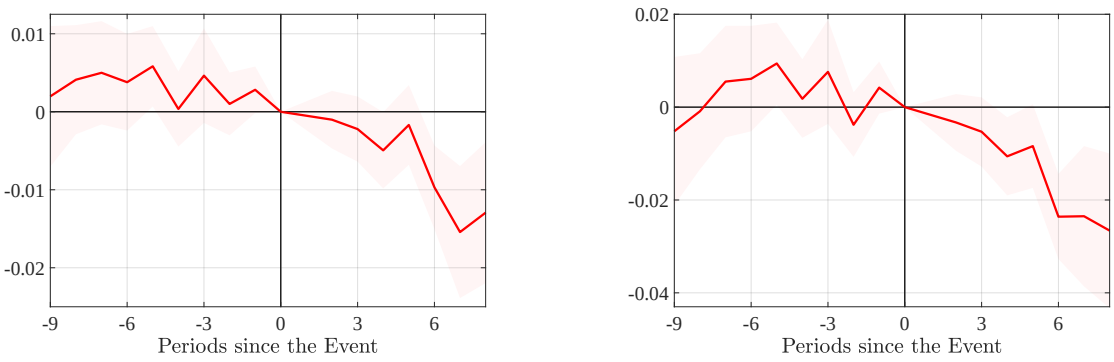
| | Treat: seismic intensity $\geq$ 4.5 | | | Treat: seismic intensity $\geq$ 5 | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| **A: Short run (–2014)** | | | | | | |
| *Treat*×*Post* | −0.006** | −0.006** | −0.005** | −0.011*** | −0.011*** | −0.010** |
| | (0.003) | (0.002) | (0.002) | (0.004) | (0.004) | (0.004) |
| Number of children | | ✓ | ✓ | | ✓ | ✓ |
| Grandparent co-residence | | | ✓ | | | ✓ |
| Observations | 276,446 | 276,446 | 276,446 | 276,446 | 276,446 | 276,446 |
| # households | 35,275 | 35,275 | 35,275 | 35,275 | 35,275 | 35,275 |
| **B: Long run (–2018)** | | | | | | |
| *Treat*×*Post* | −0.010*** | −0.009*** | −0.009*** | −0.018*** | −0.018*** | −0.018*** |
| | (0.003) | (0.003) | (0.003) | (0.005) | (0.005) | (0.005) |
| Number of children | | ✓ | ✓ | | ✓ | ✓ |
| Grandparent co-residence | | | ✓ | | | ✓ |
| Observations | 383,318 | 383,318 | 383,318 | 383,318 | 383,318 | 383,318 |
| # households | 35,275 | 35,275 | 35,275 | 35,275 | 35,275 | 35,275 |

Note: Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The table shows estimates of the impact of the earthquake on divorce rates (in percentage points) using the difference-in-differences estimation (1) based on the LSN2001 dataset. Panels A and B refer to the short- and long-run effects up to three and seven years after the earthquake, respectively. We use seismic-intensity cutoffs of 4.5 and 5 to define the treatment group. All specifications include household and year fixed effects. Columns (2) and (5) control for the number of children in the household; columns (3) and (6) additionally control for co-residence with grandparents. Standard errors clustered at the municipality level are reported in parentheses.

**Dynamic Difference-in-Differences Estimation.** We implement an event-study design to assess the parallel-trends assumption and the dynamics of the divorce effect. The identifying assumption for difference-in-differences is that, absent the earthquake, divorce trends would have been the same across treatment intensities. To check the plausibility of this assumption, we allow for time-varying treatment effects by interacting treatment with year dummies and use 2010, the last pre-treatment year, as the baseline.[12] We estimate

$$D_{irt} = \alpha_t + \alpha_i + \sum_{t \leq 2009} \beta_t Treat_r \times Pre_t + \sum_{t \geq 2012} \beta_t Treat_r \times Post_t + X'_{irt}\gamma + u_{irt}, \quad (2)$$

[12]Results are robust when we include 2011 and use it as the baseline (Figure A.4).




**(A)** Treatment: seismic intensity≥4.5 **(B)** Treatment: seismic intensity≥5

**Figure 3:** Dynamic Effect of the Earthquake on Divorce. The figure shows estimates of the impact of the earthquake on divorce using the dynamic difference-in-differences estimation (2) based on the LSN2001 dataset. The estimation includes household fixed effects, year fixed effects, a control for the number of children, and a control for co-residence with grandparents. The solid red line plots the coefficients on the year-treatment interaction terms. Shaded areas denote 90% confidence intervals. Coefficients are expressed in percentage points relative to the omitted baseline year (2010). Standard errors are clustered at the municipality level.

where $Pre_t$ and $Post_t$ are annual dummies for the pre- and post-earthquake periods, respectively, and all other variables are as defined above. For the purposes of the event study, we use the full 2001–2018 period to leverage a longer pre-treatment period that informs the plausibility of parallel trends.

Figure 3 presents the results. In the pre-earthquake period, the coefficients are largely insignificant and fluctuate around zero with no trend, consistent with parallel trends. After the earthquake, coefficients turn negative and increase in absolute magnitude over time, reinforcing the baseline results in Table 3.

## 3.2 Evidence for Intra-Household Reallocation

We use the JPSC to study the impact of the earthquake on intra-household reallocation of time and consumption using the difference-in-differences estimation (1). Given the modest sample size, we focus on long-run effects and define treatment using a seismic-intensity cutoff of 4.5.

First, columns (1-3) of Table 4 report effects on individual time use: market work, childcare and housework, and leisure. We use relative weekly hours (wife's hours minus husband's) to capture within-household reallocation. Exposure to high seismic intensity reduces wives' market hours relative to husbands', compared to the low-intensity area (column 1). As discussed in the introduction, women experienced a more severe labor-market shock induced by the earthquake, which explains the decline in wives'

**Table 4:** Effect of the Earthquake on Intra-Household Allocation

| | Weekly Hours | | | Private Consumption |
|---|---|---|---|---|
| Dependent variable | (1) Market Work | (2) Childcare/ Housework | (3) Leisure | (4) Consumption Share |
| *Treat*×*Post* | −4.186* | 8.752*** | −4.495** | −0.083* |
| | (2.154) | (2.808) | (2.129) | (0.049) |
| Observations | 3,749 | 3,749 | 3,749 | 3,703 |
| # households | 661 | 661 | 661 | 654 |

Note: Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The table shows estimates of the long-run impact of the earthquake on intra-household allocation in relative terms (wife's minus husband's) using the difference-in-differences estimation (1) based on the JPSC dataset. We use a seismic-intensity cutoff of 4.5 to define the treatment group. All specifications include household fixed effects, year fixed effects, a control for the number of children, and a control for co-residence with grandparents. Column (4) additionally controls for log monthly household income. The dependent variables in columns (1-3) are wife's weekly hours minus husband's on a given activity. The dependent variable in column (4) is wife's private consumption minus husband's, divided by the total. Standard errors clustered at the municipality level are reported in parentheses.

market hours relative to husbands'. Column (2) shows a significant increase in wives' childcare/housework time relative to husbands'. These results can be understood as a natural shift within an individual's time budget from market work to housework. However, the increase in hours of childcare/housework (+8.8 hours per unit increase in seismic intensity) exceeds the decrease in hours of market work (−4.2 hours). This additional time for childcare/housework is generated by a reduction in wives' leisure time (−4.5 hours), i.e., a reallocation of leisure time from wives to husbands (column 3).

Next, we examine changes in the allocation of private consumption. Column (4) reports the effect of the earthquake on the relative share of private consumption (wife's private expenditure minus husband's private expenditure in the same household, divided by the total). The coefficient is statistically significantly negative: an increase in seismic intensity by one reduces the wife's share by 8.3 percentage points. Because total private expenditure does not change significantly, this indicates a reallocation of private consumption from wives to husbands.

Finally, we estimate the effect of the earthquake on the shares of two types of public goods expenditure, i.e., child-related expenditures and other general public goods, as a proportion of total household expenditure. The estimated coefficients are negative for the former and positive for the latter, but neither is statistically significant (coefficient:

−0.017, p-value: 0.13, and coefficient: 0.018, p-value: 0.33, respectively).

Many studies document intra-household reallocation after shocks (e.g., Lundberg et al., 1997; Rangel, 2006; Attanasio and Lechene, 2014; Voena, 2015; Grönqvist et al., 2025; García, forthcoming). Our study contributes by providing, to our knowledge, the first direct evidence of reallocation across both consumption and leisure margins. Observing both margins shows that resources shift from wives to husbands simultaneously rather than offsetting across margins. This enables us to draw direct welfare implications of the redistribution, without estimating a structural model, and conclude that the economic shock exacerbates intra-household inequality. This contrasts with work that infers sharing rules in collective household models from assignable-goods data (e.g., clothing) under specific identification assumptions (see Chiappori and Ekeland, 2009). Moreover, this result provides a strong basis for investigating the underlying mechanisms, which we take up in the next section.

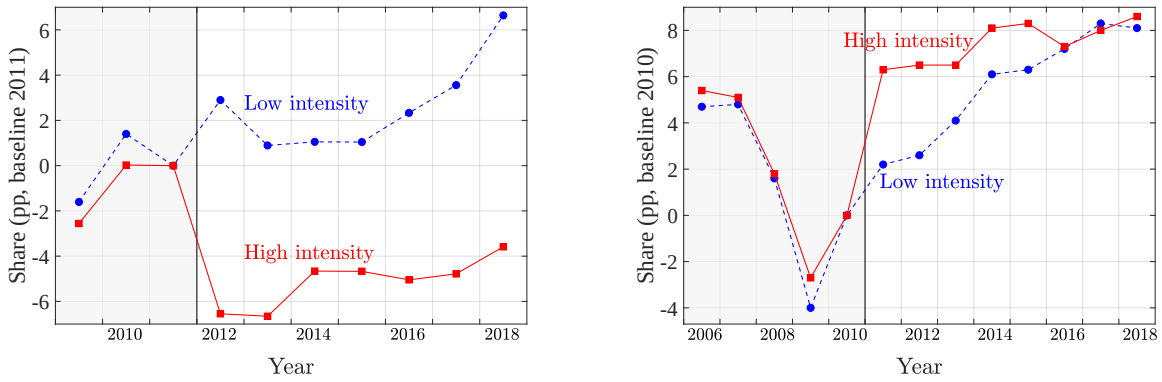
# 4 Exploration of the Mechanisms

In this section, we examine mechanisms underlying the decline in divorce and the intra-household reallocation documented in Section 3. One mechanism we are particularly interested in is the gender-specific labor-market impact of the earthquake, which substantially worsened conditions for female workers but did not for male workers. This change likely made wives more financially dependent on their husbands, reducing incentives to divorce and weakening their position in household resource sharing. We present suggestive evidence for this channel and also discuss other potential mechanisms that may play a role.

## 4.1 Gender-Specific Labor-Market Shock

Several early studies document that the earthquake generated a gender-specific labor-market shock (e.g., Higuchi et al., 2012; Ohta, 2015; Ministry of Health, Labour and Welfare, 2012). Labor-market conditions for female workers worsened as demand for women's jobs fell sharply, whereas conditions for male workers did not necessarily deteriorate and in some cases improved due to a surge in reconstruction-related demand.[13]

[13]Gender-specific labor-market shocks extend beyond natural disasters: they also occur in contexts such as import competition in female-intensive industries (e.g., Autor et al., 2019; Keller and Utar, 2022), gender-specific structural transformation (e.g., Ngai and Petrongolo, 2017), automation (e.g., Ager, Goñi, and Salvanes, forthcoming), and the COVID-19 pandemic (e.g., Alon et al., 2020).




**(A)** Female Employment Share

**(B)** Female UI Beneficiaries Share

**Figure 4:** Gender-Specific Labor-Market Shock. Panel A plots the share of female workers, relative to 2011, based on the KHPS/JHPS dataset. The base year is 2011 because the 2011 survey was conducted before the earthquake. High-intensity areas are defined by a seismic-intensity cutoff of 4.5. Panel B plots the share of female unemployment-insurance recipients, relative to 2010, based on the Ministry of Health, Labour and Welfare's Annual Report on Employment Insurance Services. The high-intensity prefectures are Fukushima, Iwate, and Miyagi. The vertical lines indicate the timing of the earthquake.

**Descriptive Evidence.** Figure 4 presents descriptive evidence that female labor-market conditions worsened relative to men's. Panel A shows the female share of full-time employment for high- and low-intensity areas using nationally representative data.[14] The female employment share trends upward in low-intensity areas but declines and then stagnates in high-intensity areas after the earthquake. Panel B plots the share of female unemployment insurance recipients over time using prefecture-level data. Although the trends in the two areas are similar before the earthquake, the share in high-intensity areas rises sharply in 2011, much more than in low-intensity areas, before returning to similar levels in 2016. This result is consistent with a demand rather than a supply shock to female employment.[15]

Why did the earthquake disproportionately affect women's employment? Women and men tend to work in different occupations, and the earthquake affected them differently. Construction, engineering, mining, transportation, and security are predominantly male jobs, whereas the majority of workers are female in service and clerical industries (Figure A.5). The earthquake severely impacted the economy in the

[14]The datasets used are the Keio Household Panel Survey (KHPS) and the Japan Household Panel Survey (JHPS), the latter of which began in 2009.

[15]The disruption of childcare facilities only had a very short-lived effect on female labor supply. The number of schools used as evacuation centers in the affected areas peaked at 622 one week after the disaster, quickly dropping to 240 after one month and 42 after six months, and then to 0 after eight months (Ministry of Education, Culture, Sports, Science and Technology, 2014).

affected area.[16] Many jobs were lost, particularly in sectors with a high share of female workers, such as sales, hotels, and restaurants (Higuchi et al., 2012; Ohta, 2015). In contrast, male-dominated jobs were relatively abundant due to the reconstruction boom. Figure A.6 illustrates employment trends in the secondary and tertiary sectors. Both sectors in the affected area experienced sharp declines in 2011. In high-intensity areas, secondary-sector employment recovered by 2012 and even surpassed low-intensity areas, whereas tertiary-sector employment never regained the national upward trend. Furthermore, the decline in demand for female employment spanned job types. In 2010, 62.1% of employed married women held non-regular jobs, compared with 9.2% of employed married men.[17] Such positions were particularly vulnerable to layoffs in firms affected by the earthquake.

As shown in Figure 4, the deterioration in labor-market conditions for women is persistent. In Figure A.7, we plot the job-finding rate (number of job openings per job seeker) for female- and male-dominated occupations, where female (male) dominance is defined as the share of female (male) workers in that occupation exceeding 60% in 2010.[18] After the earthquake, the job-finding rate for female-dominated occupations in high-intensity areas declines more than in low-intensity areas and then stagnates, whereas the rate for male-dominated occupations rises more in high-intensity areas and remains high for a long time. This makes it more difficult for female workers to find a suitable replacement job after the initial employment shock in high-intensity areas than in low-intensity areas, but easier for male workers.

**Causal Effects on Individual Income.** Next, we estimate the effects of the earthquake on individual labor income using the difference-in-differences specification (1) based on the LSN2001 dataset. Table 5 reports a negative and statistically significant effect of earthquake intensity on women's labor earnings (column 1) both in the short run (through 2014) and in the long run (through 2018).[19] An increase in seismic intensity by one is associated with a 25.1% (about 220k JPY or $1,500) decrease in women's annual gross earnings in the long run. In contrast, the earthquake has a positive effect on men's

[16] Economic conditions had long been depressed due to stagnating demand and production, partly caused by power shortages and supply disruptions (Schnell and Weinstein, 2012; Evgenidis et al., 2021; Fujita et al., 2021; Reconstruction Agency, 2024).

[17] Non-regular employment includes part-time, temporary, dispatched, and contract workers. Source: 2010 Population Census, Statistics Bureau, Ministry of Internal Affairs and Communications.

[18] Job postings with gender restrictions are illegal in Japan.

[19] Results are similar with a seismic-intensity cutoff of 5 (Table A.3). Note that treatment status is predetermined by pre-earthquake residence. Thus, households that relocated to regions with stronger labor markets could attenuate the absolute magnitude of the estimated labor-market impact. However, from 2010 to 2012, only a small fraction of households moved to another prefecture (see footnote 6). Excluding these movers does not affect the results.

**Table 5:** Effect of the Earthquake on Income

| Sample | All Households | | | Dual Earners | | Single Earners |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Dependent variable | Female log Earnings | Male log Earnings | Household log Income | Female log Earnings | Male log Earnings | Male log Earnings |
| **A: Short run (–2014)** | | | | | | |
| *Treat*×*Post* | −0.323** | 0.044 | −0.000 | −0.370*** | 0.044 | 0.026 |
| | (0.130) | (0.028) | (0.006) | (0.140) | (0.037) | (0.038) |
| Observations | 103,669 | 103,669 | 102,796 | 45,251 | 45,251 | 55,267 |
| **B: Long run (–2018)** | | | | | | |
| *Treat*×*Post* | −0.289** | 0.063** | −0.000 | −0.362** | 0.065* | 0.023 |
| | (0.141) | (0.028) | (0.006) | (0.140) | (0.038) | (0.037) |
| Mean Earnings | 0.87 | 5.77 | 6.80 | 1.53 | 5.28 | 6.25 |
| Observations | 196,018 | 196,018 | 189,271 | 84,743 | 84,743 | 104,573 |

Note: Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The table shows estimates of the impact of the earthquake on log income using the difference-in-differences estimation (1) based on the LSN2001 dataset. We use a seismic-intensity cutoff of 4.5 to define the treatment group. All specifications include household fixed effects, year fixed effects, a control for the number of children, and a control for co-residence with grandparents. Income is observed in 2005, 2008, and each year from 2013. Dual-earner couples are those with a full-time employed husband and an employed wife in 2008, the latest pre-earthquake year with income data. The dependent variable is log income: log individual labor earnings in columns (1-2) and log total household income (sum of all household members' labor earnings and other income) in column (3). "Mean Earnings" are the pre-earthquake average for the treatment group (millions of JPY). Standard errors clustered at the municipality level are reported in parentheses.

earnings in the long run (column 2): an increase in seismic intensity by one is associated with a 6.5% increase in male earnings. Total household income (sum of all household members' labor earnings and other income) does not change significantly after the earthquake for households in high-intensity areas relative to low-intensity areas (column 3).[20]

In columns (4-6), we report wives' and husbands' labor earnings for dual-earner couples (both spouses worked pre-earthquake) and husbands' labor earnings for single-earner couples (the husband is typically the sole breadwinner). For the latter, there is no statistically significant change after the earthquake. In contrast, dual-earner couples experience a significant decline in wives' earnings, whereas husbands' earnings rise in the long run. As a result, total household labor earnings for these families do not change significantly (coefficient: −0.003, p-value: 0.861).

[20]There was essentially no government financial assistance for earthquake-affected households, apart from temporary loans, unless their home was severely damaged or a primary earner was disabled or died.

The decline in female earnings operates through both the extensive and intensive margins, i.e., employment and hours conditional on employment (Table A.4).[21] The reduction is also involuntary: using an LSN2001 item that asks non-employed women whether they are seeking a job, and focusing on wives employed in at least one pre-earthquake period, we find a significant increase in job search after the shock in high-intensity areas (Table A.5), consistent with the increased share of female unemployment-insurance beneficiaries shown in Figure 4. In contrast, the increase in male earnings primarily reflects moves into higher-paying jobs. In Table A.6, we document husbands' sectoral migration from the tertiary to the secondary sector, consistent with reconstruction-driven demand in Figure A.7. We find no significant change in men's hours worked after the earthquake, indicating that the intensive margin of labor supply does not drive the increase in men's earnings.

Despite high job-finding rates for male-dominated occupations in high-intensity areas, the significant increase in earnings is experienced only by husbands in dual-earner couples; for husbands in single-earner couples, the increase is modest and statistically insignificant (Table 5, columns 5-6). This observation has an important implication. Changing jobs is generally costly, but husbands in dual-earner couples have a strong incentive to do so—the reduction in their wives' earnings. This can be interpreted as a form of family insurance against income shocks, a mechanism emphasized in prior work (see Fehr and Kindermann, 2020 for a review).

## 4.2 Mechanism: Value of Divorce and Family Insurance

The divorce effect and intra-household reallocation documented in Section 3 can be interpreted as arising from a change in the value of divorce relative to the value of marriage induced by the gender-specific labor-market shock. As women's labor-market conditions worsen and wives' earnings fall, the value of divorce declines because divorce would leave the wife as a single mother with limited resources.[22] On the other hand, the value of marriage remains high due to family insurance through the husband's income

[21] What causes the decline in hours worked by wives? Using the JPSC, we find that the number of employed married women doing home-based piecework, *naishoku*, increases significantly after the earthquake in high-intensity areas. Naishoku, which consists of simple tasks performed at home (e.g., decorating, gluing, packing), is very poorly paid and usually a last resort for earning income. Some women who became unemployed as a result of the earthquake and could not find a replacement job switched to naishoku, which may explain some of the decline in hours due to substitution effects among employed married women.

[22] Child support enforcement is not very effective in Japan. In 2011, only 19.7% of single-parent households received child support (Ministry of Health, Labour and Welfare, 2011). Japanese law does not generally recognize alimony or post-divorce spousal support.

compensation. The larger decline in the value of divorce than in the value of marriage leads to a lower probability of divorce; wives who would otherwise divorce become more financially dependent on their partners after an income loss and thus stay married to avoid a costly divorce. They also find themselves in a weaker bargaining position over household resource division than before, resulting in reallocation of resources toward their husbands.[23] We now provide suggestive evidence for this mechanism.

**Evidence from Wives' Occupations.** To establish a tight link between labor-market conditions and the estimated responses, we first exploit wives' pre-earthquake occupations in the JPSC. Because the post-earthquake reconstruction boom increased demand in male-dominated sectors (e.g., construction) but not in female-intensive sectors (e.g., services), the shock is gender-specific and tends to increase wives' financial dependence in dual-earner couples. If this channel is causal, households in which wives worked in less-affected occupations should exhibit little change in divorce and intra-household allocation.

We test this implication in Table 6 by splitting the JPSC sample into couples in which the wife worked in the secondary or tertiary sector in 2010. Panel A reports divorce effects. We find a statistically significant divorce effect for couples with wives in the tertiary sector, but little effect for those with wives in the secondary sector. Panel B shows a significant reallocation of leisure from wives to husbands and of childcare/housework from husbands to wives only when the wife is in the tertiary sector. Panel C similarly shows that the wife's private-consumption share declines significantly only for tertiary-sector wives; no such change appears for secondary-sector wives. The coefficients in column (1) are statistically different from those in column (2) for all outcomes except leisure.[24] Taken together, these results strongly support the proposed gender-specific labor-market mechanism. Moreover, we are not aware of an alternative mechanism that interacts with pre-earthquake wife occupations and jointly explains both the divorce effect and the observed reallocations.

**Heterogeneous Divorce Effects by Earner Composition and Income Level.** Next, we examine heterogeneity in divorce effects between dual-earner and single-earner families, motivated by the differential income responses across these earner-composition types

[23] A formal argument is provided in Section 5. Better labor-market conditions for husbands raise the value of divorce for them, potentially attenuating the divorce effect. However, under collective household decision-making with limited commitment, the wife's preference to remain married triggers a renegotiation of resource sharing that reallocates resources toward the husband and keeps the marriage intact. Thus, a higher value of divorce for the husband does not necessarily raise divorce rates.

[24] The coefficients on leisure are statistically different between the two groups when focusing on days off; see the analysis separating days off from workdays.

**Table 6:** Heterogeneity by Wives' Pre-Earthquake Occupation

| Sample | **Tertiary Sector** | | **Secondary Sector** | |
|---|---|---|---|---|
| | (1) | | (2) | |
| **A. Divorce** | | | | |
| *Treat*×*Post* | −0.069* | | 0.005 | |
| | (0.041) | | (0.11) | |
| Observations | 2,057 | | 451 | |
| **B. Weekly Hours** | | | | |
| | Childcare/ Housework | Leisure | Childcare/ Housework | Leisure |
| *Treat*×*Post* | 10.195** | −5.848* | −4.588 | −0.156 |
| | (4.246) | (3.068) | (5.938) | (5.049) |
| Observations | 1,874 | 1,874 | 376 | 376 |
| **C. Private Consumption Share** | | | | |
| *Treat*×*Post* | −0.160* | | 0.083 | |
| | (0.083) | | (0.102) | |
| Observations | 1,724 | | 374 | |

Note: Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The table shows estimates of the long-run impact of the earthquake on divorce and intra-household reallocation using the difference-in-differences estimation (1) based on the JPSC dataset. We use a seismic-intensity cutoff of 4.5 to define the treatment group. All specifications include household fixed effects, year fixed effects, a control for the number of children, and a control for co-residence with grandparents. We divide the sample into those in which the wife worked in the tertiary sector and in the secondary sector in 2010. Panel A reports divorce rates (in percentage points). Panel B reports wife's weekly hours minus husband's on a given activity. Panel C reports wife's private consumption minus husband's, divided by the total, and additionally controls for log monthly household income. Standard errors clustered at the municipality level are reported in parentheses.

shown in Table 5. Since wives in single-earner families typically have no market income even before the earthquake, the value of divorce can decline only via worsened future job prospects. Thus, if the proposed mechanism plays a material role, the divorce effect should be weaker for single-earner than for dual-earner families. Panel A of Table 7 reports long-run divorce effects separately for dual-earner couples (columns 1 and 3) and single-earner couples (columns 2 and 4) using the difference-in-differences estimation (1) based on the LSN2001 dataset. As expected, the decline in the probability of divorce is more pronounced for dual-earner families than for single-earner families, although the difference is not statistically significant.

**Table 7:** Heterogeneous Divorce Effects by Earner Composition and Income Level

| | **Treat: seismic intensity $\geq$ 4.5** | | **Treat: seismic intensity $\geq$ 5** | |
|---|---|---|---|---|
| **A: Earner Composition** | (1) | (2) | (3) | (4) |
| Sample | Dual Earners | Single Earners | Dual Earners | Single Earners |
| *Treat*×*Post* | −0.009** | −0.006* | −0.021*** | −0.010* |
| | (0.003) | (0.003) | (0.006) | (0.006) |
| Observations | 180,414 | 169,118 | 180,414 | 169,118 |
| **B: Income Levels** | (1) | (2) | (3) | (4) |
| Sample | Low Income | High Income | Low Income | High Income |
| *Treat*×*Post* | −0.011*** | −0.001 | −0.024*** | −0.010 |
| | (0.004) | (0.004) | (0.007) | (0.006) |
| Observations | 164,384 | 162,849 | 164,384 | 162,849 |

Note: Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The table shows estimates of the long-run impact of the earthquake on divorce rates (in percentage points) using the difference-in-differences estimation (1) based on the LSN2001 dataset. We use seismic-intensity cutoffs of 4.5 and 5 to define the treatment group. All specifications include household fixed effects, year fixed effects, a control for the number of children, and a control for co-residence with grandparents. Panel A uses the sample with employment information and defines dual-earner couples as those with a full-time employed husband and an employed wife in 2010. Panel B uses the sample with income information in 2008, the latest pre-earthquake year with income data, and splits households at the 2008 median household income. Standard errors clustered at the municipality level are reported in parentheses.

We also study heterogeneity in divorce effects by pre-earthquake household income levels. Low-income households accumulate less wealth during marriage, and hence wives receive little upon divorce.[25] The proposed mechanism thus implies that the value of divorce falls more sharply for these wives after the labor-market shock, making them more financially dependent on their husbands' labor income. Panel B reports long-run divorce effects for households with pre-earthquake household income below and above the median. As predicted, the divorce effect for low-income households is statistically significant and substantially larger than that for high-income households, which is also negative but not statistically significant. The coefficients between columns (1-2) and those between (3-4) are significantly different.[26]

The literature often finds that shocks affecting different family members can have

[25] In Japan, assets accumulated during a marriage are to be divided equally upon divorce.

[26] In Appendix B, we conduct an instrumental variables estimation that may potentially provide more direct evidence of the proposed mechanism and help quantify the effect size. Since the earthquake may affect the probability of divorce not only through female earnings but also through other channels discussed in Section 4.3, we employ an interaction instrumental variable design (as in, e.g., Bettinger et al., 2017) to reduce the plausibility that estimates reflect other potential mechanisms. We find a positive and significant effect of women's earnings on the probability of divorce, consistent with our proposed mechanism.

differential impacts on divorce. Using plant-closure shocks, Doiron and Mendolia (2012), Eliason (2012), and Huttunen and Kellokumpu (2016) document significant increases in the divorce hazard following husbands' earnings losses, but not wives'. Cesarini et al. (2023) find that among participants, a one-time positive wealth shock from lottery winnings reduces divorce when husbands win but increases short-run divorce when wives win. Our findings underscore that whether economic shocks stabilize or destabilize marriages depends on their gender incidence, highlighting the importance of understanding whose outside option shifts, in which direction, and how these interact. In our context, the earthquake worsened female labor-market prospects, lowering wives' outside options and discouraging divorce, while improving male prospects, raising husbands' outside options. In a collective framework with limited commitment, the possibility of renegotiation implies that the latter change may lead to resource reallocation toward husbands rather than a higher divorce probability. We formalize this mechanism in Section 5.

**Role of Children.** We examine how children shape divorce and intra-household allocation decisions using information on family structure in the JPSC. Prior work shows that the presence of children is important for the effectiveness of family insurance (Halla et al. 2020). Divorce is more difficult for a woman with a young child, as raising the child alone is particularly costly. Hence, we expect muted divorce effects for families with low or no child-rearing costs, i.e., those with only grown children or no children. Resource reallocation within households would also be less likely in such families.

We test this implication in Table A.7, where we estimate equation (1) separately for families with a young child (under age 10 in 2011) and for families with no children or only older children. The table shows a negative and statistically significant effect of the earthquake on the probability of divorce for families with a young child, consistent with the comparable LSN2001 result. In contrast, as expected, we find no divorce effect for families with low or no child-rearing costs. Similarly, we observe statistically significant intra-household reallocation—leisure and private consumption shift from wives to husbands—only in families with a young child, not in those without.

**Reallocation of Time: Workdays vs. Days Off.** As a final piece of suggestive evidence for our proposed mechanism, we leverage the time use information reported separately for workdays and days off in the JPSC. In Section 3.2, we find a significant increase in wives' weekly childcare/housework hours relative to husbands in affected areas. On workdays, when family time allocation is less flexible, this shift can be partly interpreted as increased specialization in response to the income shock. On days off, when neither

**Table 8:** Intra-Household Reallocation of Time: Workday vs. Day Off

| | Workday | | | Day Off | |
|---|---|---|---|---|---|
| Dependent variable | (1) Market Work | (2) Childcare/ Housework | (3) Leisure | (4) Childcare/ Housework | (5) Leisure |
| *Treat*×*Post* | −0.802* | 1.328*** | −0.516 | 1.056** | −0.957** |
| | (0.414) | (0.446) | (0.337) | (0.471) | (0.475) |
| Observations | 3,749 | 3,749 | 3,749 | 3,749 | 3,749 |

Note: Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The table shows estimates of the long-run impact of the earthquake on intra-household allocation in relative time use (wife's minus husband's) using the difference-in-differences estimation (1) based on the JPSC dataset. We use a seismic-intensity cutoff of 4.5 to define the treatment group. All specifications include household fixed effects, year fixed effects, a control for the number of children, and a control for co-residence with grandparents. The dependent variable is wife's hours per day minus husband's on a given activity. Standard errors clustered at the municipality level are reported in parentheses.

spouse is at market work and time allocation is more flexible, a shift may reflect more than specialization.

We check this argument in Table 8, which reports relative daily hours separately for workdays and days off. On workdays, exposure to a stronger earthquake shock reduces wives' market hours relative to husbands' (column 1), similar to Table 4. These reduced hours are reallocated to childcare/housework by wives relative to husbands (column 2). The coefficient for wives' leisure relative to husbands' is negative but not statistically significant (column 3). On days off, stronger exposure leads to a significant increase in wives' childcare/housework time relative to husbands and a significant decrease in wives' leisure relative to husbands (columns 4-5). Before the earthquake, wives already devoted nearly five more hours per day than husbands to childcare/housework on days off, perhaps reflecting strong gender roles in Japan. An increase in seismic intensity by one adds 1.1 hours to this gap. This additional time worked by wives is almost entirely offset by a reduction in wives' leisure time that shifts to husbands. Overall, because time allocation is flexible on days off, these shifts between spouses are more consistent with changes in bargaining power than with increased specialization.

## 4.3 Alternative Explanations

The various lines of evidence presented in the previous section suggest that the gender-specific labor-market shock is an important channel. In this section, we discuss alternative

**Table 9:** Effect of the Earthquake on Family Ties and Social Norms

| Dependent variable | (1) Marriage Satisfaction | (2) Additional Birth | (3) Family Ties through Child | (4) Mental Health | (5) Social Norm |
|---|---|---|---|---|---|
| *Treat*×*Post* | −0.066 | −0.003* | −0.015** | −0.361 | −0.391 |
| | (0.123) | (0.002) | (0.007) | (0.524) | (0.549) |
| Observations | 3,743 | 296,580 | 159,975 | 4,546 | 2,452 |

Note: Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The table shows estimates of the impact of the earthquake on variables related to the strength of family ties and social norms using the difference-in-differences estimation (1). We use a seismic-intensity cutoff of 4.5 to define the treatment group. All specifications include household fixed effects, year fixed effects, a control for the number of children, and a control for co-residence with grandparents. The dependent variable in column (1) measures marriage satisfaction based on the question in the JPSC, "Are you satisfied with your marriage to your husband?" (from "1 Not at all" to "5 Very much"). Column (2) reports the impact of the earthquake on the probability of having an additional child based on the LSN2001. Column (3) is based on the question in the LSN2001, "Was the family tie strengthened thanks to the presence of the child?" ("0 Does not apply" or "1 Does Apply"). Column (4) is based on a module on mental health in the JPSC, which consists of thirteen items on respondents' mental state in the past week, each scored 1-4, with higher scores corresponding to poorer mental health. The dependent variable is the sum of the thirteen variables. Column (5) is based on the two questions in the JLPS about respondents' agreement with statements about social norms, and we construct a variable with higher scores corresponding to more traditional social norms. Standard errors clustered at the municipality level (columns 1-4) or at the prefecture level (column 5) are reported in parentheses.

mechanisms that could account for parts of the results. Although these explanations are not mutually exclusive with the labor-market channel and may play some role, we provide suggestive evidence that none alone is fully consistent with all of our findings.

**Family Ties and Social Norms.** The earthquake was not only a major economic shock but also may have been a traumatic event that shifted people's preferences or views.

First, a positive "love shock" from the earthquake may strengthen family ties and reduce divorce. If this shock were particularly large for women, it would also explain the observed intra-household reallocation toward husbands. Since this psychological explanation may play some role, we assess its plausibility as a primary driver of our empirical findings, using the difference-in-differences specification (1). To gauge marital bonds, we analyze marriage satisfaction based on the question, "Are you satisfied with your marriage to your husband?" (ranging from "1 Not at all" to "5 Very much"), asked of women in the JPSC. If women experienced sufficiently large positive love shocks to explain their divorce and resource allocation decisions, we would expect a positive effect of the earthquake on marriage satisfaction. Column (1) of Table 9 instead shows a negative, though statistically insignificant, coefficient. We also estimate the effect of the

earthquake on higher-order fertility based on the LSN2001. Column (2) shows that the probability of having an additional child after the earthquake is significantly lower in the treatment group than in the control group.[27] Overall, these results do not fit well with strong positive love shocks and are more consistent with our mechanism in which some women remain married despite low match quality for economic reasons.

The observed heterogeneity in divorce and intra-household reallocation further tests the "stronger family ties" hypothesis. In Table 6, we find pronounced effects for couples whose wives worked pre-earthquake in the tertiary sector, but only muted effects for couples whose wives worked in the secondary sector. This pattern offers no clear channel through which stronger family ties would differentially interact with wives' occupations.

In Table A.7, we also find that the divorce effect and intra-household reallocation are present for families with a young child but not for those without. A preference shock interacting with child age/presence can, in principle, explain this pattern: parents of young children may wish to avoid exposing them to another traumatic event—parental divorce. To test this channel, we analyze the LSN2001 question, "Was the family tie strengthened thanks to the presence of the child?" ("0 Does not apply" or "1 Applies"). If the presence of a young child psychologically binds parents together so that they do not separate after the earthquake, we would expect a positive earthquake effect on this measure. Contrary to that prediction, column (3) of Table 9 shows a negative and statistically significant effect.

More broadly, the earthquake may have worsened mental health and thereby reinforced family ties. The JPSC asks thirteen items on respondents' mental state in the past week, each scored 1-4, with higher scores corresponding to poorer mental health. We construct a mental-health index by summing the responses to these questions and find no statistically significant effect of the earthquake on this variable (column 4).

Alternatively, the earthquake may have affected people's social norms: people may have become more "traditional" and thus avoided divorce. This social-norm shock can also explain the intra-household reallocation if wives adopted more traditional gender roles and accepted lower welfare shares. However, this supply-side explanation for declines in women's earnings and employment is inconsistent with the post-quake increase in married women's job search documented in Table A.5.

To better assess the possibility of social-norm change, we use attitudinal items from the Japanese Life Course Panel Surveys (JLPS) that directly elicit social views.[28] We focus on

[27] This also suggests divorce effects are unlikely to be driven by biological-clock pressure inducing fertile women to avoid divorce after a negative labor-demand shock (Keller and Utar, 2022).

[28] The JLPS is a nationally representative household panel survey conducted annually that covers the period from 2007 to 2020. We use the Youth Panel (JLPS-Y) and the Middle-Aged Panel (JLPS-M); the

two questions where respondents were asked to rate their agreement with each statement on a five-point scale from "Agree" to "Disagree": "A man's job is to earn an income, and a woman's job is to take care of the home and family" and "When a mother works, preschool children are more likely to experience hardship." We construct an index from the responses such that higher values indicate more traditional family values.

We estimate the effect of the earthquake on the social-norms index. Column (5) of Table 9 shows no statistically significant positive effect. The same holds in the short run and when estimated separately by gender, where the effect for women is significantly negative. These findings suggest that shifts toward more traditional social norms are not the main driver of our results.

**Value of Insurance.** The massive earthquake may be largely unpredictable (i.e., Knightian uncertainty), prompting people to update their beliefs after the shock. In particular, with the possibility of a deadly natural disaster explicitly incorporated into expectations, people may place greater value on insurance after the earthquake, raising the value of marriage and hence reducing divorces. This logic is related to, but distinct from, the gender-specific labor-market channel, where marriage becomes relatively more valuable because the value of divorce falls sharply. However, the uncertainty/insurance channel does not provide a straightforward explanation for the observed intra-household reallocation.

Although expectations are unobserved, we assess the plausibility of an increased value of insurance. First, using the JPSC, we estimate the effect of the earthquake on the household saving rate, defined as monthly savings divided by monthly income. If families perceived greater uncertainty after the earthquake, precautionary saving would rise. Instead, we find no statistically significant change in the saving rate.

Next, we examine the impact of the earthquake on the likelihood of owning specific insurance products. For this purpose, we use the Keio/Japan Household Panel Survey (KHPS/JHPS), a nationally representative household panel that records household ownership of fire insurance (furniture/buildings), earthquake insurance (furniture/buildings), and life insurance (husband/wife).[29] Table 10 shows no

former surveys approximately 3,400 individuals aged 20-34, whereas the latter surveys approximately 1,400 individuals aged 35-40 as of December 2006. The JLPS records household composition and marital status annually, allowing us to construct samples and controls analogously to the LSN2001 and the JPSC. As in those datasets, our sample consists of families married in 2007 with at least one young child (under ten in 2011). We drop the 2011 wave, but results are robust to including it. The JPSC contains a similar norms question, but it was added after the earthquake and is therefore unsuitable for causal analysis.

[29]The dataset started in 2004 (KHPS) and 2009 (JHPS) and interviews about 7,000 households per year. We use 2005-2018. It records household composition and marital status annually, allowing us to construct samples and controls analogously to the LSN2001 and the JPSC. As in those datasets, our sample consists of

**Table 10:** Effect of the Earthquake on Insurance Purchases

| | Fire Insurance | | Earthquake Insurance | | Life Insurance | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Dependent variable | Furniture | Buildings | Furniture | Buildings | Husband | Wife |
| *Treat*×*Post* | 0.109 | −0.048 | 0.074 | −0.041 | −0.040 | 0.062 |
| | (0.109) | (0.081) | (0.135) | (0.110) | (0.053) | (0.072) |
| Observations | 2,695 | 2,853 | 2,601 | 2,692 | 2,838 | 2,793 |

Note: Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The table shows estimates of the impact of the earthquake on household insurance holdings among families with a young child (under age ten in 2011) using the difference-in-differences estimation (1) based on the KHPS/JHPS datasets. We use a seismic-intensity cutoff of 4.5 to define the treatment group. All specifications include household fixed effects, year fixed effects, a control for the number of children, and a control for co-residence with grandparents. Standard errors clustered at the municipality level are reported in parentheses.

statistically significant effects: households more exposed to the earthquake do not change their insurance ownership relative to less-exposed households.[30]

We also examine marriage rates to test whether they rose more in high-intensity than in low-intensity areas. In Japan, couples typically marry before childbirth (only 2.1% of births were out of wedlock in 2010). Thus, a relative increase in marriage in high-intensity areas would be consistent with a higher value of family insurance, but it is not implied by our mechanism, which operates through the presence of a young child. Lacking suitable microdata on marriage formation, we use prefecture-level data. Figure A.8 shows a slight decline in marriage rates in high-intensity areas in 2011 and a rebound in 2012 relative to low-intensity areas—consistent with temporary postponement—with no overall increase.

Finally, the value of insurance would rise if the earthquake increased risk aversion, but Hanaoka et al. (2018) find no evidence of such a change.

**Housing Wealth.** The earthquake caused major damage to many residential buildings, reducing household housing wealth. It is theoretically and empirically ambiguous how declines in housing wealth affect divorce. On the one hand, lower house values reduce homeowners' equity, making it harder to finance two separate dwellings after divorce and thereby reducing divorce. On the other hand, more affordable rents would make it easier to split a family in two. Increased financial stress may also increase divorce risk.

families married in 2007 with at least one young child under ten in the sample period. Insurance questions have been asked since 2012, but respondents also report the year of purchase, enabling inclusion of the pre-earthquake period.

[30] Results are similar in the short run (through 2014). We do not control for potential supply-side changes in insurance markets.

**Table 11:** Housing Wealth and Divorce Effects

| | **Additional Controls** | | **Restricted Sample** | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Specification | House Price | Destroyed Houses | Seismic Intensity<6 | Destroyed Houses<0.01% |
| *Treat*×*Post* | −0.008*** | −0.008*** | −0.009*** | −0.008** |
| | (0.003) | (0.003) | (0.003) | (0.004) |
| Observations | 356,739 | 383,318 | 382,030 | 360,612 |

Note: Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The table shows estimates of the long-run impact of the earthquake on divorce rates (in percentage points) using the difference-in-differences estimation (1) based on the LSN2001 dataset. We use a seismic-intensity cutoff of 4.5 to define the treatment group. All specifications include household fixed effects, year fixed effects, a control for the number of children, and a control for co-residence with grandparents. Columns (1-2) add controls for house values and for the number of houses completely destroyed, respectively. Columns (3-4) exclude municipalities with seismic intensity≥6 and municipalities where at least 0.01% of all buildings were completely destroyed, respectively. Standard errors clustered at the municipality level are reported in parentheses.

Using U.K. household data, Rainer and Smith (2010) find that a negative house price shock is associated with an increase in the probability of divorce, especially for couples with young children. In contrast, using U.S. MSA-level data, Farnham et al. (2011) find that declining house prices reduce owners' divorce risk.

Given the theoretical and empirical ambiguity, it is a priori unclear how housing-wealth changes affect marital stability in our context. We nevertheless test this channel in Table 11. First, we merge municipality-level property values from the Ministry of Land, Infrastructure, Transport and Tourism into the LSN2001 and add this variable as a control in column (1). We also add the municipal number of damaged houses from administrative damage reports and control for it in column (2). In both case, results are unchanged. An alternative way of accounting for housing damage is to exclude the most affected areas from the sample. Column (3) excludes municipalities with seismic intensity≥6, where property damage is most severe (see Table A.1). In column (4), we drop municipalities where at least 0.01% of the buildings were completely destroyed (1 in 10,000). In both cases, results remain robust. These tests suggest that housing-wealth changes are not the primary driver of the divorce decline. Moreover, this channel is hard to reconcile with the occupation-based heterogeneity for wives shown in Table 6.

# 5 Theoretical Framework: A Collective Household Model

We develop a model to rationalize the empirical findings on divorce and intra-household reallocation presented in Sections 3 and 4. Our model builds on the collective household model with limited commitment (see Browning et al. 2014 and Chiappori and Mazzocco 2017 for reviews), capturing joint decision-making under unexpected shocks. A more general formulation is presented in Appendix C.1.

## 5.1 A Model of Divorce

**Environment.** Consider a married dual-earner couple with a child. The model has two periods. In period 1, the couple decides whether to divorce. In period 2, if they remain married ($M$), they choose intra-household allocations jointly; if they divorce ($D$), each spouse chooses separately.

The preferences for each spouse $i \in \{w,h\}$, where $w$ is the wife and $h$ is the husband, are represented by a utility function $\alpha \log(c_i) + (1-\alpha)\log(\ell_i)$ with $\alpha \in (0,1)$, where $c$ is private consumption and $\ell$ is leisure. We abstract from public-goods expenditures in the baseline, as they do not alter the results; we introduce them later in the welfare analysis. If the couple stays married, individual utility is given by $\alpha \log(c_i) + (1-\alpha)\log(\ell_i) + \theta_i$, where $\theta_i \in \mathbb{R}$ represents nonpecuniary benefits of marriage (match quality), is continuously distributed with cdf $F_\theta$, and is realized at the beginning of period 1.

Spouses enter the economy with exogenous incomes $(y_w, y_h) \in \mathbb{R}^2_{++}$. The budget constraints for a married couple and for a divorced individual are given by $c_w + c_h \leq y_w + y_h$ and $c_i \leq y_i$ for $i \in \{w,h\}$, respectively. Each spouse is endowed with one unit of time. If employed, a spouse spends $\varepsilon > 0$ units of time supplying market labor. For $i \in \{w,h\}$, the time constraint is

$$\ell_i + n_i \leq 1 - \varepsilon \mathbb{I}\{y_i > 0\}, \tag{3}$$

where $\mathbb{I}\{\cdot\}$ is the indicator function and $n_i$ denotes childcare time. The child requires fixed parental time $\bar{n} > 0$, where $\bar{n} + \varepsilon < 1$. If the spouses stay together, childcare is split:

$$n_w + n_h = \bar{n}. \tag{4}$$

If they divorce, the wife receives custody, so the husband provides no childcare:[31]

$$n_i = \begin{cases} \bar{n} & \text{if } i = w, \\ 0 & \text{if } i = h, \end{cases} \tag{5}$$

**Value of Divorce.** We first characterize the value of divorce in period 2. When divorced, spouses consume out of individual income. Each $i \in \{w,h\}$ solves

$$V_i^D(y_i) = \max_{\{c_i,\ell_i,n_i\}\in\mathbb{R}^3_+} \alpha \log(c_i) + (1-\alpha)\log(\ell_i), \tag{6}$$

subject to the budget constraint $c_i \leq y_i$ and the time constraints (3) and (5). Solving this problem yields, for the wife in a dual-earner couple,

$$V_w^D(y_w) = \alpha \log(y_w) + (1-\alpha)\log(1-\bar{n}-\varepsilon). \tag{7}$$

**Value of Marriage.** The married couple solves a Pareto problem in period 2. The Pareto weight represents each spouse's *decision power* (Chiappori and Mazzocco, 2017). Without loss of generality, let the wife's and husband's weights be $\mu$ and $1-\mu$. The weight $\mu$ is exogenously given and held fixed for now; we later allow $\mu$ to change endogenously.

Given match quality $(\theta_w,\theta_h)$ and income $(y_w,y_h)$, the couple jointly solves

$$\max_{\{c_i,\ell_i,n_i\}_{i\in\{w,h\}}\in\mathbb{R}^6_+} \mu\left[\alpha\log(c_w)+(1-\alpha)\log(\ell_w)+\theta_w\right] + (1-\mu)\left[\alpha\log(c_h)+(1-\alpha)\log(\ell_h)+\theta_h\right], \tag{8}$$

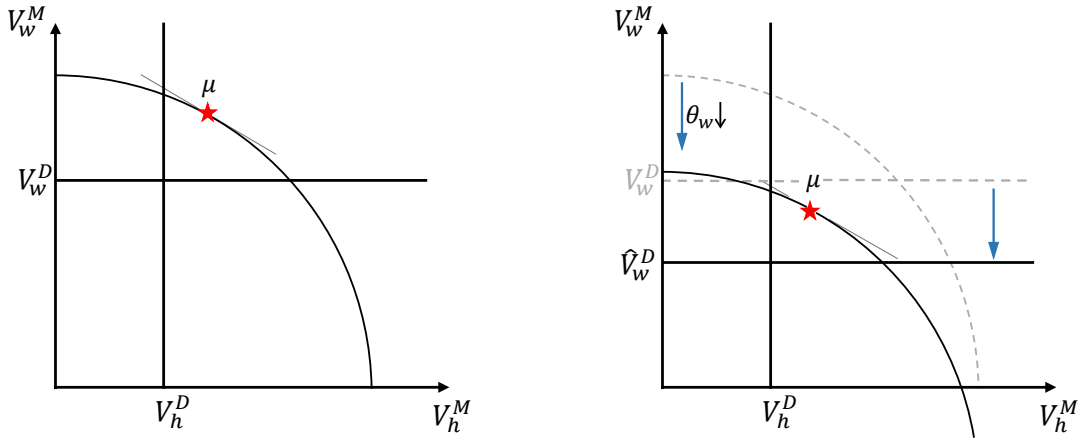
subject to the budget constraint $c_w + c_h \leq y_w + y_h$ and the time constraints (3-4).

Solving this problem yields an optimal allocation proportional to total household resources: $\{c_w,c_h,\ell_w,\ell_h\} = \{\mu Y,(1-\mu)Y,\mu T,(1-\mu)T\}$, where $Y = y_w + y_h$ is household income and $T = 2-\bar{n}-2\varepsilon$ is total non-working time. This proportionality is the standard property of a solution to a Pareto problem, and shares are given by the decision power due to log preferences. The wife's value of marriage in a dual-earner couple is then

$$V_w^M(Y,T,\theta_w;\mu) = \alpha\log(\mu Y) + (1-\alpha)\log(\mu T) + \theta_w. \tag{9}$$

**Problem of Divorce.** We now characterize the household problem of divorce in period 1. The dual-earner couple observes match quality $(\theta_w,\theta_h)$ and income $(y_w,y_h)$ and decides

[31] In 2010, among newly divorced couples with a child under the age of twenty, 83.3% of custody was awarded to the wife and 12.9% to the husband, with the remainder shared or undetermined. Source: Vital Statistics, Ministry of Health, Labour and Welfare.




**(A)** Married Couple's Efficient Allocation **(B)** Divorce Effect

**Figure 5:** Divorce Decisions, Efficient Allocations, and Divorce Effect.

whether to divorce under unilateral divorce.[32] Let spouse $i$'s participation constraint (hereafter, $P_i$) be

$$V_i^M(Y,T,\theta_i;\mu) \geq V_i^D(y_i). \tag{10}$$

Marriage provides the benefit of resource pooling for spouses but also entails match quality. Thus, even if the economic surplus from marriage is large, divorce can occur when $\theta$ is sufficiently low (negative) for both spouses.

Figure 5A illustrates a situation in which the couple chooses to remain married. The Pareto frontier is represented by the arc, and the outside options (the value of divorce) are given by the horizontal line for the wife and the vertical line for the husband. By equation (10), the couple remains married because the value of marriage $(V_w^M, V_h^M)$ lies on the arc northeast of the outside options. The resulting values (red star) correspond to a specific Pareto weight $\mu$, which determines the slope of the tangent (i.e., $-\frac{1-\mu}{\mu}$).

We derive the probability of divorce that is initiated by the wife, assuming that $P_h$ is slack (i.e., $\theta_h$ is sufficiently high). This can occur if $\theta_h$ includes substantial child-related utility from co-residence, which vanishes upon divorce. There exists $\theta_w^*$ such that the wife is indifferent between marriage and divorce, i.e., $V_w^M(Y,T,\theta_w^*;\mu) = V_w^D(y_w)$, and by monotonicity for any $\theta_w < \theta_w^*$, the wife prefers divorce. Using equations (7) and (9) and solving for $\theta_w^*$, we obtain the probability of (wife-initiated) divorce:

$$F_\theta\left[\alpha\log\left(\frac{y_w}{y_w+y_h}\right)+(1-\alpha)\log\left(\frac{1-\bar{n}-\varepsilon}{2-\bar{n}-2\varepsilon}\right)-\log(\mu)\right]. \tag{11}$$

[32] In the long run, effective unilateral divorce holds in Japan: despite no explicit unilateral divorce law, several legal options permit divorce without spousal consent; see footnote 10.

Divorce probability is lower if the value in the bracket is lower. Holding other factors fixed, from the wife's perspective, marriage is more sustainable when $y_h$ is higher (the husband's income is higher), $y_w$ is lower (the wife's income is lower, so divorce is more costly), $\bar{n}$ is higher (raising the child is more costly, especially under divorce), and $\mu$ is higher (the wife receives a larger share of household resources).

## 5.2 Labor-Market Shock, Divorce Effect, and Family Insurance

In this section, we show that a negative shock to the wife's income reduces the probability of divorce and induces the husband to compensate for the wife's income loss as a form of family insurance. We also show that the divorce effect is heterogeneous across family types, similar to the empirical results in Section 4.2.

**Gender-Specific Labor-Market Shock.** In Section 4.1, we document the deterioration of labor-market conditions for female workers and the improvement of employment opportunities for male workers after the earthquake. To capture these gender-specific shocks in the model, suppose the wife's initial income falls to zero and each individual can switch jobs to earn $y_i'$, where $y_w' < y_w$ and $y_h' > y_h$. Job switching requires a fixed time cost $\kappa_i$, with $\kappa_w > \kappa_h > 0$. Assume $\bar{n} + \varepsilon + \kappa_w < 1$ to ensure feasibility for the wife under divorce. Denote the job-switching decision by $s_i \in \{0,1\}$.[33] We assume that the earthquake does not affect the distribution of match quality $F_\theta$.

**Divorce Effects and Family Insurance.** We now characterize the probability of divorce after the shock. Since the wife has no resources after divorce and child support is limited (see footnote 22), she needs to find a new job, so $s_w = 1$. Solving the problem (6), the value of divorce becomes

$$V_w^D(0) = \alpha \log\left(y_w'\right) + (1-\alpha)\log(1-\bar{n}-\varepsilon-\kappa_w).$$

The value of marriage for the wife is given by equation (9), with total resources $Y = s_w y_w' + (1-s_h)y_h + s_h y_h'$ and $T = 2 - \bar{n} - s_w(\varepsilon+\kappa_w) - \varepsilon - s_h\kappa_h$, where $\varepsilon$ for the husband reflects market time regardless of switching, whereas switching adds $\kappa_h$.

We can characterize job-switching decisions in marriage under some conditions for $(y_w', y_h')$ detailed in Appendix C.2. If $y_w'$ is sufficiently low and $y_h'$ is sufficiently high, the wife has no incentive to switch ($s_w = 0$), whereas the husband switches to a higher-paying job ($s_h = 1$), compensating for the wife's income loss as family insurance. In this case, we

[33] Introducing job-switching into the model does not alter the results obtained so far, provided the new job is similar to the current one before the earthquake.

have $Y = y'_h$ and $T = 2 - \bar{n} - \varepsilon - \kappa_h$.

As before, we derive the probability of divorce from $P_w$, assuming that $P_h$ is slack. The probability of divorce after the earthquake (under the condition for $(y'_w, y'_h)$ ) is

$$F_\theta \left[ \alpha \log \left( \frac{y'_w}{y'_h} \right) + (1-\alpha) \log \left( \frac{1 - \bar{n} - \varepsilon - \kappa_w}{2 - \bar{n} - \varepsilon - \kappa_h} \right) - \log(\mu) \right]. \tag{12}$$

Using equations (11-12), the probability of divorce decreases after the shock if

$$\alpha \log \left( \frac{y_w}{y'_w} \frac{y'_h}{y_w + y_h} \right) + (1-\alpha) \log \left( \frac{2 - \bar{n} - \varepsilon - \kappa_h}{1 - \bar{n} - \varepsilon - \kappa_w} \frac{1 - \bar{n} - \varepsilon}{2 - \bar{n} - 2\varepsilon} \right) > 0. \tag{13}$$

Under this condition, the labor-market shock makes marriage more sustainable. The condition is more likely to hold when $y'_w$ is low (substantially worsened opportunities for women sharply reduce the value of divorce), when $y'_h$ is large (strong family insurance makes remaining married more beneficial), when $\kappa_w$ is high (very scarce opportunities for women make divorce more costly), and when $\kappa_h$ is low (a low job-switching cost for the husband limits the decline in the value of marriage).

The intuition is straightforward. With concave utility, scarce job opportunities make divorce costly for wives; a divorced wife must secure new employment to finance consumption while raising a young child. In contrast, remaining married provides family insurance through the husband's earnings, sustaining higher consumption. Therefore, even when match quality is low enough that divorce would otherwise be chosen, the wife remains married, reducing the probability of divorce.

Figure 5B illustrates this logic by showing a decline in the wife's outside option while abstracting from any small change in the value of marriage. Suppose there is a negative realization of match quality for the wife, which shifts the Pareto frontier downward. With the initial outside option $V_w^D$ (gray dashed horizontal line), no feasible allocation simultaneously satisfies both spouses' participation constraints, so divorce occurs. After the labor-market shock lowers the wife's value of divorce to $\hat{V}_w^D$, however, the efficient allocation (red star) satisfies both constraints, so marriage continues.

**Heterogeneous Divorce Effects across Family Types.** We now consider heterogeneity across family types as in Section 4.2. First, when household income $(y_w + y_h)$ is low, condition (13) is more likely to hold, implying a larger divorce effect for low-income families, consistent with Table 7. The intuition is that when pre-earthquake household income is low, family insurance after the income shock is relatively strong $(y'_h/(y_w + y_h)$ is higher), and thus marriage is more sustainable.

Next, we consider heterogeneity by earner composition. Suppose the husband is the

sole breadwinner. Adding job-switching choices to problems (6) and (8), we derive the wife's divorce and marriage values before and after the shock. Using these expressions and the wife's participation constraint $P_w$, we show that the divorce effect also arises for single-earner couples, as in Table 7, because the wife's post-shock job potential deteriorates ($y'_w < y_w$); see Appendix C.2.

Does the model predict a stronger reduction in divorce for dual-earner couples than for single-earner couples, similar to Table 7? Comparing the reduction in the probability of divorce for a dual-earner couple with that for a single-earner couple, this occurs if $y'_h$ is sufficiently high, so that family insurance is strong and the wife in a dual-earner couple finds marriage more attractive. The same result is also more likely when $\kappa_w$ is large, because the shock imposes an additional switching cost on the wife's outside option only in dual-earner couples; in single-earner couples $\kappa_w$ is present both before and after the shock.

The empirical analysis finds divorce effects for families with a young child but not for families without. To interpret this in the model, consider couples with no child or only older children, which corresponds to the case where the childcare requirement $\bar{n}$ is small (or zero). Since the left-hand side of equation (13) increases in $\bar{n}$, the divorce effect diminishes when $\bar{n}$ is small. Intuitively, a smaller $\bar{n}$ relaxes the time constraint, especially for a divorced woman, who has custody (equation 5), so with concave utility for leisure, the adverse shock reduces the value of divorce by less, weakening the divorce effect.

The theoretical results in this subsection are summarized in the following proposition, and the proof appears in Appendix C.2.

**Proposition 1** *Suppose that in a dual-earner couple with a child, the wife's income falls and her job opportunities are sufficiently poor, whereas the husband's are sufficiently good. Then,*

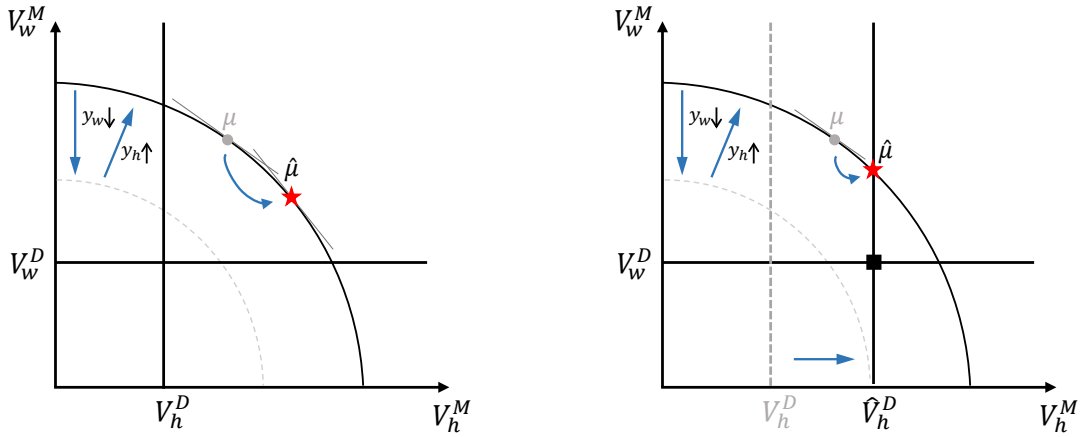
1. [Family Insurance] *The husband compensates for the wife's income loss by switching to a higher-paying job.*

2. [Divorce Effect] *The probability of divorce decreases.*

3. [Heterogeneity across Family Types] *The divorce effect is stronger for low-income than high-income couples, for dual-earner than single-earner couples, and for couples with a young child than for those without.*

## 5.3 Intra-Household Reallocation

In this section, we show that the labor-market shock leads to intra-household reallocation of consumption and leisure from the wife to the husband, consistent with the empirical




**(A)** Distribution Factor **(B)** Renegotiation

**Figure 6:** Endogenous Pareto Weight $\mu$ and Intra-Household Reallocation

evidence in Section 3.2.

We analyze intra-household allocation conditional on remaining married by relaxing the assumption that the Pareto weight $\mu$ is fixed. We consider two cases in which it changes endogenously: (i) when it is a function of *distribution factors* and (ii) when there is renegotiation. In both cases, the model predicts reallocation of resources from the wife to the husband.[34]

Browning et al. (2014) define a distribution factor as "(a)ny variable that has an impact on the decision process but affects neither preferences nor budget constraints" (p. 123). A prominent example is relative income within the household (see their Table 5.1). In a collective framework, treating relative income as a distribution factor implies that changes in relative income shift the Pareto weight and hence the intra-household allocation, holding the set of efficient allocations fixed. Let $\mu = g(y_w/y_h)$, where $g$ is an increasing function. After the shock, the relative income falls, so the wife's decision power declines to $\hat{\mu} = g\left(0/y_h'\right) < \mu$. The optimal allocation is then $\{c_w, c_h, \ell_w, \ell_h\} = \{\hat{\mu}Y, (1-\hat{\mu})Y, \hat{\mu}T, (1-\hat{\mu})T\}$, which implies that, for given resources $(Y,T)$, the wife receives less consumption and leisure than under fixed $\mu$.

Figure 6A illustrates a case in which a decline in the wife's income shifts the Pareto frontier inward but is offset by an increase in the husband's income. On the new frontier (arc), the value of marriage $(V_w^M, V_h^M)$ under fixed $\mu$ is indicated by the gray dot. When the decision power shifts to $\hat{\mu}$ due to the change in relative income, the value of marriage

[34] With endogenous Pareto weights, divorce still occurs for sufficiently low match quality. The labor-market shock also leads to the divorce effect shown above because, with concave utility, the value of divorce for the wife decreases more than the value of marriage.

moves to the red star, where the tangent has slope $-\frac{1-\hat{\mu}}{\hat{\mu}}$.

Second, $\mu$ can change through renegotiation. In this framework with limited commitment, outside options play a critical role by shaping the intra-household decision power as follows. Suppose the value of marriage $(V_w^M, V_h^M)$ associated with a given $\mu$ fails to satisfy one spouse's participation constraint. Renegotiation allows the couple to adjust $\mu$ and modify the allocation so that the constraint holds with equality, achieving ex post efficiency (Kocherlakota 1996; Ligon et al. 2002). With renegotiation, divorce occurs only if no feasible allocation satisfies both participation constraints (Browning et al., 2014).

Figure 6B illustrates this point. Suppose that the husband's outside option rises from $V_h^D$ to $\hat{V}_h^D$ (solid vertical line), for example because his job opportunities improve. His participation constraint $P_h$ then tightens and is violated at the original allocation (gray dot). Without renegotiation, divorce occurs, resulting in the values $(V_w^D, \hat{V}_h^D)$ at the intersection of the outside options (black square). However, this outcome is inefficient because there exists a set of feasible Pareto-dominant allocations, represented by the solid arc northeast of the outside options. With renegotiation, the wife, who has a positive surplus from remaining married, accepts a shift in the Pareto weight from $\mu$ to $\hat{\mu}$, keeping the husband in the marriage and restoring individual rationality. The resulting values $(V_w^M, V_h^M)$ with $\hat{\mu}$ are such that $V_w^M > V_w^D$ and $V_h^M = \hat{V}_h^D$ (red star): $\hat{\mu}$ makes $P_h$ bind.[35]

In both cases, the Pareto weight decreases from $\mu$ to $\hat{\mu}$.[36] This shift reallocates relative resources toward the husband, irrespective of the post-shock level of total household resources. That is, the husband receives a larger share than under fixed $\mu$, whereas the wife receives a smaller share and lower welfare due to intra-household reallocation. We formalize this result in the following; the proof apprears in Appendix C.3.

**Proposition 2** [Intra-household Reallocation] *Suppose the Pareto weight $\mu$ decreases. Then the husband's consumption and leisure increase and his childcare time decreases, relative to the wife. That is, $c_h/c_w$ and $\ell_h/\ell_w$ increase and $n_h/n_w$ decreases.*

Finally, the unitary household model treats the family as a single decision maker and predicts income pooling, whereby only total household income matters for choices, not the income source. Since total household income did not change significantly for married couples after the earthquake (Table 5), this model cannot explain the observed

[35]The change in the Pareto weight $\lambda \equiv \mu - \hat{\mu}$ equals the Karush–Kuhn–Tucker multiplier of the participation constraint. See Appendix C.1.

[36]These channels are not mutually exclusive, so identifying how changes in economic conditions affect Pareto weights is empirically challenging. For instance, akin to the distribution-factor channel, Chiappori et al. (2002) consider divorce legislation as a distribution factor that affects decision power. On the other hand, similar to the renegotiation channel, Voena (2015) considers a situation where changes in divorce legislation affect allocations through changes in outside options.

intra-household reallocation, under stable individual preferences. Our empirical analysis therefore provides strong evidence against the unitary assumption.[37]

## 5.4 Welfare Analysis

In this section, we conduct a simple welfare analysis of the labor-market shock (see Appendix C.4 for details). The literature often relies on inferred sharing rules to study how shocks affect intra-household inequality, but such estimates may be biased (Chiappori and Meghir, 2015). In contrast, we directly observe intra-household allocations; together with estimated individual preferences, this allows us to quantify the effect on intra-household inequality without recovering sharing rules.

For this purpose, we augment the model to allow for preference heterogeneity across spouses and for two types of public goods (child-related expenditures and other general expenditures), both observed in the data. Preferences are $\alpha_{c,i}\log c_i + \alpha_{\ell,i}\log \ell_i + \beta_{c,i}\log q_c + \beta_{o,i}\log q_o$ with $\alpha_{c,i}+\alpha_{\ell,i}+\beta_{c,i}+\beta_{o,i}=1$ for $i \in \{w,h\}$, where $q_c$ is child-related expenditure and $q_o$ is the other general public good. The specification used earlier is a special case with $\alpha_{c,w}=\alpha_{c,h}=\alpha$, $\alpha_{\ell,w}=\alpha_{\ell,h}=1-\alpha$ and $\beta_{c,i}=\beta_{o,i}=0$. Including public goods does not alter the theoretical analysis above, but it may be quantitatively important because households devote a large share of expenditures to these goods. In Section 3.2, we find no statistically significant effect of the earthquake on public-goods expenditures.[38] Given that the household budget changes little (Section 4.1), we thus consider that the levels of public-goods expenditures $q_c$ and $q_o$ remain constant.

We focus on couples with a young child and quantify each spouse's welfare change using a leisure-equivalent variation. We use leisure- rather than consumption-equivalent variation because the specification includes three consumption types (private and two public), private consumption constitutes only a small share of total expenditures, and a consumption-based metric would therefore be misleading. Let $\phi_{c,i}$ and $\phi_{\ell,i}$ denote the proportional changes in private consumption and leisure for $i \in \{w,h\}$. With public-goods expenditures held constant, the welfare change $\eta_i$ is

$$\eta_i = \phi_{c,i}^{\frac{\alpha_{c,i}}{\alpha_{\ell,i}}}\phi_{\ell,i} - 1.$$

[37] A number of studies have tested and rejected the income-pooling hypothesis. Another approach to assessing the unitary assumption is to examine whether the Slutsky matrix derived from household demand functions is negative semidefinite and symmetric, though this is more demanding as it requires price variation (see Browning et al. 2014 and Chiappori and Mazzocco 2017).

[38] This finding can be explained by the fact that the demand for public goods depends on spouses' decision power $\mu$ and $1-\mu$, and unlike private consumption or leisure, shifts in $\mu$ are offset by opposite shifts in $1-\mu$.

In words, $\eta_i$ is the fraction of pre-earthquake leisure that agent $i$ would be willing to sacrifice to attain the same level of utility after the shock, on average, holding other components fixed.

We estimate $\phi_{c,i}$ and $\phi_{\ell,i}$ directly from the data (see Section 3.2). For the preference parameters, we rely on Chiappori et al. (2025), who estimate a collective household model with the JPSC under a similar specification. We find that the earthquake and the associated labor-market shock imply a 3.6% welfare loss in leisure-equivalent terms for wives and a 0.39% *gain* for husbands. Using pre-earthquake leisure in the treatment areas (Table 2), these translate into a 3.13-hour decrease in weekly leisure for wives and a 0.36-hour increase for husbands. This welfare gain for husbands is consistent with an increase in their outside option that induces intra-household reallocation. Because married women already consume less and have fewer leisure hours before the shock (Table 2), the reallocation further increases inequality within affected households.

A caveat of this analysis is that our calculation does not capture the total welfare effects of the shock. The simple model abstracts from many elements that may be quantitatively relevant—most notably children's welfare—so the exercise should be viewed as illustrating the direction of welfare changes for the affected population rather than their magnitude. Nevertheless, it is informative because it makes clear that negative shocks can affect family members differently. In particular, the gender-specific labor-market shock disproportionately reduces wives' welfare and exacerbates intra-household inequality.

# 6 Conclusions

This paper studies how an adverse economic shock affects divorce and intra-household resource allocation. We provide new causal evidence that the probability of divorce decreases in response to the shock and that both consumption and leisure are reallocated from wives to husbands. We demonstrate empirically and theoretically that a key driver is a gender-specific labor-market shock induced by the earthquake. This lowers the value of divorce for wives, whereas the value of marriage remains high due to family insurance through husbands' income compensation. The shock disproportionately reduces women's welfare and exacerbates intra-household inequality.

Our findings are relevant in broader contexts. Our empirical setting exploits a specific natural disaster in Japan, but the underlying mechanism—a gender-specific labor-market shock that shifts intra-household bargaining power—is widely applicable. For instance, climate change is increasing the frequency and severity of hurricanes and floods,

which destroy buildings and infrastructure and create high demand for reconstruction work (e.g., Groen et al., 2020), disproportionately benefiting male workers. Alon et al. (2020) argue that the pandemic recession differs from earlier downturns because social distancing disproportionately reduced employment in female-intensive sectors. Gender-specific labor-market shocks also arise in other contexts, such as import competition in female-intensive industries, gender-specific structural transformation, and automation. As in our study, such shocks can reallocate resources within households and exacerbate intra-household inequality, beyond their effects on aggregate household outcomes.

Our findings have important implications for policymakers. They suggest that generous welfare programs and strict child-support enforcement can help prevent sharp declines in the value of divorce, thereby improving women's welfare both after divorce and within marriage. Evaluating the effects of such policies on family structure and intra-household inequality within a structural framework is a key step toward practical policy design and will be a focus of our future work.

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# When Economic Shocks Reduce Divorce but Increase Intra-Household Inequality

## Online Appendix

Wataru Kureishi  Hannah Paule-Paludkiewicz

Hitoshi Tsujiyama  Midori Wakabayashi

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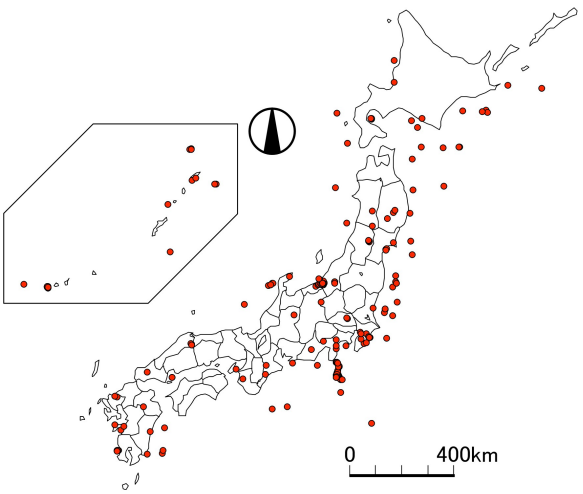
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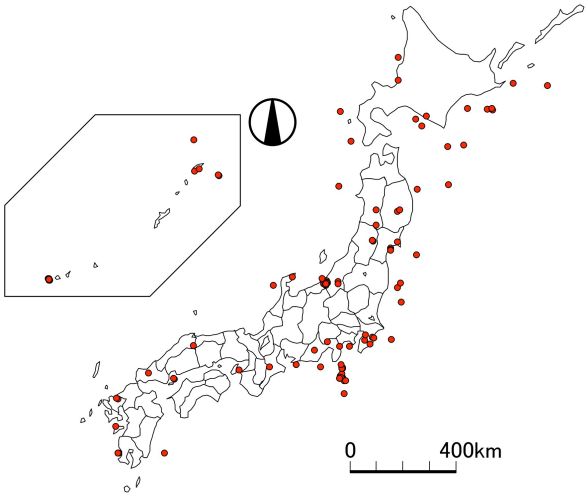
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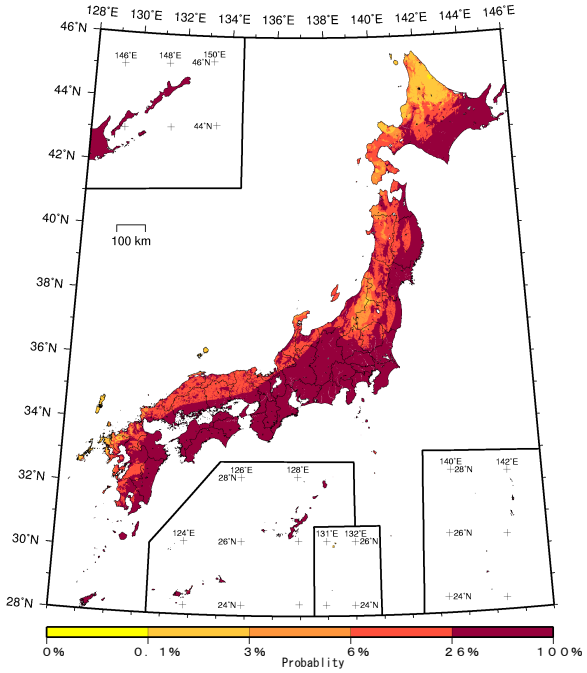
# A Appendix Figures and Tables



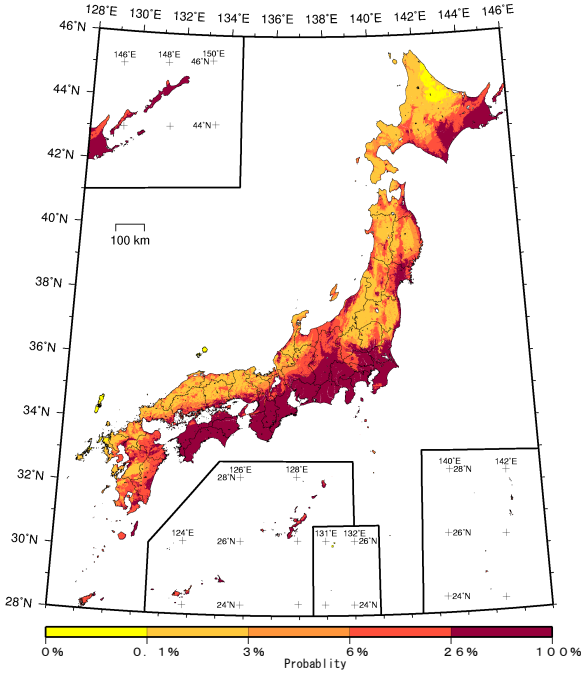

**(A)** Past Earthquakes: Seismic Intensity≥4.5




**(B)** Past Earthquakes: Seismic Intensity≥5




**(C)** Estimated Probablity: Seismic Intensity≥4.5




**(D)** Estimated Probablity: Seismic Intensity≥5

**Figure A.1:** Earthquake Hazard Map. The maps show the occurrence of large earthquakes between 1980 and 2010 (Panels A and B) and the estimated 30-year probability (as of 2010) of a large earthquake (Panels C and D). Panels A and C use an intensity of 4.5; Panels B and D use 5. Source: Japan Meteorological Agency and Headquarters for Earthquake Research Promotion (2010).

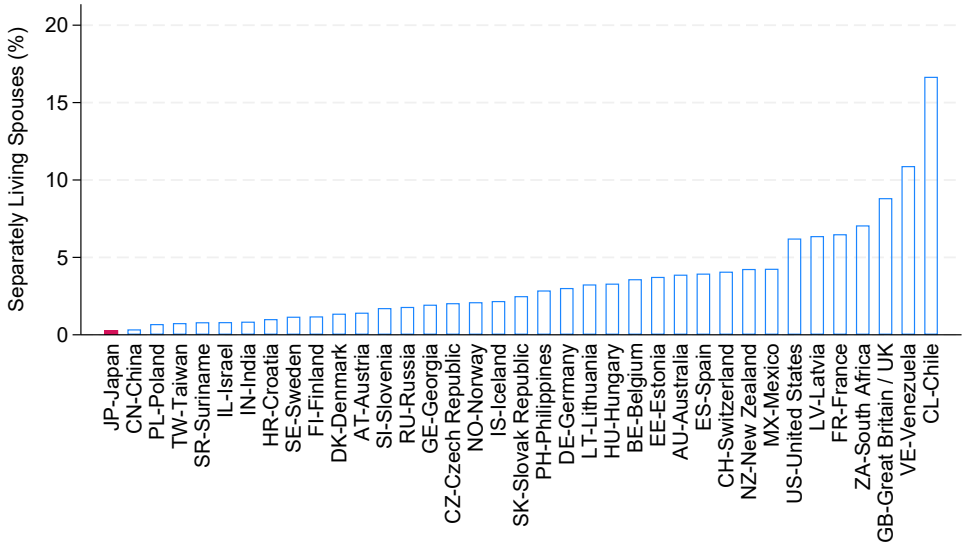



**Figure A.2:** Percentage of Married Couples Living Separately across Countries. Source: ISSP Research Group (2017)

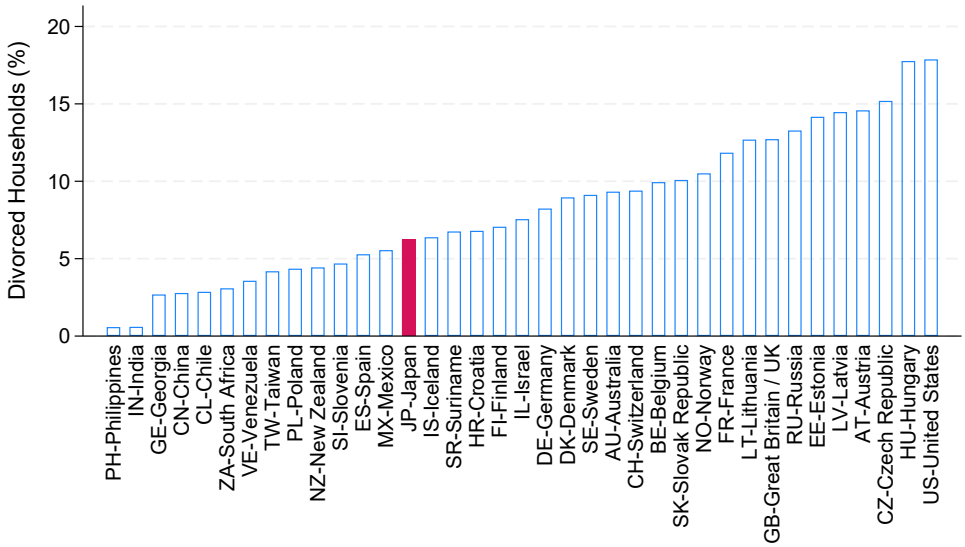
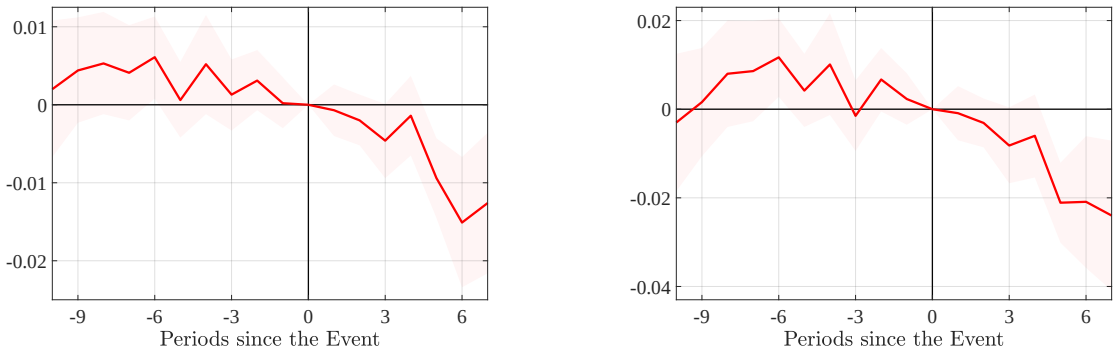



**Figure A.3:** Percentage of Divorced Households in the Population across Countries. Source: ISSP Research Group (2017)




**(A)** Treatment: seismic scale $\geq 4.5$ **(B)** Treatment: seismic scale $\geq 5$

**Figure A.4:** Dynamic Effect of the Earthquake on Divorce (Baseline 2011). The figure shows estimates of the impact of the earthquake on divorce using the dynamic difference-in-differences estimation (2) based on the LSN2001 dataset, with 2011 as the base year. The estimation includes household fixed effects, year fixed effects, a control for the number of children, and a control for co-residence with grandparents. The solid red line plots the coefficients on the year-treatment interaction terms. Shaded areas denote 90% confidence intervals. Standard errors are clustered at the municipality level.

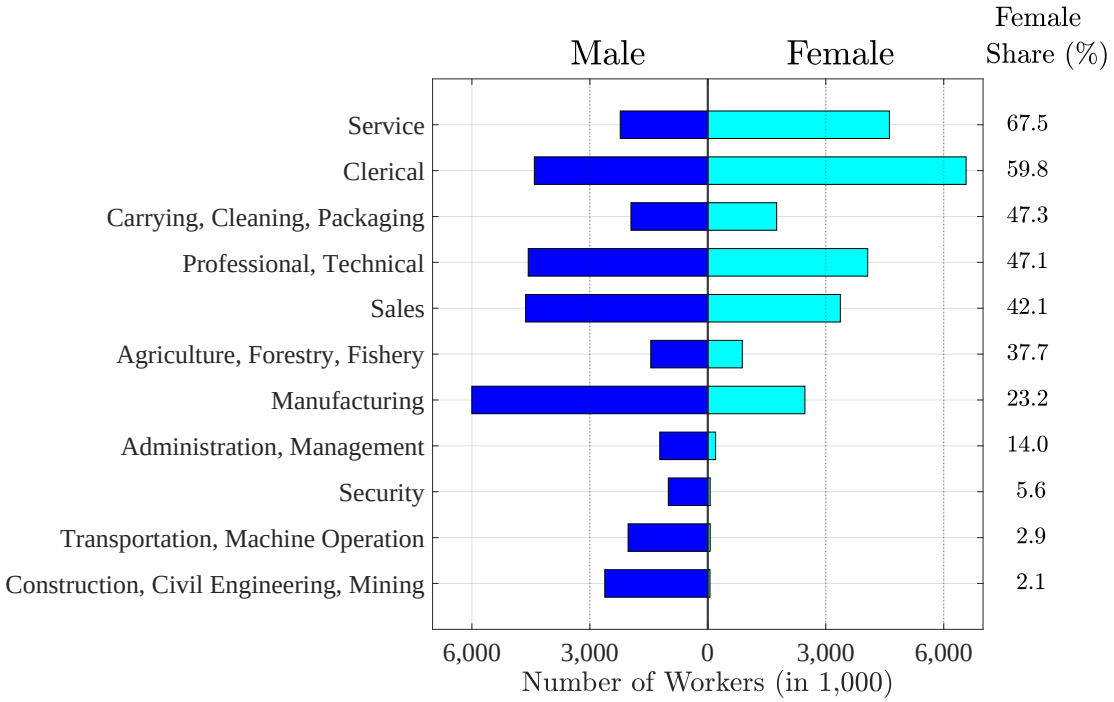
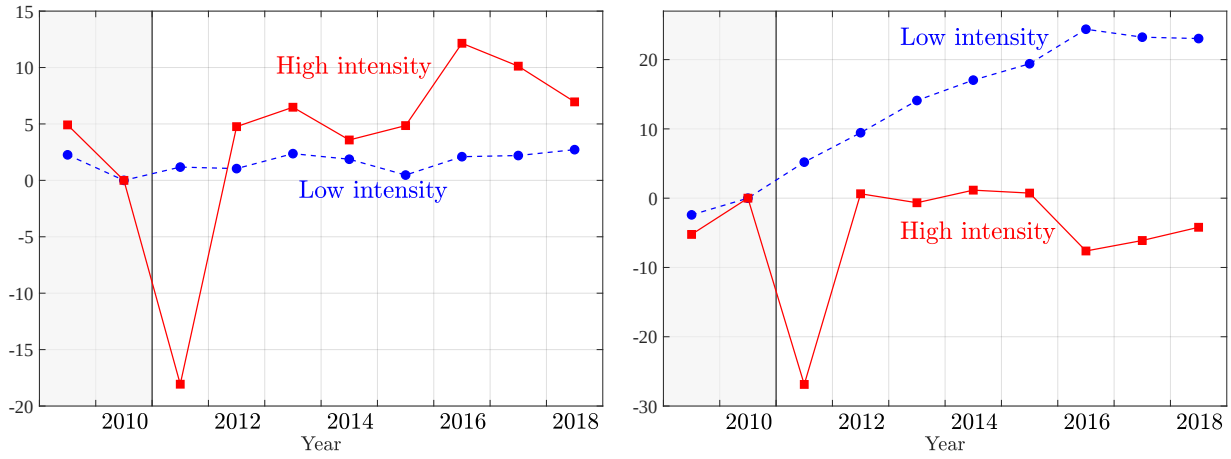
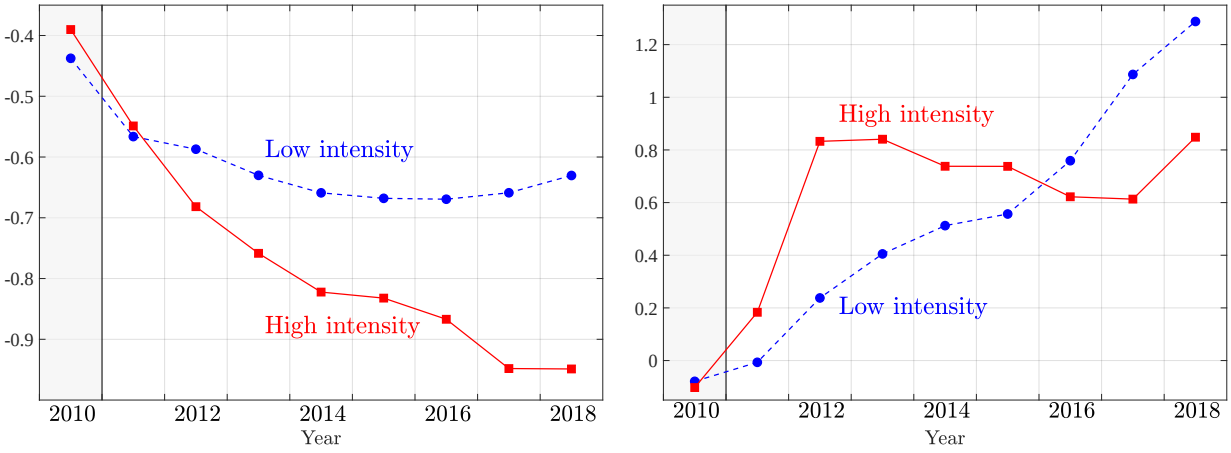



**Figure A.5:** Number of Employees by Gender in Major Industries (2010). Industries are ordered by the proportion of female workers, shown on the right axis. Source: 2010 Population Census.




**(A)** Secondary Sector **(B)** Tertiary Sector

**Figure A.6:** Sectoral Employment. The figure plots the number of employees in the secondary and tertiary sectors (percent change relative to 2010). The high-intensity prefectures are Fukushima, Iwate, and Miyagi. The vertical line indicates the timing of the earthquake. Source: Basic Survey of Japanese Business Structure and Activities.




**(A)** Female-Dominated Jobs **(B)** Male-Dominated Jobs

**Figure A.7:** Job Finding Rate by Occupation. The figure plots the number of job openings per job seeker. Panels A and B show the trend for female-dominated and male-dominated occupations, respectively, relative to gender-neutral occupations. We define a job as female-dominated (male-dominated) if the share of female (male) workers in the total number of workers in that occupation in 2010 exceeds 60%, and consider the rest as gender-neutral occupations. The high-intensity prefectures are Fukushima, Iwate, and Miyagi. The vertical line indicates the timing of the earthquake. Sources: Report on Employment Service, Ministry of Health, Labour and Welfare, and Census 2010.

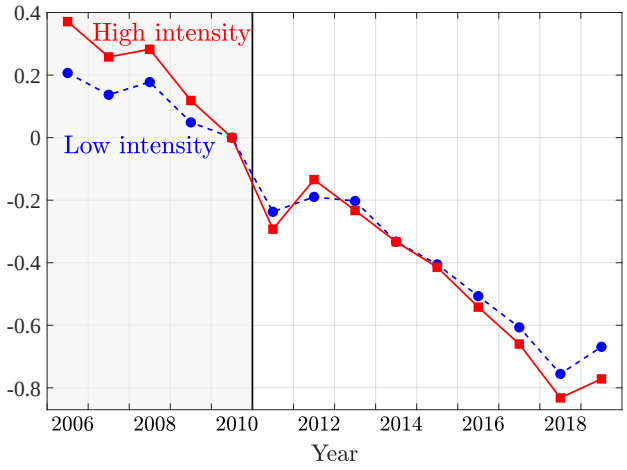



**Figure A.8:** Marriage Rates at the Prefecture Level. The figure plots the number of new marriages per 1,000 population, relative to 2010. The high-intensity prefectures are Fukushima, Iwate, and Miyagi. The vertical line indicates the timing of the earthquake. Source: Vital Statistics from the Ministry of Health, Labour and Welfare, population estimates from the Statistics Bureau, the Ministry of Internal Affairs and Communications.

**Table A.1:** Seismic Intensity Scale

| Seismic Intensity | Human Perception and Reaction | Indoor Situation | Outdoor Situation |
|---|---|---|---|
| 1 | Felt slightly by some people keeping quiet in buildings. | – | – |
| 2 | Felt by many people keeping quiet in buildings. Some people may be awoken. | Hanging objects such as lamps swing slightly. | – |
| 3 | Felt by most people in buildings. Felt by some people walking. Many people are awoken. | Dishes in cupboards may rattle. | Electric wires swing slightly. |
| 4 | Most people are startled. Felt by most people walking. Most people are awoken. | Hanging objects such as lamps swing significantly, and dishes in cupboards rattle. Unstable ornaments may fall. | Electric wires swing significantly. Those driving vehicles may notice the tremor. |
| 5 Lower (4.5 - 5) | Many people are frightened and feel the need to hold onto something stable. | Hanging objects such as lamps swing violently. Dishes in cupboards and items on bookshelves may fall. Many unstable ornaments fall. Unsecured furniture may move, and unstable furniture may topple over. | In some cases, windows may break and fall. People notice electricity poles moving. Roads may sustain damage. |
| 5 Upper (5 - 5.5) | Many people find it hard to move; walking is difficult without holding onto something stable. | Dishes in cupboards and items on bookshelves are more likely to fall. TVs may fall from their stands, and unsecured furniture may topple over. | Windows may break and fall, unreinforced concrete-block walls may collapse, poorly installed vending machines may topple over, automobiles may stop due to the difficulty of continued movement. |
| 6 Lower (5.5 - 6) | It is difficult to remain standing. | Many unsecured furniture moves and may topple over. Doors may become wedged shut. | Wall tiles and windows may sustain damage and fall. |
| 6 Upper (6 - 6.5) | It is impossible to remain standing or move without crawling. People may be thrown through the air. | Most unsecured furniture moves, and is more likely to topple over. | Wall tiles and windows are more likely to break and fall. Most unreinforced concrete-block walls collapse. |
| 7 | | Most unsecured furniture moves and topples over, or may even be thrown through the air. | Wall tiles and windows are even more likely to break and fall. Reinforced concrete-block walls may collapse. |

Note: The table summarizes how each seismic intensity level maps to the human perception, indoor/outdoor conditions, and damage. Source: Japan Meteorological Agency (https://www.jma.go.jp/jma/kishou/know/shindo/kaisetsu.html)

**Table A.2:** Effect of the Earthquake on Divorce (Different Specifications)

| | **Treat: seismic intensity $\geq$ 4.5** | | **Treat: seismic intensity $\geq$ 5** | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Specification | Logit | Dummy | Logit | Dummy |
| **A: Short run (–2014)** | | | | |
| *Treat*×*Post* | −0.198*** | −0.003* | −0.218* | −0.005* |
| | (0.069) | (0.002) | (0.119) | (0.003) |
| Observations | 276,446 | 276,446 | 276,446 | 276,446 |
| **B: Long run (–2018)** | | | | |
| *Treat*×*Post* | −0.209*** | −0.004** | −0.282*** | −0.008*** |
| | (0.057) | (0.002) | (0.100) | (0.003) |
| Observations | 383,318 | 383,318 | 383,318 | 383,318 |

Note: Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The table shows the impact of the earthquake on divorce using the difference-in-differences estimation (1) and the LSN2001 dataset. Panels A and B refer to the short- and long-run effects up to three and seven years after the earthquake, respectively. We use seismic-intensity cutoffs of 4.5 and 5 to define the treatment group. All specifications include year fixed effects, a control for the number of children, and a control for co-residence with grandparents. The specification "Logit" (columns 1 and 3) refers to a logit estimation. The specification "Dummy" (columns 2 and 4) uses a binary treatment variable instead of the kinked treatment variable and includes household fixed effects. Standard errors clustered at the municipality level are reported in parentheses.

**Table A.3:** Effect of the Earthquake on Income (Seismic Intensity Cutoff of 5)

| Sample | All Households | | | Dual Earners | | Single Earners |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Dependent variable | Female log Earnings | Male log Earnings | Household log Income | Female log Earnings | Male log Earnings | Male log Earnings |
| **A: Short run (–2014)** | | | | | | |
| *Treat*×*Post* | −0.998*** | 0.106** | 0.011 | −0.855*** | 0.106 | 0.052 |
| | (0.233) | (0.051) | (0.011) | (0.245) | (0.067) | (0.071) |
| Observations | 103,669 | 103,669 | 102,796 | 45,251 | 45,251 | 55,267 |
| **B: Long run (–2018)** | | | | | | |
| *Treat*×*Post* | −1.082*** | 0.150*** | 0.011 | −0.870*** | 0.134* | 0.063 |
| | (0.260) | (0.049) | (0.010) | (0.250) | (0.069) | (0.068) |
| Observations | 196,018 | 196,018 | 189,271 | 84,743 | 84,743 | 104,573 |

Note: Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The table shows estimates of the impact of the earthquake on income using the difference-in-differences estimation (1) based on the LSN2001 dataset. We use a seismic-intensity cutoff of 4.5 to define the treatment group. All specifications include household fixed effects, year fixed effects, a control for the number of children, and a control for co-residence with grandparents. Income (millions of JPY) is observed in 2005, 2008, and each year from 2013. Dual-earner couples are those with a full-time employed husband and an employed wife in 2008, the latest pre-earthquake year with income data. The dependent variable is log income: log individual labor earnings in columns (1-2) and log total household income (labor earnings of all household members plus other income) in column (3). Standard errors clustered at the municipality level are reported in parentheses.

**Table A.4:** Effect of the Earthquake on Labor Margins of Female Workers

| | Treat: seismic intensity ≥ 4.5 | | Treat: seismic intensity ≥ 5 | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Dependent variable | Employment | Hours | Employment | Hours |
| *Treat*×*Post* | −0.011* | −0.849*** | −0.033*** | −1.308*** |
| | (0.007) | (0.387) | (0.012) | (0.368) |
| Observations | 152,605 | 44,636 | 152,605 | 44,636 |

Note: Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The table shows estimates of the impact of the earthquake on labor margins of married female workers who were employed pre-earthquake using the difference-in-differences estimation (1) based on the LSN2001 dataset. We use seismic-intensity cutoffs of 4.5 and 5 to define the treatment group. All specifications include household fixed effects, year fixed effects, a control for the number of children, and a control for co-residence with grandparents. Hours worked, available for 2005, 2008, 2011, 2013, and 2017, are measured in four categories: less than 20 hours, 20-40 hours, 40-60 hours, and more than 60 hours. Columns (2) and (4) refer to the hours worked conditional on being employed. Standard errors clustered at the municipality level are reported in parentheses.

**Table A.5:** Effect of the Earthquake on Job Search of Married Women

| | **Treat: seismic intensity $\geq$ 4.5** | | **Treat: seismic intensity $\geq$ 5** | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Dependent variable | through 2012 | through 2013 | through 2012 | through 2013 |
| *Treat*×*Post* | 0.013*** | 0.007** | 0.021*** | 0.013** |
| | (0.004) | (0.004) | (0.008) | (0.007) |
| Observations | 150,811 | 169,953 | 150,811 | 169,953 |

Note: Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The table shows estimates of the impact of the earthquake on job search behavior of married women using the difference-in-differences estimation (1) based on the LSN2001 dataset. We use seismic-intensity cutoffs of 4.5 and 5 to define the treatment group. All specifications include household fixed effects, year fixed effects, a control for the number of children, and a control for co-residence with grandparents. Estimates are based on households that were a dual-earner couple in at least one period prior to the earthquake. Standard errors clustered at the municipality level are reported in parentheses.

**Table A.6:** Sectoral Migration of Married Male Workers

| | **Primary Sector** | | **Secondary Sector** | | **Tertiary Sector** | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Sample | All husbands | With a young child | All husbands | With a young child | All husbands | With a young child |
| *Treat*×*Post* | −0.003 | −0.002 | 0.037** | 0.042 | −0.032* | −0.031 |
| | (0.004) | (0.005) | (0.018) | (0.034) | (0.019) | (0.034) |
| Observations | 11,078 | 4,429 | 11,078 | 4,429 | 11,078 | 4,429 |

Note: Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The table shows estimates of the impact of the earthquake on husbands' sector of employment using the difference-in-differences estimation (1) based on the JPSC dataset. We use a seismic-intensity cutoff of 4.5 to define the treatment group. All specifications include household fixed effects, year fixed effects, a control for the number of children, and a control for co-residence with grandparents. Columns (1), (3) and (5) use the full sample of husbands; columns (2), (4) and (6) use husbands with a child under age ten in 2011. Standard errors clustered at the municipality level are reported in parentheses.

**Table A.7:** Heterogeneity by Presence of a Young Child

| Sample | **With a Young Child** | | **Without a Young Child** | |
|---|---|---|---|---|
| | (1) | | (2) | |
| **A. Divorce** | | | | |
| *Treat*×*Post* | −0.046** | | 0.012 | |
| | (0.020) | | (0.025) | |
| Observations | 3,889 | | 4,285 | |
| **B. Weekly Hours** | | | | |
| | Childcare/ Housework | Leisure | Childcare/ Housework | Leisure |
| *Treat*×*Post* | 8.753*** | −4.495** | 1.993 | 1.607 |
| | (2.808) | (2.129) | (2.217) | (2.377) |
| Observations | 3,749 | 3,749 | 2,608 | 2,608 |
| **C. Private Consumption Share** | | | | |
| *Treat*×*Post* | −0.083* | | 0.010 | |
| | (0.048) | | (0.029) | |
| Observations | 3,703 | | 3,610 | |

Note: Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The table shows estimates of the long-run impact of the earthquake on divorce and intra-household reallocation using the difference-in-differences estimation (1) based on the JPSC. We use a seismic-intensity cutoff of 4.5 to define the treatment group. All specifications include household fixed effects, year fixed effects, a control for the number of children, and a control for co-residence with grandparents. We divide the sample into couples with at least one child under age ten in 2011 and couples whose youngest child is over age fifteen or who have no children. Panel A reports divorce rates (in percentage points). Panel B reports wife's weekly hours minus husband's on a given activity. Panel C reports wife's private consumption minus husband's, divided by the total, and additionally controls for log household monthly income. Standard errors clustered at the municipality level are reported in parentheses.

# B Instrumental Variables Estimation

We conduct an instrumental-variables estimation that may provide more direct evidence of the proposed labor-market mechanism. This approach would allow us to isolate the earthquake-induced reduction in female earnings and estimate its effect on the probability of divorce.

Consider a fixed-effects two-stage least squares regression:

$$D_{irt} = \alpha_t + \alpha_i + \beta Y^w_{irt} + X'_{irt}\gamma + u_{irt}, \tag{B.1}$$

where $Y^w_{irt}$ denotes women's log earnings. A key challenge is that we cannot simply use the interaction $Treat_r \times Post_t$ as an instrument for $Y^w_{irt}$, because the exclusion restriction is unlikely to hold. The exclusion restriction requires that the instrument influence divorce only through women's income; however, as discussed in Section 4.3, the earthquake may also influence divorce via other channels.

To address this concern, we adapt an interaction-based instrumental-variables design (e.g., Bettinger et al., 2017). Specifically, we interact $Treat_r \times Post_t$ with $Full\text{-}Time_{ir}$, a dummy equal to one if the wife worked full time before the earthquake, and use this triple interaction as the excluded instrument for women's log earnings $Y^w_{irt}$. This interaction-term instrument is likely to be relevant, since, conditional on exposure, earnings reductions from earthquake-induced job loss should be larger for full-time female workers. Although the design still requires an exclusion restriction, it is more plausible than using only $Treat_r \times Post_t$: it requires that any other mechanism through which earthquake intensity affects divorce be homogeneous with respect to the wife's pre-earthquake full-time status. Importantly, this approach allows us to control for $Treat_r \times Post_t$ in both the first and second stages, thereby netting out mechanisms that do not vary with women's full-time status.

Table B.1 shows the results. In the first-stage regression in Panel A, the triple interaction term with the full-time dummy has a negative coefficient, consistent with our reasoning that losing a job due to the earthquake has a more negative effect on earnings for women with full-time jobs. The first-stage F-statistic suggests that the instrument is highly relevant. The second-stage result in Panel B shows a positive and statistically significant effect of female earnings on the probability of divorce, in line with the reduced-form evidence in Table 3. A 10% decrease in women's annual earnings reduces the probability of divorce by 0.04 percentage points.

**Table B.1:** Instrumental Variables Estimation

| | |
|---|---|
| **A: First Stage** (dep. var.: Female Log Earnings) | |
| *Treat*×*Post*×*Full-Time* | −6.223*** |
| | (0.349) |
| F-test (of excluded instruments) | 194.09 |
| p-value | 0.000 |
| **B: Second Stage** (dep. var.: Divorce Probability) | |
| Female log earnings | 0.004*** |
| | (0.001) |
| Observations | 182,188 |

Note: Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The table shows results of instrumental variables estimation (B.1) based on the LSN2001 dataset. We use a seismic-intensity cutoff of 4.5 to define the treatment group. We include household fixed effects, year fixed effects, a control for the number of children, and a control for co-residence with grandparents. We also control for *Treat*×*Post*. Female earnings are measured in million yen, and we use their logarithm. Standard errors clustered at the municipality level are reported in parentheses.

# C Theory Appendix

## C.1 A Generalized Model of Divorce

This appendix presents the general formulation of the model introduced in Section 5. The model in the main text is a special case that is suitable for analyzing the effects of the labor-market shock and for developing economic intuition.

**Environment.** Consider a married dual-earner couple with a child. The model has two periods. In period 1, the couple decides whether to divorce. In period 2, if they remain married ($M$), they choose intra-household allocations jointly; if they divorce ($D$), each spouse chooses separately.

The preferences for each spouse $i \in \{w, h\}$, where $w$ is the wife and $h$ is the husband, are represented by a utility function $u(c_i, \ell_i)$, where $c$ is private consumption and $\ell$ is leisure. If the couple stays married, individual utility is given by $u(c_i, \ell_i) + \theta_i$, where $\theta_i \in \mathbb{R}$ represents nonpecuniary benefits of marriage (match quality), is continuously distributed with cdf $F_\theta$, and is realized at the beginning of period 1. We assume that these nonpecuniary benefits of marriage are additively separable (Weiss and Willis, 1997).

Spouses enter the economy with exogenous incomes $(y_w, y_h) \in \mathbb{R}^2_{++}$. The employment

decision is denoted by $e_i \in \{0,1\}$ and the job-switching decision by $s_i \in \{0,1\}$. If $s_i = 1$, spouse $i$ earns $y_i'$. Each spouse is endowed with one unit of time. If $e_i = 1$, spouse $i$ spends $\varepsilon > 0$ units of time supplying market labor. Job-switching ($s_i = 1$) entails a fixed time cost $\kappa_i$. The child requires fixed parental time $\bar{n} > 0$. Assume $\bar{n} + \varepsilon + \kappa_i < 1$ to ensure feasibility under divorce.

We present a two-stage formulation. The model does not involve expectations, because match quality, the only source of uncertainty, is realized before the divorce decision. The framework can readily accommodate income and labor-market uncertainty. The savings decision can also be incorporated by introducing an intertemporal allocation stage at the beginning, similar to the three-stage formulation discussed in Chiappori and Mazzocco (2017).

**Period 2: Intra-Household Allocation Stage.** The problem of a divorcee in period 2 can be written as follows: for $i \in \{w,h\}$,

$$\begin{cases} V_i^D(y_i) = \max\limits_{\{c_i,\ell_i,n_i,e_i,s_i\}} & u(c_i,\ell_i), \\ \text{s.t.} & c_i \leq [(1-s_i)\,y_i + s_i y_i']\,e_i, \\ & \ell_i + n_i \leq 1 - e_i\varepsilon - s_i\kappa_i, \\ & n_i = \begin{cases} \bar{n} & \text{if } i = w, \\ 0 & \text{if } i = h, \end{cases} \end{cases} \tag{C.1}$$

where $n_i$ is childcare time. The first constraint is the budget constraint, and the second is the time constraint. The wife has custody of the child, which is represented by the third constraint.

Next, the problem of the married couple (8) is generalized. Denote by $\mu_i$ the Pareto weight (decision power) for $i \in \{w,h\}$ and write $\boldsymbol{\mu} = \{\mu_w, \mu_h\}$. In Section 5.1, we considered the case $\mu_w = \mu$ and $\mu_h = 1 - \mu$. Define the state variable $x \equiv \{y_w, y_h, \theta_w, \theta_h\}$. The married couple's problem is

$$\begin{cases} V^M(x,\boldsymbol{\mu}) = \max\limits_{\{c_i,\ell_i,n_i,e_i,s_i\}_{i\in\{w,h\}}} & \sum\limits_{i\in\{w,h\}} \mu_i\,[u(c_i,\ell_i) + \theta_i]\,, \\ \text{s.t.} & \sum\limits_{i\in\{w,h\}} c_i \leq \sum\limits_{i\in\{w,h\}} [(1-s_i)\,y_i + s_i y_i']\,e_i, \\ & l_i + n_i \leq 1 - e_i\varepsilon - s_i\kappa_i, \text{ for } i \in \{w,h\}, \\ & \sum\limits_{i\in\{w,h\}} n_i = \bar{n}. \end{cases} \tag{C.2}$$

The last constraint captures the fact that when spouses stay together, they share childcare time. In this model, resource pooling is the economic benefit of marriage.

The solution to this problem is denoted by $\{c_i^*, \ell_i^*, n_i^*, e_i^*, s_i^*\}_{i\in\{w,h\}}$. Analogous to equation (9), we have the value of marriage for each $i \in \{w,h\}$:

$$V_i^M(x,\boldsymbol{\mu}) = u(c_i^*(x,\boldsymbol{\mu}), \ell_i^*(x,\boldsymbol{\mu})) + \theta_i. \tag{C.3}$$

**Period 1: Divorce Decision Stage.** Given the state $x$, the couple decides whether to divorce under unilateral divorce. Accordingly, the problem of divorce reduces to an individual decision problem such that for $i \in \{w,h\}$,

$$V_i(x,\boldsymbol{\mu}) = \max\left\{V_i^M(x,\boldsymbol{\mu}), V_i^D(y_i)\right\},$$

where $V_i$ denotes individual indirect utility.

**Alternative Formulation and Renegotiation.** In Section 5.3 we discussed the possibility of renegotiation. To analyze this, we now combine the two stages. Given the value of divorce $V_i^D(\cdot)$ in (C.1), the married couple's problem can be written as

$$\begin{cases} V^M(x,\boldsymbol{\mu}) = \max\limits_{\{c_i,\ell_i,n_i,e_i,s_i\}_{i\in\{w,h\}}} & \sum\limits_{i\in\{w,h\}} \mu_i\left[u(c_i,\ell_i)+\theta_i\right], \\ \text{s.t.} & \sum\limits_{i\in\{w,h\}} c_i \le \sum\limits_{i\in\{w,h\}} \left[(1-s_i)\,y_i + s_i y_i'\right] e_i, \\ & \ell_i + n_i \le 1 - e_i\varepsilon - s_i\kappa_i, \text{ for } i\in\{w,h\}, \\ & \sum\limits_{i\in\{w,h\}} n_i = \bar{n}, \\ & u(c_i,\ell_i)+\theta_i \ge V_i^D(y_i), \text{ for } i\in\{w,h\}. \end{cases} \tag{C.4}$$

The last constraint is the participation constraint $P_i$ for each member $i \in \{w,h\}$.

There are three possibilities. First, both participation constraints are slack at the optimum. In this case, problem (C.4) reduces to problem (C.2). Second, there is no feasible allocation that satisfies both participation constraints simultaneously. That is, there is no solution to problem (C.4). In this case, the couple divorces and solves problem (C.1) separately. Finally, one participation constraint is slack, whereas the other is violated at the optimum. In this case, renegotiation of Pareto weights takes place.

We are particularly interested in the case where the wife's participation constraint $P_w$ is slack whereas the husband's $P_h$ is violated due to the labor-market shock associated with the earthquake. In this case, the Pareto weight is renegotiated and changes to $\hat{\boldsymbol{\mu}}$,

which makes the husband indifferent between marriage and divorce (Ligon et al., 2002; Mazzocco et al., 2013). That is,

$$\begin{cases} V^M(x,\hat{\boldsymbol{\mu}}) = \underset{\{c_i,\ell_i,n_i,e_i,s_i\}_{i\in\{w,h\}}}{\max} & \sum\limits_{i\in\{w,h\}} \hat{\mu}_i\left[u(c_i,\ell_i)+\theta_i\right], \\ \text{s.t.} & \sum\limits_{i\in\{w,h\}} c_i \leq \sum\limits_{i\in\{w,h\}} \left[(1-s_i)\,y_i + s_i y_i'\right] e_i, \\ & \ell_i + n_i \leq 1 - e_i\varepsilon - s_i\kappa_i, \text{ for } i\in\{w,h\}, \\ & \sum\limits_{i\in\{w,h\}} n_i = \bar{n}, \\ & V_h^M(x,\hat{\boldsymbol{\mu}}) = V_h^D(y_h), \end{cases} \tag{C.5}$$

where the value of marriage in the last constraint is given by equation (C.3).

The resulting $\hat{\mu}_h$ is given by $\hat{\mu}_h = \mu_h + \lambda_h$, where $\lambda_h \geq 0$ is the Karush-Kuhn-Tucker (KKT) multiplier on $P_h$. To see this, we follow the approach developed by Marcet and Marimon (2011), reformulating problem (C.4) as

$$\begin{cases} V^M(x,\boldsymbol{\mu}) = \underset{\{c_i,\ell_i,n_i,e_i,s_i\}_{i\in\{w,h\}}}{\max} & \sum\limits_{i\in\{w,h\}} \left\{\mu_i\left[u(c_i,\ell_i)+\theta_i\right] + \lambda_i\left[u(c_i,\ell_i)+\theta_i - V_i^D(y_i)\right]\right\}, \\ \text{s.t.} & \sum\limits_{i\in\{w,h\}} c_i \leq \sum\limits_{i\in\{w,h\}} \left[(1-s_i)\,y_i + s_i y_i'\right] e_i, \\ & \ell_i + n_i \leq 1 - e_i\varepsilon - s_i\kappa_i, \text{ for } i\in\{w,h\}, \\ & \sum\limits_{i\in\{w,h\}} n_i = \bar{n}, \end{cases} \tag{C.6}$$

where $\lambda_i \geq 0$ is the KKT multiplier on $P_i$. With this notation, the objective function becomes

$$\sum_{i\in\{w,h\}} \left\{\hat{\mu}_i\left[u(c_i,\ell_i)+\theta_i\right] - \lambda_i V_i^D(y_i)\right\},$$

where $\hat{\mu}_i = \mu_i + \lambda_i$, for $i\in\{w,h\}$.

In the case where both participation constraints are slack at the optimum, because of the complementary slackness, we have $\lambda_i = 0$ and $\hat{\mu}_i = \mu_i$, and thus the objective function reduces to the usual objective, i.e.,

$$\sum_{i\in\{w,h\}} \mu_i\left[u(c_i,\ell_i)+\theta_i\right].$$

Now consider the case where $P_w$ is slack whereas $P_h$ binds. This means $\lambda_w = 0$, which

gives $\hat{\mu}_w = \mu_w$, and $\lambda_h > 0$, which implies $\hat{\mu}_h > \mu_h$. Also, at the optimum,

$$u(c_h(x,\hat{\boldsymbol{\mu}}),\ell_h(x,\hat{\boldsymbol{\mu}})) + \theta_h = V_h^D(y_h).$$

Substituting these results into problem (C.6) yields

$$\begin{cases} V^M(x,\{\mu_w,\hat{\mu}_h\}) = & \max\limits_{\{c_i,\ell_i,n_i,e_i,s_i\}_{i\in\{w,h\}}} \quad \mu_w\left[u(c_w,\ell_w)+\theta_w\right] + \hat{\mu}_h\left[u(c_h,\ell_h)+\theta_h\right], \\ & \text{s.t.} \quad \sum\limits_{i\in\{w,h\}} c_i \leq \sum\limits_{i\in\{w,h\}} \left[(1-s_i)\,y_i + s_i y_i'\right] e_i, \\ & \quad \ell_i + n_i \leq 1 - e_i\varepsilon - s_i\kappa_i, \text{ for } i\in\{w,h\}, \\ & \quad \sum\limits_{i\in\{w,h\}} n_i = \bar{n}. \end{cases}$$

This is similar to the married couple's problem without participation constraints (C.2), but differs in that it assigns the husband a higher Pareto weight $\hat{\mu}_h > \mu_h$. The increase in weight is given by the KKT multiplier $\lambda_h$ on the participation constraint in problem (C.4).

## C.2 Proof of Proposition 1

**Family Insurance.** After the labor-market shock, the married couple jointly solves the following Pareto problem with job-switching decisions:

$$\begin{cases} \max\limits_{\{c_i,\ell_i,n_i,s_i\}} & \mu\left[\alpha\log(c_w)+(1-\alpha)\log(\ell_w)+\theta_w\right] + (1-\mu)\left[\alpha\log(c_h)+(1-\alpha)\log(\ell_h)+\theta_h\right], \\ \text{s.t.} & c_w + c_h \leq s_w y_w' + (1-s_h)y_h + s_h y_h', \\ & \ell_w + n_w \leq 1 - s_w(\varepsilon+\kappa_w), \\ & \ell_h + n_h \leq 1 - \varepsilon - s_h\kappa_h, \\ & n_w + n_h = \bar{n}. \end{cases}$$

Taking the first-order conditions (FOC) gives

$$\begin{aligned} c_w \quad &: \quad \mu\frac{\alpha}{c_w} + (1-\mu)\frac{-\alpha}{s_w y_w' + (1-s_h)y_h + s_h y_h' - c_w} = 0, \\ n_w \quad &: \quad \mu\frac{-(1-\alpha)}{1-s_w(\varepsilon+\kappa_w)-n_w} + (1-\mu)\frac{(1-\alpha)}{1-\varepsilon-s_h\kappa_h-(\bar{n}-n_w)} = 0. \end{aligned}$$

After some algebra, we obtain $\{c_w,c_h,\ell_w,\ell_h\} = \{\mu Y,(1-\mu)Y,\mu T,(1-\mu)T\}$, where $Y = s_w y_w' + (1-s_h)y_h + s_h y_h'$ and $T = 2-\bar{n}-s_w(\varepsilon+\kappa_w)-\varepsilon-s_h\kappa_h$.

Depending on the job switching decisions, we have four cases for aggregate household

resources:

$$(Y,T) = \begin{cases} (y_h, 2-\bar{n}-\varepsilon) & \text{if } s_w = 0 \text{ and } s_h = 0, \\ (y'_h, 2-\bar{n}-\varepsilon-\kappa_h) & \text{if } s_w = 0 \text{ and } s_h = 1, \\ (y'_w + y_h, 2-\bar{n}-2\varepsilon-\kappa_w) & \text{if } s_w = 1 \text{ and } s_h = 0, \\ (y'_w + y'_h, 2-\bar{n}-2\varepsilon-\kappa_w-\kappa_h) & \text{if } s_w = 1 \text{ and } s_h = 1. \end{cases}$$

Because $\kappa_h < \kappa_w < 1-\bar{n}-\varepsilon$, $T > 0$ in all cases. Given these cases, the couple optimally chooses $(s_w, s_h) = (0,1)$, so that family insurance operates, if and only if

$$\begin{aligned} \alpha\log(y'_h) + (1-\alpha)\log(2-\bar{n}-\varepsilon-\kappa_h) &\geq \alpha\log(y_h) + (1-\alpha)\log(2-\bar{n}-\varepsilon), \\ \alpha\log(y'_h) + (1-\alpha)\log(2-\bar{n}-\varepsilon-\kappa_h) &\geq \alpha\log(y'_w+y_h) + (1-\alpha)\log(2-\bar{n}-2\varepsilon-\kappa_w), \text{ and} \\ \alpha\log(y'_h) + (1-\alpha)\log(2-\bar{n}-\varepsilon-\kappa_h) &\geq \alpha\log(y'_w+y'_h) + (1-\alpha)\log(2-\bar{n}-2\varepsilon-\kappa_w-\kappa_h). \end{aligned}$$

Using the first condition, we obtain the necessary and sufficient condition for $y'_h$:

$$y'_h \geq \left(\frac{2-\bar{n}-\varepsilon}{2-\bar{n}-\varepsilon-\kappa_h}\right)^{\psi} y_h, \tag{C.7}$$

where $\psi = \frac{1-\alpha}{\alpha}$. Using this condition and the others above, we obtain, after some algebra, the sufficient condition for $y'_w$:

$$\begin{aligned} y'_w &\leq \Omega y_h, \qquad\qquad (C.8) \\ \text{where } \Omega &= \min\left\{\left(\frac{2-\bar{n}-\varepsilon}{2-\bar{n}-2\varepsilon-\kappa_w}\right)^{\psi} - 1, \left(\frac{2-\bar{n}-\varepsilon}{2-\bar{n}-2\varepsilon-\kappa_w-\kappa_h}\right)^{\psi} - \left(\frac{2-\bar{n}-\varepsilon}{2-\bar{n}-\varepsilon-\kappa_h}\right)^{\psi}\right\}. \end{aligned}$$

If men's job-search costs are sufficiently small and women's are sufficiently large, the conditions hold. Under (C.7-C.8), it is optimal for the couple to choose $(s_w, s_h) = (0,1)$, so that family insurance operates.

□

**Divorce Effects.** From equations (11-12), the probability of divorce decreases after the adverse shock if

$$\alpha\log\left(\frac{y_w}{y'_w}\frac{y'_h}{y_w+y_h}\right) + (1-\alpha)\log\left(\frac{2-\bar{n}-\varepsilon-\kappa_h}{1-\bar{n}-\varepsilon-\kappa_w}\frac{1-\bar{n}-\varepsilon}{2-\bar{n}-2\varepsilon}\right) > 0. \tag{C.9}$$

This condition is more likely to hold when $y'_w$ is low, $y'_h$ is large, $\kappa_w$ is high, and $\kappa_h$ is low.

Under condition (C.8), a sufficient condition for $y_h'$ is

$$y_h' > \left( \frac{2-\bar{n}-2\varepsilon}{2-\bar{n}-\varepsilon-\kappa_h} \cdot \frac{1-\bar{n}-\varepsilon-\kappa_w}{1-\bar{n}-\varepsilon} \right)^{\psi} \Omega \frac{y_w+y_h}{y_w} y_h.$$

Likewise, if condition (C.7) holds, a sufficient condition for $y_w'$ is

$$y_w' < \left( \frac{2-\bar{n}-\varepsilon}{2-\bar{n}-2\varepsilon} \cdot \frac{1-\bar{n}-\varepsilon}{1-\bar{n}-\varepsilon-\kappa_w} \right)^{\psi} \frac{y_w y_h}{y_w+y_h}.$$

There is one special case with a clear interpretation. Since $y_w' < y_w$, condition (C.9) is satisfied if the family insurance is substantial in the sense that

$$\frac{y_h'}{y_w+y_h} \geq \left( \frac{2-\bar{n}-2\varepsilon}{2-\bar{n}-\varepsilon-\kappa_h} \cdot \frac{1-\bar{n}-\varepsilon-\kappa_w}{1-\bar{n}-\varepsilon} \right)^{\psi}. \tag{C.10}$$

Moreover, condition (C.9) is more likely to be satisfied when women's job-switching costs $\kappa_w$ are higher, because the right-hand side decreases, reflecting a tighter time constraint for single mothers.

□

**Heterogeneous Divorce Effects across Family Income Types.** Consider a single-earner household. We add job-switching decisions to problem (6) before the adverse shock, with the wife's job opportunity given by $y_w$. Solving this problem yields the value of divorce

$$V_w^D(0) = \alpha \log(y_w) + (1-\alpha)\log(1-\bar{n}-\varepsilon-\kappa_w).$$

Likewise, solving problem (8), the value of marriage for the wife is given by equation (9) with $Y = y_h$ and $T = 2-\bar{n}-\varepsilon$.

Using these expressions and $P_w$, the probability of divorce before the earthquake is given by

$$F_\theta \left[ \alpha \log\left(\frac{y_w}{y_h}\right) + (1-\alpha)\log\left(\frac{1-\bar{n}-\varepsilon-\kappa_w}{2-\bar{n}-\varepsilon}\right) - \log(\mu) \right]. \tag{C.11}$$

This expression is similar to equation (11), but differs in two respects: the total household income is $y_h$ rather than $y_w+y_h$, and the wife bears the switching cost $\kappa_w$ upon divorce.

After the shock, the value of divorce becomes

$$V_w^D(0) = \alpha \log(y_w') + (1-\alpha)\log(1-\bar{n}-\varepsilon-\kappa_w).$$

For a single-earner household that remains married, the problem mirrors the dual-earner case, and the value of marriage for the wife is given by equation (9). The wife was not employed before the shock, with the job opportunity denoted by $y_w$, and the job opportunity becomes $y'_w < y_w$ after the shock, so $s_w = 0$. Hence household income does not fall because of the shock, and total resources need not rise above the pre-shock level unless $y'_h$ is sufficiently high. The value of marriage for the wife is therefore unchanged. Using these expressions and $P_w$, the probability of divorce after the earthquake is

$$F_\theta \left[ \alpha \log \left( \frac{y'_w}{y_h} \right) + (1-\alpha) \log \left( \frac{1-\bar{n}-\varepsilon-\kappa_w}{2-\bar{n}-\varepsilon} \right) - \log(\mu) \right]. \tag{C.12}$$

The probability of divorce after the shock (C.12) is lower than that before the shock (C.11), because the wife's job opportunity declines $y'_w < y_w$. Therefore, the divorce effect is also present for single-earner couples.

From equations (11-12) and (C.11-C.12), all else equal, the decrease in the probability of divorce is greater for the dual-earner couple than for a single-earner couple if condition (C.10) holds; in particular, if $y'_h$ is sufficiently high, the divorce effect is stronger for the dual-earner couple than for the single-earner couple.

*Q.E.D.*

## C.3 Proof of Proposition 2

By solving the Pareto problem (8), we obtain that relative consumption and leisure are pinned down solely by the Pareto weight,

$$\frac{c_h}{c_w} = \frac{1-\mu}{\mu} = \frac{\ell_h}{\ell_w},$$

so these ratios depend only on the Pareto weight. Thus, it follows immediately that when the Pareto weight falls from $\mu$ to $\hat{\mu}$ after the shock, both relative consumption $\frac{c_h}{c_w}$ and leisure $\frac{\ell_h}{\ell_w}$ increase, regardless of total household resources.

Using the time constraints (3-4), before the shock, we have $n_w = 1-\varepsilon-\ell_w$ and $n_h = \bar{n}-n_w = \bar{n}-1+\varepsilon+\ell_w$. Similarly, after the shock, solving the Pareto problem of the married couple gives $\hat{n}_w = 1-\hat{\ell}_w$ and $\hat{n}_h = \bar{n}-\hat{n}_w = \bar{n}-1+\hat{\ell}_w$, where a hat denotes the post-shock allocation. Combining these equations yields

$$\frac{n_h}{n_w} - \frac{\hat{n}_h}{\hat{n}_w} = \frac{\bar{n}(\varepsilon+\ell_w-\hat{\ell}_w)}{n_w \hat{n}_w}.$$

For the relative childcare time $\frac{n_h}{n_w}$ to decrease, it suffices to show that $\varepsilon + \ell_w - \hat{\ell}_w > 0$. Since $\mu > \hat{\mu}$,

$$\begin{aligned}
\varepsilon + \ell_w - \hat{\ell}_w &= \varepsilon + \mu(2 - \bar{n} - 2\varepsilon) - \hat{\mu}(2 - \bar{n} - \varepsilon) \\
&> \varepsilon + \hat{\mu}(2 - \bar{n} - 2\varepsilon) - \hat{\mu}(2 - \bar{n} - \varepsilon) \\
&> \varepsilon(1 - \hat{\mu}) \\
&> 0.
\end{aligned}$$

*Q.E.D.*

## C.4 Welfare Analysis

We conduct a simple welfare analysis of the labor-market shock. For this purpose, we augment the model to allow for preference heterogeneity across spouses and for two types of public goods (child-related expenditures and other general expenditures), both observed in the data. Preferences are $\alpha_{c,i} \log c_i + \alpha_{\ell,i} \log \ell_i + \beta_{c,i} \log q_c + \beta_{o,i} \log q_o$ with $\alpha_{c,i} + \alpha_{\ell,i} + \beta_{c,i} + \beta_{o,i} = 1$ for $i \in \{w, h\}$, where $q_c$ is child-related expenditure and $q_o$ is the other general public good.

Let $\phi_{c,i}$ and $\phi_{\ell,i}$ denote the proportional changes in private consumption and leisure for $i \in \{w, h\}$. Similarly, we denote the proportional changes in child-related and other general public good expenditures by $\phi_{q_c}$ and $\phi_{q_o}$, respectively. Given the pre-shock allocation $\{c_i, \ell_i, q_c, q_o\}$, the post-shock utility for $i \in \{w, h\}$ is

$$\alpha_{c,i} \log(\phi_{c,i} c_i) + \alpha_{\ell,i} \log(\phi_{\ell,i} \ell_i) + \beta_{c,i} \log(\phi_{q_c} q_c) + \beta_{o,i} \log(\phi_{q_o} q_o).$$

Define the welfare change $\eta_i$ as the leisure equivalent variation by solving

$$\begin{aligned}
& \alpha_{c,i} \log(c_i) + \alpha_{\ell,i} \log((1 + \eta_i)\ell_i) + \beta_{c,i} \log(q_c) + \beta_{o,i} \log(q_o) \\
= \; & \alpha_{c,i} \log(\phi_{c,i} c_i) + \alpha_{\ell,i} \log(\phi_{\ell,i} \ell_i) + \beta_{c,i} \log(\phi_{q_c} q_c) + \beta_{o,i} \log(\phi_{q_o} q_o),
\end{aligned}$$

which simplifies to

$$\alpha_{\ell,i} \log(1 + \eta_i) = \alpha_{c,i} \log \phi_{c,i} + \alpha_{\ell,i} \log \phi_{\ell,i} + \beta_{c,i} \log \phi_{q_c} + \beta_{o,i} \log \phi_{q_o}.$$

In Section 3.2, we find no statistically significant effect of the earthquake on public-goods expenditures. Given that the household budget changes little (Section 4.1), we

thus assume $\phi_{q_c} = 1$ and $\phi_{q_o} = 1$. It follows that

$$\eta_i = \phi_{c,i}^{\frac{\alpha_{c,i}}{\alpha_{\ell,i}}} \phi_{\ell,i} - 1.$$

We focus on couples with a young child. In the long-run, we estimate $\{\phi_{c,w}, \phi_{c,h}, \phi_{\ell,w}, \phi_{\ell,h}\} = \{1.073, 1.126, 0.957, 0.996\}$. For the preference parameters, we rely on Chiappori et al. (2025), who estimate a collective household model with the JPSC under a similar specification: $\{\alpha_{c,w}, \alpha_{c,h}, \alpha_{\ell,w}, \alpha_{\ell,h}\} = \{0.044, 0.055, 0.424, 0.821\}$. Using these values, we find that the earthquake and the associated labor-market shock imply a 3.6% welfare loss in leisure-equivalent terms for wives and a 0.39% gain for husbands. Pre-earthquake weekly leisure in the treatment areas is 87.07 hours for wives and 92.16 hours for husbands (Table 2). Thus, these welfare changes translate into a 3.13-hour decrease for wives and a 0.36-hour increase for husbands.

# References for Appendix


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