Long-Term Care and Family Caregiving

Job Market Paper

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Abstract

Adult children make up half of family caregivers of elderly individuals in the United States. Due to prolonged long-term care needs, family caregiving can have significant impact on adult children's labor supply and earnings trajectory. I provide empirical evidence that daughters bear the brunt of family care compared to sons due to lower opportunity costs and the role of gender identity norms. Motivated by the empirical evidence, I estimate a Cournot-Nash equilibrium model between a son and a daughter who are heterogeneous in wages and in 'preferences' for family care, which reflects how much weight a child puts on their family care responsibility. Using the structural estimates, I find that heterogeneity in 'preferences' for family care, rather than differences in opportunity costs, explain most of the gender gap in family caregiving. I quantify that daughters face 4.6% drop in lifetime earnings due to family caregiving compared to 1.5% drop for sons.

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1 Introduction

Rapid aging population coupled with higher life expectancy put many elderly individuals in need of long-term care (LTC) assistance in the United States. A large share of LTC is provided by the families of elderly individuals, particularly adult children. Due to high time intensity and persistence in duration, caring for an elderly parent can have long-run effect on employment and earnings of adult children. Empirical evidence shows that daughters provide majority of family care to elderly individuals, implying that the rising demand for LTC also has significant consequences for gender gap in employment and earnings. Despite its importance, the long-run effects of family caregiving on gender gap in employment and earnings have received little attention. My paper fills this gap by examining the interaction between family care decisions and labor market behavior of daughters and sons in response to parent's LTC needs over the life cycle.

My paper has three main objectives. First, I provide empirical evidence that caring for an elderly parent is a family decision involving sibling interactions. I focus on the differences in family care patterns between daughters and sons, and empirically investigate whether the differences are potentially shaped by gender identity norms. Second, I estimate a structural model capturing the strategic interaction between a daughter and a son who are heterogeneous in wages and in 'preferences' for family care. Third, I quantify the employment and earnings trajectory of daughters and sons using a life-cycle simulation of parent's LTC needs and adult children's wage processes.

I first document the following empirical facts. Elderly individuals with more children receive family care at a higher rate and from multiple children. Despite multiple children sharing family care responsibility, the majority of family care hours are provided by one adult child. I find that daughters who work less and earn less provide the majority of family care hours to elderly individuals. To explore the potential role of gender identity norms, I employ an event-study design to estimate the dynamic effects of parent's LTC needs on the family care propensity and family care hours of daughters and sons. I then examine the marginal effects of having a sibling of opposite gender on the family care behavior of daughters and sons. I find that sons are significantly less likely to provide family care both in terms of care propensity and care hours when they have a sister. However, having a brother does not change daughter's family care outcomes. This finding supports the growing empirical evidence on the role of gender identity norms in explaining the observed gender gap in time spent on care work and household production[1].

[1]See Cortés and Pan (2020) for a review of empirical evidence on gender identity norms, care work and household production.

Using these empirical facts, I motivate a Cournot-Nash equilibrium model capturing strategic interactions between a daughter and a son in making family care decisions. When a parent needs LTC, adult children enter a Cournot-Nash game of deciding how many family care hours to provide for parental well-being, which is reflected as a family public good. In addition to providing family care, adult children simultaneously decide how much to work and consume. There are two main channels that shape how daughters and sons decide their family care hours. First, they have different opportunity costs in terms of wages. Second, they are heterogeneous in 'preferences' for family care. The presence of parental well-being as a public good allows for interdependency between adult children such that they decide their consumption, employment and family care not only based on their own wages and preferences but also based on their sibling's. The structural model allows me to disentangle and quantify the differential effects of these two channels on family care and labor market outcomes of daughters and sons.

I use the pooled 1998-2014 Health and Retirement Study (HRS) to estimate the model. I employ simulated method of moments to estimate the model in two stages. In the first stage, I focus on the period when parents are healthy and adult children do not have to provide care, and estimate structural parameters describing the labor market behavior of daughters and sons. This allows me to pin down the structural parameters that capture the differences in labor market behavior of daughters and sons before parent's LTC needs. In the second stage, I focus on the period when elderly parents need LTC due to decline in health. Conditional on the first-stage parameters, I estimate the second set of structural parameters capturing family care decisions of daughters and sons. The model fits important features of labor supply and the distribution of family care hours between daughters and sons.

To quantify the life-cycle trajectory of employment and earnings, I simulate the life cycle profile of parent's LTC needs and adult children's wages. I use a first-order markov model to estimate the transition probabilities of parent's LTC needs and a random walk process to estimate the wage profiles of daughters and sons. I focus on 20 year period when the elderly parent is aged between 65 and 85, which roughly corresponds to the age range of adult children from 40s to mid 60s. This covers adult children's high earning years leading up to retirement, making it ideal to examine the effects of parent's LTC needs on the earnings trajectory of adult children. Using the structural estimates, I quantify the life-cycle trajectory of family care, employment and earnings of daughters and sons according to the simulated life-cycle profiles of LTC needs and wage processes. The model replicates the life-cycle profiles of family care, employment and earnings of daughters and sons.

I run two counterfactual exercises. The first is to show how much of the gender gap in family care hours is driven by differences in opportunity costs as opposed to heterogeneity

in 'preferences' for family public good between daughters and sons. To do so, I simulate a scenario where daughters and sons have the same 'preferences' for family public good. The second exercise quantifies the foregone lifetime earnings due to parent's LTC needs and examine the differences in foregone earnings for daughters and sons. I compute the foregone earnings by finding the differences in lifetime earnings in the presence of parent's LTC needs and the lifetime earnings in the absence of parent's LTC needs.

I find that differences in wages explain a small part of the gender gap in family caregiving. On the other hand, differences in 'preferences' for public good along with differences in wages between daughters and sons explain the large gap in family care hours in the HRS data. When considered only heterogeneity in wages, only 8% of the gender gap in family care hours is explained by the model compared to the 98% explained by the model with heterogeneity in 'preferences' in addition to wages. By running the counterfactual exercise to quantify foregone earnings, I find that earnings drop by 4.6% on average for daughters compared to 1.5% for sons over the 20 year period considered. If daughters and sons have the same 'preferences' for public good but still show gender gap in wages, the foregone earnings would lower to 1.3% for daughters and 0.8% for sons.

My paper contributes to three main strands of literature. First, I contribute to a growing literature examining the role of adult children in long-term care decisions for the elderly. Several studies have focused on the strategic interaction between an elderly parent and an adult child to capture the role of family care in meeting the LTC needs for the elderly parent (Barczyk and Kredler 2018; Ko 2021; Mommaerts 2021; Skira 2015; Fahle 2020). However, by focusing on one adult child and their interaction with an elderly parent, these studies do not capture the strategic interaction among multiple adult children in who gets to be the caregiver to their aging parents. Engers and Stern (2002), Byrne et al. (2009) and M. Brown (2006) consider the role of multiple adult children in providng care to an elderly parent using a non-cooperative Cournot-Nash model. Engers and Stern (2002) allows for financial transfers between adult children so that they can elicit each other to become the primary caregiver to their parents instead of providing care themselves. Byrne et al. (2009) incorporates formal home care and simultaneous decision to provide care and work. M. Brown (2006) examines the bequest motive of adult children in providing family care to their aging parents. My paper contributes to their theoretical framework by focusing on the effects of heterogeneity in wages and in 'preferences' for family care between daughters and sons.

Second, my paper also contributes to the extensive literature on family caregiving and labor market outcomes. At the extensive margin, most studies find a negative relationship between labor force participation and family care (Bolin, Lindgren, and Lundborg 2008; Crespo 2008; Heitmueller 2007; Lilly, Laporte, and Coyte 2007). Based on cross-sectional

evidence in the United States, family caregiving has a negligible effect on labor supply at the intensive margin (Bolin, Lindgren, and Lundborg 2008; Lilly, Laporte, and Coyte 2007). However, using the panel HRS data, Van Houtven, Coe, and Skira (2013) finds modest decreases in market hours for female caregivers but little effect for male caregivers. Based on the counterfactual scenario without parent's LTC needs, I find a modest drop in labor force participation and market hours of adult children. The reduction in market hours at the intensive margin are stronger for daughters compared to sons, which is consistent with the findings of Van Houtven, Coe, and Skira (2013). For female caregivers in the United States, Van Houtven, Coe, and Skira (2013) finds 3% decrease in current wages but negligible effect for male caregivers. Using a dynamic, structural model between a parent and a daughter, Skira (2015) finds a median value of $51,780 in lifetime foregone earnings. Using the structural estimates and life-cycle simulation, I find comparable results to Van Houtven, Coe, and Skira (2013) and Skira (2015) in terms of current and lifetime foregone earnings due to family care.

Lastly, I contribute to the literature on investigating the role of gender identity norms in explaining the gender gap in care activities and household production. With the exceptions of Grigoryeva (2017) and Barigozzi, Cremer, and Roeder (2017), the literature extensively focuses on the interaction between married spouses in deciding the division of childcare and household production (e.g., Cortés and Pan 2020; Ichino et al. 2019; Lundberg and Pollak 2008). Using cross-sectional evidence, Grigoryeva (2017) finds that the gender composition of siblings has differential effects on the family care behaviors of daughters and sons. Based on longitudinal data and event-study estimation, my findings support the results of Grigoryeva (2017): having a sister lowers care propensity and care hours of sons while having a brother does not have a significant effect on daughter's family caregiving. Barigozzi, Cremer, and Roeder (2017) incorporates the role of gender identity norms in an intergenerational bargaining model between a parent and multiple adult children. In their model, daughters and sons provide family care to their aging parents out of 'guilt', which is reflected as different disutility costs for daughters and sons if they do not provide care. Rather than a disutility, I consider parental well-being as a family public good, to which adult children have altruistic motives to contribute. Moreover, by using a non-cooperative framework, I relax the assumption of income pooling between adult children under cooperative models.

The paper is organized as follows. Section 2 provides empirical evidence on the multiple children interactions in family care decision-making and the role of gender identity norms in explaining the gender gap in family caregiving. Section 3 describes the model. Model estimation strategy is discussed in Section 4, and results and model fit are presented in Section 5. Section 6 presents results from counterfactuals. Section 7 concludes.

2 Empirical Evidence

This section provides three main empirical facts regarding family caregiving of adult children. First, providing care to an elderly parent requires a family decision-making process involving sibling interactions. Second, daughters who work less and earn less provide majority of family care to elderly parents. Third, the role of gender identity norms may explain the persistent gender gap in family caregiving among daughters and sons.

2.1 Data

I use the pooled Health and Retirement Study (HRS) between 1998 and 2014. The HRS follows a nationally representative individuals over 50 years old since 1992. The survey provides a rich set of information about elderly individuals regarding their health, income, asset, formal care use and family care receipt. In addition, the HRS collects information on adult children of the elderly individuals in terms of demographic characteristics, employment and income in addition to whether and how much a child provides family care to their elderly parent.

Within the context of the paper and the HRS data, the following definitions regarding LTC needs and family care are used. LTC needs are defined as assistance performing Activities of Daily Living (ADLs) or Instrumental Activities of Daily Living (IADLs). In the HRS, the set of ADLs include six activities: bathing, dressing, eating, getting out of bed, walking across the room, and using the toilet. The set of IADLs include five activities: grocery shopping, making meals, managing money, using a phone, and taking medication. In this paper, family care is defined as unpaid LTC assistance provided by adult children of elderly individuals.

The sample construction is as follows. I first restrict the sample to 65+ single elderly individuals who consecutively interviewed between 1998 and their death or the last wave of interview in 2014. Since I focus on adult children interactions, I further restrict the sample to individuals with at least two children who are aged 21 and above. Lastly, I focus on elderly parents who experience LTC needs and who receive family care from at least one adult child between 1998 and 2014[2]. I focus on single elderly individuals and their adult children for two main reasons. First, single elderly individuals rely mainly on adult children for family care compared to married elderly individuals who rely more on spousal caregiving (Barczyk and Kredler 2019). Second, focusing on adult children makes it ideal to study the interaction between family care decision and employment. Adult children are often still in the labor force when their parents experience LTC needs.

[2]See Appendix A for the sample details.

Table 1 disaggregates the HRS sample by number of adult children and what percentage relied on family care from an adult child during 1998-2014. Overall, 83% of the sample have two or more children, and above 81% relied on family care from at least one adult child.

Table 1: Number of Adult Children and Family Care

	Number of children					
	1	2	3	4	5+	Total
% of sample	17.1	26.8	19.9	13.6	22.6	100
% of sample receive family care	70.1	79.6	79.3	89.4	86.5	81.0

Notes: The sample includes 65+ single who experienced at least one limitation with ADL or IADL at some point in the pooled 1998-2014 Health and Retirement Study. The first row reports the share of individuals by number of adult children. The second row shows the share that received family care from at least one adult child over the sample period, split by number of children.

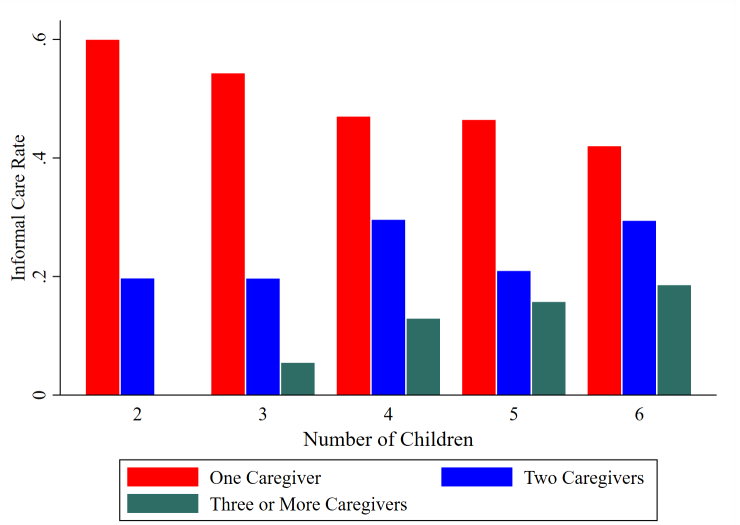
2.2 Family Care and Adult Children

Figure 1 presents the share of elderly individuals in terms of how many caregiver children they had during the 1998-2014 sample period. Getting help from only one child is the most common arrangement for families. However, the share of elderly parents with multiple caregivers become more common for those with more children. Receiving family care from two or more children roughly makes up 50% of families with six or more children, suggesting that caring for an elderly parent is a family decision involving sibling interactions[3].

Table 2 reports the family care patterns of adult children based on whether they provide care alone ("One Caregiver") or together with their siblings ("Multiple Caregivers") during the 1998-2014 sample period. For families with one caregiver, the caregivers provide an average of 24.2 weekly family care hours. These caregivers provide more than 20 weekly hours of family care for 29% of the time over the sample period. For families with multiple caregivers, the caregivers provide an average of 18.2 weekly hours of family care with a median of 6 hours, which are significantly lower than the care hours of those who provide care alone. Among multiple caregivers, I define a primary caregiver as the child that provides the most total hours of family care to their elderly parent over the sample period, compared to their other caregiver siblings. The mean family care hours of primary caregivers among the multiple caregivers is 26.1 weekly hours with a median of 7.75 hours. The family care patterns of the primary caregivers among multiple caregivers resemble the patterns of caregivers who provide care alone. This shows that even though multiple caregiver arrangements are common for families, the bulk of family care is done by one primary caregiver among multiple caregivers.

[3]See Appendix B for more descriptive on the types of care arrangements observed between adult children.

Figure 1: Number of Adult Children Caregivers



Notes: The sample includes 65+ single individuals who have two or more adult children and receive family care from at least one child in the pooled 1998-2014 Health and Retirement Study. The table records the share of individuals who receive care from one child (red bars), two children (blue bars) or three of more children (green bars) over the sample period, disaggregated by number of children. Number of children equals to six when an individual has six or more children.

In fact, 73% of the total family care hours are done by the primary caregivers in families with multiple caregivers[4].

Table 2: Caregiving Patterns

	One caregiver	Multiple Caregivers
Family care hours (mean/median)	24.2/7.5	18.2/6
Family care hours | primary caregiver		26.1/7.75
Provides $\geqslant$ 20 hrs/wk	0.29	0.23
Provides $\geqslant$ 20 hrs/wk | primary caregiver		0.33
% of hours by primary caregiver	100.0	0.73

Notes: The sample includes all adult children of 65+ single individuals who has two or more adult children and receive family care from at least one child in the pooled 1998-2014 Health and Retirement Study. 'One Caregiver' refers to families with only one adult child providing family care and 'Multiple Caregivers' refers to families with more than one adult child providing family care during sample period. Primary caregiver is the child that provides the most total hours of family care to their elderly parent, compared to their other caregiver siblings if any, over the sample period.

This section provides empirical evidence that providing family care to elderly parents is a family decision involving sibling interactions. Multiple adult children step up to care for

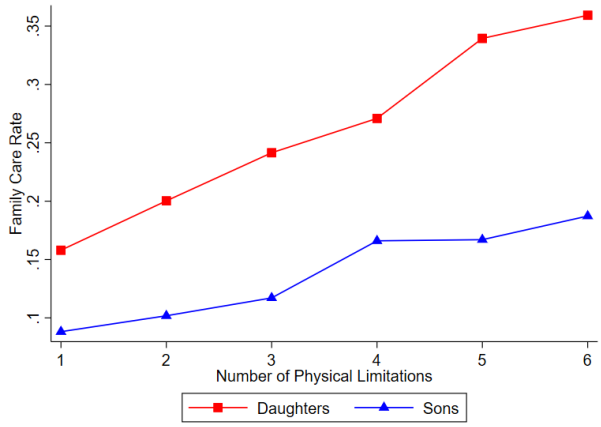
[4]This finding is consistent with the trend that 'lone' caregivers are the most common arrangement for family caregiving (Wolff and Kasper 2006).

their aging parents with LTC needs. However, the majority of family care is done by one adult child among multiple children.

2.3 Gender Gap in Family Caregiving

Figure 2 presents the shares of daughters and sons providing family care according to the number of ADL the elderly parent needs assistance with. The set of ADL includes six activities: bathing, dressing, eating, getting out of bed, walking and toileting. When the parent needs help with more ADL, the share of daughters providing care increases significantly compared to the share of sons. When a parent needs help with all six activities, roughly 35% of daughters provide care to their elderly parent while 18% of sons provide care. At the intensive margin, the average weekly hours of family care for these daughters is 35 hours per week, whereas the average weekly hours for the sons is 15 hours[5].

Figure 2: Family Care Rate by Gender of Adult Children



Notes: The sample includes all adult children of 65+ single individuals in the pooled 1998-2014 Health and Retirement Study. The figure reports the share of daughters (red line) and sons (blue line) who provide family care to their elderly parent, disaggregated by the number of activities the elderly parent needs assistance with. The set of activities: bathing, dressing, eating, getting out of bed, walking and toileting.

Table 3 presents the characteristics of adult children based on whether and how many hours of family care they provide to their elderly parent. Daughters make up 70% of children who provide more than 20 hours of family care per week. Among children who provide less than 20 hours per week, the majority are still daughters at 59%. Adult children, who provide less than 20 hours of care per week, are similar in terms of employment status and earnings to adult children who do not provide care. On the other hand, adult children who provide more than 20 hours of family care per week are less likely to work and earn higher income

[5]Author's calculation using the HRS data.

compared to the other two groups of adult children. This shows that daughters increasingly take on the caregiving role as parent's LTC needs intensify and they are less attached to the labor market in addition to earning less compared to adult children who provide no or less family care[6].

Table 3: Labor Market Characteristics of Adult Children by Caregiving Patterns

	Provide Care		Not Provide Care
	$\geqslant$ 20 hrs/wk	<20 hrs/wk	
Age	53.5	53.5	53.6
Female	0.70	0.59	0.44
Full-time employment	0.48	0.63	0.62
Part-time employment	0.10	0.09	0.07
Non-employment	0.42	0.27	0.31
Earnings $\geq \$35,000$	0.37	0.64	0.60
Earnings $\geq \$70,000$	0.05	0.12	0.12
Family care (hrs/wk)	45/28	5/3	-
Observations	3,271	7,176	14,526

Notes: The sample includes all adult children of 65+ single individuals who has two or more adult children and receive family care from at least once child in the pooled 1998-2014 Health and Retirement Study. The table reports the characteristics of children based on whether and how many hours they provide care to their parent. 'Not-employment' includes adult children who are unemployed or out of the labor force. For family care hours, the mean/median hours are reported.

2.4 Heterogeneity in Preferences and the Role of Gender Identity Norms

This section documents the heterogeneity in 'preferences' for family care among adult children, particularly between daughters and sons. While different opportunity costs and labor market behavior may explain the gap in family caregiving between daughters and sons, I argue that it does not capture the whole story and that heterogeneity in 'preferences' may play a role in how daughters and sons perceive family care responsibilities. Using point blank survey questions, Cox and Soldo (2013) finds evidence that caregiver's own perception of feeling responsible for a family member or family norms of obligations and traditions play a role in the care decisions for the elderly. I focus on one aspect of norms of obligations and traditions: the role of gender identity norms in shaping preferences for family care among daughters and sons. Akerlof and Kranton (2000) define identity as one's sense of belonging to a social group (those of "man" vs. "woman") along with a view on how one should behave according

[6]See Appendix C for an extended table.

to the norms and expectations of the social group. In the context of family care decisions, adult children may identify with a norm such that taking care of an elderly parent is the daughter's responsibility rather than the son's. This notion of gender identity norm such that daughters are responsible for caretaking or the fact that daughters internalize the norm is empirically supported in the literature. For example, Healy and Malhotra (2013) find that having sisters result in young men having more conservative attitudes regarding gender roles whereas Brenøe (2022) suggests evidence that having a brother relative to a sister increases women's traditional gender role attitudes as measured through occupational and partner choices[7].

To illustrate the potential role of gender norms in family care decisions, I examine how daughters and sons behave in sibling groups with different gender composition. Specifically, I categorize sibling groups into three groups: 1) those consisting of at least one sister and at least one brother in mixed-gender sibling groups, and those consisting of 2) only sisters, and 3) only brothers in single-gender sibling groups. Examining the family care behaviors of daughters and sons across these sibling groups allows us to explore the role of gender identity norms. In the presence of gender norm such that caregiving is the daughter's responsibility, we expect to observe that sons provide less family care in the mixed-gender sibling groups compared to sons in the single-gender groups. On the other hand, having a brother should not have have significant effect on daughter's family caregiving.

Event Study Methodology

This section estimates the effects of parent's LTC needs on family care propensity and family care hours of daughters and sons separately. To explore the role of gender identity norms across mixed-gender and single-gender sibling groups, I additionally examine the marginal effects of having a sibling of opposite gender on family care outcomes of daughters and sons. To estimate these effects, I use two-way fixed effects model with event-study specification. de Chaisemartin and D'Haultfœuille (2022) discusses the bias of two-way fixed effects estimation when treatment effects are heterogeneous over time. Since parent's LTC needs are likely to worsen over time, I employ an event-study specification and estimate the time-varying effects of parent's LTC needs on family caregiving of adult children. Specifically, I estimate the following fixed effects event-study regression for sons and daughters:

$$Y_{ist} = \alpha_i + \beta D_{ist}^{Event} + \gamma Z_i \times D_{ist}^{Event} + \mu D_{ist}^{Age} + \theta X_{ist} + \lambda_t + \nu_{ist} \tag{1}$$

[7]See Cortés and Pan (2020) for more evidence on what drives gender norms in the context of marriage, occupational choice and the division of household labor.

where Y_{ist} denotes the outcome variables of son or daughter i in year s and at event time t where the outcome variables are: 1) whether child i provides care to their parent and 2) how many weekly family care hours child i provides in year s and at event time t. An event time t is indexed to the year that an elderly parent experiences LTC needs, which are defined as needing assistance with ADL or IADL such as eating, dressing or bathing[8]. Given the biannual nature of the HRS, $t = \{-2, 0, 2, 4, 6\}$ where $t = 0$ is the year the parent experiences LTC needs. D_{ist}^{Event} includes event time dummies with the base as two years before the event ($t = -2$). In this way, the event time coefficients β capture the dynamic responses of care propensity and care hours to parent's LTC needs over 6 years at $t = \{0, 2, 4, 6\}$, in relation to the year their parent was healthy at $t = -2$. Since I am interested in how sons and daughters behave in family caregiving based on their sibling gender composition, I include an interaction term between the event time dummies D_{ist}^{Event} and a sibling group indicator Z_i, which equals 1 if son or daughter i is in mixed-gender sibling group. The interaction term coefficients γ capture the marginal effects of having a sibling of opposite gender on outcome variables, in relation to those in single-gender sibling group captured by β. Next, I include age dummies D_{ist}^{Age} to control for life-cycle effects and time-fixed effects λ_t to account for business cycles and other time trends in macroeconomic conditions. Conditional on age and year, this identifies variation in event time driven by variation in age at which the adult child faces LTC assistance from their elderly parent[9]. I also control for child and parent characteristics X_{ist} such as child's marital status, number of own children, home ownership and parent's region, total income, non-housing wealth and, subjective health status. I include individual fixed effects to control for time-invariant unobserved heterogeneity in family care decisions.

Results

Before presenting the estimation results, I report the differences in earnings and labor market outcomes of daughters and sons before the parent experiences LTC needs. Since high wages and stronger labor market attachment can play a role in the family care decisions of adult children, it is important that these channels do not drive the differences in family caregiving of daughters and sons across sibling groups. Table 4 presents the baseline differences in labor market outcomes for daughters and sons, based on the sibling gender composition. As shown in Panel (a), there are no statistically significant baseline differences in employment status and earnings for sons in mixed-gender versus single-gender sibling groups. Daughters in mixed-

[8]See Section 2.1 for a detailed description of activities under ADL and IADL.

[9]See Kleven, Landais, and Søgaard (2019) and Kleven, Landais, and Søgaard (2020) for a similar identification using the arrival of first child in the context of labor supply decisions of married couples.

gender sibling groups are more likely to be employed and employed full-time compared to those in single-gender sibling groups. Regarding earnings, there are no statistically significant differences between the daughters across two sibling groups. Low labor market attachment before parent's LTC needs is expected to affect family caregiving in the future negatively. For example, Truskinovsky (2021) empirically shows that children experiencing unemployment spell before parent experiences LTC needs are more likely to provide care when the parent actually experiences LTC needs. This suggests that daughters in mixed-gender sibling groups are more attached to the labor market and thus have lower incentive to provide care than their counterparts in single-gender sibling groups do.

Table 4: Earnings and Employment

	(1) Mixed-gender	(2) Single-gender	(3) Diff
Panel A. Sons			
Non-employment	.19	.20	-0.01
Part-time employment	.06	.05	.009
Full-time employment	.75	.75	.00
Earnings $\geq \$35,000$	.56	.58	-.02
Earnings $\geq \$70,00$	.11	.10	.01
Panel A. Daughters			
Non-employment	.26	.29	-.03**
Part-time employment	.11	.10	.01
Full-time employment	.64	.61	.03*
Earnings $\geq \$35,000$	.54	.56	-.02
Earnings $\geq \$70,00$	.08	.07	.01

Notes: The table reports employment and earnings of adult sons and daughters before the parent needs LTC assistance. Column (1) refers to adult children with sibling(s) of the opposite gender in mixed-gender sibling groups. Column (2) refers to adult children without sibling(s) of the opposite gender in single-gender sibling groups. Column (3) reports the differences in employment and earnings between daughters and sons across two sibling groups. 'Non-employment' refers to adult children who are unemployed or out of the labor force. * p<0.10, ** p<0.05, ***p<0.01

I report the fixed effect estimates of family care propensity of daughters and sons in response to parent's LTC needs in Table 5. Column (1) refers to the sample of daughters and Column (2) refers to the sample of sons. The upper panel of Table 5 refers to the event-time coefficients describing how daughters and sons in single-gender sibling groups respond to parent's LTC needs over time. In the year parent experiences LTC needs, daughters and sons in single-gender sibling groups are 26% and 31% more likely to provide family care to their parent. The effects persist for at least 6 years, suggesting that the parent's health declines after the first year of experiencing LTC needs as they rely on their adult children for family

care. Sons in single-gender sibling groups are more or equally likely to provide family care compared to daughters in single-gender groups across all periods.

The lower panel of Table 5 reports the marginal effects of having a sibling of opposite gender on the care propensity of daughters and sons. For daughters, having a brother does not significantly change their care propensity in response to parent's LTC needs. On the other hand, having a sister significantly lowers the care propensity of sons. In the year that parent experiences LTC needs, sons with a sister(s) are 19% less likely to provide family care to their parent in need of LTC compared to sons without a sister. These effects persist for at least 6 years after parent experiences LTC needs.

Table 6 reports the fixed effect estimates of weekly family care hours in response to parent's LTC needs. Again, we see similar patterns between daughters and sons across sibling groups. Having a sibling of the opposite gender does not have statistically significant effect on daughter's family care hours. However, sons significantly lower their family care hours when they have a sister(s). Figure 3 compares the marginal effects of having a sibling of the opposite gender on family care of daughters and sons, along with their 95% confidence intervals. After controlling for individual and time-fixed effects along with family and individual characteristics, the marginal effects of having a sibling of the opposite gender on family care propensity are statistically significantly different between daughters and sons, as shown in Panel (a)[10]. On the other hand, Panel (b) shows that the marginal effects of having a sibling of opposite gender on family care hours are not statistically different between daughters and sons. Among daughters and sons who provide family care, sons provide less care to their parent when they have a sister but this effect is not drastically different from the effects of having a brother on care hours of daughters. Thus, having a sibling of opposite gender appears to explain the family care responses of daughters and sons at the extensive margin (care propensity) rather than at the intensive margin (weekly family care hours).

To sum up, daughters and sons in single-gender sibling groups are equally likely to provide family care to their parent with LTC needs. Interestingly, sons in single-gender sibling groups have higher care propensity and provide more family care hours than daughters in single-gender sibling groups, after accounting for observed and unobserved heterogeneity. Furthermore, the stark differences in family care propensity for sons in single-gender versus mixed-gender sibling groups suggests the potential role of gender identity norms present in mixed-gender sibling groups. This is especially important given that daughters and sons in mixed-gender groups do not have strong differences in opportunity costs or labor market attachment from their counterparts in single-gender sibling groups.

[10]The exception is the event-time coefficient on four years after parent's LTC needs. However, when averaged over the post-event periods, the marginal effects are still statistically significant.

Table 5: Fixed Effect Estimates of Care Propensity by Sibling Gender Composition

	Daughters (1)	Sons (2)
Single-Gender ×		
At event	0.26***	0.31***
	(0.026)	(0.033)
Two years after	0.19***	0.24***
	(0.028)	(0.034)
Four years after	0.24***	0.23***
	(0.017)	(0.038)
Six years after	0.18***	0.22***
	(0.036)	(0.039)
Mixed-Gender ×		
At event	-0.019	-0.19***
	(0.028)	(0.034)
Two years after	-0.005	-0.16***
	(0.029)	(0.035)
Four years after	-0.040	-0.17***
	(0.032)	(0.037)
Six years after	0.022	-0.18***
	(0.030)	(0.035)
Controls	yes	yes
Fixed effects	yes	yes
N	13,332	12,580

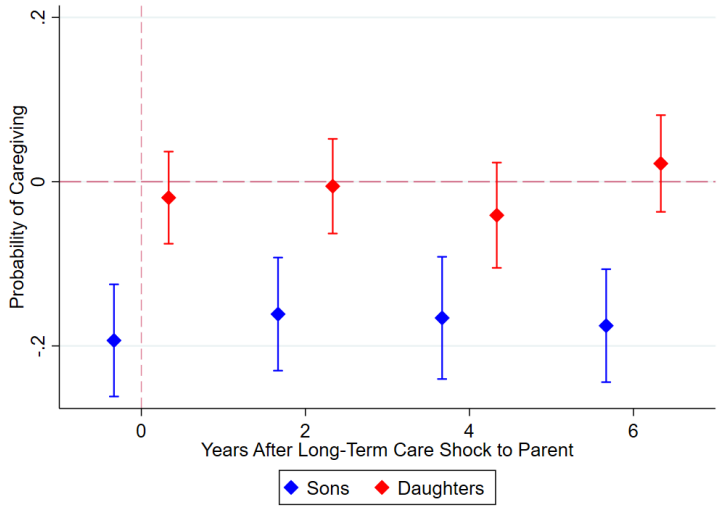
Notes: The table reports the two-way fixed effects estimates of the event-study specification in Equation (1). The dependent variable equals 1 if an adult child provides family care to their elderly parent. 'At event' refers to the year parent needs assistance with activities or instrumental activities of daily living. All estimates on the event dummies are in reference to two years before the event ($t = -2$). Single-Gender refers to siblings that only consist of sisters or brothers. Mixed-Gender refers to siblings with at least one sister and one brother. Controls include the adult child's marital status, number of own children, home ownership and parent's region, total income, non-housing wealth, and subjective health status. Robust standard errors are clustered at the family level and are in parentheses. * p<0.10, ** p<0.05, ***p<0.01

Table 6: Fixed Effect Estimates of Weekly Care Hours by Gender Composition of Siblings

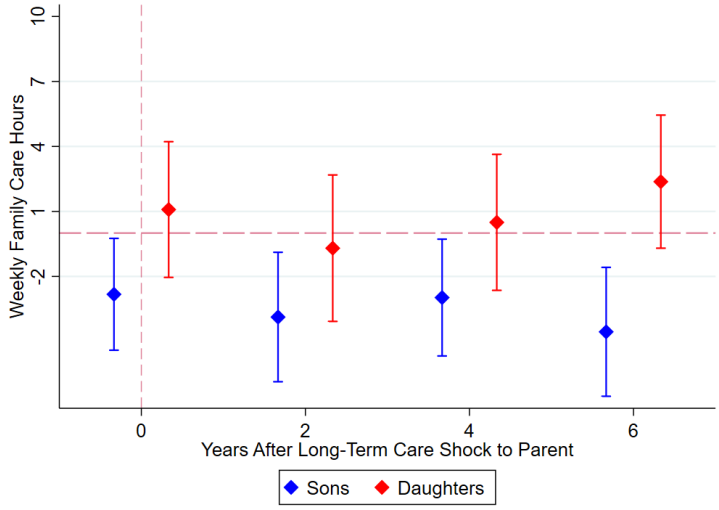
	Daughters (1)	Sons (2)
Single-Gender ×		
At event	3.17**	4.41***
	(1.51)	(1.29)
Two years after	4.73***	4.95***
	(1.62)	(1.52)
Four years after	3.65**	3.82***
	(1.58)	(1.38)
Six years after	2.32	5.06***
	(1.79)	(1.57)
Mixed-Gender ×		
At event	1.08	-2.83**
	(1.59)	(1.32)
Two years after	-0.69	-3.87**
	(1.72)	(1.52)
Four years after	0.49	-2.97**
	(1.59)	(1.37)
Six years after	2.37	-4.56***
	(1.56)	(1.52)
Controls	yes	yes
Fixed effects	yes	yes
N	13,332	12,580

Notes: The table reports the two-way fixed effects estimates of the event-study specification in Equation (1). The dependent variable is the weekly family hours an adult child provides to their elderly parent. 'At event' refers to the year parent needs assistance with activities or instrumental activities of daily living. All estimates on the event dummies are in reference to two years before the event ($t = -2$). Single-Gender refers to siblings that only consist of sisters or brothers. Mixed-Gender refers to siblings with at least one sister and one brother. Controls include the adult child's marital status, number of own children, home ownership and parent's region, total income, non-housing wealth, and subjective health status. Robust standard errors are clustered at the family level and are in parentheses. * p<0.10, ** p<0.05, ***p<0.01

Figure 3: Fixed Effect Estimates of Family Caregiving in Mixed-Gender Sibling Group



(a) Mixed-Gender



(b) Mixed-Gender

Notes: The figure reports the fixed effect estimates of event-study specification in Equation (1) with 95% confidence interval. Figure (a)-(b) refer to the probability of caregiving, and Figure (c)-(d) refer to the weekly family care hours of daughters and sons. Single-Gender refers to siblings that only consist of sisters or brothers. Mixed-Gender refers to siblings with at least one sister and one brother. Controls include the adult child's marital status, number of own children, home ownership and parent's region, total income, non-housing wealth, and subjective health status. The red bars refer to daughters, and the blue bars refer to sons in each group. The red, vertical dashed line is the event that a parent needs assistance with activities of daily living or instrumental activities of daily living. All estimates are in reference to two years before the event ($t = -2$). Robust standard errors are clustered at the family level.

3 Model

Motivated by the empirical evidence, I present a game-theoretic model of sibling interactions with three main features. First, I model family care decision as a result of non-cooperative Cournot-Nash game between two adult children, namely a daughter and a son. Second, adult children are heterogeneous in wages and in 'preferences' for family care. Based on their wages and preferences, adult children simultaneously decide how much to consume and work in addition to providing family care hours. Third, I model parental well-being as a family public good, to which adult children voluntarily contribute with their family care hours based on altruistic motives. Several studies find evidence for altruistic motives of adult children in family care provision to elderly parents (Pezzin and Schone 1999; Engers and Stern 2002; M. Brown 2003). Motivated by these studies, I depart from formulations that assume adult children provide family care out of 'guilt' (e.g., Becker 1993; Barigozzi, Cremer, and Roeder 2017; Mommaerts 2021)[11].

I use a non-cooperative framework over cooperative bargaining models to model family care decisions of adult children for two main reasons. First, the non-cooperative approach allows for separate budget constraints for each adult child. On the other hand, the cooperative models assume income pooling between family members[12]. Given that adult children mainly live in separate households, income pooling is a stringent assumption. Second, the cooperative framework assumes that adult children commit to binding agreements on how much family care to provide to ensure a Pareto-optimal outcome. In the context of marriage, Lundberg and Pollak (1993) and Lundberg and Pollak (2008) argue that without outside mechanisms (e.g., a legal institution enforcing one to commit certain care hours to provide optimal level of public good), a cooperative outcome may not hold. In a similar vein, adult children also cannot fully enforce each other on how many family care hours to commit. Public good is under-provided in the non-cooperative framework since siblings are not able to take advantage of resource pooling and rely on voluntary contribution of family care hours rather than binding agreements.

[11] A limitation of focusing on altruistic channel, however, ignores the dimension of bequest motives of care provision. For example, Groneck (2017) finds that caregiver children are significantly more likely to receive a bequest. I implicitly assume that daughters and sons do not inherently differ in their bequest motives and thus the differences in 'preferences' between daughters and sons are not driven by their differences in bequest motives. See M. Brown (2006) for a formulation of altruistically motivated adult children who also provide care due an expected bequest.

[12] See Barigozzi, Cremer, and Roeder (2017) in the case of a parent and two adult children, and Mommaerts (2021) in the case of an elderly parent and an adult child.

3.1 The Family Problem

The simple model of family care decisions between a daughter and a son is introduced. Given child-specific wage w_i and parent's LTC needs e, child i decides how to consume and work in addition to providing family care hours. The parental well-being is represented as a family public good Q and child i voluntarily provides family care hours q_i to the public good, taking the other child's family care hours q_{-i} as given. Formally, child i solves the following problem[13]:

$$U(w_i, e) = \max_{c_i, l_i, q_i} u(c_i, l_i) + \theta_i \cdot u(Q) \tag{2}$$

subject to the following constraints:

$$Q = f(q_i, q_{-i}) \tag{3}$$

$$c_i = \max\{\bar{c}_i, w_i \cdot h_i\} \tag{4}$$

$$\bar{L} = l_i + h_i + q_i \tag{5}$$

$$h_i, q_i \geq 0 \tag{6}$$

where the utility of child i consists of consumption c_i, leisure l_i and parental well-being Q. The weight on parental well-being θ_i captures how much child i weighs family public good over their own consumption and leisure. Public good Q is a product of own family care hours of q_i and their sibling's family care hours q_{-i}[14]. Child i works h_i hours at the wage rate w_i and spends it on consumption c_i as long as their earnings are not below a consumption floor $\bar{c}_i$[15]. In addition, child i allocates their total available time $\bar{L}$ between family care q_i, market work h_i and leisure l_i. I assume non-negativity constraints on h_i and q_i. Public good Q is assumed to have diminishing marginal returns to its inputs such that $f'(q_{i,-i}) > 0$ and $f''(q_{i,-i}) < 0$.

For tractability, I assume additively separable functional forms for the utility function. I

[13]Based on the private contribution models of Bergstrom, Blume, and Varian (1986), M. Brown (2006) proposes a similar formulation with multiple adult children contributing to a family public good. M. Brown (2006) does not consider leisure in the utility functions of adult children and incorporates non-labor income instead of consumption floor. The author also focuses on the bequest motives of adult children rather than heterogeneity in 'preferences' for family public good.

[14]In the HRS data, the incidences of adult child helping financially with parent's LTC needs is only 1.4% during the sample period 1998-2014. Thus, I do not consider adult children contributing with monetary transfers and ignore the channel that adult children may help pay for formal paid care for their elderly parent rather than providing care on their own.

[15]Below $\bar{c}_i$, an adult child decides to drop out of the labor force. You can interpret $\bar{c}_i$ as reservation wages in standard labor supply models. For the rest of the paper, I use the term 'reservation wages' to describe the earnings threshold below which an adult child would drop out of the labor force.

assume constant relative risk aversion (CRRA) specification for consumption, leisure and family public good:

$$U_i(c_i, l_i, q_i) = \frac{c_i^{1-\gamma_c}}{1-\gamma_c} + \alpha \frac{l_i^{1-\gamma_l}}{1-\gamma_l} + \theta_i \frac{(q_i + q_{-i})^{1-\gamma_q}}{1-\gamma_q} \tag{7}$$

where γ_c, γ_l and γ_q are curvatures on consumption, leisure, and public good, respectively. α refers to the weight adult child puts on leisure relative to consumption and family public good. I assume that q_i and q_{-i} are perfect substitutes. This is motivated by the fact that Checkovich and Stern (2002) finds the care provided by one child reduces the other child's time in providing care to their parent. The perfect substitution also allows me to demonstrate the decrease in one adult child's family care hours in response to an increase in their sibling's family care hours under the Cournot-Nash model. I assume adult children differ in their 'preferences' θ_i for family public good Q.

Parent's LTC needs e take on three states: parent is healthy ($e = 0$), parent needs LTC ($e = 1$) and parent is dead ($e = 2$). Note that public good Q only enters the utility function if parent needs LTC at $e = 1$. Otherwise, each child's behavior is a simple consumption-labor-supply problem where they still face heterogeneity in wages.

3.2 Marginal Rates of Substitution

Given the family problem in Equations $2 - 6$ and the functional form in Equation 7, I solve for the following first-order conditions of child i for $i = 1, 2$.
The first-order conditions for Child 1 are as follows:

$$\begin{aligned}
\frac{\partial U_1}{\partial c_1} &: \quad c_1^{-\gamma_c} = \lambda_1 \\
\frac{\partial U_1}{\partial l_1} &: \quad \alpha l_1^{-\gamma_l} = \lambda_1 w_1 \\
\frac{\partial U_1}{\partial q_1} &: \quad \theta_1 (q_1 + q_2)^{-\gamma_q} = \lambda_1 w_1
\end{aligned}$$

Similarly, the first-order conditions for Child 2 are as follows:

$$\begin{aligned}
\frac{\partial U_2}{\partial c_2} &: \quad c_2^{-\gamma_c} = \lambda_2 \\
\frac{\partial U_2}{\partial l_2} &: \quad \alpha l_2^{-\gamma_l} = \lambda_2 w_2 \\
\frac{\partial U_2}{\partial q_2} &: \quad \theta_2 (q_1 + q_2)^{-\gamma_q} = \lambda_2 w_2
\end{aligned}$$

where λ_i refers to shadow prices of the budget constraints. Equating the first-order conditions with regards to leisure and family care, we get the following marginal rates of substitutions between time spent on family care and time spent on leisure:

$$l_1^{\gamma_l} = \frac{\alpha}{\theta_1}(q_1 + q_2)^{\gamma_q} \tag{8}$$

$$l_2^{\gamma_l} = \frac{\alpha}{\theta_2}(q_1 + q_2)^{\gamma_q} \tag{9}$$

Next, equating the first-order conditions with regards to leisure and consumption, we get the following marginal rates of substitution between leisure and consumption:

$$c_1^{\gamma_c} = \frac{w_1}{\alpha} l_1^{\gamma_l} \tag{10}$$

$$c_2^{\gamma_c} = \frac{w_2}{\alpha} l_2^{\gamma_l} \tag{11}$$

From the marginal rates of substitution in Equations 8 and 14, we can observe that the ratio between leisure l_i and family care q_i depends positively on α and negatively on θ_i. Since α is assumed to be homogeneous across adult children, the child-specific weight on public good θ_i plays a crucial role in the ways adult children allocate their time differently. As for the marginal rates of substitution in Equations 15 and 12, the ratio between consumption c_i and leisure l_i depends positively on wage w_i but negatively on α. Higher wage reflects higher opportunity cost to take time off to provide care (substitution effect) but it can also increase time for family care since high wages increase consumption (income effect).

3.3 Cournot-Nash Equilibrium

I define a strategy profile $\delta = (q_1, q_2)$ where q_1 and q_2 are family care hours of each child in response to one another. A strategy profile $\delta^* = (q_1^*, q_2^*)$ is the Cournot-Nash equilibrium if all of the following conditions are satisfied.

Optimality of the Child 1's decision problem:

$$\delta_1^*(w_1) = \arg\max_{d_1^*} U_1(d_1^*|w_1, \delta^*) \qquad \forall w_1 \tag{12}$$

Optimality of the Child2's decision problem:

$$\delta_2^*(w_2) = \arg\max_{d_2^*} U_2(d_2^*|w_2, \delta^*) \qquad \forall w_2 \tag{13}$$

where decision variables $d_i^* = \{c_i^*, l_i^*, q_i^*\}$ for $i = 1, 2$. Given wages w_1 and w_2, adult children simultaneously choose optimal consumption c_1^* and c_2^*, optimal leisure l_1^* and l_2^*, and optimal family care hours q_1^* and q_2^*.

4 Estimation

In this section, I detail the steps to estimate the model in Section 3. I first parameterize the wage distribution of daughters and sons, and simulate the wage processes of adult children and parental LTC needs over 20 year period, using values taken from the literature or directly using the HRS data. Conditional on the parameterization, I estimate the remaining parameters in two stages using simulated method of moments[16]. Lastly, using the structural estimates and the life-cycle simulation of wages and LTC needs, I quantify the trajectory of employment and earnings of adult children over 20 year period.

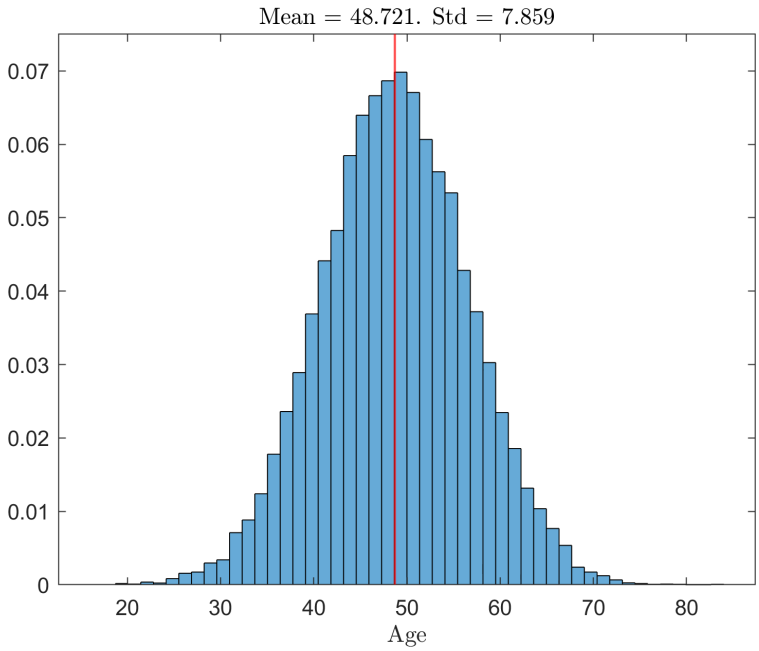
4.1 Estimation sample

I use the pooled Health and Retirement Study (HRS) 1998-2014 to parameterize and internally estimate model parameters[17]. For parameterization of wage processes and parental LTC needs, I use the HRS sample constructed in Section 2.1. I then split the HRS sample into two sets of estimation sample for the moment matching. The estimation sample for the first-stage estimation includes the sample period of children when their elderly parents are healthy (i.e., pre-LTC period). The estimation sample for the second-stage estimation includes the sample period of children when their elderly parents have at least one limitation with ADL or IADL (i.e., post-LTC period). Figure 4 shows the age distribution of adult children in the full HRS sample.

Table 7 shows the summary statistics of the pre-LTC estimation sample. Daughters and sons are similar in age and marital status. Daughters are more college educated and have higher home ownership compared to sons. As for labor market outcomes, sons are more likely

[16]See McFadden (1989) and Pakes and Pollard (1989) for the theoretical background of the method.
[17]For details on HRS and sample restrictions, see Section 2.1.

Figure 4: Age distribution of adult children in the HRS sample



to be employed and employed full-time compared to daughters. Sons also earn slightly higher. This indicates that daughters and sons already exhibit gender gap in labor market behavior and earnings before they face their trade-off between working and providing care to their frail parents.

Table 8 presents the summary statistics of the post-LTC estimation sample. Adult children are around age 52 when their parents experience LTC shock. Daughters are less likely to be married and more likely to live closer to their parents compared to sons. Adult children are less likely to work during post-LTC period. This can reflect the trade-off between family caregiving and work but also early retirement and changes in employment over the life cycle. Among those working, sons earn more with age while daughters earn less. Daughters provide more family care hours and at a higher rate than sons do.

Table 7: Pre-LTC estimation sample

	Daughters	Sons
Age	48.17	48.17
Married	.63	.65
Lives within 10 miles to parent	.49	.46
Co-resides with parent	.11	.12
College	.50	.44
Home ownership	.64	.60
Not working	.26	.19
Working full-time	.63	.75
Working part-time	.11	.06
Earns $\geq \$35,000$	.55	.57
Earns $\geq \$70,000$	.09	.11
No. of observations	5,782	5,557
No. of individuals	3,175	2,968

Notes: The sample includes adult daughters and sons of 65+ single parents who have two or more children and receive family care from at least one child in the pooled 1998-2014 Health and Retirement Study. Pre-LTC period refers to the sample period of children when their elderly parents did not have any limitations with ADL or IADL and did not need long-term care (LTC) assistance. The table reports the mean summary statistics of the pre-LTC period.

Table 8: Post-LTC estimation sample

	Daughters	Sons
Age	51.69	52.14
Married	.61	.67
Lives within 10 miles to parent	.53	.45
Co-reside with parent	.13	.11
College	.50	.44
Home ownership	.61	.58
Not working	.37	.31
Working full-time	.53	.63
Working part-time	.10	.06
Earns $\geq \$35,000$	.49	.54
Earns $\geq \$70,000$	.10	.15
Provides family care	.28	.15
Weekly family care hours (mean/median)	22/7.5	14.5/4
No. of observations	10,592	9,932
No. of individuals	3,175	2,968

Notes: The sample includes adult daughters and sons of 65+ single parents who have two or more children and receive family care from at least one child in the pooled 1998-2014 Health and Retirement Study. Post-LTC period refers to the sample period of children when their elderly parents had at least one limitation with ADL or IADL and needed long-term care (LTC) assistance. The table reports the mean summary statistics of the post-LTC period.

4.2 Parameterization

Total Hours Available. I set 5,824 as the total hours available to each child, which they can allocate between market work and leisure in the case parent does not need LTC assistance and between market work, leisure and family care in the case parent needs LTC assistance. Total hours available in a year includes 16 hours per day, net of 8 hours of sleeping, multiplied by 7 days per week and 52 weeks per year. I include weekend days since family caregiving often involves co-residency or the elderly parent's intensive long-term care need requires 24/7 attention and care.

Wages. I parameterize the wage distribution for daughters and sons. Table 9 lists the values taken from the literature or computed directly from the HRS data to parameterize the wage distribution. In the HRS data, the income variables are reported in brackets only. Thus, I fit the wage distribution based on the income brackets observed[18]. I set $\$38,000$ as the mean income for daughters and $\$42,000$ as the mean income for sons based on the HRS data. I take wage variances for daughters and sons from Blundell, Pistaferri, and Saporta-Eksten (2018), referred to as BPS (2018) in Table 9. Using a sample of men and women in their prime working years, the authors compute the wage variances as .285 for women and .256 for men. See Appendix E for the simulated wage distribution and its fit against the data.

Table 9: Wage parameterization

Parameter	Description	Value	Source
Wages			
w_1^0	Mean wage for daughters	$\$38,000$	HRS
w_2^0	Mean wage for sons	$\$42,000$	HRS
$\sigma_{w_1^0}$	Wage variance for daughters	.285	BPS (2018)
$\sigma_{w_2^0}$	Wage variance for sons	.256	BPS (2018)

4.3 Long-Term Care Needs and Permanent Wage Shock

To quantify the employment and earnings trajectory of adult children, I simulate the life-cycle profiles of LTC needs and wage processes of adult children.

Long-Term Care Needs. The parental long-term care needs $e_t \in \{1, 2, 3\}$ is defined as: parent is healthy ($e_t = 1$), parent needs LTC ($e_t = 2$) and parent is dead ($e_t = 3$). The first-order markov transition probabilities for parent's long-term care needs depend on their long-term care needs in the previous period, parent's permanent income (y_p), gender (g) and

[18]See Section 2.1 for details on income variables in the HRS.

age:

$$e_{t+1} = e_{t+1}(e_t, y_p, g, t) \tag{14}$$

Using the HRS data, I run a multinomial logit model to estimate the transition probabilities of long-term care states, following Hurd, Michaud, and Rohwedder (2017). Specifically, I run a logit model from two non-absorbing states - healthy ($e_t = 1$) and needs LTC ($e_t = 2$) - to one absorbing state where the parent is dead ($e_t = 3$). Healthy state refers to periods when elderly parent does not have any limitations with ADL or IADL whereas LTC state refers to periods when elderly parent has at least one limitation with ADL or IADL. Table 10 reports the simulate transition probabilities of parental LTC needs.

Table 10: Simulated Probabilities Long-Term Care Needs

	Age 65	Age 75	Age 85	Age 95
Percent dead	0.0	.10	.33	.77
Percent healthy	.89	.81	.69	.56
Percent need care	.11	.19	.31	.44

Permanent Wage Shock. I specify the life-cycle profile of wages as a random walk process. Specifically, each child faces a permanent income shock such that:

$$\log w_{it} = \log w_{it-1} + \epsilon_{it} \tag{15}$$

where $\epsilon_{it} \in \mathcal{N}(0, \sigma_\epsilon^2)$. This is motivated by several studies that empirically show income shocks are well approximated as a random walk (Abowd and Card 1989; MaCurdy 1982; Meghir and Pistaferri 2004). I set the wage shock variance σ_ϵ^2 at 0.05 (Mommaerts 2021).

4.4 Moment Matching

This section documents the steps to internally estimate structural parameters using simulated method of moments. I focus on two different periods to estimate two sets of parameters. First, I use the pre-LTC estimation sample when parent is healthy and does not need long-term care assistance and estimate consumption curvature γ_c, leisure curvature γ_l, weight on leisure α and reservation wages $\bar{c}_1^{NL}$ and $\bar{c}_2^{NL}$. In this way, I estimate the earnings and labor supply behavior of daughters and sons before they face the trade-off between labor supply and family care. This is to account for the pre-LTC gender gap between daughters and sons in labor market outcomes such as labor market participation, market hours and labor earnings.

Second, I use the post-LTC estimation sample when parent has long-term care needs and estimate public good curvature γ_q, weights on public good θ_1 and θ_2 and reservation wages

$\bar{c}_1^L$ and $\bar{c}_1^L$. During post-LTC sample period, adult children face not only trade-off between labor and leisure but also between labor and family care. Given the large gap in family caregiving between daughters and sons, the estimation of these parameters are shaped by the differential changes in labor market participation, market hours and labor earnings due to family caregiving among daughters and sons.

The estimation process goes as follows. I first solve the model numerically across wage distributions of each adult child and simulate the model with the objective to estimate the structural parameters that minimize the distance between data moments and model moments such that:

$$\hat{\boldsymbol{\lambda}}_{1,2} = \arg\min_{\boldsymbol{\lambda}_{1,2}} (\boldsymbol{X}_D - \boldsymbol{X}_M(\boldsymbol{\lambda}_{1,2}))\boldsymbol{\Omega}(\boldsymbol{X}_D - \boldsymbol{X}_M(\boldsymbol{\lambda}_{1,2}))' \tag{16}$$

where the first-stage parameters $\lambda_1 = \gamma_c, \gamma_l, \alpha, \bar{c}_1^{NL}, \bar{c}_2^{NL}$ and the second-stage parameteres $\lambda_2 = \gamma_q, \theta_1, \theta_2, \bar{c}_1^L, \bar{c}_2^L$. X_D is a vector of empirical moments from the data and $X_M(\lambda_{1,2})$ is a vector of moments simulated by the model at $\lambda_{1,2}$. Ω is a weighting matrix computed as the inverse of the diagonal of the variance-covariance matrix of the data moments. To compute the simulated moments, I simulate 10,000 daughter-son pairs who face different wage distributions. See Section 4.2 for the parameterization of the wage processes for daughters and sons.

4.4.1 First Stage Estimation

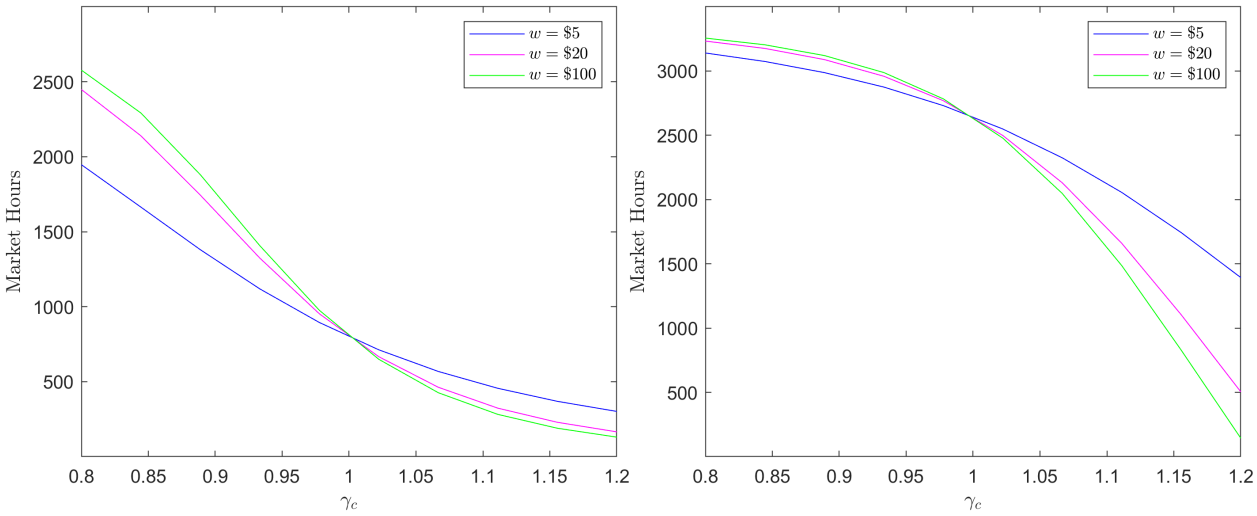
Table 11 lists the first-stage parameters that are estimated internally using the pre-LTC estimation sample. The identification of these parameters are discussed in this subsection along with the empirical moments informative of these parameters. Figure 5 shows how consumption curvature γ_c and leisure curvature γ_l govern the income and substitution effects of wages on labor supply. When consumption curvature γ_c is less than 1, as shown on the horizontal axis, the substitution effect dominates and market hours increase as wage increases. On the other hand, the income effect dominates when γ_c is more than 1, which is shown as higher wage lowers market hours.

If consumption curvature γ_c governs the strength of income and substitution effects of wages on labor supply, the two panels of Figure 5 illustrate that leisure curvature γ_l governs the strength of labor supply elasticity. In the case γ_l is less than unity, labor supply is more elastic to changes in wages when the substitution effect dominates, as shown in the left panel of Figure 5. Conversely, in the case γ_l is more than unity, labor supply is more elastic when the income effect dominates, as shown in the right panel of Figure 5. That is, as γ_c and γ_l are closer to zero, labor supply increases as wage increases and in a larger magnitude whereas

Table 11: First-stage parameters: pre-LTC period

Parameter	Description
γ_c	Consumption curvature
γ_l	Leisure curvature
α	Weight on leisure
$\bar{c}_1^{NL}$	Reservation wage for daughters
$\bar{c}_2^{NL}$	Reservation wage for sons

Figure 5: Income and Substitution Effects



(a) Low leisure curvature $\gamma_l < 1$

(b) High leisure curvature $\gamma_l > 1$

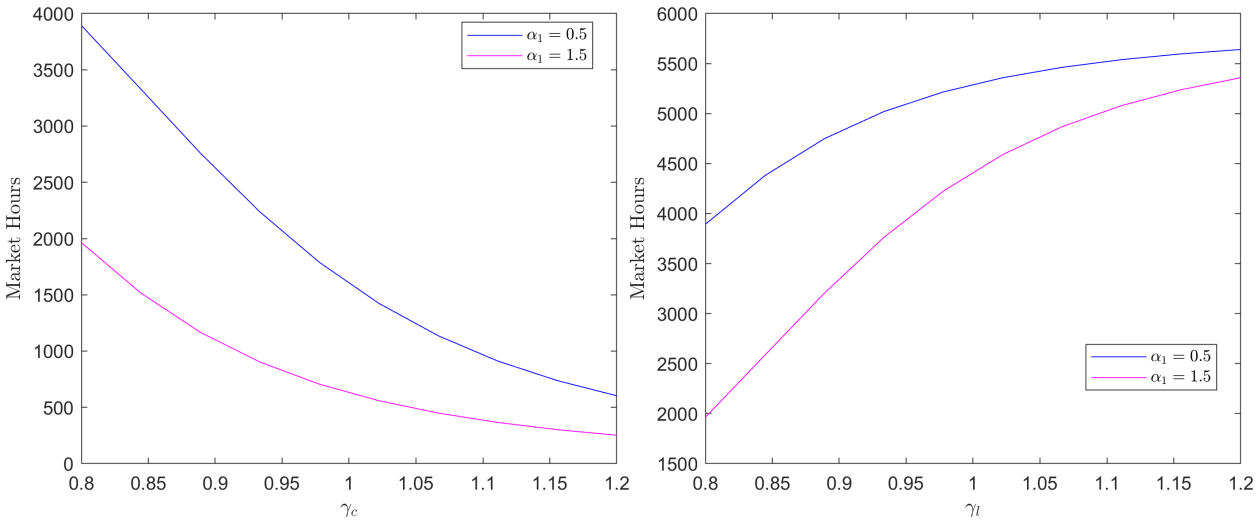
as γ_c and γ_l go farther from unity, labor supply lowers as wage increases and in a larger magnitude[19].

Figure 6 shows the effect of weight on leisure α on market hours in relation to γ_c and γ_l, as shown in the left and the right panel, respectively. As expected, lower weight on leisure increases market hours by shifting the labor supply curve upwards. Note also that market hours are convex and decreasing in γ_c whereas market hours are concave and increasing in γ_l. Figure 5 and Figure 6 are informative of the moments that can identify γ_c, γ_l and α. While the direction of labor supply responses to wages are more informative about γ_c, the magnitude of labor supply responses to wages can be more informative about γ_l. On the other hand, α can be explained by the level of market hours adult children supply.

I use the following four empirical moments to identify consumption curvature γ_c, leisure curvature γ_l and weight on leisure α: percents of daughters working full-time and part-time; and the percents of sons working full-time and part-time. The identification of reservation

[19]See **??** on the implications of γ_c and γ_l on consumption and leisure.

Figure 6: Labor supply in response to weight on leisure α



wages $\bar{c}_1^{NL}$ and $\bar{c}_2^{NL}$ and more straightforward as they are strictly identified by the labor force participation rate of daughters and sons, respectively. Thus, I use two moments to identify the reservation wages: the labor participation rate of daughters and the labor participation rate of sons.

4.4.2 Second Stage Estimation

Conditional on the first-stage estimation of γ_c, γ_l and α, I estimate the remaining parameters that are listed in Table 12 via model simulation using the estimation sample when parent needs long-term care assistance (i.e., post-LTC period). the The identification of these parameters are discussed in this subsection along with the empirical moments informative of these parameters.

Table 12: Second-Stage Parameters: Post-LTC Period

Parameter	Description
γ_q	Public good curvature
θ_1	Daughter's weight on public good
θ_2	Son's weight on public good
$\bar{c}_1^L$	Reservation wage for daughters
$\bar{c}_2^L$	Reservation wage for sons

Figure 7 shows the responses of family care hours to changes in own weight on public good and the public good curvature. As expected, higher weight on public good θ_1 increases one's family care hours Q_1, holding their sibling's weight on public good θ_2 constant. An increase

in public good curvature γ_q shifts the family care response curve downwards[20]. In addition, at low levels of own weight on public good θ_1, family care hours are at corner solutions when public good curvature γ_q is high enough. This shows that public good curvature and weights on public good are shaped by not only hours of family care hours but also by the rate of family caregiving of adult children.

Figure 7: Family care hours Q_1 in response to θ_1 and γ_q

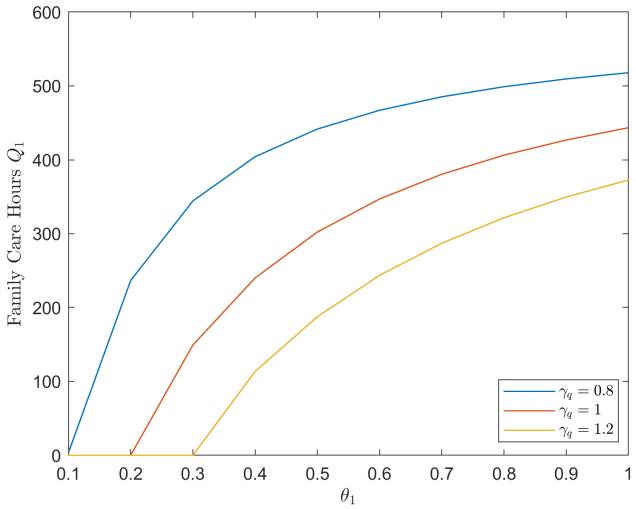


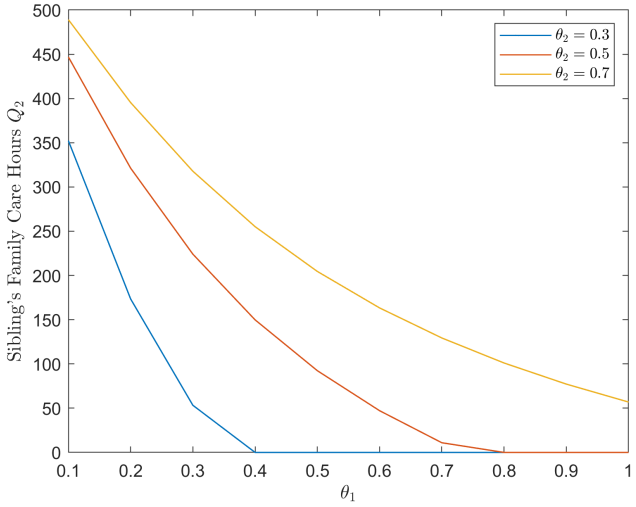
Figure 8 illustrates family care hours in response to the interaction of both weights on public good. Due to the Cournot-Nash game, the family care response functions of each adult child are such that family care hours of one child lowers in response to higher family care hours of their sibling. As expected, when weight on public good of daughters θ_1 increases, the family care hours of sons decrease as demonstrated by the sons' downward sloping family care response function to their sister's weight on public good. However, the total change in family care hours of sons depend on the combination of own weight on public good θ_2 and their sister's weight on public good θ_1.

I use the following six moments to identify public good curvature γ_q and weights on public good θ_1 and θ_2: average family care hours of daughters, percent of daughters working full-time, and percent of daughters working part-time; average family care hours of sons, percent of sons working full-time, and percent of sons working part-time[21]. In addition, I use two more moments to identify the reservation wages $\bar{c}_1^L$ and $\bar{c}_2^L$: percent of daughters and percent of sons who are employed.

[20]Note that consumption curvature is set at less than unity for all scenarios.

[21]Since the model does not specifically incorporate extensive margin for family caregiving, I put zeros for those who do not provide any positive care hours when computing the mean family care hours. In this way, I account for those at the extensive margin.

Figure 8: Family care hours Q_2 in response to θ_1 and θ_2



5 Results and Model Fit

I report the results from the model estimation in this section. The first stage and the second stage parameters along with their targeted moments are first reported. I then simulate the life cycle profile of employment and earnings trajectory for daughters and sons using the structural parameters from the two stages and analyze the model fit.

5.1 Consumption curvature, leisure curvature and weight on leisure

Table 13 presents the structural estimation of first-stage parameters. Consumption curvature γ_c is estimated at 0.948 and the leisure curvature γ_l at 0.776. As illustrated in Figure 5, γ_c captures the strength of income effect and a value lower than unity implies that substitution effect dominates. Given the empirical pattern that high wage children are more likely to work and work full time in the HRS data, the estimated value for γ_c accurately reflects the strength of the substitution effect[22]. In addition, γ_l shapes the elasticity of labor supply and the estimated value being lower than unity demonstrates higher elasticity when the substitution effect dominates[23]. How much adult child weighs leisure compared to consumption, reflected by α, is estimated at 0.51 and is similar to the structural estimate found in Mommaerts (2021).

As for the reservation wages, the lowest wage at which an adult child would enter the labor market, are \$27,000 for daughters and \$26,000 for sons. Daughters having higher reservation wage than sons is somewhat inconsistent with the empirical literature that finds positive

[22]Using a household model with two earners who have young children, Blundell, Pistaferri, and Saporta-Eksten (2018) finds a similar structural estimate for γ_c at 0.903.

[23]See Panel (a) of **??** for the labor supply responses when both γ_c and γ_l are lower than unity.

Table 13: First-stage estimation

Parameter	Estimates
γ_c	0.948
γ_l	0.776
α	0.51
$\bar{c}_1^{NL}$	\$27,000
$\bar{c}_2^{NL}$	\$26,000

male-to-female reservation wage gap (e.g., S. Brown, Roberts, and Taylor (2011) and Caliendo, Lee, and Mahlstedt (2017)). There are two major reasons for this finding. First, note that adult children are relatively younger during the pre-LTC period and daughters may have slightly higher reservation wage compared to sons due to larger time spent on childcare and household throughout their later adulthood. In fact, the role of marriage and motherhood in increasing reservation wages for women is empirically supported (Parera-Nicolau and Mumford (2005), Youderian (2014) and Ma (2021)). Second, I assume daughters and sons have the same weight on leisure and thus any differential 'preferences' for time spent at any activities other than market work is additionally being captured by the differences in $\bar{c}_1^{NL}$ and $\bar{c}_2^{NL}$. Table 14 shows the targeted moments used in the estimation of first-stage parameters.

Table 14: Targeted moments used in first-stage estimation

Moments	Model	Data
Percent of daughters not working	.27	.26
Percent of daughters working full-time	.65	.63
Percent of daughters working part-time	.08	.11
Percent of sons not working	.18	.19
Percent of sons working full-time	.74	.75
Percent of sons working part-time	.08	.06

5.2 Public good curvature and weights on public good

Conditional on the first-stage parameters, I then use the post-LTC estimation sample where children now face family care responsibilities due to parental LTC needs. Table 15 reports the structural estimates governing the family care hours of daughters and sons. Public good curvature γ_q is identified by the level of family care hours, as shown in Figure 7, and is estimated at 0.923. The structural estimates of weights on public good θ_1 and θ_2 demonstrate heterogeneity in 'taste' for public good. That is, daughters weigh family public good at 0.2006 compared to 0.195 for sons. The difference may appear negligible in magnitude but I

show the importance of this heterogeneity in 'preferences' for public good between daughters and sons in Section 6.1 by running a counterfactual where daughters and sons differ in their wages but are homogeneous in their 'preferences' for public good.

Table 15: Second-stage estimation

Parameter	Estimates
γ_q	0.923
θ_1	0.2006
θ_2	0.195
$\bar{c}_1^L$	\$23,000
$\bar{c}_2^L$	\$25,000

Interestingly, reservation wages $\bar{c}_1^L$ and $\bar{c}_2^L$ change moderately during post-LTC period due to higher non-employment rates of adult children. During pre-LTC period, 26% of daughters and 19% of sons were not working while these percentages go up to 37% for daughters and 31% for sons, respectively, during post-LTC period. These differences may account for some children dropping out of the labor force to care for their parent but a significant part is due to life-cycle events affecting employment rate such as retirement or early retirement (for reasons other than family care responsibility) and adult children themselves facing health decline. Due to these changes, the reservation wage for daughters lower to \$23,000 and the reservation wage for sons to \$25,000[24]. Table 16 reports the targeted moments used in the estimation of the second-stage parameters.

Table 16: Targeted moments used in second-stage estimation

Moments	Model	Data
Mean family care hours of daughters	287	288
Percent of daughters not working	.38	.37
Percent of daughters working full-time	.55	.53
Percent of daughters working part-time	.07	.09
Mean family care hours of sons	99	96
Percent of sons not working	.30	.31
Percent of sons working full-time	.65	.62
Percent of sons working part-time	.05	.07

[24]This is consistent with the findings of Krueger and Mueller (2014), which empirically show that decrease in reservation wages are driven by older individuals.

5.3 Life-Cycle Simulation and Model Fit

Using the wage process and LTC needs over 20 year period when elderly parent is aged between 65 and 85, I quantify the labor market behavior and family care hours over this period of the life cycle.[25]. Since the moments over the life cycle were not targeted for the model estimation, the life cycle behavior can give us how well the model fits. Table 17 shows the labor force participation of daughters and sons over the parent's age quintiles. The model fits reasonably well, except the moderate underestimation of labor force participation for sons.

Table 17: Labor force participation by parent'a age quintile

	Age 65-70	Age 71-75	Age 76-80	Age 81-85
A. Daughters				
Model	.78	.74	.72	.69
Data	.75	.74	.72	.67
B. Sons				
Model	.81	.77	.74	.72
Data	.81	.80	.79	.74

Table 18 reports the earnings over the life cycle for daughters and sons. Given that income are only reported in brackets in the HRS, I compute the share of daughters and sons earning more than \$35,000 using the simulated data and compared it against the data. Table 19 reports the family care hours of daughters and sons over the life cycle. Notably, family care hours are moderately underestimated for daughters but overestimated for sons.

Table 18: Probability of earning $\geq \$35,000$ by parent'a age quintile

	Age 65-70	Age 71-75	Age 76-80	Age 81-85
A. Daughters				
Model	.51	.53	.56	.55
Data	.49	.55	.57	.56
B. Sons				
Model	.57	.59	.61	.63
Data	.50	.57	.62	.65

[25]See **??** for the wage process and LTC needs simulated over the period of the life cycle.

Table 19: Family care hours by parent's age quintile

	Age 65-70	Age 71-75	Age 76-80	Age 81-85
A. Daughters				
Model	155	178	260	301
Data	132	192	288	336
B. Sons				
Model	63	80	93	105
Data	32	73	85	96

6 Counterfactuals

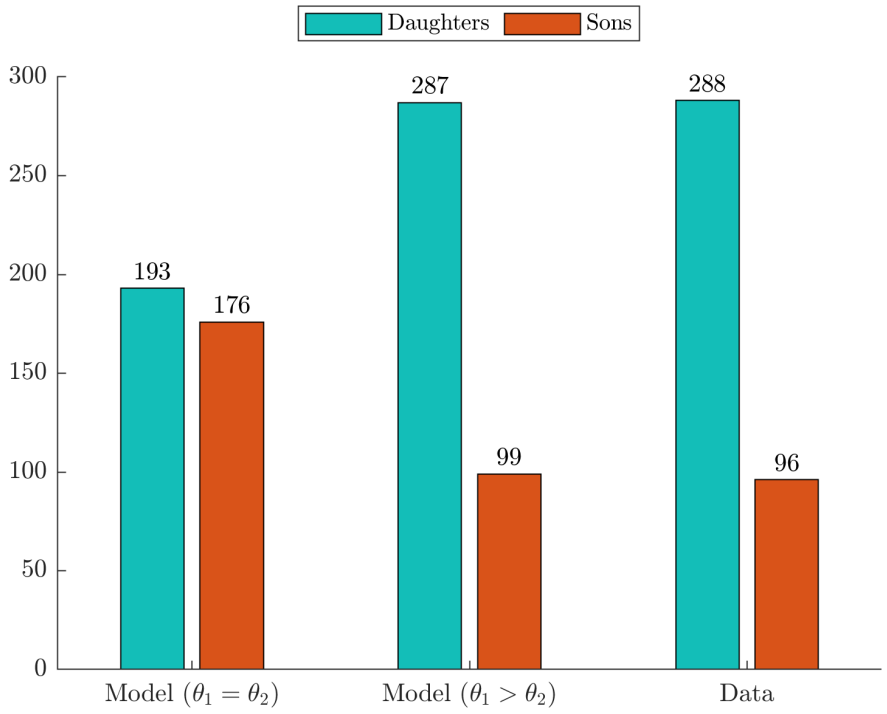
I run two counterfactual exercises using the stylized life-cycle simulation of labor market and family care behavior of daughters and sons. First, I assume a scenario where daughters and sons have same weights on family public good. The purpose of this exercise is to show how much of the gender gap in family are hours is driven by differences in opportunity costs of daughters and sons as opposed to heterogeneity in 'preferences' for family public good. Second, I quantify the life-cycle earnings trajectory of daughters and sons in the absence of parental LTC needs and compare the results to the trajectory with parental LTC needs. This allows me to show potential foregone earnings associated with family caregiving and the differences in foregone earnings between daughters and sons.

6.1 Homogeneous Preferences for Public Good

In this exercise, I assume daughters and sons have the same weight on family public good at 0.2. Figure 9 illustrates the differences in family care behavior of daughters and sons under two scenarios: homogeneous preferences ($\theta_1 = \theta_2$) and heterogeneous preferences ($\theta_1 > \theta_2$). Compared to the data, we can see that the model with homogeneous preferences significantly underestimates the gender gap in family caregiving. However, we still observe a gap in family care hours between daughters and sons in this counterfactual scenario. This is entirely driven by differences in opportunity costs of daughters and sons in terms of wages. The results for the model with heterogeneous preferences for public good, on the other hand, show the gender gap in family caregiving driven by differences in opportunity costs and in 'preferences' for public good. Note that the estimated values are $\theta_1 = 0.2006$ and $\theta_1 = 0.195$. This exercise illustartes the importance of accounting for heterogeneity in preferences in order to explain gender gap in family care. This channel to explain gender gap in unpaid care work and household production has been largely ignored in family interactions other than married

couples and specifically in the context of long-term care[26].

Figure 9: Family care hours with and without heterogeneous preferences



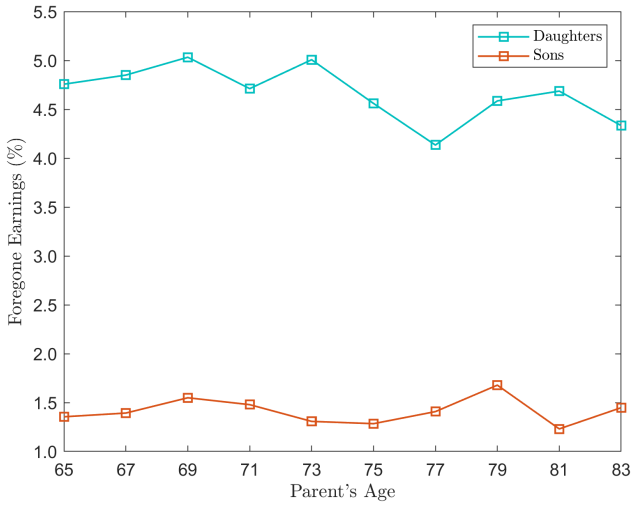
6.2 Foregone Earnings and Family Care

Using the simulated life-cycle earnings trajectory for daughters and sons when they face parental LTC needs, I run a counterfactual exercise where adult children do not face LTC needs from their parents. This is to examine how adult children would have behaved in the labor market in the absence of their responsibility to take care of their elderly parent in a stylized life-cycle simulation. By comparing the earnings under the counterfactual simulation with no parental LTC needs to the earnings under the simulation with LTC needs, I quantify the foregone earnings associated with family caregiving for daughters and sons. Figure 10 presents the foregone earnings associated with family caregiving in percentage of what adult children would have earned if they did not have parental LTC needs. In other words, the foregone earnings represent the percentage drop in earnings associated with family caregiving. I report the foregone earnings over 20 year period when parent is aged 65 and 85. This roughly reflects the working period of adult children during their mid 40s to mid 60s. Daughters face an average of 4.6% drop in earnings over this time period compared to sons who face an

[26]See Blundell, Pistaferri, and Saporta-Eksten (2018) and Cortés and Pan (2020) for the inclusion of heterogeneity in 'preferences' for childcare and household production among married couples.

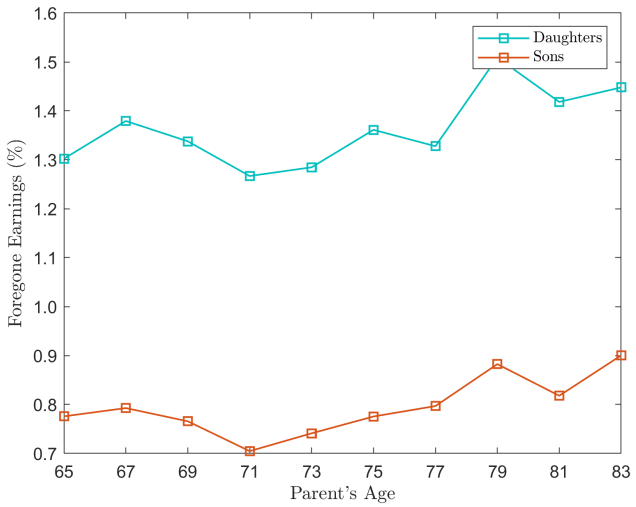
average of 1.3% drop in earnings. Note that the gender gap in foregone earnings are driven by two channels in Figure 10: 1) daughters have lower opportunity cost to provide care in terms of wages, and 2) daughters have higher 'preference' for family care compared to sons.

Figure 10: Foregone earnings under heterogeneous preferences



But how much of the foregone earnings for daughters and sons are driven purely by differences in wages? Figure 11 shows the scenario where daughters and sons have homogeneous preferences for public good. The foregone earnings drop to 1.3% for daughters and to 0.8% to sons over the 20 year period.

Figure 11: Foregone earnings under homogeneous preferences



7 Conclusion

Demography aging is increasingly pushing families to meet the rising demand for long-term care assistance from their elderly loved ones. Family care in a prolonged and intensive LTC needs can affect family caregivers to reduce their labor supply or exit the labor market, thus affecting their earnings over time. One group that is particularly affected by the trade-off between working and care for their elderly is adult children. This paper focuses on the family decision to provide care among adult daughters and sons, and how those decisions affect their labor supply and earnings of adult children in their mid 40s to mid 60s.

To analyze what shapes adult children's decision to provide familu care, I estimate a Cournot-Nash equilibrium model between daughters and sons who are heterogeneous in wages and in 'preferences' for family care for their parent. My main takeaways are twofold. First, I find that heterogeneity in 'preferences' is an important channel to explain the observed gender gap in family caregiving in addition to gender differences in opportunity costs. Second, daughters face 4.6% drop in earnings due to family caregiving whereas sons face 1.3% drop in earnings over the 20 year period considered.

Appendix A Sample Details

The pooled 1998-2014 Health and Retirement Study is used to construct the data used in empirical evidence and model estimation. The sample restrictions and their corresponding number of observations are reported in Table 20.

Table 20: Sample construction

	No. of parents	No. of children	No. of child-wave observations
65+ single elderly parents	3,740	9,508	85,572
Those with ≥ 2 adult children	2,454	8,864	79,776
Those who experienced LTC needs	1,942	7,047	63,423
Those who received family care	1,317	4,966	44,694

Out of 3,740 65+ single elderly individuals who consecutively interviewed between 1998 and 2014, 2,454 have at least two adult children aged 21 and over. Out of those individuals with at two or more adult children, 1,942 experienced at least one limitation with ADL or IADL during 1998-2014. Further 1,317 individuals received family care from at least one child. The restriction gives us 4,966 adult children of elderly parents who rely on family care between 1998-2014. The final individual-wave observations of these adult children are 44,694 over the sample period.

Appendix B More on Multiple Children Caregivers

Table 21: Caregiving Arrangement by Number of Caregivers

		Caregiving Arrangement	
	Provide care	Take turns	Simultaneous
One caregiver	82%	-	-
Multiple caregivers	88%	52%	48%

Notes: The sample includes 3,261 observations when a parent is sick, disaggregated by how many caregivers the parent has over the 1998-2014 sample period. The observations are from 1,340 parents aged 65 and over with multiple multiple children and at least one caregiver. Provide care refers to the periods when a caregiver child provides care to the sick parent. For multiple children caregivers, in each period they either take turns (i.e. one providing care in some periods and another providing care in other periods) or provide care simultaneously in the same period (over two years).

Appendix C Descriptive statistics on Adult Children by Caregiving Intensity

Table 22: Characteristics of Adult Children by Caregiving Patterns

	Provide Care		Not Provide Care
	$\geqslant$ 20 hrs/wk	<20 hrs/wk	
Age	53.5	53.5	53.6
Female	0.70	0.59	0.44
Married	0.49	0.69	0.69
Home ownership	0.51	0.74	0.66
College	0.21	0.32	0.24
Working full-time	0.48	0.63	0.62
Working part-time	0.10	0.09	0.07
Not working	0.42	0.27	0.31
Earns >$35,000	0.37	0.64	0.60
Earns >$70,000	0.05	0.12	0.12
Lives within 10 miles	0.75	0.61	0.31
family care (hrs/wk)	45/28	5/3	-
Observations	3,271	7,176	14,526

Notes: The sample includes 24,973 person-wave observations of 4,967 adult children of 65+ single individuals who has two or more children and receive family care from at least once child in the pooled 1998-2014 Health and Retirement Study. The table reports the characteristics of children based on whether they provide care to their parent during the sample period, and on whether they provide more than 20 hours of care during the sample period. For family care hours, the mean/median hours are reported.

Appendix D Caregiving Arrangements by Sibling Groups

Table 23 presents the family caregiving patterns across the three sibling groups. The percent of elderly parents who do not receive care from any adult child is highest among the group of only brothers at 27.7% compared to around 15% of the other two groups. One child providing all the family care is most prevalent in single-gender sibling groups ranging from 55.9% to 58.4%. In contrast, one child as the sole caregiver is less prevalent in the mixed-gender sibling group at 49.7%. As families with only sons and daughters have fewer children on average (see Figure 12), this pattern is consistent with the empirical evidence that the share of multiple caregivers for elderly parents increases as the number of adult children increases. Despite

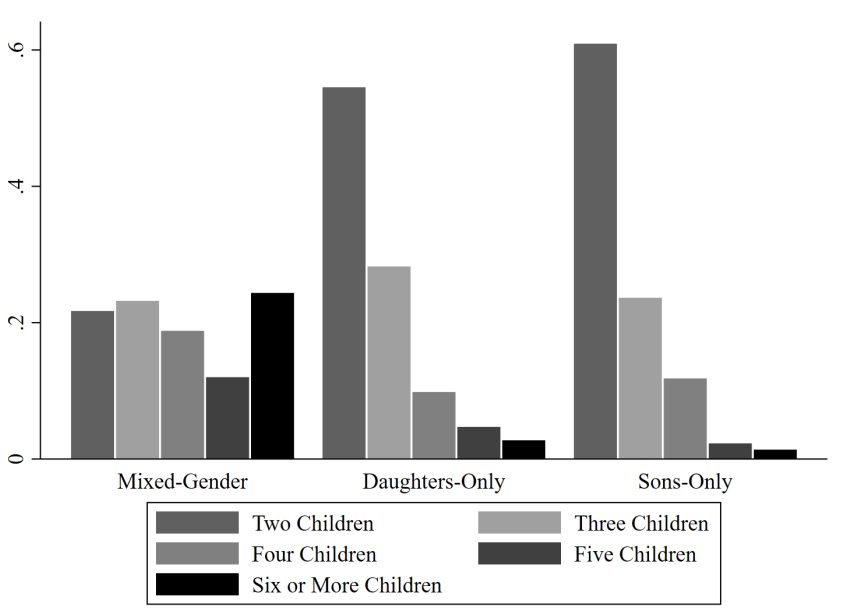
the lower number of siblings, however, we observe a higher rate of shared caregiving for sisters-only groups than brothers-only groups.

Table 23: Number of Children Caregivers by Sibling Groups

	Mixed-gender	Sisters-only	Brothers-only	Total
% with no caregiver	14.8	15.7	27.7	16.7
% with one caregiver	49.7	58.4	55.9	52.0
% with multiple caregivers	35.5	25.9	16.4	31.3
Total	100.0	100.0	100.0	100.0

Notes: The sample includes 65+ single individuals with two or more children and experience needs with activities or instrumental activities of daily living during the pooled 1998-2014 Health and Retirement Study. The rows represent the percent of elderly parents in terms of how many adult children provided care during the sample period. Mixed-gender refers to sibling groups with at least one brother and one sister. Single-gender sibling groups are disaggregated by those with only sisters and only brothers.

Figure 12: Distribution of Number of Adult Children By Sibling Groups

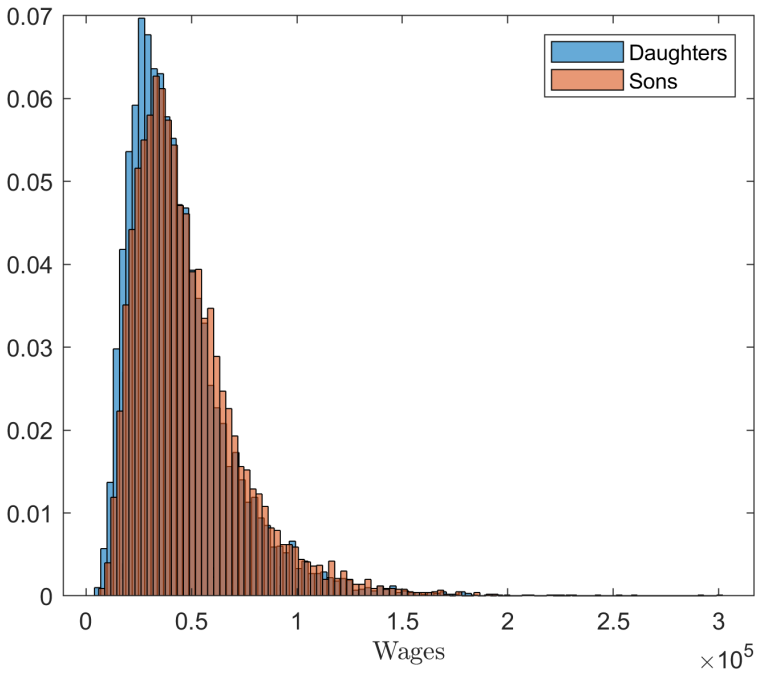


Notes: The sample includes single individuals aged 65 and over with at least one adult child in the pooled 1998-2014 Health and Retirement Study. "Mixed-Gender" refers to the set of families that have both sons and daughters, "Daughters-Only" refers to the set of families that only have daughters, and "Sons-Only" refers to the set of families that have only sons.

Appendix E Simulated wage distribution and fit

Figure 13 illustrates the parameterized wage distributions for daughters and sons. Table 24 shows the fit of the simulated wage distributions against the HRS data. For both daughters and sons, simulated income overestimates the upper income bracket but the lower and middle income brackets fit well against the data.

Figure 13: Simulated wage distribution



Notes: The figure shows the simulated wage distribution of adult children using the parameters in Table 9.

Table 24: Wage distribution fit

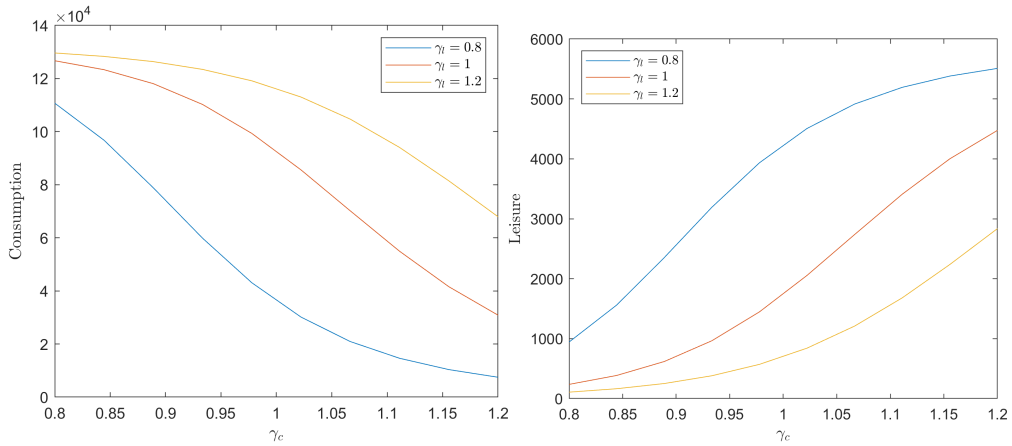
	Daughters		Sons	
	Simulated	Data	Simulated	Data
$\geq \$35,000$	.57	.59	.65	.65
$\geq \$70,000$	.13	.09	.16	.13

Notes: The table reports the fit of the simulated wage distribution of daughters and sons using the parameters listed in Table 9. The data moments are from the HRS. $\geq \$35,000$ refers to earning more than \$35,000.

Appendix F Implications of Structural Parameters on Consumption and Leisure

Figure 14 shows the responses of consumption and leisure to the interaction of γ_c and γ_l. As income effect gets stronger, represented by an increase in γ_c along the horizontal axis, consumption decreases as one reduces their labor supply and enjoys more leisure instead. On the other hand, the leisure curvature γ_l has the opposite effect. Higher γ_l increases consumption while lowering leisure as the response of market hours become more concave at any given γ_c, as illustrated in Figure 5.

Figure 14: Leisure and Consumption in Response to γ_c and γ_l



(a) Consumption response to γ_c and γ_l

(b) Leisure response to γ_c and γ_l

Notes:

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