Family Trajectories and the Burden of Care in the Aftermath of Old-Age Health Shocks

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Abstract

Due to increasing longevity and declining fertility, families in many rich countries have experienced sharply rising aging-related care needs at the same time that the labor capacity within those families has fallen. How families meet those care needs given their constraints—and at what cost—is an increasingly important question. This paper shows that sudden declines in the health of elderly Taiwanese adults disrupts the life cycles of their adult children. Rather than causing substitution away from the labor force, elderly parental health shocks are followed by increased mortality, poorer indicators of health, and reduced marriage and fertility rates. Burdensome care needs are likely a key mechanism, judging from the observable characteristics that predict particularly adverse responses to a parental stroke. We find evidence that allowing families to hire migrant care workers can attenuate the negative associations between old-age health issues and family outcomes, improving the survival, health, and well-being of adult children of the elderly.

Keywords: Long-Term Care, Family Welfare, Fertility, Health Shocks, Caregiving.
JEL Codes: J14, D10

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1 Introduction

Recent trends in fertility rates and longevity have spurred an increase in the prevalence of aging-related health problems and greater concern regarding their social consequences. Public and private expenditures dedicated toward the long-term care (LTC) needs associated with these health problems are substantial, exceeding 1.5 percent of annual GDP across OECD countries in 2008 (Colombo et al., 2011). However, the broader costs of aging-related health problems to families are not well understood.

The objective of this paper is to characterize the associations between old-age health problems and the economic well-being and health of families. Whereas existing evidence has focused primarily on the implications of old-age health for family earnings and labor supply, we theorize that responses on other margins may be larger and more costly. The setting of our paper, Taiwan, is typical of rich East Asian societies where formal social safety net programs are limited, and where families that are unable to absorb an old-age health shock are plausibly left in great distress. After establishing the negative outcomes that follow old-age health shocks, we leverage the expansion of migrant caregiving in Taiwan to study whether access to formal care assistance mediates these costs.

We identify family associations with old-age health shocks using a staggered difference-in-difference design, where otherwise similar "later-shocked" families serve as control units for families that suffer shocks earlier in time. Our analysis first focuses on strokes, as they represent severe and acute health events for which timing is plausibly difficult to predict (Chandra and Staiger, 2007; Doyle, 2011; Fadlon et al., 2019; Fadlon and Nielsen, 2021). We document modest declines in the aggregate employment of adult sons after an elderly parents' stroke (0.5 percentage points), which are consistent in magnitude with responses documented elsewhere in the literature.

Going beyond labor supply responses, sons also exhibit adverse outcomes on other margins following these health shocks. We find that adult sons' marriage and fertility decline after a parental stroke, while adult sons' medical spending, depression diagnoses, and general mortality all increase sharply. Marriage and fertility changes are concentrated among those who are comparatively young at the time that their parent suffers a stroke (35 years old or younger). Depression, medical spending, and mortality changes are concentrated among older sons on the other hand, consistent with economic models of suicidal behavior or "deaths of despair" (Case and Deaton, 2017; Hamermesh and Soss, 1974). These associations are large in magnitude: mortality rates increase on average by 0.565 deaths per thousand per year, relative to pre-stroke baseline mortality rates of 0.86 per thousand per year. Adverse

outcomes that are broadly similar in magnitude arise in the aftermath of parental health shocks associated with less severe care needs (hip fractures) and shocks tied to cognitive rather than physical decline (dementia hospitalizations).

Empirical patterns suggest that caregiving responsibilities are an important channel through which associations arise. Negative outcomes after a stroke are concentrated in smaller families which have lower capacity to absorb the time demands of care needs, and among families in which the parent endures a more severe shock as measured by the duration of the hospitalization spell.

Having established the associations between old-age health shocks and family outcomes, the second part of the paper examines if those associations are mediated by the hiring of live-in formal caregivers. Formal caregiving in Taiwan is performed almost exclusively by migrant workers, who first came to Taiwan in meaningful numbers after the introduction of centrally-regulated migrant care labor markets in the 1990's. Rates of migrant caregiver hiring subsequently increased to the point that migrant care workers represent over 1 percent of Taiwan's total population as of 2020.

The rise in caregiver hiring is disproportionately concentrated among dependents over the age of 80, for whom the Taiwanese government has gradually relaxed eligibility criteria. Focusing on families that suffer a stroke in this more advanced age group, propensities to concurrently hire a caregiver increased from 25 percent for the cohort suffering a stroke in 2007, to nearly 45 percent for the cohort suffering a stroke in 2016. At the same time, the associations between parental health shocks and adverse outcomes in families vanished as caregiver hiring rates increased across these cohorts. We show that this cross-cohort variation in caregiver hiring propensity is not matched by systematic variation in the pre-shock income or employment of adult children, supporting the idea that it is driven by supply factors exogenous to families rather than factors related to family demand for caregiving. Taken together, we interpret this as evidence of how a migrant work policy targeted at the problems of an aging society can improve the health and well-being of the native working-age population.

The paper proceeds as follows. Section 2 positions our contribution within the empirical literature on health shocks and LTC needs. Section 3 describes the socio-demographic and policy environment of Taiwan, where we draw our data, and discusses the theoretical predictions that arise from a stylized model of LTC needs and caregiving in multi-generational families. Section 4 describes our data sources and key measures. Section 5 presents our workhorse staggered difference-in-difference design and uses the data to estimate associa-

tions between parental strokes and family outcomes. Section 6 characterizes associations between family outcomes and other health events—hip fractures and dementia diagnoses—using the same design. Section 7 examines how intertemporal variation in the scale of migrant caregiving is tied to family responses to old-age health shocks. Finally, Section 8 concludes.

2 Literature

Our paper contributes to an active empirical literature on the economic consequences of a negative health shock for families. Many studies have leveraged registry data and difference-in-differences designs to examine associations between health shocks and one's own employment outcomes (see, e.g., Halla and Zweimüller, 2013; Heinesen and Kolodziejczyk, 2013; Garcia-Gomez et al., 2013; Gupta et al., 2015; Dobkin et al., 2018; Parro and Pohl, 2021).[1] A smaller but growing volume of research has examined associations with spousal employment as well, finding that sudden diagnostic health shocks have tended to reduce it by 0 to 3 percentage points.[2] Non-fatal heart attacks in Denmark (Fadlon and Nielsen, 2021) have been associated with no clear changes in spousal labor supply, whereas clear but modest responses have been documented to urgent hospitalizations in the Netherlands (Garcia-Gomez et al., 2013) and cancer diagnoses in Canada (Jeon and Pohl, 2017).

Less is known regarding diagnostic shocks suffered by old-age adults, who may be more frail and are less likely to engage themselves in labor force participation. To our knowledge, the existing evidence comes from two recent papers , which together suggest parental health shocks are connected with weak, if any, declines in the labor supply of adult children in Austria and the Netherlands (Frimmel et al., 2023; Rellstab et al., 2020).[3] The onset of informal caregiving spells (Maestas et al., 2022) or functional limitations (Chen and Lin, 2022) is associated with comparatively sharper declines in family labor supply, consistent with the idea that LTC needs are an important channel for family labor supply responses to diagnostic health events—and that diagnostic events do not always cause major LTC needs to arise.

[1] Beyond consequences for family labor supply, other notable papers have focused on broader financial distress following health shocks (e.g., Dobkin et al., 2018), on positive spillovers to family health behaviors (Fadlon et al., 2019), and on inheritance following a relative's fatal shock (Druedahl and Martinello, 2022).

[2] See Bauer and Sousa-Poza (2015) for a review of earlier survey-based evidence.

[3] Frimmel et al. (2023) find that parental strokes but not heart attacks are associated with slight (2.5 percentage point) declines in labor supply among adult children in Austria. More generally, Rellstab et al. (2020) finds that unexpected parental hospitalizations are not associated with any clear changes in the income or employment of adult children in the Netherlands.

Little attention has been paid in the economics literature to the potential spillovers of old-age health shocks to the health and well-being of families. To a degree, this has been the focus of a strand in the medical literature, which has focused on the health outcomes of informal caregiver specifically. Several small-scale surveys and clinical studies have found informal caregivers to be of unusually poor health compared to the overall population or matched non-caregivers (e.g., Cameron et al., 2016; Haley et al., 2015; Roth et al., 2013; Schulz and Beach, 1999; see Adelman et al., 2014 for a review). However, whether this represents selection into caregiving, intra-family correlations in health, or changes in caregiver health associated with the burden of care remains unclear. Furthermore, with small sample sizes, no study has precisely characterized the kinds of caregivers—or families—for whom distress arises (Rigby et al., 2009).

Our main contributions to the literature are twofold. First, we document in national registry data that families experience substantial declines in well-being in the aftermath of severe health shocks, in addition to labor supply responses: increases in mortality, decreases in childbirths and marriage, and increases in medical spending and depression diagnoses. Second, we leverage our large and long administrative panels to document heterogeneity which suggests that LTC needs are an important driver of these negative family outcomes. Specifically, we find sharper changes in outcomes for smaller families, for families with more severe or care-intensive health events, and for family members already living with the LTC-needer prior to their health event.

This paper also contributes to a smaller and actively-developing literature on public policy interventions to mitigate the costs of LTC needs to families. The literature's main empirical result is that expanding access to formal care leads to an increase in labor supply for some informal caregivers. Using a 1998 grant program that disproportionately increased funding for formal care in some Norwegian municipalities, Løken et al. (2017) finds that formal care access increases the labor supply of daughters who have no siblings and one surviving elderly parent, but not for sons or daughters with siblings. Frimmel et al. (2023) argues that allowing large inflows of migrant care workers in Austria reduced the adverse effects of a parental stroke on children's labor supply, comparing changes in the responses to a stroke around a migrant care reform to changes in the response to a heart attack. Similarly, Chen and Lin (2022) studies the consequences of the 2012 reform in Taiwan using household survey data. They find large increases in labor supply among children with functionally-limited elderly parents who are only made eligible for formal care by the reform, when those children are compared against a control group whose parents were already eligible for a

caregiver.

Our paper's focus attention to health, fertility, household formation, and other indicators of well-being is also a contribution to this policy-oriented literature. Relative to Chen and Lin (2022) and Frimmel et al. (2023), our results highlight that liberalizing access to migrant LTC workers in Taiwan plausibly improved the health, well-being, and longevity of working-age relatives of the LTC-needing elderly in ways that are not captured by labor supply responses alone. Given Taiwan's strict border controls and the absence of a domestic labor market for formal caregivers, we argue that the scope for negative spillovers on other Taiwanese families is low, meaning the approximate domestic costs and benefits of these policies are plausibly internalized by the LTC-needing families that we study.

3 Background

3.1 Institutional Background

LTC Needs in Taiwan. With persistently low fertility rates and increasing life expectancies, Taiwan has one of the fastest aging populations in the world. As of 2021, 17 percent of the population is over the age of 65, and 4 percent is over the age of 80 (Department of Household Registration, 2022). LTC needs are a large and growing social problem that affects approximately 12.7 percent of adults older than 65 years of age. Taiwanese families predominately meet these needs through informal caregiving performed by younger relatives. Beyond informal care, roughly one-third of LTC-needers hire an in-home caregiver. These in-home caregivers are predominantly foreign workers. To hire such a caregiver, a family must receive government authorization, at which point a foreign caregiver is permitted to enter Taiwan on a short-term visa, live with the host family, and provide around-the-clock caregiving assistance. Institutional care (such as nursing homes) also exists but is less common than these at home arrangements, representing roughly one-quarter of LTC cases (Chen and Lin, 2022).

The prevalence of in-home care, either by family members alone or with the aid of a live-in caregiver, aligns with the norms of filial piety which are well-established in Taiwan and other rapidly-aging East Asian societies. Traditionally, the greatest expectations of care are imposed upon the LTC-needer's first-born son and—if married—that son's spouse. In a 2013 government survey of LTC-needing families, 29 percent identified the LTC-needer's spouse as the primary caregiver (Department of Health, 2013). Sons, daughters-in-law, and daughters are primarily caregivers within 16, 10, and 8 percent of LTC-needing families respectively,

with the remaining 37 percent cared for by other relatives (e.g., mothers, fathers, or siblings) and in nursing homes.

LTC needs and the Taiwanese Social Safety Net. Whereas Taiwan is well-known for advanced health care and a generous universal health insurance system, Taiwan maintains a limited set of social assistance programs for families that suffer LTC needs. These programs provide a collection of small in-kind transfers, including up to 90 hours per month of day care, transportation services to hospitals, and subsidies on assistive devices. Notably, Taiwan does not have analogs for key social programs that exist in other countries, such as public insurance against LTC needs (the role filled by Medicaid in the United States) or paid leave for caregivers. Taiwan tends to spend far fewer public resources on LTC needs (0.2 percent of GDP per year) than most OECD countries (1.5 percent of GDP per year overall) (Mueller and Morgan, 2020; Long-Term Care Division, 2022).

Given the lack of public insurance against LTC needs, a Taiwanese family might be expected to turn to other social programs should such needs arise. Taiwan's general social safety net consists primarily of two means-tested programs, known as the low income program and the middle-low income program. Both programs provide beneficiaries with a variety of in-kind transfers, including coverage of medical expenses, school tuition, and small housing subsidies.[4] The low income program also provides cash transfers which depend on family size and place of residence: a family in New Taipei City (Taiwan's largest county) with no income could receive a monthly transfer of 12,393 NTD (approx 413 USD) per person in 2023. By comparison, the 2023 minimum wage was 26,400 NTD (880 USD) per month and the average worker in 2022 earned 57,718 NTD (1,923 USD) per month.[5] Cash transfers through the middle-low income program are smaller and provided only to elderly and disabled individuals.

Eligibility for both programs are subject to income and asset at the *family* level. These means tests are especially aggressive because they can apply even to one's parents or one's children *who live in a separate household*, reflecting the social expectation that supporting the needy is first and foremost a responsibility of the family unit. For example, in Taipei, a family must have per-person income no higher than 26,689 NTD (approx. 890 USD) in order to receive cash transfers through the low-income program, and total family savings

[4]Housing subsidies vary across counties. National law imposes a cap on this subsidy of 3,600 NTD (120 USD) per month for a family. The largest county, New Taipei City, has no housing subsidy.

[5]It is common for even minimum wage employers to provide an annual bonus in addition to a monthly salary. In 2022, the average retail service worker received a bonus worth 1.48 months of pay.

including investments cannot exceed 150,000 NTD (approx. 50,000 USD). Slightly more lenient means tests apply for the middle-low income program, though they are augmented with a restriction on the value of the family's total property holdings.[6] In accordance with the stringency of these restrictions, participants in both the low income program or middle-low income program combined amount to only 2.6 percent of the Taiwanese population (Ministry of Health and Welfare, 2018).

With a social safety net that can arguably be characterized as "threadbare," shrinking Taiwanese families may face high private costs when LTC needs arise. While there is no systematic study on how LTC needs affect indicators of distress like depression, domestic abuse, suicide, or parricide risks within families, these concerns have received wide attention from the government and national media. The auditory branch of the government in Taiwan, the Control Yuan, has filed a formal "Corrective Measure" that requires the executive branch of the government to act toward preventing these incidents (The Control Yuan, 2020). Concerns are often raised in Congress as well; a keyword search of Congressional session minutes returns more than 40 instances when LTC-related suicides were discussed between 2016 to 2022.

Caregiver Regulations in Taiwan. In Taiwan, international caregivers play a crucial role in the LTC system. The number of international caregivers grew from nearly 0 in the early 1990's to 259,660, or more than 1 percent of Taiwan's entire population, in 2020. Virtually all of Taiwan's formal caregivers are international caregivers.

The process of hiring an international caregiver is heavily regulated by the Taiwanese government. An individual that intends to hire a caregiver needs to obtain a certification of need issued by a doctor. The certification records the applicant's Barthel index, which is a commonly-used numerical score measuring functional limitations. An individual is approved if one's Barthel index score is sufficiently low, where the threshold against which one's score is compared decreases weakly with age. If an individual meets the eligibility criteria, she can formally start the hiring process.

To find a caregiver after receiving approval, families usually rely on intermediary firms that match them with foreign workers. The total average wage costs to a family (not including living accommodations) amounted to 239,016 NTD in 2019, or roughly 20 percent

[6]Thresholds for per-person income and family savings are roughly 50 percent higher for the middle-low income program. A separate test is applied to property holdings for the middle-low income program; a beneficiary will receive no cash transfers if his or her family owns property worth more than 7.5 million NTD.

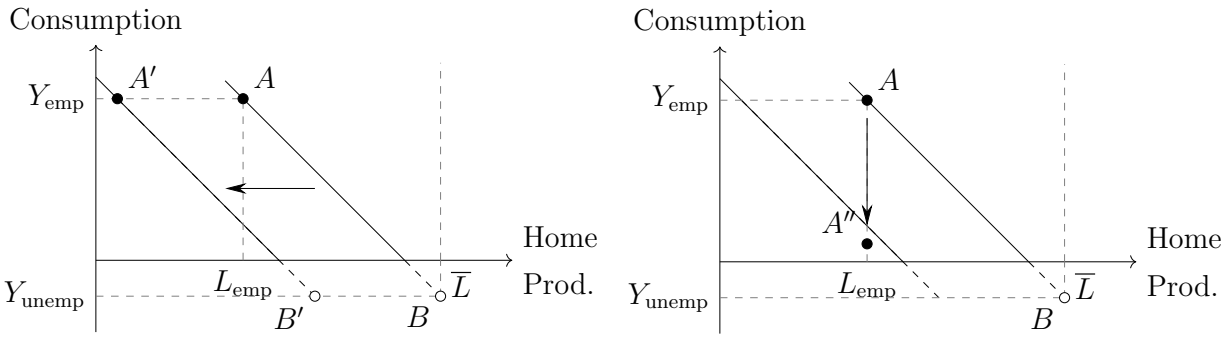
of average gross household income (Statistics Office of the Ministry of Labor, 2021). An international caregiver receives a temporary work visa for the duration of his or her employment contract, and he or she resides in the household of the LTC-needer for this period. A contract is typically valid for three years, after which the LTC-needer must seek a renewal to continue receiving formal care. In most cases where the condition is severe, applying for renewal does not require a re-assessment of the LTC-needer's health. The clear, formal ties between international caregivers and their host families limits the scope for undocumented immigration or the overstaying of visas through this system.

While this framework has been in place since 1992, two major reforms were implemented in recent years to expand access to formal caregiving. Both reforms relax the Barthel index thresholds that older-age LTC-needers must reach in order to receive approval for an international caregiver. The first reform, occurring in 2012, introduced the age gradient by relaxing the Barthel index threshold from a score of 35 to a score of 60 for LTC-needers who are 80 years of age or older (Ministry of Labor, 2012). The second reform, occurring in 2015, further relaxed the criteria so that any LTC-needer with 85 years of age or older is eligible to hire an international caregiver if her Barthel index is strictly less than 100 (Ministry of Labor, 2015).

The changes in the certification thresholds introduced by these reforms are substantial. To put them into clearer context, a Barthel score of 35 would exclude any LTC-needer who can engage in 3 or 4 of 10 basic daily activities without assistance. For instance, a LTC-needer would be ineligible if she can eat and use the toilet without assistance, and if she does not suffer from bowel or bladder control issues. By contrast, one can meet a score threshold of 60 if one is unable to climb stairs, move 50 yards across a level surface, *or* transfer between a bed and chair.

3.2 Conceptual Framework

To formalize the ways in which care needs and caregiver hiring opportunities can impact families, we present a stylized model of work and leisure which we view as a reasonable approximatino of the true problem faced by many Taiwanese families. In this problem, a work-capable adult with a single living relative (e.g., a parent) acts with a fixed time endowment to maximize a private payoff subject to a constraint that the relative's caregiving



(a) Informal Care Provision

(b) Formal Caregiver Hiring

Figure 1: Budget Set in a Stylized Model with Family LTC Needs

Notes: $\overline{L}$ is the agent's time endowment. Points A and B are bundles representing full-time employment and non-employment. Points A' and B' represent the same bundles after the agent pays a fixed time cost of informal care provision. Point A'' is the bundle of consumption and home production one receives if working full-time and hiring a formal caregiver.

needs are met. The private payoff is an increasing in consumption and home production.[7] We think of home production as a general non-market time investment; it can capture investments that facilitate good health or family development (meeting and marrying a partner, bearing and raising a child, etc.). Consumption is a composite good that captures most importantly food and housing.

Consider in Figure 1 the comparative statics that can arise when the agent's relative suffers LTC needs. If the agent could freely choose work hours at his contracted wage, then the agent's budget set would consist of a line with a slope corresponding to his wage rate, which we denote as the line passing through a point indicating full employment (A) and and non-employment (B). If a parental health shock causes LTC needs that manifest as an additional demand on the agent's time, then they drive a leftward parallel shift of the budget constraint, which we draw such that the new budget set passes through A' and B'.[8]

[7]The framework we lay out here can be connected to the static problem of the child generation in the two-generation, non-cooperative model of LTC needs of Barczyk and Kredler (2018). Our framework is close to a special case of the model where the parent generation has limited income and savings, and no Medicaid coverage exists (so that informal caregiving or child-funded formal caregiving must occur). We view this as a reasonable approximation of the circumstances faced by many Taiwanese families. Unlike Barczyk and Kredler (2018), we distinguish between between consumption and home production in order to make theoretical predictions regarding marriage and fertility. For pedagogical purposes, we start with the case where only informal caregiving is an option.

[8]A parental health shock can alternatively manifest as both a time cost and financial cost, i.e., if children respond to LTC needs with both care and child-parent inter vivos transfers as in Barczyk and Kredler (2018). The shock would instead cause an inward shift of the budget constraint toward the origin, but predictions

The magnitude of that shift depends on the time cost demanded by the LTC needs (e.g., their severity).

The implications of the LTC shock for consumption and home production depends on the marginal rate of substitution between consumption and home production. For at least two reasons, that marginal rate of substitution might heavily favor maintaining one's consumption at the expense of home production. First, the marginal utility of consumption might diverge as the agent approaches a binding subsistence level represented by the graphical x-axis (one must pay rent and food bills in order to survive). Second, the agent might face constraints on the choice of work hours, for instance with employment available only through full-time jobs. Panel A of Figure 1 illustrates a case where these two factors together drive the agent to entirely pass the time cost of LTC needs into home production, as the non-employment bundle with or without caregiver hiring would fail to achieve subsistence consumption. The costs of care provision will therefore manifest as declines in fertility, and other related family outcomes—not declines in earnings or labor supply.

A second insight from the model involves how family size and formal caregiver hiring might affect the agent's problem. If families are large, then multiple members can distribute the burden of caring for a single LTC-needer. One simple form that this cost-sharing can take is via intra-family transfers provided to the agent responsible for informal care—including from the LTC-needing parent. Supposing these transfers take the form of cash, they shift the agent's budget set $A'B'$ vertically upward. Compared to agents with small families, we would therefore expect to see smaller declines in home production for agents with large families. Introducing the option of hiring a formal caregiver has a closely related effect on the agent's choice set. It provides households with the opportunity to meet LTC needs through a monetary transfer to a third party. Absent any constraints, the result will be to shift out the budget set of the agent so long as the caregiver's wage is lower than the agent's wage. With constraints on work though, access to caregiver hiring may benefit the agent even *if the caregiver's wage is relatively high*, as it introduces a new feasible bundle (A'') vertically *below* the initial bundle associated with full-time employment (A). This may allow the agent to trade off consumption for home production in a way that is otherwise impossible, mitigating adverse outcomes associated with very low home production.

of the model would not qualitatively change.

4 Data

4.1 Data Sources

How LTC needs affect families is ultimately an empirical question. The data for this paper consists of multiple linked Taiwanese administrative registries. The main resource is the National Health Insurance Research Database (NHIRD), which contains administrative records from the universal health care insurance system. We link multiple datasets within the NHIRD to the Household Registry, which is an actively-maintained running register of all Taiwanese households. In this way we construct a dataset that contains rich demographic information, family structure, employer-reported earnings records, and other economic variables, complete inpatient, outpatient, and drug records, international caregiver hiring, and statuses for disability and middle-low income programs. Our data covers virtually the whole population of more than 23 million individuals, and we construct a panel spanning from 2000 to 2020. Our data on the hiring of international caregivers runs from 2007 to 2020.

We identify family links in our analytic sample by combining two information channels. The first is health insurance records; access to Taiwan's universal health care system is nominally tied to employment, where young children and unemployed adults are linked to the employment accounts of a family member (a spouse or parent). This allows us to reliably link children to parents, at least for children who can be observed as adolescents at some point in our data. The second source comes from the Household Registry, which is an annually renewed administrative record of individuals' addresses and co-residing family members. With the Household Registry, we can link any relatives or spouses who were cohabiting at some point between 2000 and 2018.

The weakness of our approach is that we can fail to link an elderly person to adult children if, by 2000, those children were old enough to access health insurance through their own employment account (or that of a spouse) and were old enough to no longer co-reside with the elderly parent. Appendix Figure A.1 summarizes parental match rates by sex and birth cohort. Overall, we manage to identify at least one parent for 53 percent of women and 65 percent of men who ever appear in our administrative data. Our method is somewhat less successful at matching daughters to their parents because daughters tend to leave the household upon marriage. By contrast, sons (especially the eldest son) tend to cohabit with parents more consistently throughout adulthood, and they may link to their parents through health insurance records even as an adult. We therefore choose to focus our analyses mainly on adult sons and define our parameters of interest accordingly, but it is worth noting that

our measure of family size will be downward biased. Nevertheless, we have an accurate accounting of individuals who cohabit with elderly family members, who presumably are most responsible for care in the event that a negative health shock arises.[9]

4.2 Measurement of Health Shocks and LTC Needs

We detect negative health shocks to the elderly using medical record data drawn from the NHIRD. In our main analyses, we focus on the onset of a stroke. We isolate the first time in an individual's medical history that an ICD code tied to the diagnosis or treatment of a stroke arises.[10] We then restrict to a sub-sample of these events that happen during an emergency hospital visit, since it is especially plausible that the timing of these events is unanticipated and conditionally random.

We focus first on strokes because they are strongly tied to an abrupt change in care needs. Using representative survey data collected every four years on elderly adults from the Taiwanese Longitudinal Study of Aging (TLSA), Table 1 shows that the onset of a stroke is associated with sharper increases in many functional limitations than hip fractures. Moreover, strokes are a frequent focus in the public health literature (Bickel et al., 2012; Dobkin et al., 2018; Fadlon et al., 2019; Fadlon and Nielsen, 2021).

4.3 Sample Construction

We construct our analytic sample by first identifying all individuals who suffer one of our identified health shocks—*LTC-needers* hereafter. For each LTC-needer, we identify the *first time* they experience a shock, and we take that first shock to be our event of interest.[11] We then merge this core dataset of health events with panel data on family members, based on family links that had been established at least one calendar year before the shock. Indexing links in this way is most relevant for spouses and children-in-law who can enter and exit the

[9]However, to appear in the household registry, an individual had to be alive in 2011. The links in the household registry are therefore selected in survival of both the adult child and older parent in a way which may bias some of our results—especially when examining death as an outcome. However, we find that our results generally hold in post-2011 data.

[10]The ICD-9 and ICD-10 codes we use are listed in Appendix C.

[11]When we study other conditions in addition to strokes, we handle sample construction separately for each condition to maintain consistency with the sample used in our main analysis. For instance, a person who suffers a stroke and later suffers dementia will appear in both the stroke and dementia samples, with different dates of onset.

Table 1: Changes in elderly functional limitations around strokes and other health events

	Strokes	Hip Fractures
Barthel Score (upper)	-16.50***	-8.56***
	(2.51)	(2.13)
Barthel Score (lower)	-19.95***	-10.89***
	(2.79)	(2.55)
Bathing	0.69***	0.34***
	(0.10)	(0.09)
Clothing	0.65***	0.34***
	(0.10)	(0.08)
Eating	0.36***	0.15**
	(0.07)	(0.06)
Ambulating	0.49***	0.31***
	(0.08)	(0.08)
Walking	0.57***	0.35***
	(0.09)	(0.08)
Continence	0.54***	0.40***
	(0.09)	(0.09)

Notes: This table reports the average change in each functional measure when an elderly person reports a given condition, relative to the previous survey wave. Survey waves occur every four years. Samples consist of all elderly individuals for whom onset of the given condition is observable in the TLSA.

family over time through marriage and divorce.[12]

We refine our sample with five restrictions on the health shock events. Our design requires that we observe pre-shock outcomes, so we first exclude families of elderly who suffer a shock in the first year of our data. Second, we restrict our sample to cases where this health shock event occurs after age 50, out of concern that the few earlier-life events shocks may be less severe, less random, or more predictable. Third, we exclude one's health shock event if one's spouse had already suffered a shock, to avoid potential endogeneity concerns. Fourth, to focus on individuals who are initially in good health, we exclude those who hired foreign caregivers *before* the health shock. Fifth, to focus our attention on events that tied to LTC needs, we exclude events where the LTC-needers died in the year of the health shock. Individuals are followed over the entire data period, until either the end of the panel or their deaths.

[12]If a married woman's parent and parent-in-law both suffer LTC needs, then she may appear twice in our analysis: once as a daughter, and once as a daughter-in-law.

4.4 Summary Statistics

Families that suffer a stroke are not a representative sample of the population of Taiwanese families. To contextualize the responses that we document and to describe how the burden of strokes are distributed across society, we first examine the observable characteristics of families that suffer a stroke. We present summary statistics on families in Table 2, splitting separately families which are never observed suffering a stroke from those which we observe suffering a stroke.

In total, we observe almost 500,000 unique families in which an elderly person suffers a stroke. Among those elderly, 59 percent have an identified spouse. We link them to an average of 2.34 relatives including daughters-in-law, where we identify more sons (0.84 on average) than we do daughters (0.51 on average) consistent with the limitations of our matching procedure. Compared to the elderly Taiwanese population, those who suffer a stroke are slightly less likely to have a spouse (0.59 versus 0.63) and are matched to fewer daughters (0.51 versus 0.61), but a similar number of sons (0.84 for both). They tend to match with more daughters-in-law (0.40 versus 0.31), indicating their sons are more likely to be married. Overall, the result is that families which suffer a stroke tend to consist of slightly fewer immediate relatives than the overall population (3.34 versus 3.40 people per family).

Table 2: Summary Statistics on Families of the Taiwanese Elderly

	Never-Event	Analytic Sample (Pre-Stroke)
Panel A: Statistics on Families of the Elderly		
Total Elderly (thousands)	6,004.03	498.74
Spouses per Elderly	0.63	0.59
Sons per Elderly	0.84	0.84
Daughters per Elderly	0.61	0.51
Daughters-in-Law per Elderly	0.31	0.40
Average Family Size	3.40	3.34

Notes: This table reports statistics on our main analytic sample of families as defined in Section 4.3. Working age family members are older than 20 and younger than 65 years of age.

Table 3: Covariate balance between sons in stroke-suffering families, their matched controls, and the broader population

	Other Families	Analytic Sample Families			
	Never-Treated (Mean)	Control (Mean)	Treated (Mean)	Treated - Control (Mean)	(Std. Error)
Age	32.63	34.06	34.06	0.00	(0.02)
Marital Status	0.35	0.43	0.43	0.00	(0.00)
Number of Children	0.64	0.84	0.84	0.00	(0.00)
Annual Earnings	257.42	249.10	251.70	2.61	(0.51)
Years of Schooling	10.64	11.36	11.36	0.00	(0.01)
Annual Hospital Bed Days	0.76	0.78	0.86	0.08	(0.02)
Annual Medical Spending	12.78	11.49	11.65	0.16	(0.22)
Deaths per Thousand	1.20	0.50	0.62	0.11	(0.02)
Suicides per Thousand	0.11	0.04	0.05	0.01	(0.01)
Depression Diagnoses	0.01	0.01	0.01	0.00	(0.00)
LTC-Needer is Female		0.48	0.45	-0.03	(0.00)
LTC-Needer Age		62.47	63.57	1.09	(0.02)
LTC-needer Schooling		7.43	7.38	-0.04	(0.01)

Notes: This table reports statistics on our main analytic sample of working-age sons in families defined in Section 4.3. Working age family members are older than 20 and younger than 65 years of age. Control individuals consist of individuals in later-treated families which have been matched to treated families on birth year, education level, and family structure.

5 Responses to an elderly parent's stroke

5.1 Methodology

In order to estimate the effects of elderly health shocks, we rely on a staggered difference-in-differences design. This design compares trends around the calendar year of a health shock for individuals in affected families to trends among contemporaneous "control" individuals who are observably similar but belong to families that suffer health shocks at a later date. To implement the design, we estimate a series of regressions for a range of values of ℓ, on different subsamples consisting of observations from event-year ℓ and from a pre-shock reference event-year ℓ_0:

$$Y_{it}^c = \alpha_{ic} + \sum_{\ell \neq \ell_0} \left(\gamma_\ell \mathbb{1}\{t = \ell\} + \delta_\ell D_i^c \mathbb{1}\{t = \ell\}\right) + \epsilon_{it}^c, \quad t \in \{\ell_0, \ell\} \tag{1}$$

where Y_{it}^c denotes the outcome for person i in year t relative to calendar year c. The subsample contains individuals from "treated" families that suffer a health shock in calendar year c (for whom $D_i^c = 1$), as well as otherwise similar individuals from later-treated families who

serve as "controls" (for whom c denotes the year in which their treated peer's family suffered a health shock). These later-treated controls are reweighed to exactly match the treated families on the distribution of observable characteristics, meaning our estimator amounts to the IPW estimator proposed by Callaway and Sant'Anna (2021). The characteristics on which we balance in all analyses are birth year (for person i), education level (six categories: none, elementary, junior high, high school, college, college above), and family structure (LTC needer has a spouse, LTC needer has zero vs. one vs. multiple children).[13] We define family structure by a combination of the following: the number of adult children linked to the LTC needer (one versus two or more) and whether the LTC-needer has a non-LTC-needing spouse.[14] Our design restricts to individuals who survive $t = -3$, but allows both treated and control individuals to die in years $t \geq -2$, falling out of the data in subsequent years.[15] The target parameters δ_ℓ represents the average treatment effect on the treated (ATT) for the given outcome Y, among treated families observed ℓ years from onset of the health shock.

5.2 Covariate balance between treated and later-treated controls

Table 3 compares average pre-period characteristics of adult sons and their stroke-suffering parents to those of the later-treated individuals. For reference, we also report average characteristics of adult sons whose parents are never observed suffering a stroke. By design, our treated and control samples match exactly on age and marital status. They are nearly indistinguishable on average marital status and years of schooling—an unsurprising but not strictly mechanical because we balance the groups coarsely on these characteristics.We do not balance on one's own pre-period fertility or health, but nevertheless treated and later-treated sons have nearly identical average numbers of children and average annual medical spending.

[13]For certain analyses, we control also for other characteristics such as one's marital status and presence of children before the shock, proxies for the severity of the shock itself, and whether the individual lived with the LTC needer before the shock.

[14]Note that family structure is time-varying; an individual can appear as a control unit for two different family structures, for different values of c, if that individual's family structure changes between those two calendar years.

[15]We use 3 years prior to a health shock as the baseline year for defining our sample so that we can test for differential mortality between treated and control units in the two years running up to the parental health shock. To the extent that we study LTC-needers, they must mechanically be alive at the time that the health shock arises. Otherwise, control individuals include those in later-treated families who die before their own families experiences their health shocks. This allows us to study the effects of the health shock on mortality hazard rates within families.

We detect evidence of slight differences between treated and later-treated individuals on other characteristics. Most notably we see some evidence that adult sons in the weighted control group are more healthy, aside from medical spending: they spend about 10 percent fewer days in the hospital on average (0.78 versus 0.86), and their annual mortality rate is about 20 percent lower (0.5 versus 0.62 deaths per thousand). The weighted control group also earns slightly less (2,610 NTD per year) yet works slightly more regularly than the treated sample of sons. Their parent who ultimately suffers a stroke is more likely to be female (3 percentage points) and tends to be slightly less educated. Despite the fact that we do not balance on age of the LTC-needing parent in the interest of keeping the characteristics for matching somewhat parsimonious, later-LTC-needing parents in the weighted control group are only one year older on average than LTC-needing parents in the treated group. Given that we balance exactly on age of the adult sons, this suggests we are not implicitly comparing adult sons with very young parents in the control group to otherwise-similar adult sons with very old parents in the treated group.

5.3 Results

Overall outcomes. We report overall responses of adult sons to a stroke, averaging across all post-stroke years, in Column 1 of Table 4. Strokes are tied to substantial declines in the health and well-being of adult sons. Their mortality rate increases by an additional 0.565 deaths per thousand per year, while their depression diagnoses increase by 2.90 diagnoses per thousand and their medical costs increases by 1000 NTD per year. Notably, adult sons' higher mortality is not driven by deaths administratively classified as suicides, which increase only by 0.053 per thousand per year. Adult sons' responses to a stroke also extend to their family formation. The probability of being married in an arbitrary year following the parental stroke falls by 1.49 per thousand. At the same time, adult sons experience a drop in fertility so that families have 4.82 fewer children per thousand adult sons. As we will see shortly, these responses are driven entirely by the disruption of life cycle processes for sons who are younger and who have not yet started a family at the time that the stroke occurred.

Outcomes of older versus younger adult children. How the costs of a parent's stroke materialize for adult children likely depends on the life cycle phase in which the shock materializes. Marriage and fertility tend to happen when adult children are relatively young, whereas mortality is a greater risk in general among older adults. Moreover, a simple model

of "suicidal" behavior would predict larger mortality responses to a negative shock among older people than younger people (i.e., Hamermesh and Soss, 1974). Motivated by this reasoning, we split our sample based on the life cycle phase of the adult son three years prior to the stroke event and estimate effects separately for each group. We group individuals into three age bins: i) younger than 35, ii) between 35 and 50 years old, and iii) older than 50 years of age. Within the first age bin, we further distinguish between adult sons who were married and already had at least one child versus all other adult sons of that age group (which we loosely describe as "unmarried" families for brevity). We report the results in Columns 2, 3, 4, and 5 of Table 4.

All-cause mortality, suicide, depression, and medical spending responses tend to increase in magnitude as adult sons progress through the life cycle. Annual all-cause mortality increases by 0.121 deaths per thousand among the young and unmarried, but by more than 1.74 per thousand among those age 50 and older. Yet even the early-life increase in mortality is substantial when compared to adult sons' overall pre-shock average mortality rate of 0.62 per thousand. A similar pattern arises for medical spending, where we see an increase of 727 NTD per year among the young and unmarried, versus increases of 1822 NTD per year among those age 50 and older.

Decreases in marriage and fertility are concentrated in the earliest phase of the life cycle, suggesting that a parental stroke disrupts the household formation process. Among unmarried adult sons who are age 35 and younger prior to the stroke, marriage rates decline by 5.7 per thousand and cumulative fertility declines by 10 children per thousand. Fertility declines to a lesser and extent among young sons with pre-existing families (6.3 kids per thousand), suggesting that elderly strokes are linked to further fertility decisions even among those who have already had at least one child. Marriage and fertility do not change much among older-age adult sons, for whom families have largely settled by the time of the health shock.

Time trends in outcomes. While we have so far focused on summarizing average responses to a stroke, it can be informative to examine how these responses vary over time. We therefore plot in Figure 2 the "dynamic" responses to a parent's stroke (the separate event-time response coefficients δ_ℓ for each ℓ in Equation 1) for several key outcomes: employment, all-cause mortality, medical spending, and fertility. For the first three outcomes we report overall average responses for all adult sons, but we focus on those age 35 and younger when estimating fertility responses. These figures illustrate a remarkable persistence over time underlying the average medium-term estimates documented in our preceding results. As a general rule, labor market, distress, and household formation responses to a parent's

stroke do not attenuate over time. Instead, they either remain stable or *increase* in magnitude as years pass. Broadly, these "dynamic" responses rule out meaningful anticipation effects in the lead-up to the stroke as well.[16]

Comparing the scale of labor and non-labor responses. Adult sons' health-related responses to a parental stroke are large in magnitude relative to their labor supply responses. Employment declines by 7.48 workers per thousand adults, and work income declines by 2,323 NTD per year or about 1 percent of pre-stroke income. To compare this against the all-cause mortality increase attributable to parental strokes, we cumulate the excess deaths over the first 10 post-stroke years and assume that adult sons would have earned average pre-stroke income had the stroke (and their resulting deaths) not occurred. Supposing further that all deaths happen at the *end* of a calendar year to be conservative, this implies that excess mortality due to parental stroke is responsible for a loss of 6.67 days of life over this entire interval, or 470 NTD per adult son per year in *counterfactual earnings alone*. Turning to medical expenditures, the additional medical care that adult sons incur costs *the Taiwanese government* 1,000 NTD per year. Presumably, lost earnings and government health care costs do not fully capture the losses to adult sons from mortality or poor health, but these alone are of comparable magnitude to labor supply responses.

Likewise, the declines in fertility of adult sons under the age of 35 are substantial. By the tenth year from the stroke, they have had on average 0.02 fewer children than their later-treated peers. This represents a 2 percent decline in the size of the next generation coming from these families. If these marginal births are random with respect to the children's future outcomes, then this also represents a 2 percent decline in the labor force generated by these families. By comparison, adult sons themselves reduce their employment by less than 0.5 percentage points.

5.4 Evaluating channels for adult childrens' responses.

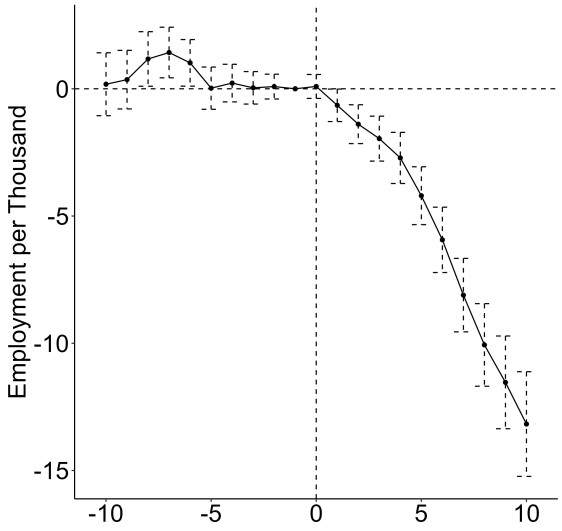
Long-term care needs are one channel by which elderly health shocks are plausibly linked to adverse outcomes for adult children. To gauge the potential role of care needs, this section explores heterogeneity in the magnitude of adverse outcomes between families facing higher

[16]We do detect some evidence of anticipation for fertility responses (Figure 2d). We investigate this further in Appendix Figure A.2, where we repeat the event study plot separately for unmarried adult sons, married but childless adult sons, and married adult sons with pre-existing children. The pre-trend comes entirely from married adult sons with pre-existing children, who tend to have slightly fewer children than their later-treated peers in the year just before the stroke.

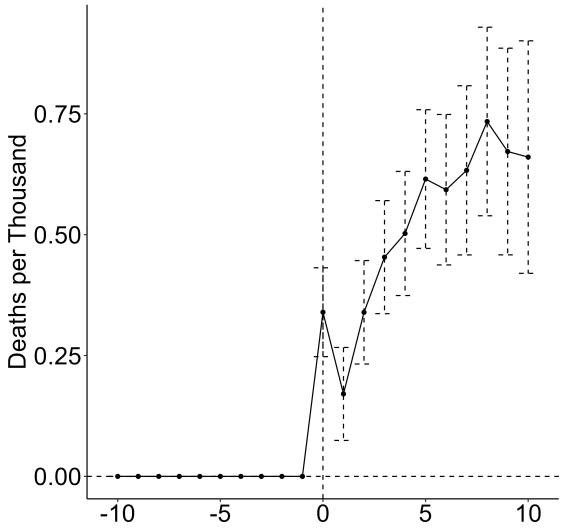
Table 4: Average Annual Responses of Adult Sons to Elderly Parents' Strokes

	(1)	(2)	(3)	(4)	(5)
	Average Response of Adult Sons				
		35 and Younger			
	Overall	Married w/ Kids	All Others	35 to 50	50 and Older
Deaths per Thousand	0.5646***	0.2173***	0.1206***	0.5302***	1.736***
	(0.05122)	(0.08266)	(0.03463)	(0.07263)	(0.2368)
Suicides per Thousand	0.05304***	0.04083*	0.03009***	0.04986***	0.118***
	(0.008426)	(0.02274)	(0.01151)	(0.01438)	(0.02133)
Depression per Thousand	2.898***	2.985***	2.913***	2.994***	2.559**
	(0.2871)	(0.9621)	(0.3785)	(0.4208)	(1.033)
Medical Spending	1000***	1036***	726.5***	927***	1822***
	(145)	(308.9)	(223.7)	(212.3)	(475.6)
Hospital Days	0.1267***	0.06496**	0.1276***	0.1412***	0.1054**
	(0.01835)	(0.03119)	(0.02656)	(0.02997)	(0.05322)
Work Income	-2323***	-1827*	-624.7	-1722***	-8033***
	(385.2)	(1044)	(515.6)	(552.5)	(1421)
Employment per Thousand	-7.479***	-4.247**	-4.473***	-6.259***	-19.07***
	(0.5842)	(1.663)	(0.9319)	(0.7638)	(2.122)
Annual Months of Work	-0.09886***	-0.06904***	-0.06269***	-0.08546***	-0.2331***
	(0.006943)	(0.02014)	(0.01056)	(0.009297)	(0.0254)
Married per Thousand	-1.486***	-1.122	-5.719***	-0.07952	-0.25
	(0.4769)	(1.638)	(0.7622)	(0.6755)	(1.08)
Children per Thousand	-4.835***	-6.295**	-10.06***	-1.289*	-0.16
	(0.608)	(2.931)	(1.249)	(0.7634)	(0.5516)

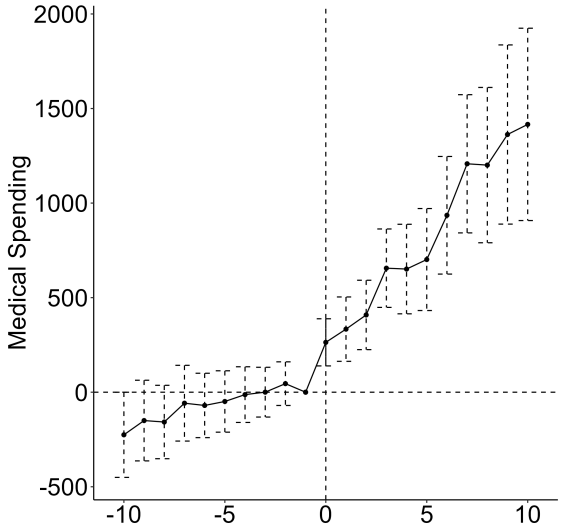
Notes: Estimates are obtained from the event study in Equation 1 pooling all post-event periods. Standard errors are preliminary. Due to computational limitations, they do not account for correlations in responses by strata defined by age bins and family structure, caused by overlap in the later-treated control groups. "Employment" indicates if one has earned work income for at least six months in the year. "Earnings" are measured in NTD per year ($1 is approximately NTD 30). "Depression" is the indicator of whether an individual has been ever diagnosed with depression (a measure of the stock of depression diagnoses). See Appendix C for the depression ICD-9 and ICD-10 codes.



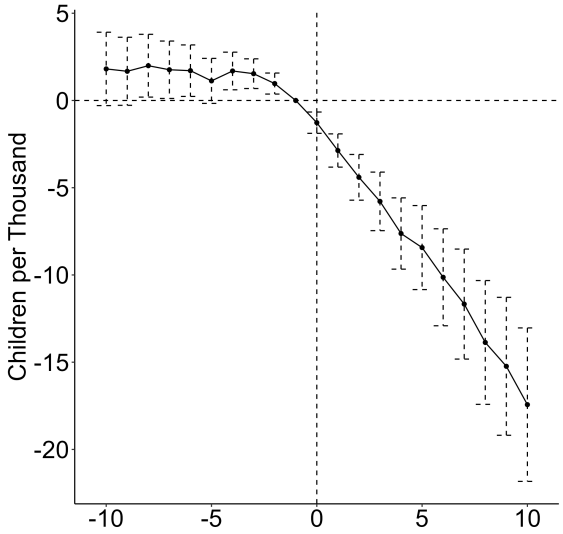
(a) Work among all adult sons



(b) Death among all adult sons



(c) Medical costs among all adult sons



(d) Fertility responses of adult sons under age 35

Notes: The x-axis plots the years relative to the LTC-needer's shock. Estimates reported here correspond to the event study estimates, δ_ℓ, in Equation 1. Standard errors are preliminary. Due to computational limitations, they do not account for correlations in responses by strata defined by age bins and family structure, caused by overlap in the later-treated control groups.

Figure 2: Event study responses of adult sons to elderly parents' strokes

Table 5: Heterogeneity Analysis: Responses to Strokes and Proxies for the Scope of LTC Needs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Average Response of Adult Sons						
	by Family Size				by Time in Hospital		
	Sib. + Parent	No Parent	No Siblings	No Relatives	None	Short	Long
Deaths per Thousand	-0.04791	0.3135***	1.015*	1.119***	0.4033***	0.637***	0.8926***
	(0.2355)	(0.0552)	(0.5316)	(0.1112)	(0.07049)	(0.1092)	(0.106)
Suicides per Thousand	0.08181	0.03674***	-0.3208	0.08866***	0.04063***	0.09084***	0.07576***
	(0.08988)	(0.01104)	(0.5585)	(0.01201)	(0.01018)	(0.01708)	(0.02343)
Depression per Thousand	0.5421	2.742***	3.936	3.278***	2.493***	3.118***	2.422***
	(1.953)	(0.2998)	(4.579)	(0.6445)	(0.3682)	(0.5997)	(0.5969)
Medical Spending	311.2	873.8***	1347	1285***	786.1***	1423***	1151***
	(545.9)	(152.6)	(1293)	(323.4)	(168.6)	(367)	(361.1)
Hospital Days	0.0419	0.1216***	0.4594	0.1382***	0.07367***	0.2842***	0.1728***
	(0.1517)	(0.02167)	(0.2867)	(0.0348)	(0.02395)	(0.04064)	(0.04816)
Work Income	-4432*	-1361***	-6931	-4345***	-2469***	-1715**	-3009***
	(2325)	(423.7)	(5445)	(815.4)	(509.6)	(803.2)	(808.2)
Employment per Thousand	-10.58**	-4.679***	-3.651	-13.49***	-7.317***	-6.817***	-7.12***
	(5.101)	(0.6658)	(11.19)	(1.175)	(0.753)	(1.314)	(1.338)
Annual Months of Work	-0.08075	-0.0578***	-0.1035	-0.1881***	-0.09853***	-0.08478***	-0.09744***
	(0.05673)	(0.007851)	(0.1249)	(0.01413)	(0.008961)	(0.01556)	(0.01582)
Married per Thousand	-3.077	-1.125**	0.08791	-2.243**	-1.103*	-3.361***	-2.095*
	(3.948)	(0.5665)	(9.74)	(0.8948)	(0.6097)	(1.122)	(1.074)
Children per Thousand	-7.281	-5.315***	-6.483	-3.74***	-5.878***	-3.041**	-4.774***
	(5.281)	(0.7453)	(11.37)	(1.069)	(0.7712)	(1.463)	(1.39)

Notes: Estimates are obtained from the event study in Equation 1, pooling all post event periods. For other notes, see Table 4. Standard errors are preliminary. Due to computational limitations, they do not account for correlations in responses by strata defined by age bins and family structure, caused by overlap in the later-treated control groups.

versus lower burdens of cares. Since we cannot measure care needs or care provision directly, we instead assess response heterogeneity associated with two proxies for the burden of care: 1) the size of the family and 2) the duration of the hospitalization spell associated with the event (where we distinguish between stroke events associated with no overnight hospital stay at all versus those with a hospital stay of below-median duration versus those with an above-median duration). Both of these measures plausibly suffer different limitations as a proxy for the stroke's LTC burden, which is why it is useful to take them together. We summarize heterogeneity along these proxies in Table 5.

Overall, we see results consistent with the reasoning laid out in our conceptual framework (Section 3.2). We find no statistically significant evidence of health, fertility, or marriage declines in the "largest" families where LTC-needers can be linked to both a partner and multiple children, and we find the sharpest declines in all these outcomes among the "smallest" families, where the LTC-needer can be linked only to one adult son and no other relative. We also see sharper declines in all health outcomes among families that required shorter versus longer hospitalization spells. By contrast, there are no clear patterns in the relatively modest employment responses across these proxies for burden of care. Together, we view these results as suggestive evidence that care needs are an important channel for an effect of parental strokes on adult children's health outcomes and household formation.

6 Generalizing from strokes to broader health events

While plausibly amenable to a staggered event study design, strokes represent only a fraction of LTC-related diseases. Moreover, as we showed in Table 1, they tend to be linked to especially intense care needs. Other major LTC-related conditions cause a different composition of LTC needs, and their implications for family members may therefore diffe ras well. The challenge with studying other conditions, such as those tied to cognitive decline, is that they are often associated with a gradual loss of functional ability over time. If these declines materialize or can be anticipated well in advance of a formal diagnosis, then this would be a potential threat to the identifying assumptions of the staggered event study design we have used to study responses to strokes. Alternatively, the substantial costs of such conditions may only materialize long after the initial diagnosis, which is a separate but not insurmountable challenge for the design.

Nevertheless, we repeat our main empirical exercises for two additional health shocks: hip fractures and dementia diagnoses. We choose these conditions because both are common,

Table 6: Average Annual Responses of Adult Sons, by Type of Shock

	(1)	(2)	(3)
	Average Response of Adult Sons		
	Stroke	Hip Fracture	Dementia
Deaths per Thousand	0.5646***	0.8099***	0.6572***
	(0.05122)	(0.1975)	(0.2278)
Suicides per Thousand	0.05304***	0.09264***	0.02941
	(0.008426)	(0.02367)	(0.04658)
Depression per Thousand	2.898***	1.977**	2.846**
	(0.2871)	(0.8615)	(1.116)
Medical Spending	1000***	1303***	729.4
	(145)	(372.9)	(635.2)
Hospital Days	0.1267***	0.2383***	0.07811
	(0.01835)	(0.06869)	(0.08542)
Work Income	-2323***	-4460***	-3373**
	(385.2)	(1199)	(1467)
Employment per Thousand	-7.479***	-9.862***	-6.52***
	(0.5842)	(1.823)	(2.248)
Annual Months of Work	-0.09886***	-0.1215***	-0.1003***
	(0.006943)	(0.02148)	(0.02658)
Married per Thousand	-1.486***	-1.091	-0.5604
	(0.4769)	(1.406)	(1.71)
Children per Thousand	-4.835***	-4.761***	-2.76
	(0.608)	(1.579)	(2.017)

Notes: The estimates are obtained from the event study in Equation 1 pooling all post-event periods. Standard errors are preliminary. Due to computational limitations, they do not account for correlations in responses by strata defined by age bins and family structure, caused by overlap in the later-treated control groups. For other notes, see Table 4.

serious health shocks that differ materially in their consequences for care needs compared to strokes. As shown by Table 1, elderly parents who suffer a hip fracture tend to face a less sharp increases in difficulty bathing, clothing, and eating. However, they face changes in difficulty ambulating, walking, and with incontinence which are more comparable to the increases suffered by elderly stroke survivors—though still smaller on average. While one might expect a parent's hip fracture to therefore act as a less severe shock to adult children than a parent's stroke, dementia on the other hand is plausibly associated with a different profile of care needs altogether.

The overall associations between children's outcomes and a parent's hip fracture or dementia diagnosis are summarized in Table 6, alongside analogous estimates for strokes for ease of comparison. Our main conclusion from this table is that adverse outcomes associated with a parental hip fracture or dementia diagnosis are strikingly similar, on average, to the adverse outcomes associated with a parental stroke. In other words, the event study design suggests these health shocks are qualitatively comparable in terms of their implications for the health and well-being of adult sons, despite the qualitative differences in care needs that they imply.[17] However, compositional differences in the kinds of families that suffer these shocks are to some extent masking differences in responses that occur for otherwise-similar families. For instance, Appendix Table A.1 reports responses to each shock conditioning on the age of the adult son in the year prior, and it shows some evidence that responses to strokes are more severe than responses to hip fractures or dementia diagnoses after fixing age.

7 The Expansion of Migrant Caregiving

Having characterized the persistent adverse outcomes that Taiwanese adult sons experience after health shocks suffered by their parents, we now consider whether the caregiving-related social policies pursued by Taiwan have attenuated them. Our approach is to leverage large increases in migrant caregiver hiring propensities over time, specifically among families in which the parent suffered a health shock at a particularly advanced age. These are the families targeted by expansionary reforms described in Section 3. Among families that suffer a stroke, Figure 3 shows that rates of caregiver hiring in the same year as one's stroke rose from roughly 25 percent to nearly 45 percent from 2007 to 2018 for care-needers over the age

[17] There are a few exceptions to this generalization. For instance, strokes have a detectable effect on fertility and marriage, whereas hip fractures have a detectable effect only on fertility and dementia diagnoses have no impact on either outcome.

of 80. By contrast, rates of caregiver hiring for care-needers between ages 50 and 80 have been stable near 13 to 15 percent over this period.

It is revealing to compare these cross-cohort patterns in caregiver hiring rates to cross-cohort patterns in family responses to a stroke. We report average cohort-specific employment, mortality, medical spending, and depression responses to parental strokes for the families of older care-needers in Figure 4.[18] Each bar in these graphs corresponds to an estimate of the near-term cohort-specific response to the health shock for those who suffer it in a particular calendar year, averaging over response estimates in the year of onset and the year afterward. The graphs illustrate that adverse responses to a stroke have attenuated markedly across cohorts, coincident with the rise in caregiver hiring rates.

To make that correlation clearer, Figure 5 plots the cohort-specific, near-term response estimates from Figure 4 against these cohorts' contemporaneous caregiver hiring rates from the second panel of Figure 3. The graph restricts to stroke cohorts 2007 through 2018, as caregiver hiring data is only available to us starting in 2007. The relationship between the effect estimates and caregiver hiring rates across cohorts is quite strong, despite the fact that those effect estimates had already attenuated substantially by 2007.

The cauasl effect of caregiver hiring. Given that the sharp rise in caregiver hiring rates over time that is concentrated specifically among the types of care-needing families targeted by expansionary reforms, one might be tempted to view cross-cohort caregiver hiring rates as an instrument to identify an effect of increased caregiver hiring on family outcomes. However, there is good reason to suspect that this variation does not represent a valid instrument for *individual caregiver hiring* due to a violation of the exclusion restriction: even if a family does not hire a caregiver today, a forward-looking adult son may adjust his behavior under a more lenient caregiver hiring regime because he knows that his family will be surely able to hire a caregiver *in the future*. We can avoid this problem by redefining our parameter of interest to be an intent-to-treat: the causal effect on *adult children as a whole* of living in a marginally more lenient caregiver hiring regime, measured by the caregiver hiring rate. But note that even this interpretation relies on some assumptions on expectations and their relationship to current caregiver hiring rates.

If we are willing to impose this exogeneity assumption on all observed cross-cohort variation, then we can a natural way to estimate a linear intent-to-treat is by simply drawing the line of best fit in the scatterplots of Figure 5. This would suggest that increasing caregiver

[18] We do not report fertility responses for this analysis because these are driven by younger adult children, whose parents are generally below the age of 80 at the time of their stroke.

hiring rates by 1 percentage point would decrease mortality by 0.02 per thousand per year, decrease medical spending by 54 NTD per person per year, would have no clear impact on depression diagnoses, and would increase employment by 0.3 workers per thousand people per year.

However, caregiver hiring rates are likely not the only relevant factor which has trended over this interval of years. Medical technology has plausibly improved over time for example, which might also alter the consequences of a parental stroke. On the other hand, underlying health might be evolving across cohorts as the Taiwanese population gradually ages. One might therefore prefer to more narrowly exploit variation in caregiver hiring rates immediately surrounding a known expansionary reform. For this reason, we compare the caregiver hiring rate and average near-term stroke responses across three cohorts preceding the 2012 reform (2008-2010) against the values for three cohorts following that reform (2012-2014). We exclude the 2011 cohort because outcomes for this cohort are partially realized after the reform.

We plot these estimates in red over the scatterplots of Figure 5. They suggest similar—if anything more dramatic— attenuation of the adverse effects of stroke with greater access to international caregiver markets. Average effects of a stroke on mortality among the pre-reform cohorts amounted to 0.64 additional deaths per thousand per year, whereas there is no increase in mortality at all among post-reform cohorts. Medical spending responses averaged 549 NTD per person per year among pre-reform cohorts but also vanished among post-reform cohorts as well. Labor supply responses reversed from a pre-reform decline of 2.6 workers per thousand per year to a slight *increase* of 1.2 workers per thousand per year among post-reform cohorts. On the other hand, additional depression diagnoses rose slightly across these cohorts from 0.275 per thousand to 0.50 per thousand, though recall that Figure 4d indicates that these depression responses remain far lower over this whole period than were the responses documented for prior cohorts.

Reframing these estimates, they suggest a 1 percentage point increase in caregiver hiring from the reform decreased deaths by 0.075 per thousand per year, decreased medical spending by 64 NTD per person per year, and increased employment by 4 workers per thousand per year among targeted families.

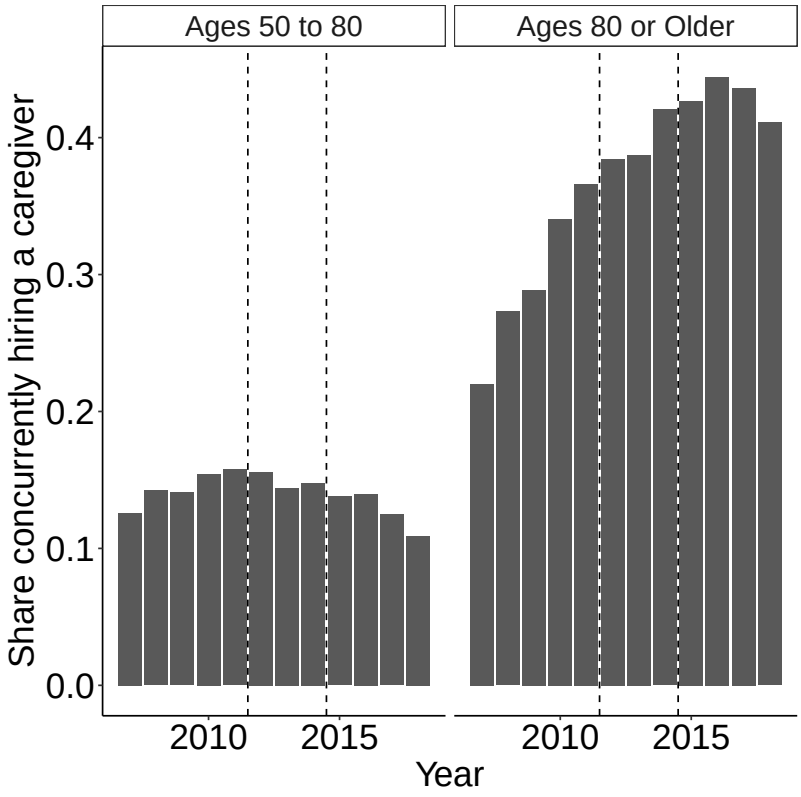
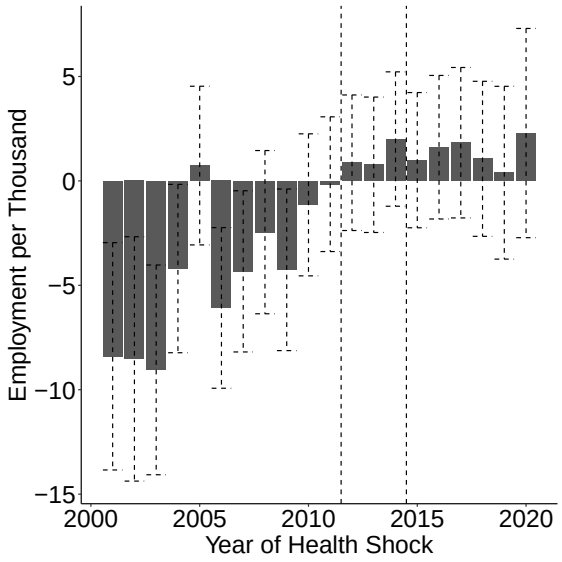
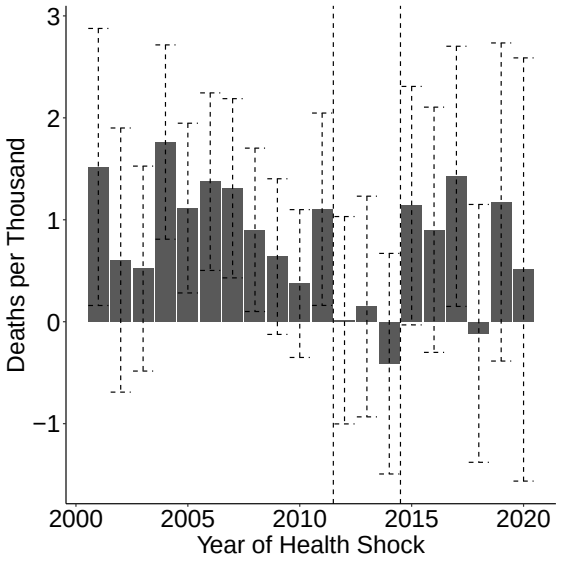


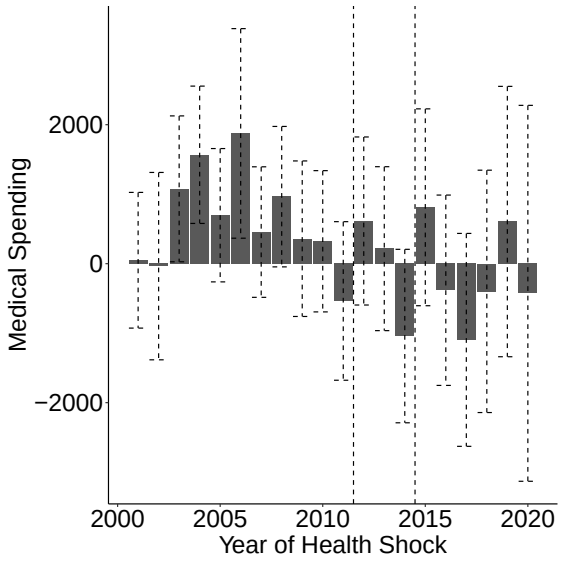
Figure 3: Share of stroke-suffering families hiring a caregiver in the same calendar year of their stroke



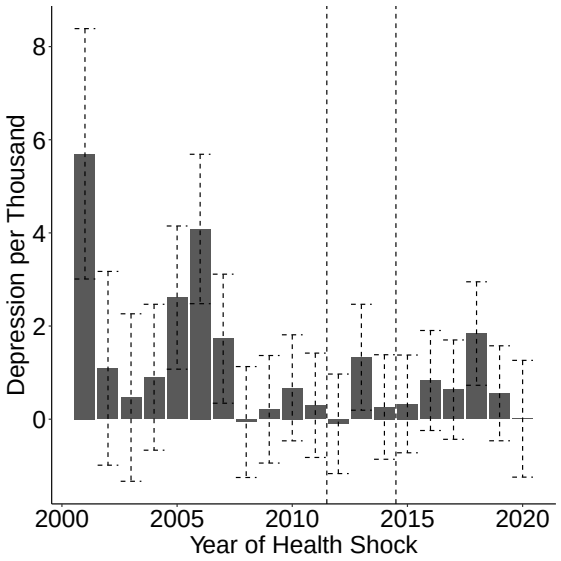
(a) Work among all adult sons



(b) Death among all adult sons



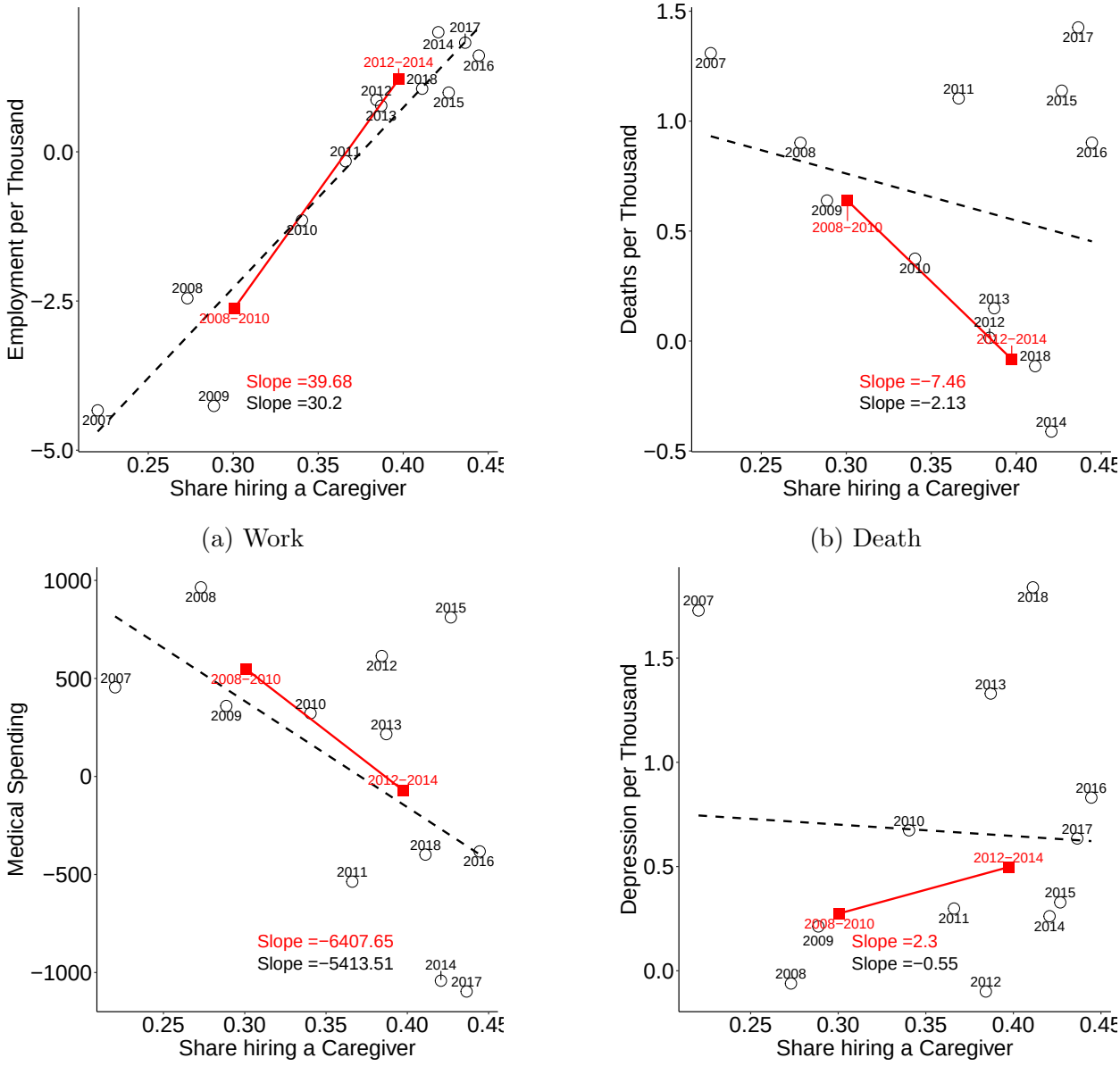
(c) Medical costs among all adult sons



(d) Depression diagnoses among all adult sons

Notes: These graphs report estimates for the average treatment effect on the treated using Equation 1, estimated separately for each event cohort and pooling all post event periods. The sample is restricted to families where the health shock occurs at age 80 or older. Standard errors are preliminary. Due to computational limitations, they do not account for correlations in responses by strata defined by age bins and family structure, caused by overlap in the later-treated control groups.

Figure 4: Event study responses of adult sons by event cohort



(a) Work

(b) Death

(c) Medical costs

(d) Depression diagnoses

Notes: These graphs plot outcome associations from Figure 4 on the y-axis against caregiver hiring propensities of these cohorts from the second panel of Figure 3 in the x-axis. The sample is restricted to families where the health shock occurs at age 80 or older.

Figure 5: Correlations between cohort-specific responses to a stroke and caregiver hiring propensities

8 Conclusion

With major demographic changes looming over the horizon for many of the world's rich countries, the consequences of aging-related health shocks for families of the elderly are increasingly important yet so far poorly understood. In this paper, we contributed to that understanding by examining mortality, well-being, household formation, and labor market responses of adult sons to the old-age health shocks of their parents. We examined these responses in the setting of Taiwan, which is one of the rich East Asian societies with limited social safety nets which are at the frontier of the modern demographic transition.

We find that parental health shocks are generally disruptive for the life cycles of adult sons. In the wake of these shocks, adult sons face higher mortality, depression, and medical spending—especially adult sons who are older at the time it occurs. Earlier in the life cycle though, adult sons also respond to parental health shocks with substantial declines in fertility. Turning towards potential mechanisms underlying these responses, we showed that heterogeneity along observable characteristics suggests that the burden of care provision plays an important role—at least for the stroke events that we focus on for this exercise. All adverse responses to a parental stroke are sharper for adult sons with no living second parent available to provide care. Declines in indicators of good health tend to also be sharper among sons whose parents had longer hospital stays than shortre ones.

Finally, we consider whether formal caregiver hiring may help attenuate some of these adverse responses, leveraging variation from national reforms which relaxed eligibility criteria for accessing foreign caregiver markets. Trends over time in how families respond to health shocks suggest that recent increased access to foreign caregiver markets has caused the mortality, depression, and medical spending responses to a parental stroke to all but vanish. Focusing more narrowly on the families that suffer a stroke just before versus after a specific reofmr in 2012 tells a consistent story. Caregiver hiring increases substantially for families that suffer the event in the post-reform period. At the same time, average mortality and medical spending responses vanish for adult sons, while their employment rises slightly.

We conclude by discussing some important qualifications to these results and potential areas for future research. First, the nature of our administrative records has lended itself to the study of sons of the elderly and their spouses, as opposed to their daughters. Second, the national reforms to caregiver markets which we study only apply to care-needers over the age of 80, meaning that they do not produce much variation in access to formal caregiver hiring for families where adult sons are of child-producing age. Whether policies like this may address the declines in fertility among adult sons that we have documented remains

unclear. Taken together though, the results of this paper suggest that aging-related health conditions may have broad and serious consequences for the families of the elderly, but that public policy which reduces the burden of long-term care can alleviate some of the worst consequences.

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Appendix A Additional Figures and Tables

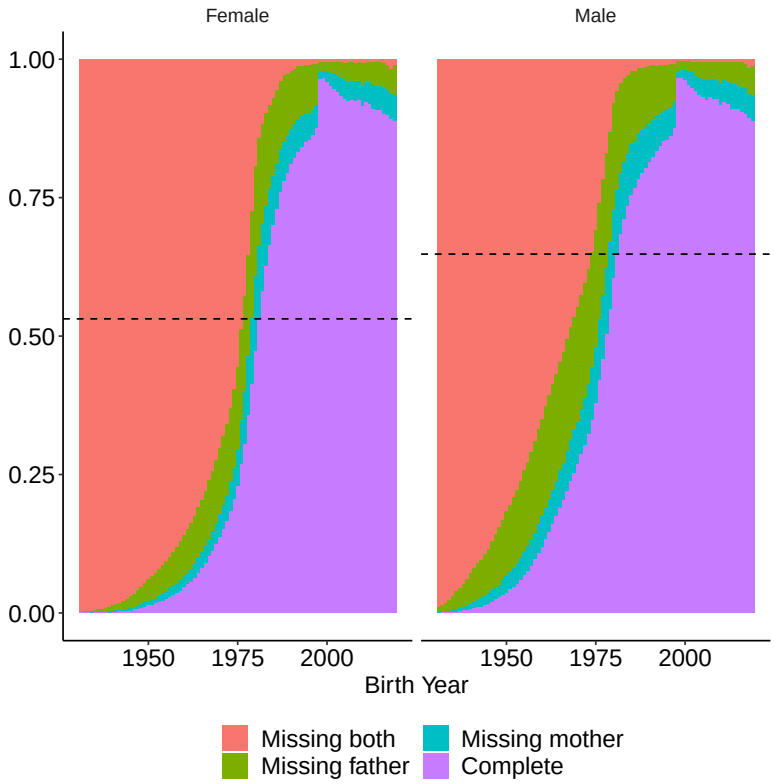


Figure A.1: Match rate of children to their parents

Notes: The dashed lines indicate average match rates by sex to at least one parent: 53 percent for women and 65 percent for men.

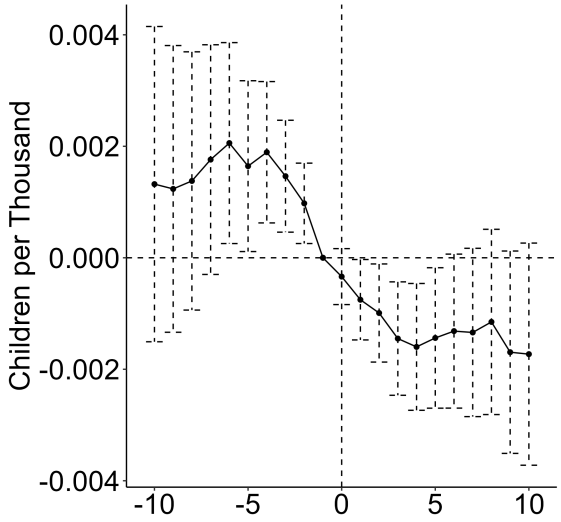
Appendix B Measurement of LTC

A word on severity (may take out if not used in the end.)

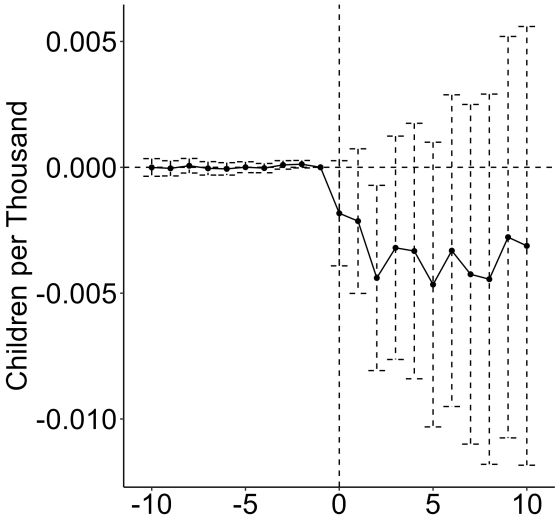
1. Take stroke, dementia, and hip fractures as the event of interest directly. Dementia accounts for about 30 to 40 percent of all to LTC needs, and some LTC literature papers are focusing on dementia alone. However, dementia is a progressive disease with an arguably unclear "onset."

   Put the validation of measurement in the Appendix.

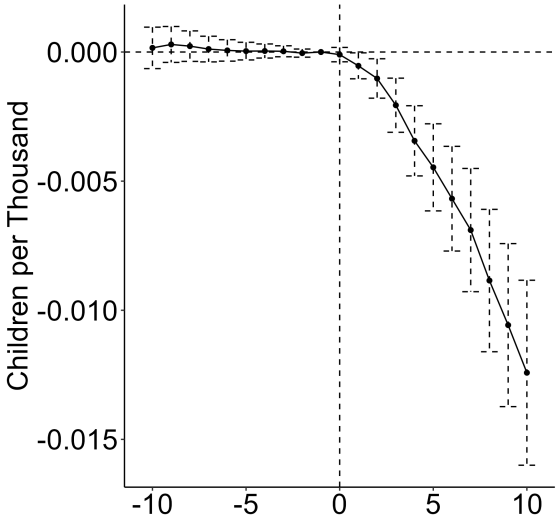
2. Use the LTC system data. We know in the same dataset who have applied for LTC services. Take that as the LHS variable and then regress (or some other machine-learning fashion) it on past clinic records. In our current prediction model, we do predict intensity of the LTC needs.



(a) Fertility responses among married sons with at least one pre-stroke child



(b) Fertility responses among married sons with no pre-stroke children



(c) Fertility responses among unmarried sons

Notes: The x-axis plots the years relative to the LTC-needer's shock. Estimates reported here correspond to the event study estimates, δ_ℓ, in Equation 1. Graphs condition on the status of the adult son's family in the calendar year before his parent's stroke. Standard errors are preliminary. Due to computational limitations, they do not account for correlations in responses by strata defined by age bins and family structure, caused by overlap in the later-treated control groups.

Figure A.2: Fertility responses of adult sons, conditional on pre-stroke family structure

Table A.1: Average Annual Responses of Adult Sons, by Type of Shock and Age in the Prior Year

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Average Response of Adult Sons								
	Stroke			Hip Fracture			Dementia		
	< 35	35 to 50	> 50	< 35	35 to 50	> 50	< 35	35 to 50	> 50
Deaths per Thousand	0.1349***	0.5302***	1.736***	0.02483	0.924***	1.229**	0.08155	0.5429**	1.34**
	(0.03313)	(0.07263)	(0.2368)	(0.1194)	(0.1908)	(0.5448)	(0.2064)	(0.2442)	(0.6579)
Suicides per Thousand	0.03097***	0.04986***	0.118***	0.02673	0.09504***	0.1373***	-0.01119	0.05408	0.02656
	(0.01065)	(0.01438)	(0.02133)	(0.03807)	(0.03559)	(0.04724)	(0.05332)	(0.06434)	(0.1164)
Depression per Thousand	2.923***	2.994***	2.559**	1.134	2.396**	2.027	1.573	2.597*	4.35*
	(0.3617)	(0.4208)	(1.033)	(1.621)	(1.177)	(1.766)	(2.11)	(1.549)	(2.329)
Medical Spending	755.1***	927***	1822***	-121.6	1271**	2388***	386.5	1538	-219
	(202.2)	(212.3)	(475.6)	(425.9)	(526.5)	(847.3)	(504.8)	(1058)	(1365)
Hospital Days	0.1185***	0.1412***	0.1054**	-0.03229	0.2487**	0.4219***	0.1916	0.2081	-0.2226
	(0.02327)	(0.02997)	(0.05322)	(0.1006)	(0.102)	(0.1429)	(0.1597)	(0.1302)	(0.1592)
Work Income	-733.7	-1722***	-8033***	158.2	-5064***	-7013***	-2231	-3698*	-3873
	(488.2)	(552.5)	(1421)	(2104)	(1523)	(2658)	(2502)	(1920)	(3405)
Employment per Thousand	-4.252***	-6.259***	-19.07***	-3.282	-10.37***	-13.97***	-1.169	-8.194***	-8.634*
	(0.855)	(0.7638)	(2.122)	(3.868)	(2.195)	(3.845)	(4.654)	(2.66)	(5.062)
Annual Months of Work	-0.06063***	-0.08546***	-0.2331***	-0.03732	-0.1207***	-0.1839***	-0.07358	-0.102***	-0.1211**
	(0.009812)	(0.009297)	(0.0254)	(0.04394)	(0.02646)	(0.04556)	(0.05289)	(0.03217)	(0.06045)
Married per Thousand	-3.621***	-0.07952	-0.25	-3.582	-2.166	2.184	-5.881	2.641	-0.8343
	(0.831)	(0.6755)	(1.08)	(3.546)	(1.915)	(2.318)	(4.24)	(2.314)	(2.762)
Children per Thousand	-10.84***	-1.289*	-0.16	-17.03***	-1.03	-0.8524	-16.36***	4.322*	-1.76
	(1.263)	(0.7634)	(0.5516)	(5.26)	(2.113)	(0.8744)	(6.274)	(2.588)	(1.142)

Notes: The estimates are obtained from the event study in Equation 1 pooling all post-event periods. For each type of health shock, columns condition on the age of the adult son in the year prior to the health shock. Standard errors are preliminary. Due to computational limitations, they do not account for correlations in responses by strata defined by age bins and family structure, caused by overlap in the later-treated control groups. For other notes, see Table 4.

3. Use the TLSA. We could link TLSA to our data, but the issue is the sample size is small in TLSA, so maybe should combine with the previous method and use TLSA as a check.

Appendix C ICD Codes for Diseases

Here we list the ICD-9 and ICD-10 codes for various diseases discussed in this paper.

1. Stroke:

   - ICD-9: 430, 431, 4321, 4320, 4329, 43391, 43321, 43301, 43311, 43381, 43401, 43411, 43491, 43331, 43320, 43300, 43310, 43330, 43380, 43390, 43400, 43410, 43490, 4373, 4370, 463, 4372, 4375, 4376, 4374, 4371, 3483, 4359, 436, 4378, 4379
   - ICD-10: I6000, I6001, I6002, I6010, I6011, I6012, I6020, I6021, I6022, I6030, I6031, I6032, I604, I6050, I6051, I6052, I606, I607, I608, I609, I610, I611, I612, I613, I614, I615, I616, I618, I619, I6200, I6201, I6202, I6203, I621, I629, I6300, I63011, I63012, I63019, I6302, I63031, I63032, I63039, I6309, I6310, I63111, I63112, I63119, I6312, I63131, I63132, I63139, I6319, I6320, I63211, I63212, I63219, I6322, I63231, I63232, I63239, I6329, I6330, I63311, I63312, I63319, I63321, I63322, I63329, I63331, I63332, I63339, I63341, I63342, I63349, I6339, I6340, I63411, I63412, I63419, I63421, I63422, I63429, I63431, I63432, I63439, I63441, I63442, I63449, I6349, I6350, I63511, I63512, I63519, I63521, I63522, I63529, I63531, I63532, I63539, I63541, I63542, I63549, I6359, I636, I638, I639, I6501, I6502, I6503, I6509, I651, I6521, I6522, I6523, I6529, I658, I659, I6601, I6602, I6603, I6609, I6611, I6612, I6613, I6619, I6621, I6622, I6623, I6629, I663, I668, I669, I670, I671, I672, I673, I674, I675, I676, I677, I6781, I6782, I6783, I67841, I67848, I6789, I679

2. Dementia:

   - ICD-9: 29040, 29041, 29042, 29043, 2941, 29410, 29411, 2900, 29010, 29011, 29012, 29013, 29020, 29021, 2903, 2908, 2909, 2948, 2949, 3101, 2940, 29382, 29381, 2939, 3100, 3102, 3108, 3109, 3308, 3309, 3310, 3311, 3312, 3317, 33189, 3319
   - ICD-10: F0150, F0151, F0280, F0281, F0390, F0391, F04, F060, F062, F068, F070, F0781, F0789, F079, F09, G3181, G3182, G319, G300, G301, G308, G309,

G3101, G3109, G311, G312, G3183, G3185, G3189

3. Depression :

   - ICD-9: 296, 2960 $\sim$ 2968, 3004, 309, 3090 $\sim$ 3091, 311, 3110 $\sim$ 3115
   - ICD-10: F320, F321, F322, F323, F324, F325, F328, F329, F330, F331, F332, F333, F334, F339, F301, F302, F303, F304, F308, F309, F310, F311, F312, F313, F314, F315, F316, F317, F318, F319, F341