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

Kuan-Ming Chen† Maxwell Kellogg‡ Kuan-Ju Tseng§

This Version: July 31, 2026

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 much substitution away from the labor force, elderly parental health shocks cause 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. We find evidence that allowing families to hire migrant care workers can attenuate those negative effects between old-age health issues and family outcomes. This implies substantial welfare gains from migrant caregiver hiring, driven primarily by lower mortality rates for adult children of care-needers.

Keywords: Long-Term Care, Family Welfare, Fertility, Health Shocks, Caregiving.

*We gratefully acknowledge Taiwan's Ministry of Health and Welfare and Ministry of Labor for providing access to the administrative data underlying this study. We thank Ming-Jen Lin and Su-Yuan Chan for valuable comments and guidance, Liang-Cheng Chen, Po-Kang Hsiao, and Wei-Lun Lo for outstanding research assistance. All views expressed and any remaining errors are our own; they do not reflect the views of the Ministry of Health and Welfare or the Ministry of Labor.

†National Taiwan University. kuanmingchen@ntu.edu.tw Kuan-Ming Chen acknowledges the support from the National Science and Technology Council grant NSTC 114-2628-H-002-019 and the Yushan Fellow Program by the Ministry of Education (MOE) MOE-112-YSFSL-0003-001-P1.

‡University of Oslo. maxwell.kellogg@econ.uio.no

§Princeton University. kjtseng@princeton.edu

JEL Codes: J14, D10

Across the developed world, populations face rapid aging and rising rates of severe health problems, straining a shrinking base of working-age caregivers. The measurable costs of aging-related health problems are already large: long-term care (LTC) spending averaged 1.8 percent of GDP across OECD countries in 2021 (OECD, 2023). Yet formal services and safety nets rarely cover the physically demanding, day-to-day labor that LTC requires. In practice, spouses and children tend to provide this care informally: valued economically, informal care amounts to roughly half of all LTC provision across ten rich countries recently surveyed by Gruber and McGarry (2025). Precisely because this care flows through families rather than markets, the true social costs of care provision are difficult to study.

This paper characterizes the burden of aging-related health shocks on families, the mechanisms by which they arise, and how public policy can mediate them. Existing evidence on aging-related health shocks has focused primarily on how shocks affect family earnings and labor supply via the substitution of relatives from formal employment into informal care provision. However, we theorize that responses on other margins may be more important. With limited social support and few working-age adults across whom to balance both income and care needs, substitution away from employment is a luxury that many families simply cannot afford. Instead, families may be forced to borrow against their futures by neglecting investments in the health, marriage, and fertility of their younger generations.

The identification strategy that we use to explore this problem is a staggered difference-in-difference design, where otherwise similar "later-shocked" families serve as control units for families that suffer shocks earlier in time. We take the design to rich registry and health care utilization data on the population of Taiwan. 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.

But the consequences of an old-age stroke for adult sons extend beyond employment. We find that adult sons' marriage rates and fertility also decline due to parental strokes, while public medical spending on adult sons, their depression diagnoses, and their general mortality all increase sharply. Consistent with standard life cycle theory, marriage and fertility effects are concentrated among those who are comparatively young just before their parent suffers a stroke (younger than 34 years of age). 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 effects are large in magnitude: in the overall population of adult sons, mortality rates increase on average by 0.56 deaths per thousand per year, relative to baseline age-specific mortality rates ranging from 2 to 5 deaths per thousand per year for men in their 40's. Men who were younger than 34 just before their parents' stroke tend to have 0.008 fewer children than their peers five years later. By comparison, Taiwan's total fertility rate was 0.98 in 2021 (and has since fallen below 0.9).

We next present evidence suggesting that the burden of informal care provision is a key driver of the adverse effects of a parental stroke on adult sons. Effects are heavily concentrated among sons in families less able to absorb the time demands of care needs: those where sons have no identifiable siblings, and where sons have lower levels of schooling. Turning from strokes to parental health shocks more broadly, we find effects that are similar in magnitude when we examine hip fractures and even dementia diagnoses.

Because our results generalize from strokes to hip fractures and dementia, we treat parental stroke as an instrument for parental functional limitations more broadly, and view our stroke-based estimates as informative about the general costs those limitations impose on adult sons. We formalize this by using linked survey-administrative data to estimate a stroke's "first-stage" effect on their Barthel score, a summary index describing the extent of one's functional ability. We then scale our reduced-form stroke estimates by this first stage to recover marginal effects, and project that effect onto the average Barthel score among the elderly population. The result is a back-of-the-envelope estimate of the total burden that existing parental functional limitations place on adult sons, linearly extrapolating from the effects of a stroke. It suggests that this total burden is substantial. For instance, functional limitations of a parent can explain 0.28 deaths per thousand adult sons–again relative to age-specific mortality rates ranging from 2 to 5 deaths per thousand per year for men in their 40's.

The second part of the paper examines if those substantial adverse effects of a stroke 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 roughly 1 percent of Taiwan's total population as of 2020.

The rise in caregiver hiring has been concentrated among dependents over 80, for whom the Taiwanese government has gradually relaxed eligibility criteria. Among families that

suffer a stroke in this older age group who do not have a pre-existing caregiver, caregiver hiring rates rose from 29 percent for families suffering a stroke in 2007 to nearly 37 percent for those suffering one in 2018. Over the same period, the adverse effects of parental strokes on adult sons' outcomes vanished in these families. To identify a causal effect of caregiver hiring, we exploit changes in the effect of a stroke just before versus after a pair of major Taiwanese reforms in 2012 and 2015. This triple-difference design suggests that the broader time-series correlation, if anything, *understates* how much caregiver hiring mitigates a parental stroke's adverse effects on adult sons. We interpret this as evidence that targeted migrant labor policy can improve the health and well-being of the native working-age population. To the extent that we can examine consequences for marriage and fertility, caregiver hiring seems to attenuate the adverse effects of a stroke on these outcomes as well. However, because existing reforms have targeted only LTC-needers aged 80 and older, we cannot verify whether this is true among the younger adult sons at more critical ages for family formation (who tend to have younger parents).

These effects of reform-induced caregiver hiring also bolster the causal interpretation of our estimates for health shock effects: that a parental stroke's adverse effects vanish precisely as caregiver hiring expands is strong evidence that those effects to begin with were driven by the burden of informal care.

Having established that reform-induced caregiver hiring buffers adult sons against a parental stroke's adverse effects, we quantify the private welfare gains from caregiver hiring driven by these effects. To do this, we borrow and slightly adapt the framework of Murphy and Topel (2006) for valuing health and longevity, which allows us to price caregiver hiring's effects on survival, quality of life, and income. We find the private welfare gains substantial: a more conservative estimate for the value of a life indicates that the mortality-related benefits alone from the average three-year hiring contract are worth roughly $65,000 in 2019 USD, which is twice the total hiring cost of $32,000. A more conventional estimate finds those gains are $372,000–exceeding caregiver hiring costs by more than an order of magnitude. But even before accounting for these substantial mortality-related gains, one third of the costs of hiring are offset by adult sons' labor force entry. Using our more conventional value of life estimate implies that improvements in quality of life, proxied by depression diagnoses, offset another 18 percent of the caregiver hiring costs.

We argue this exercise points to substantial *social* welfare gains as well, as we find no clear negative externalities from the reform. Direct competition with the domestic labor force—the externality of greatest interest to economists in the context of immigration policy—is limited

because Taiwan never had a meaningful domestic labor market for formal caregivers. Any crowd-out of informal care, meanwhile, is a cost families already internalize when deciding whether to hire a caregiver. Consistent with substantial welfare gains, the initial 2012 reform was quickly followed by another expansionary reform in 2015, and more recently a third in 2024.

Related 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 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. The existing evidence suggests parental health shocks are connected with weak, if any, declines in the labor supply of adult children in Austria, the Netherlands, and Norway (Frimmel et al., 2025; Rellstab et al., 2020; Ramirez Lizardi et al., 2025).[3]

The onset of informal caregiving spells (Maestas et al., 2024) 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. (2025) 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. Rellstab et al. (2020) find that unexpected parental hospitalizations are not associated with any clear changes in the income or employment of adult children in the Netherlands. Most closely related to our design, Ramirez Lizardi et al. (2025) find that first-time strokes and hip fractures suffered by lone elderly parents in Norway cause small increases in the sickness absences and diagnosed mental disorders of adult children.

Far less attention has been paid in the economics literature to the non-employment spillovers of old-age health shocks to the health and well-being of relatives. What evidence exists concerns shocks *within* the household: a spouse's health shock or death worsens the survivor's health care utilization, mental health, and mortality (Arteaga et al., 2025; Fadlon et al., 2026). For the far more common event of an elderly *parent's* health shock, the evidence is limited to the modest mental health responses documented by Ramirez Lizardi et al. (2025). To a degree, these spillovers have instead been the focus of a strand in the medical literature, which has concentrated on the health outcomes of informal caregivers 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 that literature on the family spillovers of health shocks are twofold. First, we document in national registry data that families experience substantial declines in indicators of well-being in the aftermath of severe old-age health shocks, in addition to labor supply responses. We show back-of-the-envelope calculations suggesting that neglecting the indirect losses from excess mortality may cause one to understate the true labor supply effects of parental strokes for adult sons by 16 percent. Second, we show that LTC needs are likely a key driver of these outcomes, based on an examination of effect heterogeneity across family structure and socioeconomic status–and how those effects attenuate with increase in migrant caregiver hiring.

This paper also speaks to how public policy can mitigate the costs LTC needs impose on families. Existing work finds that expanding access to formal care increases labor supply among informal caregivers—for example, among only-child daughters of elderly parents in Norway (Løken et al., 2017), children of stroke-afflicted parents in Austria (Frimmel et al., 2025), and daughters of low-income elderly who gain publicly-financed home care in the United States (Shen, 2024). Insurance against LTC needs appears to operate on the same margin: private LTC insurance coverage strengthens the labor market attachment of adult children (Coe et al., 2023), and public LTC insurance programs in Germany, Japan, and Korea offset part of caregiving's employment costs (Fischer-Weckemann and Korfhage, 2024;

Fu et al., 2017; Kim and Lim, 2015). Relative to the existing work that has studied similar expansions in access to international care labor markets (Frimmel et al., 2025; Grabowski et al., 2023), our results show that such policies also improve the health, well-being, and longevity of working-age relatives of the LTC-needing elderly—effects that labor supply responses alone would miss. Going further, we price the welfare gains from these improvements, finding longevity gains to be the key reason that adult sons stand to benefit from caregiver hiring.

The paper proceeds as follows. Section 1 describes Taiwan's socio-demographic and policy environment and develops a stylized model of LTC needs and caregiving in multi-generational families, generating a set of testable predictions. Section 2 describes our data sources and key measures. Section 3 presents our workhorse staggered difference-in-difference design and reports our main effect estimates. Section 4 extends these estimates to non-stroke health shocks and extrapolates them to approximate the broader consequences of parental functional limitations. Section 5 examines how the effects of a parental stroke have evolved as caregiver-hiring criteria have liberalized, and estimates the welfare value of caregiver hiring for families that suffer strokes. Section 6 concludes.

1 Background

1.1 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. Over our 2000-2020 data period, the share of the population over the age of 65 rose from 9 to 16 percent; by the end of 2025 it crossed 20 percent, formally making Taiwan a "super-aged" society (Ministry of the Interior, Republic of China (Taiwan), 2026). The government projects that this share will approach 47 percent by 2070, as fertility rates that have hovered below one child per woman since 2020 continue to shrink each successive generation (National Development Council, 2024). LTC needs are a large and growing social problem: the Ministry of Health and Welfare estimates that 923,000 Taiwanese (roughly 4 percent of the population) suffer functional limitations requiring long-term care as of 2026, a figure projected to reach 1.3 million by 2035 (Ministry of Health and Welfare, 2025b).

Taiwanese families predominantly 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 migrant 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-fifth of LTC cases (Chan and Chen, 2026).

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, 26 percent identified a son (16 percent) or a daughter-in-law (10 percent) as the primary caregiver (Department of Health, 2013). By comparison, 29 percent identified the LTC-needer's spouse as the primary caregiver, 8 percent identified a daughter, and the remaining 37 percent relied on care by other relatives (e.g., mothers, fathers, or siblings), formal caregivers, and in nursing homes.

LTC needs and the Taiwanese Social Safety Net. Whereas Taiwan is well-known for modern health care services and a generous universal health insurance system, it 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.

The most important expansion of this system during our data period is the "Long-Term Care 2.0" plan, launched in 2017, which subsidizes home visits, day care, transportation, and respite services delivered through a network of community care stations. The program is tax-financed (from earmarked tobacco and estate tax revenues rather than social insurance premiums) and its budget has grown rapidly, from roughly 5 billion NTD in 2016 to 93 billion NTD by 2025 (Ministry of Health and Welfare, 2025a). Even so, public LTC programs are best understood as complements to, rather than substitutes for, family care. Subsidized services are capped at modest weekly hours and do not provide the around-the-clock supervision that severe functional limitations demand; moreover, families employing a live-in migrant caregiver were excluded from the program's main home-care services until after the end of our data period.[4] Despite this growth, Taiwan continues to spend far fewer public

[4]Eligibility for LTC 2.0 services is determined by a questionnaire-based needs assessment administered by government care managers, which is separate from the Barthel-index certification process for hiring migrant caregivers described below. Families employing a migrant caregiver gained access to respite and short-term replacement care in 2023, and to the program's home- and community-care services only in 2026 under the

resources on LTC (roughly 0.4 percent of GDP per year) than most OECD countries (1.8 percent of GDP per year overall), and (unlike Japan, Korea, Germany, or the Netherlands) it has repeatedly declined to adopt public LTC insurance, retaining a tax-financed model (OECD, 2023; Ministry of Health and Welfare, 2025a).

Given the lack of public insurance against LTC needs, one might expect a care-needing Taiwanese family to turn to the general social safety net. But as we describe in Appendix B, the general safety net also provides little support. While income support programs exist, they are subject to aggressive *family*-level means tests, accounting for the resources of one's parents and children and potentially other relatives. Participation in these programs is consequently low, amounting 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 auditing 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). There is no official statistic on these incidents, but the Taiwan Association of Family Caregivers has documented 62 cases between 2018 and 2024 in which a family caregiver killed the relative in their care (roughly one every six weeks) and in about one third of these cases the caregiver attempted suicide thereafter (Taiwan Association of Family Caregivers, 2024). 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. International caregivers play a crucial role in the LTC system. As shown in Figure 1, 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, and has remained above 200,000 since (Ministry of Labor, 2025). Virtually all of Taiwan's formal live-in caregivers are international caregivers.

successor "Long-Term Care 3.0" plan (Ministry of Health and Welfare, 2025b).

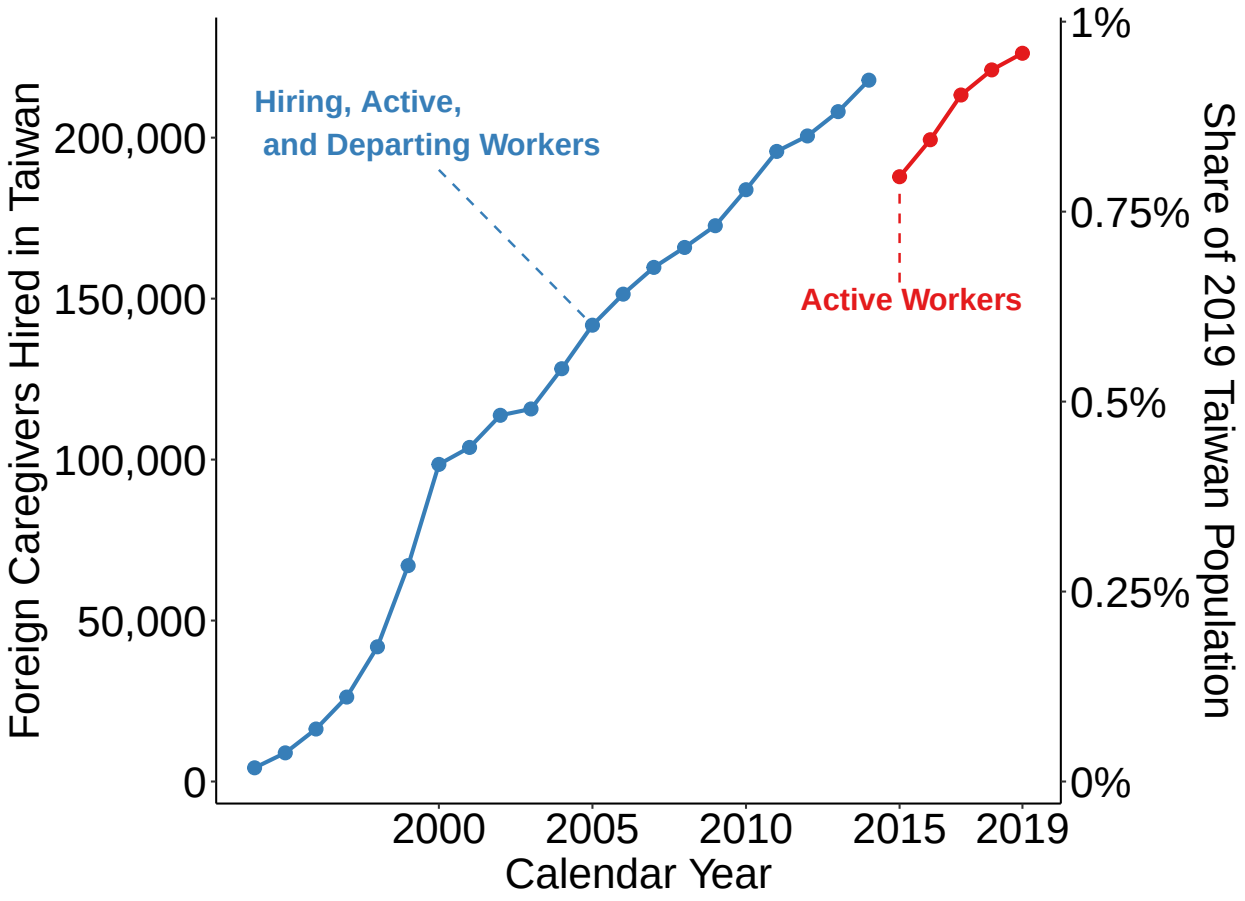


Figure 1: Number of International and Domestic Hired Caregivers

Notes: The number of hired caregivers comes from the statistics of the Ministry of Labor's Foreign Worker Statistics (Ministry of Labor, 2025). Through 2014, the reported counts include workers who had entered Taiwan but not yet completed hiring, and workers reported missing who had not yet departed; from 2015 onward, the counts include only workers actually under employment.

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 measure that summarizes the number and severity of functional limitations suffered by an individual with a single numerical score (Mahoney and Barthel, 1965). An individual is approved if one's Barthel index score is sufficiently low (meaning one has sufficiently many and severe limitations), where the score threshold below which one qualifies is higher (more lenient) at older ages. 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 costs to a family (excluding living accommodations; caregivers reside with the LTC-needer) amounted to 335,000 NTD in the

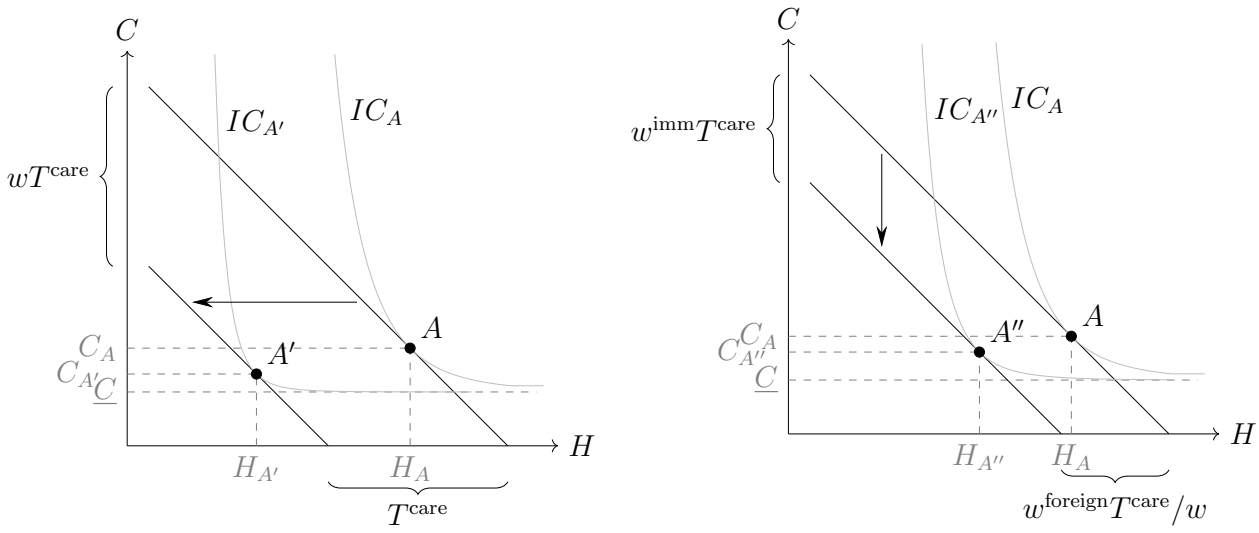
early 2020's, or roughly 25 percent of average gross household income.[5] An international caregiver receives a temporary work visa for the duration of his or her employment contract, and he or she resides in the household of the LTC-needer for this period. A contract is typically valid for three years, 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 over our data period 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 receive a score of 60 if one is unable to climb stairs, move 50 yards across a level surface, or transfer between a bed and chair.

More recently, a further legislative reform has continued this liberalization, lifting the Barthel Index requirement completely for LTC-needers age 80 and older and for those age 70 to 79 diagnosed with Stage II or more advanced cancer (Legislative Yuan, Republic of China, 2024). The exemption, passed in December 2024 and effective from August 2025,

[5] Annualized caregiver hiring costs include 240,000 NTD in wages, 29,500 NTD in health insurance fees, 24,000 NTD in "employment stability fees", and 1,000 NTD for a residence permit. Caregivers are also due overtime pay if they work during the weekly day off to which they are entitled. In addition, families must pay for flights and hire through an intermediary, which typically charged around 9,000 NTD in additional fees in 2025 (see, for example, https://www.kdmanpower.com.tw/news-detail/143/). The largest component, wages, has been fixed at 20,000 NTD per month since 2022; from 2015 until then it stood at 17,000 NTD (Ministry of Labor, 2022).



(a) Informal Care Provision

(b) Migrant Caregiver Hiring

Figure 2: 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.

newly qualifies more than 600,000 elderly Taiwanese for caregiver hiring. While this reform is too recent to enter our data, it reflects continued political momentum toward liberalizing the caregiver hiring system. Opposition to this reform within the labor and health ministries was meaningful, but based primarily on concerns that further expansion could outstrip the supply of migrant caregivers and have distributional consequences (Taiwan News, 2025).

1.2 Conceptual Framework

To formalize just one way in which care needs and caregiver hiring opportunities can seriously impact families, we present a stylized model of work and leisure which we view as a reasonable approximation of the true problem faced by many Taiwanese families. A work-capable adult ("worker") with a dependent older relative (e.g., a parent) chooses home production (H) and consumption (C) to maximize utility. The worker trades off between these goods through a time endowment of T hours, which can be directly allocated to home production or to

funding consumption via work at wage w:[6]

$$\max_{C,H} U(C,H) \quad \text{s.t. } T - T^{\text{care}}\mathbb{1}\{\text{Care Needs}\} = C/w + H$$

where preferences U are smooth and increasing in both C and H, with a subsistence point $\underline{C}$ that the worker will maintain at any cost:

$$U_C(C,H) \to \infty \qquad \text{as } C \to \underline{C}^+$$

We think of home production as capturing non-work time investments that facilitate good health or family development (meeting and marrying a partner, bearing and raising a child, etc.). Consumption is a composite good, and subsistence represents the point where the worker consumes only the food and shelter necessary for his immediate survival.

Panel a of Figure 2 demonstrates the comparative statics in this framework from introducing long-term care needs for the worker's dependent relative. Those care needs require T^{care} hours of care which the worker can either perform himself or hire a *domestic* caregiver to perform at a wage similar to his own. In either case, the cost is the same: amounting to a leftward shift in the budget constraint by T^{care} or an equivalent downward shift of wT^{care}.

Key insights. This framework provides two key insights that will shape our empirical analyses. First, LTC needs will primarily cause workers in small families to reduce home production–not consumption–simply because they *cannot afford* to forego their sole income source. The preferred bundle in the absence of care needs (bundle A) is already close to the subsistence level of consumption. Thus, we expect to see the costs of LTC provision manifest not in reduced work or earnings (which fund consumption), but instead in outcomes generated by home production: marriage, fertility, and good health. Workers adjust on the home production margin not because doing so is costless, but because the alternative of reducing consumption would be even more costly.

Our second insight comes from considering how migrant caregiver hiring should affect these families. The option to hire a migrant caregiver, willing to work at an hourly wage

[6]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 that 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 consumption and home production in order to make theoretical predictions regarding marriage, fertility, and mortality.

$w^{\text{foreign}} < w$, effectively reduces the cost of long-term care provision. In hiring the migrant caregiver, the worker's budget for consumption and home production is shifted downward by only $w^{\text{foreign}} T^{\text{care}}$, mitigating the adverse effects of care needs on the worker's budget set and allowing the worker to enjoy a higher level of home production.

Relevance. While plausibly relevant for *some* families in many developed economies, we argue that this framework provides a good representation of the *average family's problem* in Taiwan for three reasons. First, families in Taiwan tend to be self-reliant: we already established the "threadbare" nature of Taiwan's social safety net in Section 1.1. Second, Taiwanese families tend to be small: like many developed countries, Taiwan has faced below-replacement fertility since the mid-1980's. Third, families tend to allocate a large fraction of their consumption toward basic necessities, suggesting that cutting back on work income would be difficult. Data from the Taiwan Survey of Family Income and Expenditure indicates that 31 percent of non-health consumption was dedicated toward food alone in 2015. By comparison, only 16 percent of non-health consumption goes to food in the United States, based on Consumer Expenditure Survey data.[7]

A second, complementary mechanism may extend this prediction even to higher-income families, though it falls outside the stylized model above: opportunities to mix caregiving with part-time employment may simply be unavailable. Part-time employment is exceedingly rare in Taiwan, representing less than 4 percent of all employment (Ministry of Labor, 2023). If small families cannot afford a worker forgoing employment *entirely*, then LTC needs will force even high-income workers to substitute away from home production instead.

2 Data

How LTC needs affect families is ultimately an empirical question. We take this question to data consisting of multiple linked Taiwanese administrative registries. Our 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

[7]These statistics are based on food spending both at and outside home. However, the Survey of Family Income and Expenditure does not distinguish food spending outside the home with (comparatively smaller) spending on hotels. Food at home on its own accounts for 17 percent and 9 percent of total non-health spending in Taiwan and the United States respectively.

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 applications for and hiring of international caregivers runs from 2007 to 2020.

We identify family links by combining two information channels. The first is health insurance records; access to Taiwan's universal health care system is nominally tied to employment, but young children and unemployed adults are linked to the employment accounts of a close relative. Observing the adult from whom a child derives her health insurance coverage provides a reliable way of identifying the child's parent, at least if she is observed as an adolescent 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 continuously 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 reports parental match rates by sex and birth cohort, focusing on the cohorts most relevant for our analysis (1950 to 2000). Overall, we manage to identify at least one parent for 55 percent of women and 68 percent of men. 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. Beyond cultural norms that would place the burden of care on the eldest son, this is another reason we choose to focus our analyses mainly on adult sons. However, it is worth noting that our measure of family size will be downward biased. We do 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.[8]

[8]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.

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.[9]

We focus first on strokes because they are strongly linked 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–another regularly-studied health shock with ties to care needs. In doing so, we follow a public health literature in which strokes have been a frequent focal event (Bickel et al., 2012; Dobkin et al., 2018; Fadlon et al., 2019; Fadlon and Nielsen, 2021).

2.1 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.[10] 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 family over time through marriage and divorce.

We refine our sample with three 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. Within that analytic sample, we follow individuals over the entire data period, until either the end of the panel or their own deaths.

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

[10]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	
	Pre	Post-Pre	Pre	Post-Pre
Bathing Difficulty	0.1988	0.69***	0.2242	0.34***
		(0.10)		(0.09)
Clothing Difficulty	0.1601	0.65***	0.1858	0.34***
		(0.10)		(0.08)
Eating Difficulty	0.0863	0.36***	0.1074	0.15**
		(0.07)		(0.06)
Ambulating Difficulty	0.1488	0.49***	0.1681	0.31***
		(0.08)		(0.08)
Walking Difficulty	0.1648	0.57***	0.1824	0.35***
		(0.09)		(0.08)
Incontinence	0.1535	0.54***	0.1727	0.40***
		(0.09)		(0.09)
Barthel Score (upper)	95.5288	-16.50***	94.8197	-8.56***
		(2.51)		(2.13)
Barthel Score (lower)	94.1641	-19.95***	93.4208	-10.89***
		(2.79)		(2.55)

Notes: This table reports the differential change in functional limitations an elderly person reports in the last survey wave just before ("Pre") versus first survey wave just after ("Post") reporting the given health condition, compared to otherwise-similar peers in the TLSA. Individuals are exactly matched on birth year and sex. TLSA survey waves occur every four years. The final two rows use these limitation reports to impute a Barthel score. Limitation reports are binary in the TLSA, which is not sufficiently granular to exactly construct a Barthel score. Instead, we construct a lower bound by supposing any reported limitations are "severe," and an upper bound by supposing they are "moderate". See Chan and Chen (2026) for detailed construction.

2.2 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 stroke-suffering families. We present summary statistics on these families in Table 2, comparing them to families which are never observed suffering a stroke.

In total, we observe almost 1.7 million unique families in which an elderly person suffers a stroke. Within those families, the average older generation consists of 1.49 adults (i.e., we find 0.49 spouses for each stroke-sufferer), who we link to an average of 1.73 younger relatives including daughters-in-law. We manage to link more sons (0.83 on average) than we do daughters (0.49 on average) consistent with the limitations of our matching procedure. Compared to the average family of an older-age Taiwanese, those who suffer a stroke tend to have similar average family sizes (3.22 immediate relatives versus 3.20). However, stroke-suffering families have fewer identifiable daughters (0.49 versus 0.66) but more identifiable daughters-in-law (0.41 versus 0.22). Table 2 also shows that the composition of stroke-suffering families is roughly similar to the composition suffering a hip fracture or dementia diagnosis, except that those suffering dementia tend to have slightly fewer adult children.

Table 2: Average Family Links to Old-Age Taiwanese Adults

	Stroke Sample			
	Never-Treated	Treated (Stroke)	Hip Fracture	Dementia
Elderly Parents	1.48	1.49	1.46	1.45
Sons	0.84	0.83	0.82	0.77
Daughters	0.66	0.49	0.43	0.42
Daughters-in-Law	0.22	0.41	0.45	0.44
Total	**3.20**	**3.22**	**3.16**	**3.07**
Number of Families		1,694,377	526,891	395,222

Notes: This table reports statistics on our main analytic sample of families as defined in Section 2.1. Averages among never-treated families are taken based on a 5% random sample.

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

	Other Families	Analytic Sample Families		
	Never-Treated	Control	Treated	Treated - Control
Parent's Age		65.99	67.01	1.02
Married (pct)	25.71	50.08	49.95	-0.13
Children per Hundred	42.08	92.39	92.59	0.20
Worked (at all)	0.64	0.74	0.74	0.00
Months Worked	6.97	8.31	8.33	0.01
Annual Earnings (1k)	229.14	297.35	298.43	1.08
Annual Hospital Bed Days	0.72	0.95	1.03	0.08
Annual Medical Spending (1k)	8.94	12.15	12.57	0.41
Depression Diagnoses	11.36	13.66	14.20	0.54
Age at Parent's Own Onset		43.85	38.72	-5.13

Notes: This table reports statistics on our main analytic sample of working-age sons in families defined in Section 2.1, in event-year -1. Control individuals consist of individuals in later-treated families which have been matched to treated families on birth year, education level, and family structure. "Parent's age" and "age at parent's own onset" are omitted from the never-treated column because they are not defined in this sample by construction. Averages among never-treated families are taken among a 5% random sample.

3 Responses to a Parent's Stroke

In this section, we estimate the average effect of health shocks in our data, integrating across the various caregiver hiring regimes that occurred over our sample period. We will distinguish the effects of health shocks under alternative caregiver hiring regimes to Section 5.

Our core parameters of interest are average treatment effects on the treated. Formally, let $Y_{it}^c(1)$ denote the potential outcome an individual i would experience t years from calendar year c, having suffered a family health shock in year c. Let $Y_{it}^c(0)$ denote the potential outcome that same individual would experience if the shock had not yet occurred by calendar year $c+t$. Our first object of interest is the t-specific average treatment effect on the treated, which averages over effects for different shock cohorts c:

$$ATT(t) \equiv E_c\left[E\left[Y_{it}^c(1) - Y_{it}^c(0) \mid D_i^c = 1\right]\right], \tag{1}$$

the average effect, t years after a health shock, among individuals whose families actually experienced one. We also examine the overall ATT that averages across all available post-

shock event times $t \geq 0$:

$$ATT \equiv E_t\big[\, ATT(t) \,\big], \qquad t \geq 0. \tag{2}$$

3.1 Empirical Strategy

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. The validity of the design hinges on a common trends assumption: had one's health shock occurred *later*, one's outcomes would have continued evolving over time with the same trends observed among the actually-later-shocked families. This assumption is implied by–but is weaker than–the assumption that the timing of health shocks is random with respect to one's outcomes.[11] That the timing of old-age strokes are plausibly random therefore makes strokes particularly amenable to this design.

Taking the design to our data, we estimate a series of two-by-two difference-in-difference regressions, each on different subsamples consisting of observations from a given event-year ℓ and from a fixed pre-shock reference event-year ℓ_0:

$$Y_{it}^c = \alpha_{ic} + \sum_{\ell \neq \ell_0} \left(\gamma_\ell \mathbb{1}\{t = \ell\} + \delta_\ell D_i^c \mathbb{1}\{t = \ell\}\right) + \epsilon_{it}^c, \quad t \in \{\ell_0, \ell\} \tag{3}$$

where Y_{it}^c denotes the outcome for person i, t years away from 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.[12] Beyond the restrictions we already imposed on our analytic sample in Section 2.1, 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 and/or zero vs. one vs. multiple children) in calendar year $c-1$.[13] Our

[11] If the timing of health shocks is fully random, we would see not just common pre-shock trends between shocked and later-shocked families, but common pre-shock *levels*.

[12] Our estimator amounts to the IPW estimator proposed by Callaway and Sant'Anna (2021).

[13] 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.

design restricts to relatives who survive up to $t = -1$, but allows both treated and control relatives to die in years $t \geq 0$, falling out of the data in subsequent years.

Under the common trends assumption above, the coefficients δ_ℓ recover $ATT(\ell)$ from Equation 1 for the given outcome Y. We construct overall ATT estimates (Equation 2) throughout the paper by averaging $\hat{\delta}_\ell$ over post-shock event times $\ell = 0, \ldots, L$.

3.2 Covariate Balance

If the timing of strokes are indeed conditionally random, then we should find no meaningful conditional differences across treatment cohorts in observable pre-stroke characteristics. Table 3 compares average pre-period characteristics of adult sons and their stroke-suffering parents to those of the later-treated controls. 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 their own age, birth year, and education which we omit from the table. They are nearly indistinguishable on average marital status—an unsurprising but not strictly mechanical result because we balance the groups coarsely on education and family structure.

We do not balance on one's own pre-period number of children, employment, earnings, or health. It is therefore reassuring to see that differences on these pre-stroke outcomes between treated and later-treated adult sons are economically negligible and much smaller than differences between treated and never-treated families. We also do not directly balance on the LTC-needing parent's age, in order to keep the set of matching characteristics parsimonious. Even so, later-LTC-needing parents in the weighted control group are only one year older on average than LTC-needing parents in the treated group—despite suffering their own strokes roughly five years later in calendar time. Given that we *do* balance exactly on age of the adult sons, this suggests we are exploiting primarily variation in the timing of a stroke across otherwise-similar families as intended, instead of comparing adult sons with very young parents in the control group to otherwise-similar adult sons with very old parents in the treated group.

3.3 Results

Overall effects on mortality, health, and family formation. We begin by reporting estimates for the overall ATT, pooling across all post-stroke years, in Column 1 of Table 4. Strokes are tied to substantial adverse effects on the health and well-being of adult sons, all

of which are very precisely estimated. Mortality rates increase by an additional 0.56 deaths per thousand per year. This includes more deaths classified explicitly as suicides, the risk of which increases by 0.053 per thousand per year. While the specific contribution of suicides to all-cause mortality is comparatively small, stigma against classifying suicide as a cause of death means this estimate represents a plausible lower bound on the mortality effect coming from intentional self-harm.

Other measures of health and family formation suggest adverse effects beyond mortality. Depression diagnoses increase by 2.90 diagnoses per thousand and their medical costs increases by 1000 NTD per year. Five years after the stroke, the probability that an adult son would be married falls by 8 per thousand and their fertility declines by 4.04 per thousand.

Outcomes of older versus younger adult children. How the costs of a parent's stroke materialize for adult children should depend on the life cycle phase in which the shock occurred. Marriage and fertility tend to happen when adult children are relatively young, whereas mortality tends to be a greater risk at older ages. 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 one year prior to the stroke event and estimate effects separately for each group. We group individuals into three age bins: i) younger than 34, ii) between 34 and 48 years old, and iii) older than 48 years of age. We report the results in Columns 4, 5, and 6 of Table 4.

Effects on all-cause mortality, suicide, depression, and medical spending tend to increase in magnitude as adult sons progress through the life cycle. Annual all-cause mortality increases by 0.13 deaths per thousand among the youngest age group, but by more than 1.74 per thousand among those age 48 and older. Yet even the early-life increase in mortality is substantial when compared to baseline mortality rates for young men (1.1 deaths per thousand at age 35). 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.

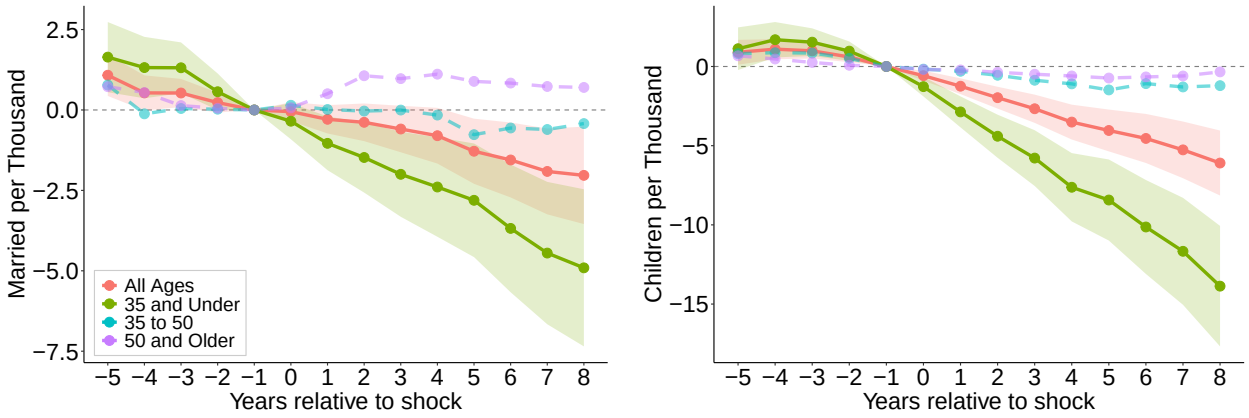
Decreases in marriage and fertility are concentrated in the earliest phase of the life cycle, suggesting that a parental stroke disrupts the household formation process. Among adult sons who are younger than 34 prior to the stroke, marriage rates decline by 2.8 per thousand and cumulative fertility declines by 8.4 children per thousand five years later. 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.

Dynamic effects of a stroke. While we have so far focused on average effects of a stroke integrating over post-stroke years, it can be informative to examine how these responses vary over time. We next plot in Figures 3 and 4 estimates for the "dynamic" average effects of a parent's stroke (the separate event-time response coefficients δ_ℓ for each ℓ in Equation 3) for several key outcomes: those related to family formation (marriage and fertility) in Figure 3 and those related to health and economic outcomes (employment, mortality, medical spending, and depression) in Figure 4. These figures illustrate a remarkable persistence over time underlying the overall average effect estimates. For all outcomes. effects of a parent's stroke do not attenuate over time. Instead, they either remain stable or *increase* in magnitude as years pass. Constructing these "dynamic" estimates in pre-stroke years also generally reveals no meaningful evidence of pre-trends, consistent with the idea that strokes are unanticipated random events.[14]

Comparing the scale of labor and non-labor effects of a stroke. The effects of a stroke on mortality are large in magnitude: both in terms of the total loss of life they imply, and relative to their effects on income and labor supply. The average mortality effects of 0.56 deaths per thousand would represent a 17 percent increase in all-cause mortality for men age 45 (who in 2020 had an annual mortality rate of 3.37 deaths per thousand). The increases in mortality risk are, in proportional terms, equally large across the age profile: our age-specific estimates represent approximately 20 percent increases in the average mortality risk faced by men in that age group. As we show in Section 5.1 where we consider the welfare implications of caregiver hiring reforms, the social value of the life at stake is substantial as well.

Mortality effects also matter for measuring the true labor-supply losses caused by a parental stroke. Accumulating mortality effects over the first five post-stroke years, average increases of 0.56 deaths per thousand per year imply 8.4 years of lost life per thousand workers. If sons who died would otherwise have maintained their pre-stroke employment rate (0.74 workers per adult), these deaths alone account for 6.2 lost worker-years of employment per thousand adults. Employment effects among surviving sons—7.5 fewer workers per

[14]We do detect some evidence of anticipation for fertility responses (Figure 3b). We investigate this further in Appendix Figure A.2, where we repeat the event study plot after splitting the younger age group into three finer subpopulations based on their pre-stroke family status: 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. Meanwhile, fertility effects are driven most by unmarried sons.



(a) Marriage responses (b) Fertility responses

Notes: These plots report estimates separately by age of the adult son. 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 3. 95 percent confidence intervals are plotted as the shaded regions for one subgroup (age 34 and under) and for the pooled estimates. Standard errors are clustered at the individual level.

Figure 3: Event study responses of adult sons to elderly parents' strokes: family formation outcomes

thousand per year—account for a further 37.5 lost work-years per thousand over the same five years. Under these assumptions, ignoring mortality would understate the *near-term employment losses alone* from a parental stroke by roughly 16 percent.

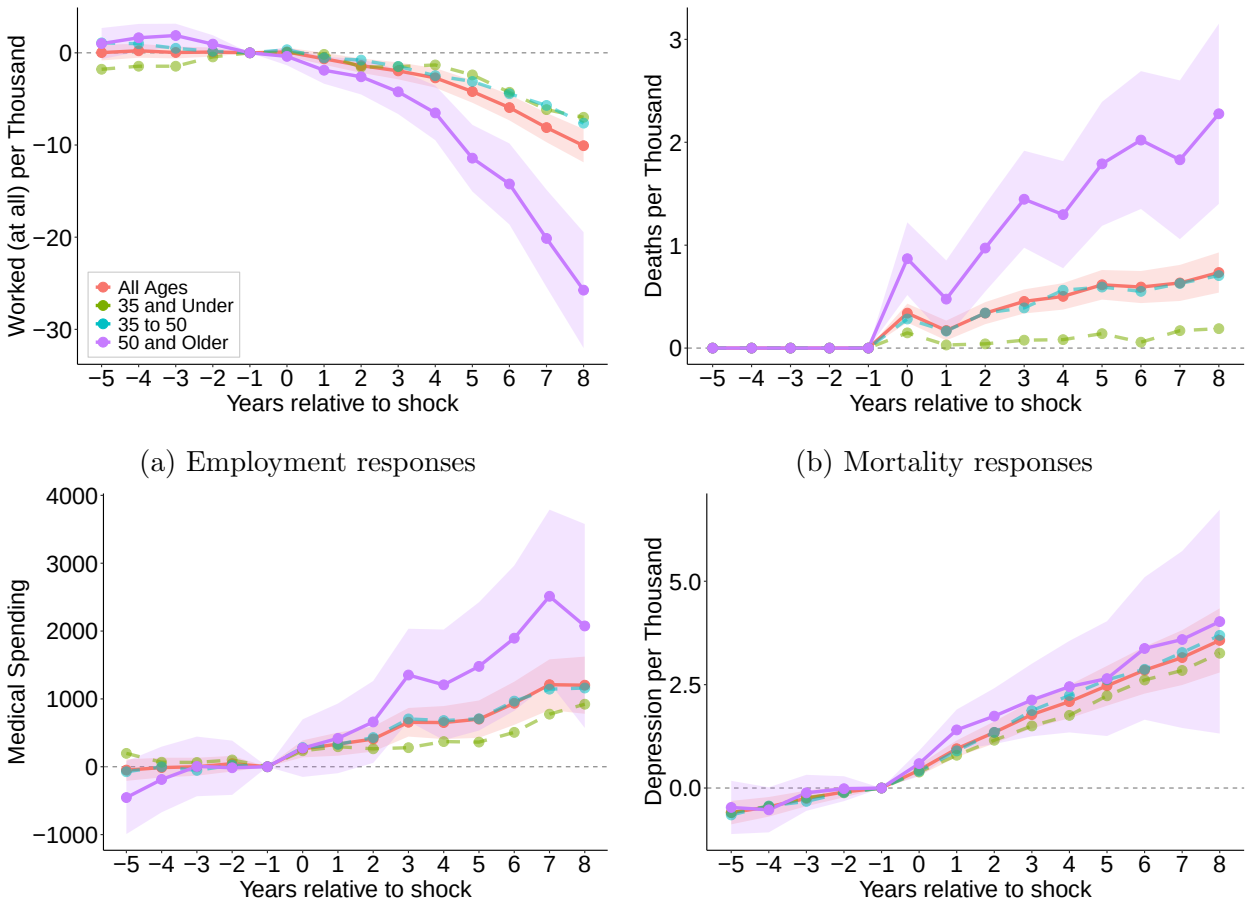
Turning to medical expenditures, our main effect estimate suggests that the additional medical care incurred by adult sons costs the Taiwanese government 1,000 NTD per year. While this average increase is not an enormous fiscal externality for the Taiwanese government, it does represent a precise 8 percent increase relative to average pre-stroke medical costs. Viewing health care spending instead as a summary index of one's health, this increase points to a broad deterioration of health consistent with the increases in mortality and depression diagnoses.

Likewise, the declines in fertility of adult sons under the age of 35 are meaningful. By the fifth year from the stroke, having on average 8.4 fewer children per thousand sons amounts to a 0.84 percent decline relative to the total fertility rate. Panel (b) of Figure 3 suggests that this fertility effect only continues accumulating over time. Eight years after the stroke, that effect estimate grows in magnitude to 14 fewer children per thousand adult sons (a 1.4 percent decline in the total fertility rate).

Table 4: Economic and Health Effects on Adult Sons of Elderly Parents' Strokes

	(1)	(2)	(3)	(4)	(5)	(6)
	Overall Effects			Effects of Stroke, by Age of Son		
	Stroke	Hip Fracture	Dementia	Under 34	34 to 48	49 and Older
Deaths per 1k	0.5645***	0.8099***	0.6572***	0.1348***	0.5302***	1.736***
	(0.06314)	(0.1975)	(0.2278)	(0.03332)	(0.07294)	(0.2383)
Suicides per 1k	0.05287***	0.09264***	0.02941	0.0309***	0.04983***	0.117***
	(0.01014)	(0.02367)	(0.04658)	(0.0107)	(0.01446)	(0.0212)
Depression per 1k	2.898***	1.977**	2.846**	2.923***	2.994***	2.559**
	(0.3131)	(0.8615)	(1.116)	(0.3629)	(0.4217)	(1.035)
Medical Spending	1000***	1303***	729.4	755.1***	927***	1823***
	(166.3)	(372.9)	(635.2)	(202.3)	(212.7)	(476.1)
Hospital Days	0.1267***	0.2383***	0.07811	0.1185***	0.1412***	0.1055**
	(0.02025)	(0.06869)	(0.08542)	(0.02331)	(0.03002)	(0.05353)
Worked (at all) per 1k	-7.478***	-9.862***	-6.52***	-4.252***	-6.259***	-19.06***
	(0.7066)	(1.823)	(2.248)	(0.859)	(0.7656)	(2.133)
Months Worked	-0.09885***	-0.1215***	-0.1003***	-0.06062***	-0.08546***	-0.2331***
	(0.008567)	(0.02148)	(0.02658)	(0.009859)	(0.009319)	(0.02554)
Work Income (NTD)	-2321***	-4460***	-3373**	-733.5	-1722***	-8020***
	(477.8)	(1199)	(1467)	(490.3)	(553.6)	(1423)
Household Formation (5 years later)						
Married per 1k	-1.283**	-1.683	0.499	-2.808***	-0.7676	0.8886
	(0.5167)	(1.577)	(1.933)	(0.9012)	(0.6736)	(0.9533)
Children per 1k	-4.04***	-4.648***	-0.4346	-8.431***	-1.48*	-0.7288*
	(0.6735)	(1.717)	(2.186)	(1.306)	(0.7974)	(0.4218)
Treated Units	1,224,087	94,037	66,212	453,535	547,286	223,266

Notes: Estimates are obtained from the event study in Equation 3 pooling all post-event periods. Treated unit counts exclude individuals who failed to match with a single later-treated control unit. Columns 4-6 report estimates separately by age in the year before the parent's stroke. Standard errors are reported in parentheses. Standard errors are clustered at the individual level."Employment" indicates if one has earned work income for at least six months in the year. "Earnings" are measured in NTD per year (1 USD is approximately NTD 31). "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. Effects for the final two outcomes, Married per Thousand and Children per Thousand, are reported at a specific point in time because these measures are stocks rather than flows.



(a) Employment responses

(b) Mortality responses

(c) Medical Cost responses

(d) Depression Diagnosis responses

Notes: These plots report estimates separately by age of the adult son. 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 3. 95 percent confidence intervals are plotted as the shaded regions for one subgroup (age 49 and older) and for the pooled estimates. Standard errors are clustered at the individual level.

Figure 4: Event study responses of adult sons to elderly parents' strokes: economic and health outcomes

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

	(1)	(2)	(3)	(4)	(5)
	By Education			By Sibling Status	
	Below HS	HS Degree	Above HS	Only Child	Has Siblings
Deaths per Thousand	1.676***	0.3569***	0.1609**	1.118***	0.3102***
	(0.1739)	(0.1219)	(0.06333)	(0.1361)	(0.067)
Suicides per Thousand	0.1322***	0.04247**	0.02075**	0.08748***	0.03706***
	(0.02706)	(0.02051)	(0.00966)	(0.01403)	(0.0132)
Depression per Thousand	3.423***	2.618***	2.849***	3.281***	2.722***
	(0.7403)	(0.5383)	(0.441)	(0.7013)	(0.3222)
Medical Spending	1254***	1108***	786.3***	1286***	868.7***
	(466.6)	(279.1)	(200.9)	(382)	(166.7)
Hospital Days	0.2452***	0.1477***	0.05008***	0.1395***	0.1209***
	(0.06347)	(0.03588)	(0.01785)	(0.03741)	(0.02392)
Worked (at all) per Thousand	-12.77***	-7.062***	-5.112***	-13.45***	-4.733***
	(1.542)	(1.142)	(1.077)	(1.394)	(0.7796)
Months Worked	-0.1715***	-0.09253***	-0.06679***	-0.1877***	-0.05801***
	(0.01847)	(0.01385)	(0.0131)	(0.01692)	(0.009383)
Work Income (NTD)	-3838***	-2308***	-1559*	-4349***	-1389***
	(655.4)	(602.2)	(901)	(998.3)	(509.8)
Household Formation (5 years later)					
Married per Thousand	1.226	-1.528*	-2.366***	-1.62*	-1.135*
	(0.9797)	(0.8608)	(0.8173)	(0.8685)	(0.6337)
Children per Thousand	-0.8932	-3.456***	-6.092***	-2.559**	-4.689***
	(1.043)	(1.084)	(1.15)	(1.093)	(0.8314)
Treated Units	261,047	415,227	547,813	342,361	881,726

Notes: Estimates are obtained from the event study in Equation 3, pooling all post event periods. For other notes, see Table 4. Standard errors are clustered at the individual level.

3.4 Evaluating Channels for Adult Children's Responses

Long-term care needs are one channel by which elderly health shocks may be linked to adverse outcomes for adult children. To gauge their role, we examine how the magnitude of adverse outcomes varies with a family's capacity to absorb the burden of care. Since we cannot measure care needs or care provision directly, we rely on two proxies for that capacity: i) the adult son's educational attainment and ii) whether he has identifiable siblings. We summarize heterogeneity along these proxies in Table 5.

Overall, our results are consistent with the reasoning laid out in our conceptual framework (Section 1.2): effects on mortality, medical spending, and employment attenuate for sons who have siblings or higher levels of education. The gradient on mortality effects is particularly sharp; it is an order of magnitude larger for high school dropouts than for those with schooling beyond a high school degree (1.67 versus 0.16 deaths per thousand per year). Mortality effects are nearly 4 times larger for adult sons with no siblings (1.12 deaths per thousand per year) compared to those who have at least one sibling (0.31 deaths per thousand per year).

Marriage and fertility effects, however, do not follow the same pattern: they are indistinguishable across sons with versus without siblings, and are actually *larger*—not smaller—for sons with more schooling. This runs counter to the direction our simple conceptual framework would predict. Given however the sharp, consistently-signed gradients we find for our more severe indicators of distress, we view the overall pattern as suggestive evidence that care needs are a key channel through which parental strokes affect adult sons' well-being.

4 Generalizing from Strokes

Strokes, while well-suited to a staggered event-study design, represent only a fraction of LTC-related diseases. Focusing on strokes alone risks an incomplete picture of families' LTC burden, since strokes cause acute and unusually severe care needs relative to other conditions. This motivates us to ask what our design can reveal about other LTC-related shocks as well.

Other prevalent conditions, however, pose a challenge: they often involve a gradual loss of functional ability over time. Neurodegenerative diseases linked to cognitive decline, for example, account for a large share of existing care needs. If these declines materialize or can be anticipated before a formal diagnosis, then the design's identifying assumptions may not hold. Conversely, their costs may not materialize until long after diagnosis, complicating the interpretation of any effects we do estimate.

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, serious health problems whose consequences for care needs differ materially from those of strokes. As shown in Table 1, elderly parents who suffer a hip fracture tend to experience less pronounced increases in difficulty bathing, dressing, and eating. Their increases in difficulty with ambulation, walking, and incontinence, however, are more comparable to those of stroke survivors, though still smaller on average. A parent's hip fracture might therefore be expected to act as a milder shock to adult children than a stroke. Dementia, by contrast, is plausibly associated with a different profile of care needs altogether.

The overall effects of a parent's hip fracture or dementia diagnosis on adult sons are summarized in the second and third columns of Table 4, alongside our previously-discussed estimates for strokes. Comparing estimates across these events, we find that adverse effects of a parental hip fracture or dementia diagnosis are remarkably similar, on average, to the adverse effects of a parental stroke. In Appendix Table A.1, we show no substantial systematic differences conditional on the age of the adult son as well. One interpretation of this finding is that the common requirement all three conditions impose on families–that a person be regularly available to support and monitor the LTC-needer–may be a key driver of negative health and family outcomes.

4.1 Extrapolating to Broader Functional Limitations

Strokes, hip fractures, and dementia are only three of many potential drivers of parental functional decline. To the extent that functional limitations are the fundamental mechanism linking these shocks to adult-son outcomes, we can pose a more general question: how does a decline in a parent's functional ability *in general* affect adult sons?

We answer this question by treating health shocks as instruments for functional limitations. Let ΔF denote the change in a parent's functional ability induced by a shock Z, and let Y denote an adult-son outcome. The IV estimate of the causal effect of functional limitations on adult sons' outcomes is:

$$\hat{\beta}^{IV} = \frac{\text{Effect of shock on adult-son outcomes}}{\text{Effect of shock on functional limitations}} = \frac{\hat{\pi}_{YZ}}{\hat{\pi}_{FZ}}, \tag{4}$$

where $\hat{\pi}_{YZ}$ is the reduced-form effect estimated by our event-study design and $\hat{\pi}_{FZ}$ is the first-stage effect of the shock on functional ability. Beyond relying on the standard IV assumptions, $\hat{\beta}^{IV}$ will give a reasonable estimate for the broader average effects of parental functional limitations on adult sons if 1) effects of parental functional ability on outcomes are approximately linear, and 2) effects for sons of shock-suffering parents generalize to sons

of parents with more gradually-arising functional limitations.

Estimating $\hat{\pi}_{FZ}$ from administrative data alone is not feasible, since individual functional-limitation records are not available at scale in Taiwan. The most readily available source is the TLSA, but its comparatively small sample size and multi-year gaps between survey waves make it unsuitable for the staggered difference-in-differences design of Section 3. We therefore estimate the first stage using the difference-in-difference estimates from Table 1, taking the Barthel score as our measure of functional ability.

Table 6 presents the IV estimates for effects of a marginal (1-point in the Barthel index) decrease in a parent's functional ability on adult sons' outcomes. Panel A reports first stage effects directly from columns 2 and 4 of Table 1, which are approximately 20 points for strokes and 11 points for hip fractures. Panel B then divides the reduced-form estimates from Table 4 by these figures to yield our marginal effect estimates.

This exercise suggests that the costs of parental functional limitations are large for adult sons. Using strokes as the shifter (column 1), a 1 point decrease in a parent's Barthel score increases annual mortality risks for adult sons by 0.03 per thousand or roughly 1 percent relative to male mortality rates at age 45 (3.37 deaths per thousand in 2020). The reduction in fertility, 0.2 children per thousand 5 years later, corresponds to a 0.02 percent decrease in the 2020 total fertility rate. Person-years with a depression diagnoses increase by 0.145 per thousand or roughly 0.3 percent of adult sons' pre-stroke baseline. Annual public medical spending increases by 50 NTD per year, or roughly 0.4 percent of adult sons' pre-stroke baseline. The increase in hospital bed days, 6 days per thousand per year, amounts to a 0.6 percent increase in adult sons' pre-stroke hospital time.

As a benchmark, Table 1 shows that stroke-suffering parents had already lost an average of 6 Barthel points *even before* their stroke occurred, while old-age respondents to the TLSA more generally have lost 10 points on average (Chan and Chen, 2026). If the average adult son's parent has functional ability typical of the average TLSA respondent, our estimates imply that functional limitations alone account for 0.28 deaths per thousand per year among adult sons. This represents a large share of mortality given that annual age-specific mortality rates for men in their 40s range from only 2 to 5 deaths per thousand, and it points to a heavy average burden of care provision. Effects on fertility, a decline of 2 children per thousand adult sons, are clearly smaller but not trivial considering the age distribution at which parental strokes (and other functional limitations) occur.

These conclusions are not driven by our choice to focus on stroke events in particular. Using hip fractures instead for this exercise suggests *even larger* effects of functional limita-

Table 6: IV Estimates for Effects of Functional Ability on Adult Sons

	(1) Stroke	(2) Hip Fracture
Panel A: First Stage Estimate		
Barthel Index	-19.95	-10.89
	(2.79)	(2.55)
Panel B: IV Estimate		
Deaths per Thousand	-0.02831***	-0.07436***
	(0.004719)	(0.02515)
Depression per Thousand	-0.1453***	-0.1815**
	(0.02491)	(0.08981)
Medical Spending	-50.13***	-119.7***
	(10.1)	(44.26)
Hospital Days	-0.006354***	-0.02188***
	(0.001279)	(0.008128)
Worked (at all) per Thousand	0.375***	0.9054***
	(0.06007)	(0.2702)
Months Worked	0.004956***	0.01115***
	(0.0007758)	(0.003274)
Work Income (NTD)	116.5***	409.4***
	(25.27)	(146)
Children per Thousand	0.2024***	0.4267**
(5 Years Later)	(0.04122)	(0.1866)

Notes: IV estimates are constructed by dividing effects of health shocks on outcomes (Table 4) by their effects on functional ability (columns 2 and 4 of Table 1 and copied to panel A), measured by the Barthel Index. For these estimates, we have selected the most conservative (largest) first stage estimate for each shock. Standard errors on IV estimates abstract from dependence between the TLSA sample and the population-level administrative data.

tions on adult children, because hip fractures have smaller impacts on functional abilities of parents but similar adverse consequences for adult sons.

5 The Expansion of Migrant Caregiving

A natural next question is whether Taiwan's caregiving-related policies can attenuate these costs of parental health shocks. We exploit large increases over time in migrant caregiver hiring rates, concentrated among families whose parent suffered a health shock at a particularly advanced age. These are exactly the families targeted by the expansionary reforms described in Section 1. Among families that suffer a stroke, Figure 5 shows that post-stroke caregiver hiring rates for LTC-needers over 80 rose from 29 to 37 percent between 2007 and

2018.[15] By contrast, hiring rates for LTC-needers aged 50 to 80 have remained stable, just below 10 percent, over the same period.

It is revealing to compare these cross-cohort patterns in caregiver hiring rates to cross-cohort patterns in family responses to a stroke, among those families with LTC-needers over the age of 80. Figure 6 plots caregiver hiring rates in LTC-needing families against near-term estimates of the effect of LTC needs separately by year of the health shock. It shows that adverse mortality and health effects of a stroke have attenuated markedly across shock cohorts, coincident with the rise in caregiver hiring rates. By contrast, Figure A.7 shows that the adverse effects for families of LTC-needers between ages 50 and 79 at the time of their stroke—who are not immediately eligible for more lenient hiring criteria under the reforms—have been stable or worsening with the slight differences they face in caregiver hiring rates across cohorts. This suggests that the reforms are improving post-stroke outcomes through the actual hiring of caregivers by LTC-needing families, not through changing their expectations over future caregiver hiring or some other indirect mechanism.

That the expansions to caregiver hiring targeted older LTC-needers renders them less useful for studying how caregiver hiring affects marriage and fertility of adult sons, because those effects were concentrated among younger adult sons (who, naturally, tend also to have younger parents). However, there still remains some room for effects of the reforms on these outcomes given the delayed age at which men tend to form families in Taiwan. We compare cohort-by-cohort near-term effect estimates against caregiver hiring rates for marriage and fertility outcomes in Appendix Figure A.8, in the same way as Figure 6 does for other outcomes. We nonetheless find that adverse effects of a stroke on adult sons' marriage and fertility have tended to weaken in these families as caregiver hiring rates have increased.

The causal effect of caregiver hiring. Given that the sharp rise in caregiver hiring rates over time is concentrated specifically among the types of care-needing families targeted by expansionary reforms, one might be tempted to treat cross-cohort caregiver hiring rates as an instrument for the effect of caregiver hiring on family outcomes. This variation, however, plausibly violates the exclusion restriction as an instrument for *individual* caregiver hiring: even if a family does not hire a caregiver today, a forward-looking adult son may adjust his behavior under a more lenient hiring regime simply because he knows his family will surely be able to hire one *in the future*. We sidestep this problem by redefining our parameter of interest as an intent-to-treat effect: the causal effect on *adult children as a whole* of

[15] For these cohort-by-cohort effect estimates, we take a 20% random sample of adult sons from our main analytic dataset.

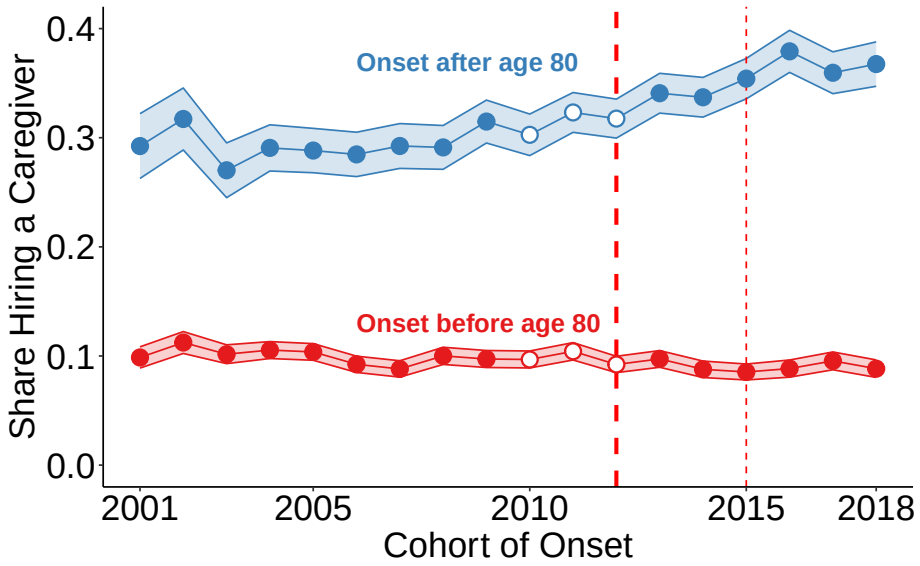
living under a marginally more lenient caregiver-hiring regime, as proxied by the aggregate caregiver hiring rate.

We estimate a linear version of this intent-to-treat effect by fitting a line to the scatterplots in Figure 6. This implies that a 1 percentage point increase in caregiver hiring rates would increase employment by 1.17 workers per thousand per year (panel a), decrease mortality by 0.20 per thousand per year (panel b), reduce medical spending by 71 NTD per person per year (panel c), and reduce depression diagnoses by 0.33 per thousand (panel d). Appendix Figure A.8 indicates it would increase marriage rates by 0.2 per thousand and fertility by 0.14 per thousand.

However, caregiver hiring rates are likely not the only relevant factor which has trended over this interval of years. Medical technology has 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 known expansionary reforms. For this reason, we compare the caregiver hiring rate and average near-term stroke responses across three cohorts preceding the 2012 reform (2007-2009) against the values for three cohorts following that reform (2013-2015). Because the 2015 reform follows so closely after the 2012 reform and targets a similar population, this contrast mixes the effects of both reforms. We exclude the 2010, 2011, and 2012 cohorts because they are partially treated by the 2012 reform. Across these two groups of cohorts, caregiver hiring rates rose by 4.45 percentage points (with a "first-stage" t-statistic of 5.56).

We plot these estimates in red over the scatter plots of Figure 6. They suggest similar—if anything more dramatic— attenuation of the adverse effects of stroke with greater access to international caregiver markets. Labor supply responses reversed from a pre-reform decline of 10.56 workers per thousand per year to a slight *increase* of 1.74 workers per thousand per year among post-reform cohorts. Average effects of a stroke on mortality among the pre-reform cohorts amounted to 1.87 additional deaths per thousand per year, but only 0.17 additional deaths per thousand per year among post-reform cohorts. Depression diagnoses reversed across these cohorts as well, from an increase of 0.50 per thousand to a *decrease* of 2.21 per thousand. Effects on marriage and fertility also tend to weaken locally around the reform, in Appendix Figure A.8. On the other hand, medical spending responses are virtually unchanged across these cohorts.

These estimates, though, capture only short-run effects. We can also estimate longer-run effects by comparing families that suffered a stroke in the early 2000s to those that suffered



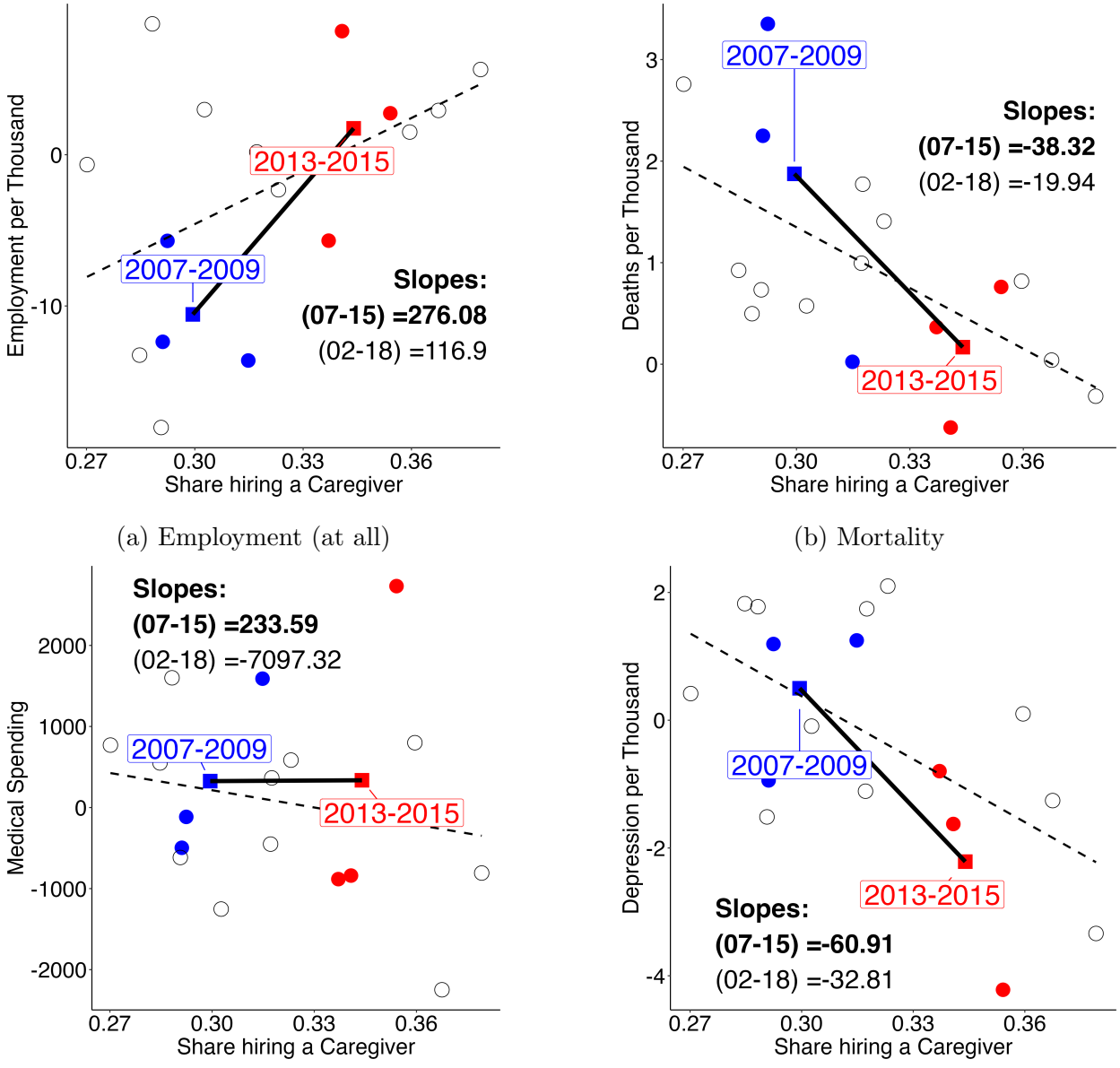
Notes: This figure plots, among families suffering a stroke in the given calendar year, the share who hire a caregiver within two years. The hollow dots denote three stroke cohorts (2010, 2011, and 2012) which were partially exposed to the 2012 reform. The vertical dashed lines denote the calendar years in which expansionary reforms occurred, which only targeted families with care-needers age 80 and older. Among families with onset after age 80, caregiver hiring shares averaged 0.344 over 2013-2015 and 0.299 over 2007-2009 (difference: 0.0445, t-statistic 5.56).

Figure 5: Share of stroke-suffering families hiring a caregiver within two years of their stroke

one after the reform; these longer-run effects are qualitatively similar to the short-run effects described above. We verify this in Appendix Figure A.9, comparing effect estimates up to five years after a stroke for pre-reform cohorts (2001–2006) against post-reform cohorts (2013–2015).

5.1 Assessing Welfare Gains from Caregiver Hiring for Adult Children

For the 37 percent of families that were hiring caregivers in the aftermath of a stroke by the late 2010's, revealed preferences would suggest that caregiver hiring is welfare-improving. But how large are the private welfare gains from caregiver hiring, for adult sons? Answering that question requires understanding what our effect estimates reveal about the difficult trade-offs families make. To make ground, we focus on the health and economic effects (abstracting from the effects on marriage and fertility, which are also not trivial), adapting the framework of Murphy and Topel (2006) for valuing life and health. Let one's lifetime expected utility from period a up to an upper limit L integrate over a stream of quality-



(a) Employment (at all)

(b) Mortality

(c) Medical Costs

(d) Depression Diagnoses

Notes: These graphs plot average effects of a stroke separately by the calendar year in which that stroke occurred, for families with an LTC-needer age 80 or older. Effects are averaged over the stroke year and two subsequent years. The line of best fit between all cohort-specific average effects is plotted in the thin dashed line, and its slope reported as (02-18). Red dots correspond to effects for 2013, 2014, and 2015 cohorts. Blue dots correspond to effects for 2007, 2008, and 2009 cohorts. Squares represent the averages within those groups of cohorts. The line of best fit locally around the expansionary reforms (comparing cohorts 2007-2009 versus 2013-2015) is plotted in solid black and its slope reported as (07-15). The solid points denote the set of cohort-specific estimates entering that local comparison. The sample is based on a 20% draw of sons to families where the health shock occurs at age 80 or older.

Figure 6: Cross-cohort correlations between stroke effects and caregiver hiring propensities among reform-targeted families

adjusted flow payoffs:

$$U(c) = \sum_{t=a}^{L} H(t)u(c(t))\frac{1}{(1+\rho)^{t-a}}\left[\prod_{s=a}^{t}\lambda(s)\right]$$

where H denotes one's quality of life, $\lambda(s)$ is the survival rate in year s (so that $\prod_{s=a}^{t}\lambda(s)$ is the probability of surviving from a to t), and ρ is a rate of time preference. Quality of life in this framework scales the utility of consumption multiplicatively, and death sends one's flow payoffs to zero. Individuals choose consumption to maximize U subject to a budget constraint, which balances consumption against income net of taxes and fixed expenses (like caregiver hiring) denoted $y(t)$, and initial assets A. Assuming a perfect annuity market implies the budget constraint is deterministic:

$$A + \sum_{t=a}^{L}[y(t) - c(t)]\frac{1}{(1+r)^{t-a}}\left[\prod_{s=a}^{t}\lambda(s)\right]$$

Letting μ denote the shadow net-present value of expected income (which, thanks to the deterministic budget constraint, is common across time periods), the first order condition with respect to consumption implies:

$$\mu = H(t)u_c(c(t))\frac{(1+r)^{t-a}}{(1+\rho)^{t-a}} \quad \text{for all } t \in a, a+1, \ldots, L$$

Constrained optimization yields an indirect utility function V which depends on three inputs for each period: annual survival rates (λ), disposable incomes (y) and quality of life (H). Caregiver hiring plausibly affects all three by improving survival rates and increasing quality of life at the expense of reduced disposable income. A first-order approximation of the welfare gains from caregiver hiring, accumulating up to some year $\bar{t} \leq L$, can be expressed as:

$$\begin{aligned} V^{\text{caregiver}} - V^{\text{no caregiver}} \approx & \sum_{t=a}^{\bar{t}} V_{\lambda(t)} \times (\lambda(t)^{\text{caregiver}} - \lambda(t)^{\text{no caregiver}}) \\ & + \sum_{t=a}^{\bar{t}} V_{H(t)} \times (H(t)^{\text{caregiver}} - H(t)^{\text{no caregiver}}) \\ & + \sum_{t=a}^{\bar{t}} \underbrace{\frac{\mu}{(1+r)^{t-a}}}_{V_{y(t)}} \times (y(t)^{\text{caregiver}} - y(t)^{\text{no caregiver}}) \end{aligned}$$

and dividing both sides by μ provides a money-metric expression for this gain:

$$\begin{aligned}\frac{V^{\text{caregiver}} - V^{\text{no caregiver}}}{\mu} \approx & \sum_{t=a}^{\bar{t}} \frac{V_{\lambda(t)}}{\mu} \times (\lambda(t)^{\text{caregiver}} - \lambda(t)^{\text{no caregiver}}) \\ & + \sum_{t=a}^{\bar{t}} \frac{V_{H(t)} \times H(t)^{\text{no caregiver}}}{\mu} \times \left(\frac{H(t)^{\text{caregiver}} - H(t)^{\text{no caregiver}}}{H(t)^{\text{no caregiver}}} \right) \\ & + \sum_{t=a}^{\bar{t}} \frac{1}{(1+r)^{t-a}} \times (y(t)^{\text{caregiver}} - y(t)^{\text{no caregiver}})\end{aligned} \tag{5}$$

Equation 5 forms the basis for valuing the private gains from caregiver hiring.

Notice that, in Equation 5, we have translated effects of quality of life ($\frac{V_{H(t)}}{\mu}$) and changes in quality of life into proportional terms by multiplying and dividing by $H(t)^{\text{no caregiver}}$. This is useful because it maps more naturally to how the health economics literature measures the welfare effect of health conditions through disability weights. Additionally, the value of proportional changes in quality of life can be more cleanly linked to the value of a life ($\frac{V_{\lambda(t)}}{\mu}$).

According to this framework, we can approximate the gains from caregiver hiring if we know how caregiver hiring affects the three key model inputs (survival, quality of life, and consumption), and the money-metric marginal value of improvements in survival and quality of life.

Valuing mortality and quality of life. That means we must pin down two key parameters: the value of life, $\frac{V_{\lambda(t)}}{\mu}$, and the value of proportional changes in quality of life, $\frac{V_{H(t)} \times H(t)^{\text{no caregiver}}}{\mu}$. A benefit of this framework is that it connects these two unknowns. Assuming the year-a annual survival rate is close to 1 and that extending life does not affect one's budget constraint (because individuals consume their annual income), then we show in Appendix D that this relationship takes on a simple form:

$$\frac{V_{\lambda(a)}}{\mu} \approx \sum_{t=a}^{L} \frac{V_{H(t)} \times H(t)}{\mu} = \sum_{t=a}^{L} \frac{u(c_j^*)}{u_c(c_j^*)} \frac{1}{(1+r)^{t-a}} \left[\prod_{s=a}^{t} \lambda(s) \right] \tag{6}$$

which is to say that the value of a life from year a equals the value of a permanent proportional increase in quality of life for all years from a to L. Meanwhile, the value of the quality of life increase in year t corresponds to the present-discounted, survival-probability-weighted, money-metric utility flow from year t.

Estimated values of life and quality of life. We calculate welfare gains using existing estimates for the value of a life and a simplifying assumption: that the undiscounted value

of living a year is stable over time ($\frac{u(c^*(j))}{u_c(c^*(j))}$ is not a function of j). Under this assumption, Equation 6 implies the value of a life is simply the present-discounted, survival-probability-weighted sum of life-years with *constant undiscounted value*. For the following calculations, we assume individuals will live 40 years with a discount rate (r) of 0.03. That means the value of a life and the undiscounted value of quality of life are linked by an annuity factor of 23.

We consider the sensitivity of our welfare inclusions to two plug-in estimates for the value of a life, both of which are derived from a classic hedonic wage regression implemented by Liu et al. (1997) in Taiwan. That study found a value of a statistical life (VSL) from mortality-related wage premia of 413,000 USD in the mid-1980's. Our first estimate simply adjusts this value for inflation–an exceedingly mild adjustment in light of the high economic growth that Taiwan experienced since then–to arrive at a VSL of 560,000 USD or 17.3 million NTD in 2019.[16] This implies a value of a life year of 24,350 USD (750,000 NTD).

We derive the second estimate by borrowing the method underlying OECD recommendations for national VSL calculations: linearly adjusting a baseline VSL estimate for differences in GDP per capita (i.e., assuming an income elasticity of 1; OECD, 2025). With Taiwan's per capita GDP growing by a factor of 7.84 in USD terms from 1985 to 2019, this implies a 2019 VSL of 3.2 million USD or 100 million NTD, and a value of a life year of 140,000 USD (4.34 million NTD).

Deriving estimated effects on survival, quality of life, and disposable income. Starting from our IV results (the "2007–2009" slope estimates in Figure 6), we extract estimates for the effect of hiring on survival, quality of life, and present-value disposable income. Our mortality effect estimates naturally provide estimates of survival effects. For disposable income, we accumulate effects on employment and net out the costs of caregiver hiring laid out in Section 1.1. We assume all reform-induced caregiver hiring families are substituting from informal care provision instead of nursing home care. If some substitute instead from nursing home care, then that will overstate the true cost of migrant caregiver

[16]By comparison, the OECD recommended VSL estimate for Japan and South Korea, based on a meta-analysis of VSL estimates for OECD countries, is 6 million in 2022 USD (OECD, 2025). The inflation-adjusted estimate of Liu et al. (1997) is also more than an order of magnitude smaller than central VSL benchmarks actually used by the U.S. Department of Transportation (U.S. Department of Transportation, 2016) and the Environmental Protection Agency (U.S. Environmental Protection Agency, 2010), and several times lower than VSL benchmarks recommended in EU guidelines (European Commission et al., 2020, Appendix A).

hiring, which would be offset by savings from foregone nursing home care. In practice, the cost of nursing home care is similar to–if not higher than–the cost of migrant caregiver hiring.

Measuring quality of life changes requires more work, because quality of life is not directly observed. We use changes in depression diagnoses as our main proxy, and take the average disability weight of 0.23 from the Global Burden of Disease 2010 to mean that depression proportionally reduces H by 23 percent (Ferrari et al., 2013).[17] Since we only measure causal effects on depression *diagnoses*, we assume a person diagnosed with depression suffers it for at least the first three years.

Estimated private welfare gains. To accommodate our limited ability to estimate long-run effects of caregiver hiring and long-run variation in the value of life, we accumulate costs and benefits only over *the first three years* of the health shock, setting the horizon of the sums in Equation 5 to $\bar{t} = a + 3$.[18] This corresponds to the duration of a standard caregiver contract. Truncating at $\bar{t}$ arguably understates the total gain from caregiver hiring; recall that Appendix Figure A.9 suggests reform-driven caregiver hiring continues to shut down large adverse effects on mortality and quality of life in later years as well.

We present our welfare calculations in Table 7. Column (1) of this table reports for each measure how effects of a stroke changed between the 2007-2009 cohorts versus the 2013-2015 cohorts. Column (2) scales this by the change in caregiver hiring across these cohort groups, to provide an estimate for the annual effect of reform-induced caregiver hiring. Columns (3) and (4) price the effect in (2) using our two estimates for the value of a life and quality of life: the inflation-adjusted estimates and the substantially larger growth-adjusted ones. The costs of caregiver hiring and the income gains from labor force re-entry do not depend on this choice, but it matters for valuing improvements in the survival rate and quality of life (through the value of a life-year).

Our calculations suggest the private welfare effects from hiring are dominated by improvements in survival. For each caregiver hiring induced by the reforms, annual survival

[17] Reductions in medical spending would serve as a more general proxy for good health than depression, but we have no natural way to understand how declines in medical spending relates to a proportional change in health. Conveniently, effects of a stroke on medical spending are virtually flat around the reform. So if one prefers medical spending as a measure of quality of life, one would simply conclude that caregiver hiring has no effect.

[18] When calculating welfare gains using Equation 5, we abstract from slight differences in $\frac{V_{\lambda(t)}}{\mu}$ over $t \in \{a, \ldots, \bar{t}\}$ and use a single value of life estimate over these years. We do the same for the value of a life year and the present value of disposable income, abstracting from the slight discounting of costs and benefits accrued in later years (or equivalently, assuming r=0).

rose by 38.3 adult sons per thousand. Accumulating these survival gains over the three years of the hiring contract, our inflation-adjusted VSL estimate implies a private gain from increased survival alone worth 64,383 USD over the three-year hiring period or twice the total cost of caregiver hiring. With the growth-adjusted VSL estimate, that gain becomes 372,261 USD–an order of magnitude larger than caregiver hiring costs.

Entry into the labor force also partially offsets caregiver hiring costs. For every caregiver hired, 0.276 sons re-enter employment. Assuming average pre-stroke *nominal* earnings conditional on working (400,000 NTD or roughly 13,000 USD, calculated from Table 3) are representative of counterfactual earnings for these sons, then 3,600 USD is gained from earnings per caregiver per year which implies 10,800 USD in gains over the hiring contract. These earnings gains would offset one third of the costs of caregiver hiring.

Quality of life effects, measured by changes in depression diagnoses, offset a more modest share of caregiver hiring costs. For each caregiver hired, effects on depression fall by 61 per thousand (panel d of Figure 6). With depression reducing quality of life by 23 percent, this amounts to quality losses worth 14 life years per thousand. Accumulating this over the three-year hiring interval and multiplying by the value of a life year yields 1,023 USD in gains using our inflation-adjusted VSL estimate, and 5,917 using the growth-adjusted one. In the latter case, these gains offset 18 percent of the costs of caregiver hiring.

Social costs of caregiving-related immigration. Relating the private welfare gains from reform-induced migrant caregiver hiring to social welfare gains requires accounting for positive and negative spillovers from caregiver hiring. Figure 6 presented evidence of some small *positive* spillovers: lower medical costs and higher employment (and therefore higher tax revenue).

Negative externalities, on the other hand, are not obvious. Unlike other forms of immigration, migrant caregivers should not cause direct competition in the labor market with native Taiwanese because in-home caregiving is predominately done informally by relatives; the costs and benefits of crowding out informal care should be internalized by the hiring family. While substitution from nursing homes to live-in care is one way that migrant caregiver reforms may indirectly impact native-born workers, other research exploiting expansionary reforms in Taiwan has found very few complier families in general rely on nursing home care in the absence of migrant care hiring (Chan and Chen, 2026). In a 2020 survey, 26 percent of families that hired a foreign caregiver reported a nursing home or long-term care facility as their next best alternative mode of care provision. That caregiver hiring causes roughly 1 in 4 adult sons to re-enter the labor force is another indirect channel for spillovers

Table 7: Private gains from reform-induced caregiver hiring for adult sons with a stroke-suffering parent

	(1)	(2)	(3)	(4)
	Annual Effect Estimate		Three-Year Private Gain	
	Δ Effect	Δ Effect per Hire	Low	High
Disposable Income			**-21,458**	**-21,458**
Caregiver Hiring	0.0445	1	-32,258	-32,258
Work	0.0123	0.276	10,800	10,800
Survival Rate	0.00171	0.0383	**64,383**	**372,261**
Quality of Life	0.000624	0.014	**1,023**	**5,917**
Total Private Gain ($)			**43,948**	**356,720**

Notes: Column (1) reports the "reduced form" effect of the 2012 and 2015 reforms on outcomes, comparing effects of a stroke for the 2013-2015 stroke cohorts to effects for the 2007-2009 cohorts (the y-axis difference between the red and blue squares in Figure 6). For "Survival Rate," we report the negative of the effect for mortality. For "Quality of Life," we report the effect on depression diagnoses times 0.23 (the disability weight for depression; Ferrari et al., 2013). Column (2) scales this by the average change in caregiver hiring rates across these two cohorts (4.45 percentage points), and corresponds to the "(07-15)" slope reported in Figure 6. Columns (3) and (4) convert these effects into 2019 USD. For caregiver hiring, this is the cost of hiring reported in Section 1.1. For work, this is average pre-stroke earnings conditional on doing any work (calculated from Table 3). For the survival rate, this is the value of a life. For the quality of life, this is the value of a life-year. In column (3), we inflation-adjust the VSL estimate of Liu et al. (1997) to get a value of life of $560,000. In column (4), we use the OECD-recommended linear GDP adjustment for a value of $3.2 million. All values are in 2019 USD.

into the labor market equilibrium, but that should be second order to the social welfare gains from the re-entry itself. Whatever the source of negative spillovers, the post-reform system being optimal would require that their total social cost would have to offset the private gains of 43,948 USD (using the inflation-adjusted VSL estimate) or 356,720 USD (the growth-adjusted VSL estimate) per three-year caregiver hiring contract.

The direction of Taiwanese policy is also consistent with the idea that social returns to the liberalization of migrant caregiver hiring were high. That the 2012 reform was followed so soon by the 2015 reform is consistent with the idea that policymakers understood the gains from the 2012 reform. Even after that, further liberalization occurred more recently in 2024. To the extent that liberalization in 2024 faced political opposition, that opposition was centered primarily around concerns that further expansions can have distributional consequences by causing supply shortages or shifting the equilibrium cost of caregiver hiring.

6 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 a parental stroke, 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 face substantial declines in fertility and marriage. 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. We also showed that adult sons exhibit similar responses to parental hip fractures and even dementia diagnoses. Extrapolating from the effects of a stroke suggests that the total burden of parental functional limitations on adult sons is substantial, especially in terms of excess mortality; it can explain 0.28 deaths per thousand per year among adult sons, relative to annual age-specific mortality rates of 2 to 5 deaths per thousand for men in their 40's.

Finally, we consider whether formal caregiver hiring may help attenuate some of these adverse responses, leveraging variation from a national reform which relaxed eligibility criteria for accessing migrant caregiver markets. Trends over time in how families respond to health shocks suggest that recent increased access to migrant caregiver markets has attenuated the adverse effects of a parental stroke. Using the reform to estimate causal effects of caregiver hiring on the consequences of a stroke, we find that for every thousand migrant caregivers hired, 276 adult sons entered the labor force, 38 fewer adult sons died each year, and 61 fewer sons were diagnosed with depression. Taking these effect estimates to a simple model of health, longevity, and consumption suggests that the private welfare gains from reform-induced caregiver hiring were substantial. Alternative VSL estimates point to net gains worth 44,000 USD or 357,000 USD per three-year hiring contract.

We conclude by discussing some important qualifications to these results and potential areas for future research. First, the nature of our administrative records has lent itself to the study of sons of the elderly, as opposed to their daughters or daughters-in-law. 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 at ages more critical for family formation. 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 them.

References

Adelman, R. D., Tmanova, L. L., Delgado, D., Dion, S., and Lachs, M. S. (2014). Caregiver burden: A clinical review. *JAMA*, 311:1052–1060. 7

Arteaga, C., Vigezzi, N., and García-Gómez, P. (2025). Health spillovers: The broad impact of spousal health shocks. Working Paper 33994, National Bureau of Economic Research. 7

Barczyk, D. and Kredler, M. (2018). Evaluating long-term-care policy options, taking the family seriously. *Review of Economic Studies*, 85(2):766–809. 14

Bauer, J. M. and Sousa-Poza, A. (2015). Impacts of Informal Caregiving on Caregiver Employment, Health, and Family. *Journal of Population Ageing*, 8(3):113–145. 6

Bickel, H., Ander, K.-H., Brönner, M., Etgen, T., Gnahn, H., Gotzler, O., Poppert, H., Pürner, K., Sander, D., and Förstl, H. (2012). Reduction of long-term care dependence after an 8-year primary care prevention program for stroke and dementia: The invade trial. *Journal of the American Heart Association*, 1(4):e000786. 17

Callaway, B. and Sant'Anna, P. H. (2021). Difference-in-differences with multiple time periods. *Journal of Econometrics*, 225(2):200–230. 21

Cameron, J. I., Chu, L. M., Matte, A., Tomlinson, G., Chan, L., Thomas, C., Friedrich, J. O., Mehta, S., Lamontagne, F., Levasseur, M., Ferguson, N. D., Adhikari, N. K., Rudkowski, J. C., Meggison, H., Skrobik, Y., Flannery, J., Bayley, M., Batt, J., dos Santos, C., Abbey, S. E., Tan, A., Lo, V., Mathur, S., Parotto, M., Morris, D., Flockhart, L., Fan, E., Lee, C. M., Wilcox, M. E., Ayas, N., Choong, K., Fowler, R., Scales, D. C., Sinuff, T., Cuthbertson, B. H., Rose, L., Robles, P., Burns, S., Cypel, M., Singer, L., Chaparro, C., Chow, C.-W., Keshavjee, S., Brochard, L., Hébert, P., Slutsky, A. S., Marshall, J. C., Cook, D., and Herridge, M. S. (2016). One-year outcomes in caregivers of critically ill patients. *New England Journal of Medicine*, 374:1831–1841. 7

Case, A. and Deaton, A. (2017). Mortality and morbidity in the 21st century. *Brookings Papers on Economic Activity*, pages 397–443. 4

Chan, S.-Y. and Chen, K.-M. (2026). Foreign-born care workers and their care recipients' health outcomes. *SSRN Electronic Journal*. 9, 18, 31, 41

Chandra, A. and Staiger, D. O. (2007). Productivity spillovers in health care: Evidence from the treatment of heart attacks. *Journal of Political Economy*, 115:103–140. 3

Coe, N. B., Goda, G. S., and Van Houtven, C. H. (2023). Family spillovers and long-term care insurance. *Journal of Health Economics*, 90:102781. Verify article number before submission. 7

Department of Health (2013). Survey of long-term care needs, stage ii. Technical report. 9

Dobkin, C., Finkelstein, A., Kluender, R., and Notowidigdo, M. J. (2018). The economic consequences of hospital admissions. *American Economic Review*, 108:308–52. 6, 17

Doyle, J. J. (2011). Returns to local-area health care spending: Evidence from health shocks to patients far from home. *American Economic Journal: Applied Economics*, 3:221–43. 3

Druedahl, J. and Martinello, A. (2022). Long-run saving dynamics: Evidence from unexpected inheritances. *Review of Economics and Statistics*, 104:1079–1095. 6

European Commission, Directorate-General for Mobility and Transport, CE Delft, Essen, H. v., Wijngaarden, L. v., Sutter, D., Bieler, C., Maffii, S., Fiorello, D., Fermi, F., Parolin, R., Schroten, A., Brambilla, M., and El Beyrouty, K. (2020). *Handbook on the external costs of transport – Version 2019 – 1.1.* Publications Office. 39

Fadlon, I., Fugleholm, A. S., and Nielsen, T. H. (2026). Survivors' mental health and the protective role of income stability. *American Economic Review: Insights*, 8(2):265–284. 7

Fadlon, I. and Nielsen, T. H. (2021). Family labor supply responses to severe health shocks: Evidence from danish administrative records. *American Economic Journal: Applied Economics*, 13(3):1–30. 3, 6, 17

Fadlon, I., Nielsen, T. H., Clemens, J., Cullen, J., Cutler, D., Dahl, G., Duflo, E., Finkelstein, A., Leth-Petersen, S., Muralidharan, K., and Skinner, J. (2019). Family health behaviors †. *American Economic Review*, 109:3162–3191. 3, 6, 17

Ferrari, A. J., Charlson, F. J., Norman, R. E., Patten, S. B., Freedman, G., Murray, C. J. L., Vos, T., and Whiteford, H. A. (2013). Burden of depressive disorders by country, sex, age, and year: Findings from the Global Burden of Disease Study 2010. *PLOS Medicine*, 10(11):e1001547. 40, 42

Fischer-Weckemann, B. and Korfhage, T. (2024). Long-run consequences of informal elderly care and implications of public long-term care insurance. *Journal of Health Economics*, 96:102884. 7

Frimmel, W., Halla, M., Paetzold, J., and Schmieder, J. (2025). Health of parents, their children's labor supply, and the role of migrant care workers. *Journal of Labor Economics*, 43(3):803–841. 6, 7, 8

Fu, R., Noguchi, H., Kawamura, A., Takahashi, H., and Tamiya, N. (2017). Spillover effect of Japanese long-term care insurance as an employment promotion policy for family caregivers. *Journal of Health Economics*, 56:103–112. 8

Garcia-Gomez, P., van Kippersluis, H., O'Donnell, O., and van Doorslaer, E. (2013). Long-term and spillover effects of health shocks on employment and income. *Journal of Human Resources*, 48:873–909. 6

Grabowski, D. C., Gruber, J., and McGarry, B. (2023). Immigration, the long-term care workforce, and elder outcomes in the U.S. Working Paper 30960, National Bureau of Economic Research. Still unpublished as of July 2026 — re-check before submission. 8

Gruber, J. and McGarry, K., editors (2025). *Long-Term Care Around the World*. NBER Conference Report. University of Chicago Press, Chicago. Introduction circulated as NBER Working Paper 31882. 3

Gupta, N. D., Kleinjans, K. J., and Larsen, M. (2015). The effect of a severe health shock on work behavior: Evidence from different health care regimes. *Social Science Medicine*, 136-137:44–51. 6

Haley, W. E., Roth, D. L., Hovater, M., and Clay, O. J. (2015). Long-term impact of stroke on family caregiver well-being: A population-based case-control study. *Neurology*, 84:1323–1329. 7

Halla, M. and Zweimüller, M. (2013). The effect of health on earnings: Quasi-experimental evidence from commuting accidents. *Labour Economics*, 24:23–38. 6

Hamermesh, D. S. and Soss, N. M. (1974). An economic theory of suicide. *Journal of Political Economy*, 82(1):83–98. 4, 23

Heinesen, E. and Kolodziejczyk, C. (2013). Effects of breast and colorectal cancer on labour market outcomes—average effects and educational gradients. *Journal of Health Economics*, 32:1028–1042. 6

Jeon, S. H. and Pohl, R. V. (2017). Health and work in the family: Evidence from spouses' cancer diagnoses. *Journal of Health Economics*, 52:1–18. 6

Kim, H. B. and Lim, W. (2015). Long-term care insurance, informal care, and medical expenditures. *Journal of Public Economics*, 125:128–142. 8

Legislative Yuan, Republic of China (2024). Employment service act (), article 46, as amended. Laws & Regulations Database of the Republic of China (Taiwan). Amendment passed third reading 31 December 2024; Barthel Index exemption for care recipients aged 80 and older effective 29 July 2025. 12

Liu, J.-T., Hammitt, J. K., and Liu, J.-L. (1997). Estimated hedonic wage function and value of life in a developing country. *Economics Letters*, 57(3):353–358. 39, 42

Løken, K. V., Riise, J., and Lundberg, S. (2017). Lifting the burden: Formal care of the elderly and labor supply of adult children. *Journal of Human Resources*, 52(1):247–271. 7

Maestas, N., Messel, M., and Truskinovsky, Y. (2024). Caregiving and labor supply: New evidence from administrative data. *Journal of Labor Economics*, 42(S1):S183–S218. 6

Mahoney, F. I. and Barthel, D. W. (1965). Functional evaluation: The Barthel index. *Maryland State Medical Journal*, 14:61–65. 11

Ministry of Health and Welfare (2018). Current status of social assistance. 10, 60

Ministry of Health and Welfare (2025a). Long-term care 2.0 implementation report to the executive yuan. Technical report, Ministry of Health and Welfare, Republic of China (Taiwan), Taipei. Reports 2024 service users of 757,000, coverage rate of 84.9 percent, and budget growth from 5.0 billion NTD (2016) to 92.7 billion NTD (2025). 9, 10

Ministry of Health and Welfare (2025b). Long-term care 3.0 plan (2026–2035), approved by the executive yuan december 31, 2025. Technical report, Ministry of Health and Welfare, Republic of China (Taiwan), Taipei. 8, 10

Ministry of Labor (2012). Review standards and employment qualifications for foreign workers engaging in work specified in subparagraphs 8 to 11, paragraph 1, article 46 of the employment service act. art. 22 (current verision at art. 18). 12

Ministry of Labor (2015). Review standards and employment qualifications for foreign workers engaging in work specified in subparagraphs 8 to 11, paragraph 1, article 46 of the employment service act. art. 22 (current verision at art. 18). 12

Ministry of Labor (2022). Monthly wages for newly hired and renewed domestic migrant workers raised to NT$20,000 from august 10; ministry of labor provides wage subsidies of up to NT$108,000 for disadvantaged employers. https://www.mol.gov.tw/1607/1632/1640/54530/post. Press release, August 10, 2022. In Chinese. Accessed July 25, 2026. 12

Ministry of Labor (2023). Summary of the 2023 survey of part-time workers' employment conditions [112]. Technical report, Ministry of Labor, R.O.C. (Taiwan). Part-time workers 415,000, 3.65% of total employment (May 2022). Accessed 2026-07-06. 15

Ministry of Labor (2025). Taiwan Labor Quarterly. 10, 11

Ministry of the Interior, Republic of China (Taiwan) (2026). Population statistics: Share of population aged 65 and over reaches 20.06 percent. Announced January 9, 2026, based on end-December 2025 household registration data. Reported by Central News Agency. 8

Murphy, K. and Topel, R. (2006). The value of health and longevity. *Journal of Political Economy*, 114(5):871–904. 5, 35

National Development Council (2024). Population projections for the R.O.C. (Taiwan): 2024–2070. Technical report, National Development Council, Republic of China (Taiwan), Taipei. 8

OECD (2023). *Health at a Glance 2023: OECD Indicators*. Health at a Glance. OECD Publishing, Paris. 3, 10

OECD (2025). Value of statistical life (VSL), alternative estimates (for sensitivity analysis). OECD Data Explorer, dataset `DSD_VSL@DF_VSL_ALTERNATIVE`. Mean VSL, 2022, constant USD PPP. Estimates derived from the meta-analysis in OECD (2025), *Mortality Risk Valuation in Policy Assessment*, https://doi.org/10.1787/76ca89a2-en. Accessed 2026-07-11. 39

Parro, F. and Pohl, R. V. (2021). The effect of accidents on labor market outcomes: Evidence from chile. *Health Economics*, 30:1015–1032. 6

Ramirez Lizardi, E., Fevang, E., Røed, K., and Øien, H. (2025). Effects of health shocks on adult children's labor market outcomes and well-being. *Health Economics*, 34(10):1804–1820. 6, 7

Rellstab, S., Bakx, P., García-Gómez, P., and van Doorslaer, E. (2020). The kids are alright - labour market effects of unexpected parental hospitalisations in the netherlands. *Journal of Health Economics*, 69:102275. 6

Rigby, H., Gubitz, G., and Phillips, S. (2009). A systematic review of caregiver burden following stroke. *International Journal of Stroke*, 4:285–292. 7

Roth, D. L., Haley, W. E., Hovater, M., Perkins, M., Wadley, V. G., and Judd, S. (2013). Family caregiving and all-cause mortality: Findings from a population-based propensity-matched analysis. *American Journal of Epidemiology*, 178:1571–1578. 7

Schulz, R. and Beach, S. R. (1999). Caregiving as a risk factor for mortality: The caregiver health effects study. *JAMA*, 282:2215–2219. 7

Shen, K. (2024). Who benefits from public financing of home-based long-term care? evidence from Medicaid. *Journal of Public Economics*, 236:105151. 7

Taiwan Association of Family Caregivers (2024). Tally of family-caregiver homicide cases, 2018–2024. NGO compilation of 62 documented cases, 2018–2024; no official government statistic exists. As reported by NOWnews and United Daily News. 10

Taiwan News (2025). Amendment allows Taiwanese over 80 to bypass health evaluations when hiring caregivers. Taiwan News. 13

The Control Yuan (2020). Corrective measure of the control yuan, no. 109-0006. 10

U.S. Department of Transportation (2016). Revised departmental guidance on valuation of a statistical life in economic analysis. Departmental guidance memorandum, Office of the Secretary, U.S. Department of Transportation, Washington, DC. 39

U.S. Environmental Protection Agency (2010). Guidelines for preparing economic analyses. Technical Report EPA 240-R-10-001, National Center for Environmental Economics, Office of Policy, U.S. Environmental Protection Agency, Washington, DC. 39

Appendix A Additional Figures and Tables

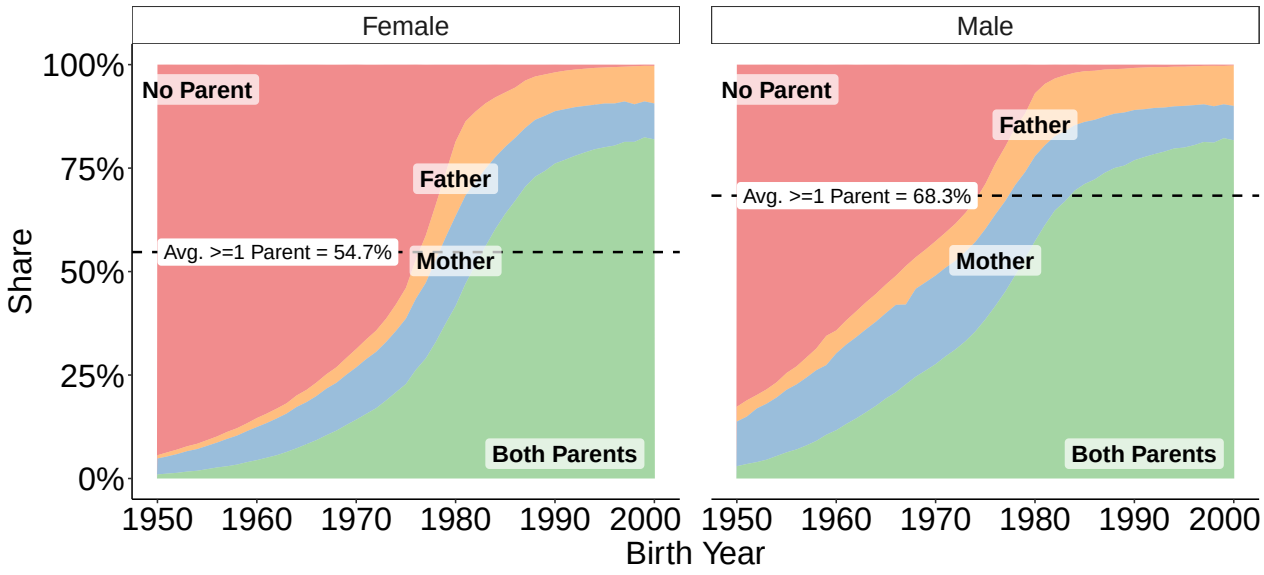
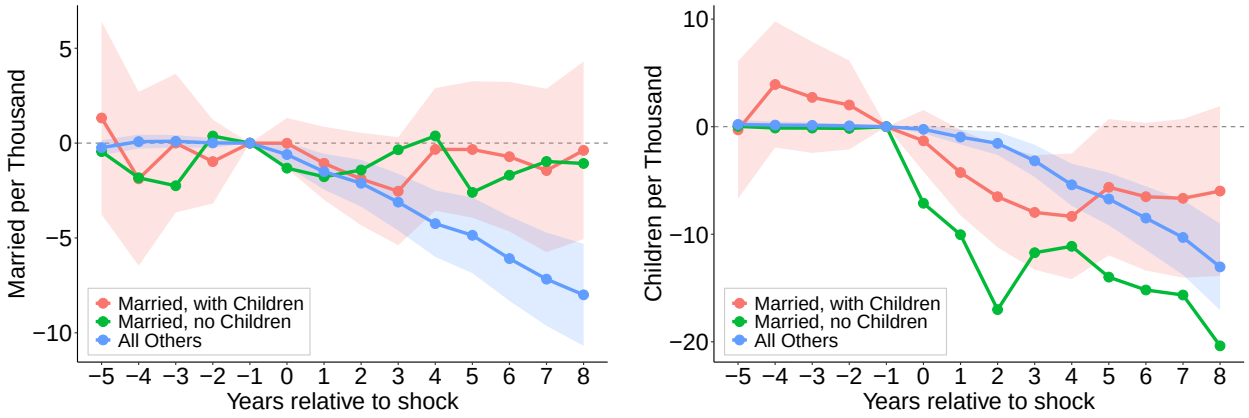


Figure A.1: Match rate of children to their parents

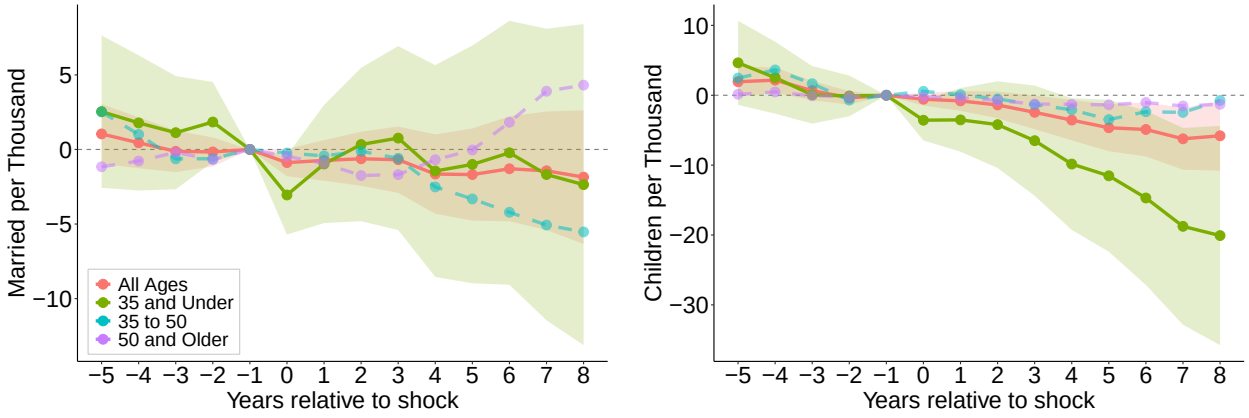
Notes: Parent links may be missing because parents were already dead before the periods of our data sources begin.



(a) Marriage responses (b) Fertility responses

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 3. To construct these estimates, we compare stroke-suffering adult sons to later-treated individuals with the same marital status and number of children in the calendar year before the treated son's stroke, in addition to matching on the observables described in Section 3. These estimates restrict to adult sons younger than age 34 before the stroke. Shaded regions denote 95 percent confidence intervals. We suppress confidence intervals for the "Married, no Children" subgroup for legibility; all point estimates are marginally insignificant for this group in panel (a), and marginally significant only in years 0, 1, 2, and 8 in panel (b). Standard errors are clustered at the individual level.

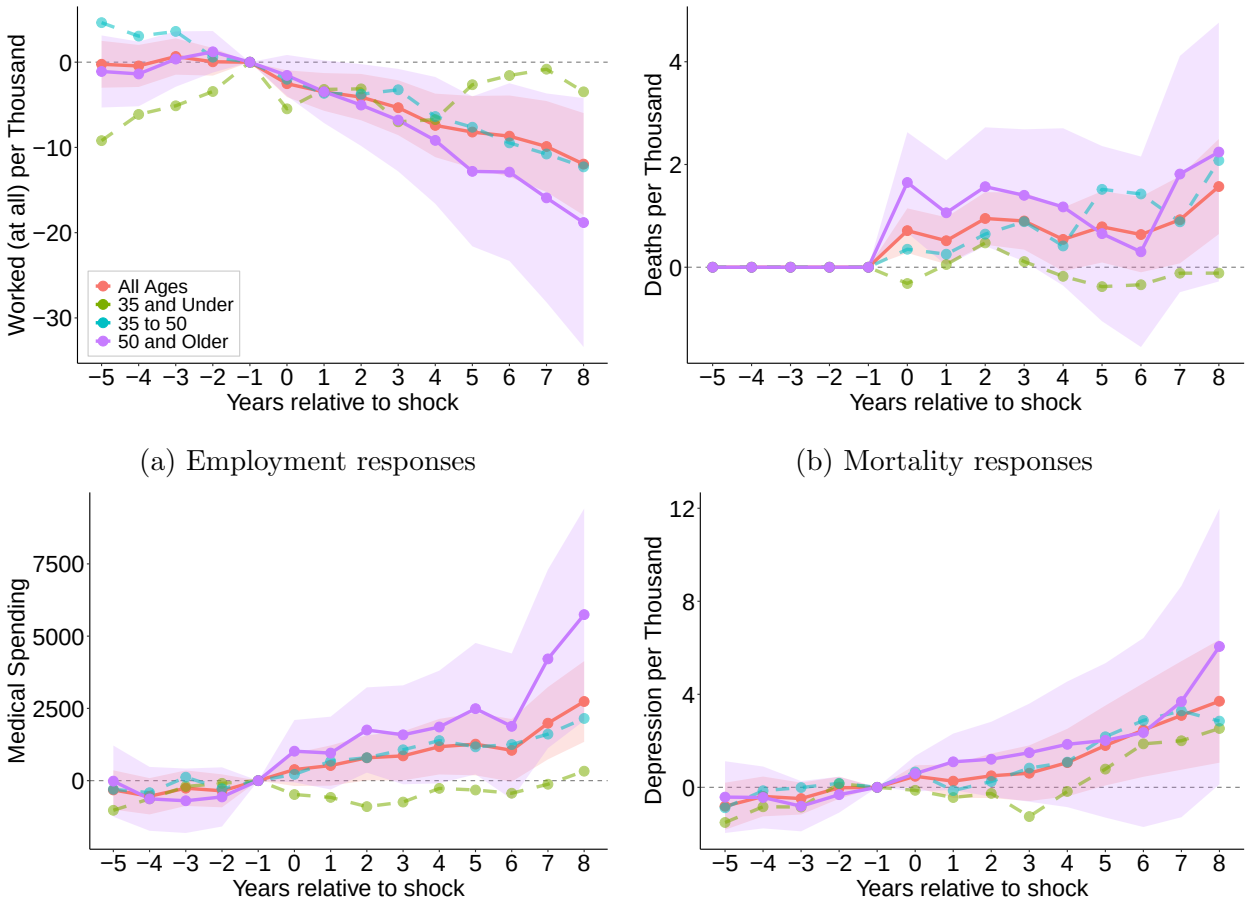
Figure A.2: Family formation responses of younger adult sons, conditional on pre-stroke family structure



(a) Marriage responses (b) Fertility responses

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 3. 95 percent confidence intervals are plotted as the shaded regions for one subgroup (age 34 and under) and for the pooled estimates. Standard errors are clustered at the individual level.

Figure A.3: Event study responses of adult sons to elderly parents' hip fracture: family formation outcomes



(a) Employment responses

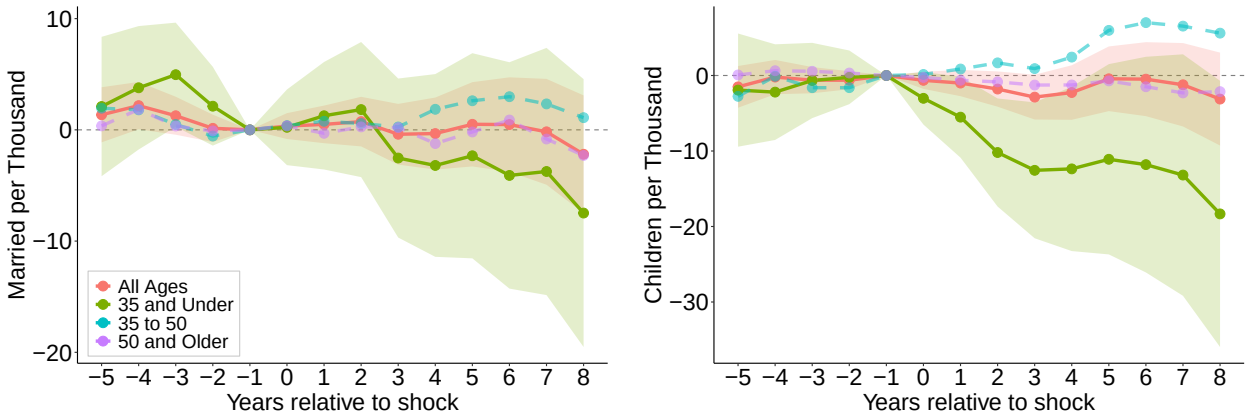
(b) Mortality responses

(c) Medical Cost responses

(d) Depression Diagnosis responses

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 3. 95 percent confidence intervals are plotted as the shaded regions for one subgroup (50 and older) and for the pooled estimates. Standard errors are clustered at the individual level.

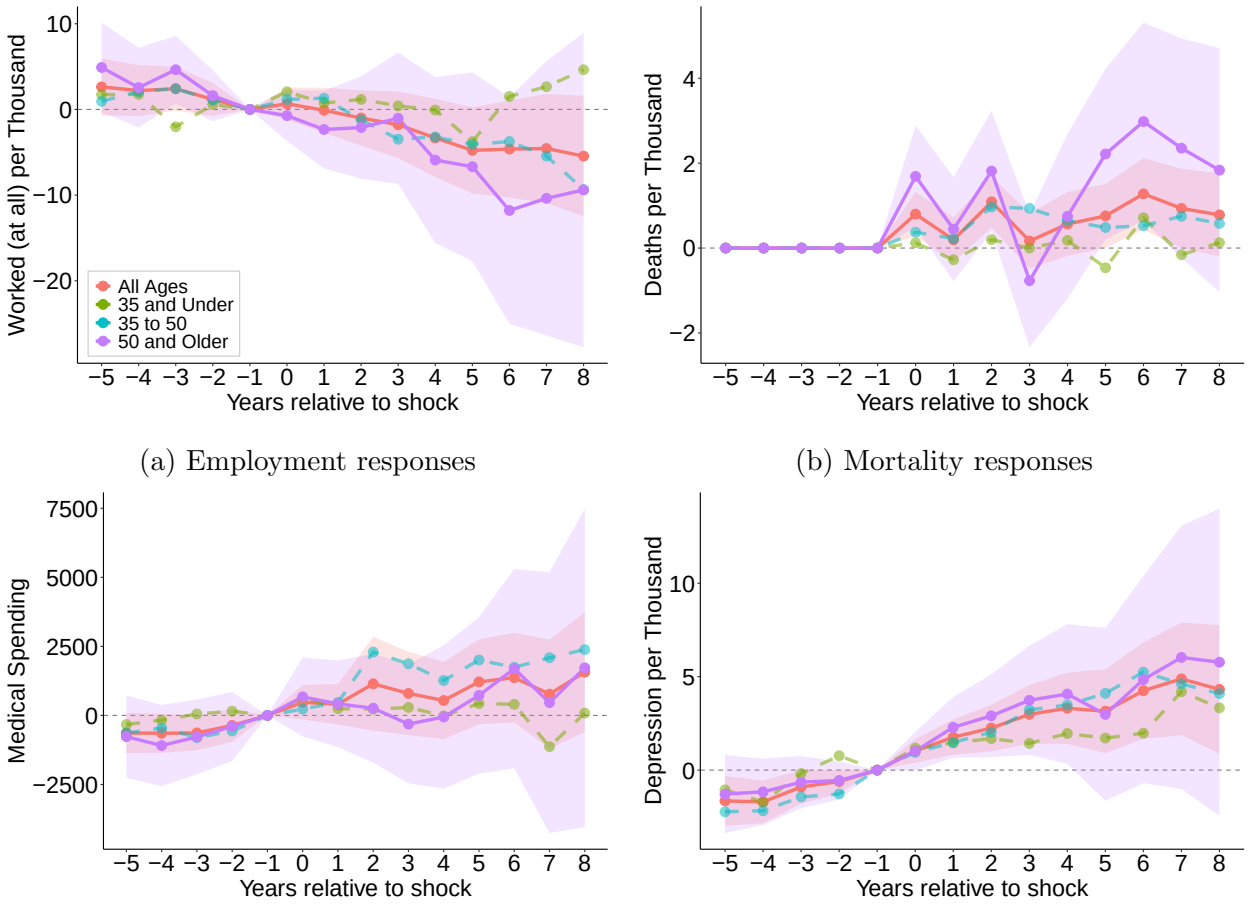
Figure A.4: Event study responses of adult sons to elderly parents' hip fracture: economic and health outcomes



(a) Marriage responses (b) Fertility responses

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 3. 95 percent confidence intervals are plotted as the shaded regions for one subgroup (age 34 and under) and for the pooled estimates. Standard errors are clustered at the individual level.

Figure A.5: Event study responses of adult sons to elderly parents' dementia: family formation outcomes



(a) Employment responses

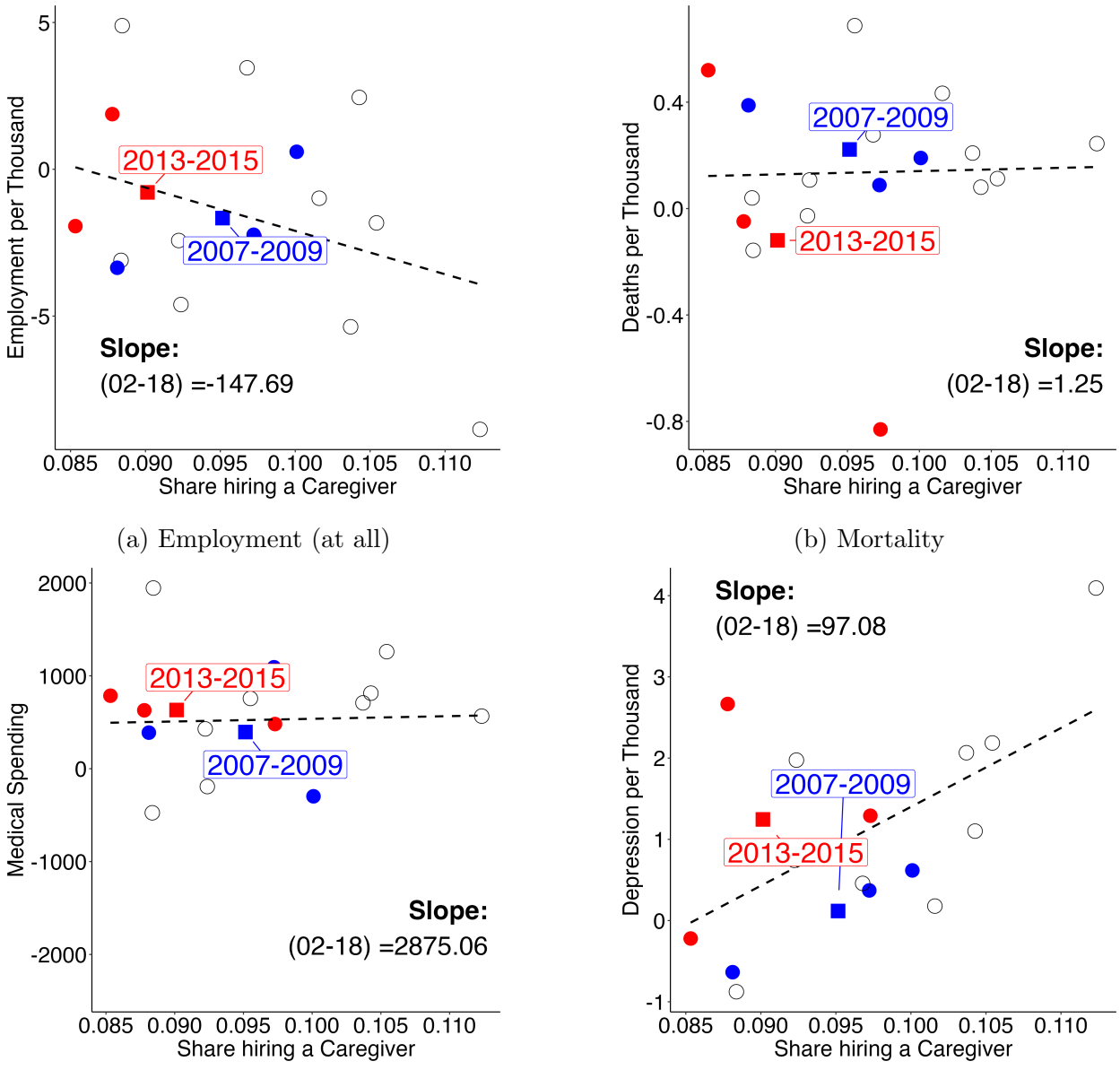
(b) Mortality responses

(c) Medical Cost responses

(d) Depression Diagnosis responses

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 3. 95 percent confidence intervals are plotted as the shaded regions for one subgroup (age 50 and older) and for the pooled estimates. Standard errors are clustered at the individual level.

Figure A.6: Event study responses of adult sons to elderly parents' dementia diagnosis: economic and health outcomes



(a) Employment (at all)

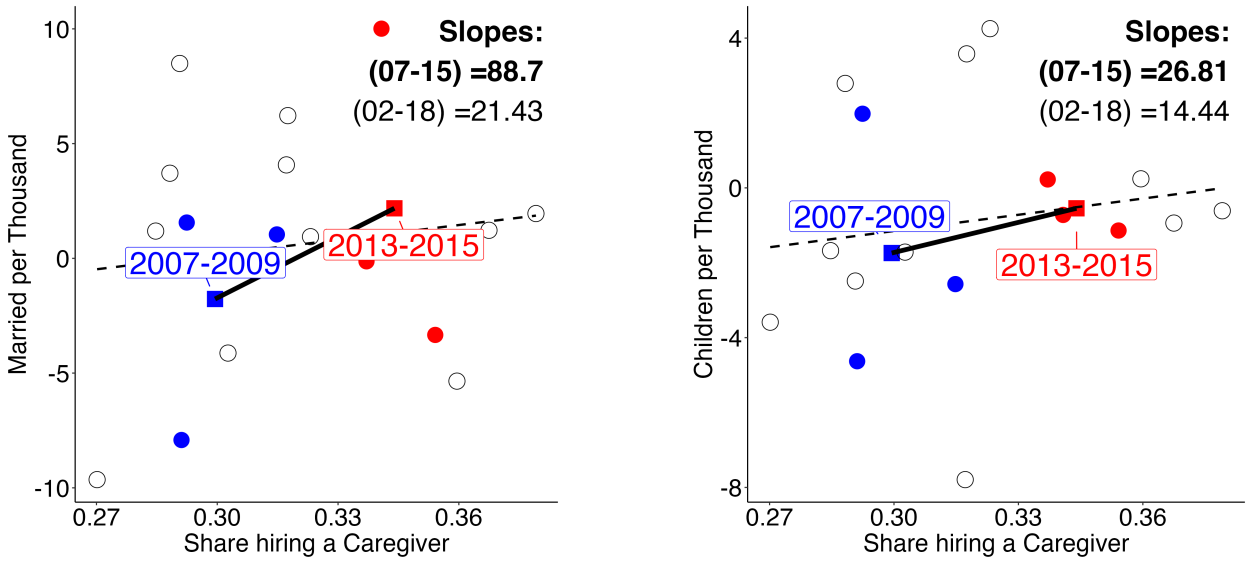
(b) Mortality

(c) Medical Costs

(d) Depression Diagnoses

Notes: These graphs plot average effects of a stroke separately by the calendar year in which that stroke occurred, for families with an LTC-needer younger than age 80. Effects are averaged over the year of the stroke and the two following years. The line of best fit between all cohort-specific average effects is plotted as the dashed line. Red dots correspond to effects for 2013, 2014, and 2015 cohorts. Blue dots correspond to effects for 2007, 2008, and 2009 cohorts. Squares represent the averages within those groups of cohorts. We omit the line of best fit local to the 2012 reform (plotted in Figure 6) because caregiver hiring rates hardly changed over these years. The solid points denote the set of cohort-specific estimates entering that local comparison. The sample is based on a 10% draw of sons to families where the health shock occurs at age 79 or younger.

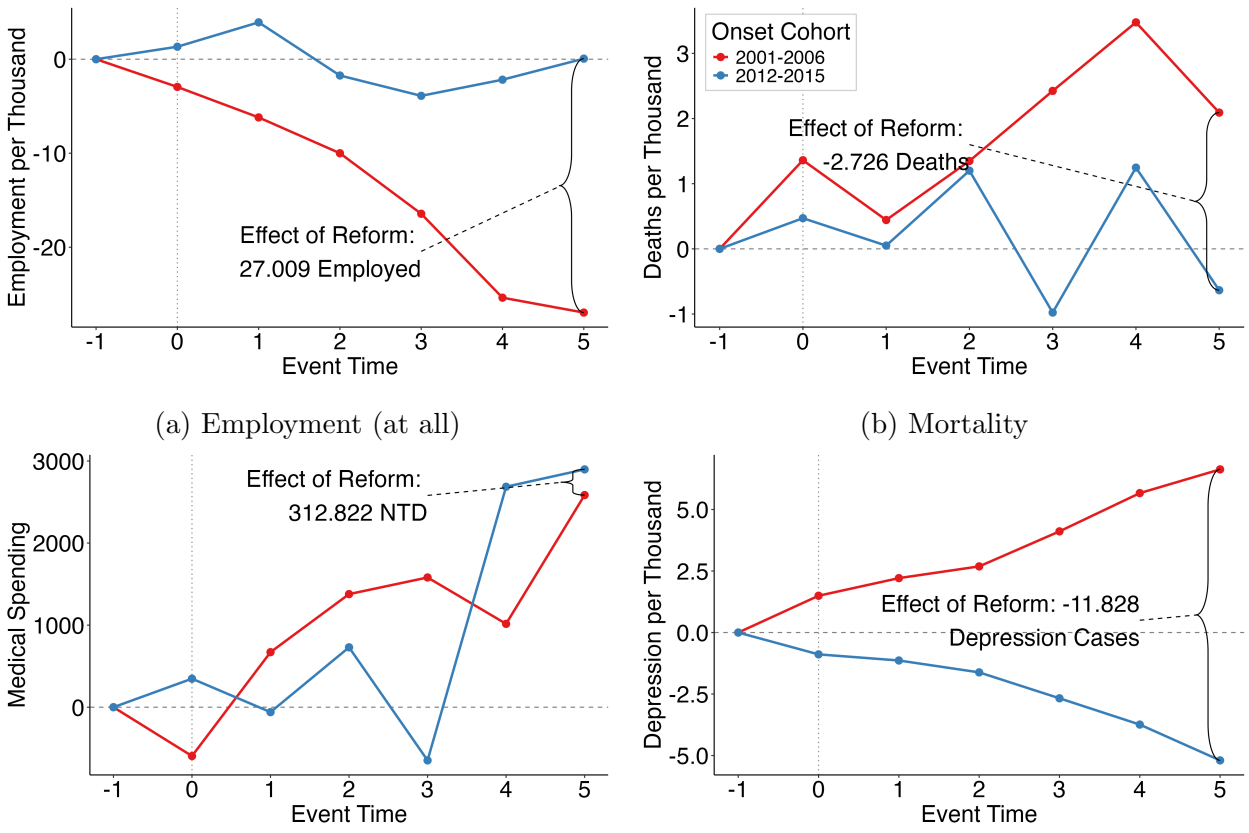
Figure A.7: Cross-cohort correlations between stroke effects and caregiver hiring propensities among non-targeted families



(a) Marriage (b) Fertility

Notes: These graphs plot average effects of a stroke separately by the calendar year in which that stroke occurred, for families with an LTC-needer age 80 or older. Effects are averaged over the stroke year and two subsequent years. The line of best fit between all cohort-specific average effects is plotted as the dashed line, and its slope reported as (02-18). Red dots correspond to effects for 2013, 2014, and 2015 cohorts. Blue dots correspond to effects for 2007, 2008, and 2009 cohorts. Squares represent the averages within those groups of cohorts. The line of best fit locally around the reforms (comparing cohorts 2007-2009 versus 2013-2015) is plotted in solid black, with its slope reported as (07-15). The solid points denote the set of cohort-specific estimates entering that local comparison. The sample is based on a 20% draw of sons to families where the health shock occurs at age 80 or older.

Figure A.8: Cross-cohort correlations between stroke effects and caregiver hiring propensities among reform-targeted families



(a) Employment (at all)

(b) Mortality

(c) Medical Costs

(d) Depression diagnoses

Notes: These plots report effect estimates by year from one's stroke, averaging over the given groups of cohorts.

Figure A.9: Longer-run effects of a stroke on pre-reform versus post-reform cohorts

Table A.1: Average Annual Responses of Adult Sons, by Type of Shock and Age Just Before Shock

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Stroke			Hip Fracture			Dementia	
	Under 34	34 to 48	49 and Older	Under 34	34 to 48	49 and Older	Under 34	34 to 48	49 and Older
Deaths per Thousand	0.1348***	0.5302***	1.736***	0.02483	0.924***	1.229**	0.08155	0.5429**	1.34**
	(0.03332)	(0.07294)	(0.2383)	(0.1194)	(0.1908)	(0.5448)	(0.2064)	(0.2442)	(0.6579)
Suicides per Thousand	0.0309***	0.04983***	0.117***	0.02673	0.09504***	0.1373***	-0.01119	0.05408	0.02656
	(0.0107)	(0.01446)	(0.0212)	(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*
	(0.3629)	(0.4217)	(1.035)	(1.621)	(1.177)	(1.766)	(2.11)	(1.549)	(2.329)
Medical Spending	755.1***	927***	1823***	-121.6	1271**	2388***	386.5	1538	-219
	(202.3)	(212.7)	(476.1)	(425.9)	(526.5)	(847.3)	(504.8)	(1058)	(1365)
Hospital Days	0.1185***	0.1412***	0.1055**	-0.03229	0.2487**	0.4219***	0.1916	0.2081	-0.2226
	(0.02331)	(0.03002)	(0.05353)	(0.1006)	(0.102)	(0.1429)	(0.1597)	(0.1302)	(0.1592)
Worked (at all) per Thousand	-4.252***	-6.259***	-19.06***	-3.282	-10.37***	-13.97***	-1.169	-8.194***	-8.634*
	(0.859)	(0.7656)	(2.133)	(3.868)	(2.195)	(3.845)	(4.654)	(2.66)	(5.062)
Months Worked	-0.06062***	-0.08546***	-0.2331***	-0.03732	-0.1207***	-0.1839***	-0.07358	-0.102***	-0.1211**
	(0.009859)	(0.009319)	(0.02554)	(0.04394)	(0.02646)	(0.04556)	(0.05289)	(0.03217)	(0.06045)
Work Income (NTD)	-733.5	-1722***	-8020***	158.2	-5064***	-7013***	-2231	-3698*	-3873
	(490.3)	(553.6)	(1423)	(2104)	(1523)	(2658)	(2502)	(1920)	(3405)
Household Formation (5 years later)									
Married per Thousand	-2.808***	-0.7676	0.8886	-1.003	-3.318	-0.0377	-2.33	2.615	-0.1905
	(0.9012)	(0.6736)	(0.9533)	(4.067)	(2.272)	(2.356)	(4.705)	(2.701)	(3.048)
Children per Thousand	-8.431***	-1.48*	-0.7288*	-11.52**	-3.477	-1.364	-11.1*	5.977*	-0.713
	(1.306)	(0.7974)	(0.4218)	(5.546)	(2.49)	(1.004)	(6.429)	(3.122)	(1.102)
Treated Units	453,535	547,286	223,266	18,699	39,530	35,808	13,305	28,903	24,004

Notes: The estimates are obtained from the event study in Equation 3 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 clustered at the individual level.For other notes, see Table 4.

Appendix B The General Safety Net of Taiwan

The Taiwanese general safety net consists primarily of two means-tested programs: 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.[19] 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.[20] Cash transfers through the middle-low income program are smaller and provided only to elderly and disabled individuals.

However, 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 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.[21] In accordance with the stringency of these restrictions, participants in both programs is limited, amounting combined to only 2.6 percent of the Taiwanese population (Ministry of Health and Welfare, 2018).

Appendix C ICD Codes for Diseases

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

[19] 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.

[20] 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.

[21] 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.

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

Appendix D Linking the Value of Life and the Value of Quality of Life

In this section, we derive the relationship between the value of life and the value of quality of life, used in Section 5.1. Notice by differentiating the Lagrangian that the value of *proportional* increases in quality of life in year j is:

$$\frac{V_{H(j)} \times H(j)}{\mu} = \underbrace{\frac{u(c^*(j))}{u_c(c^*(j))} \frac{1}{(1+r)^{j-a}}}_{\text{value of living in year j}} \underbrace{\left[\prod_{s=a}^{j} \lambda(s)\right]}_{\text{P(survive to j)}} \tag{7}$$

where $c^*(j)$ denotes one's optimal consumption in year j. Meanwhile, supposing that extending life does not affect one's budget constraint (which is implied if individuals do not save), the value of life from year a is:

$$\begin{aligned} \frac{V_{\lambda(a)}}{\mu} =& \frac{1}{\lambda(a)} \sum_{t=a}^{L} \frac{u(c^*(t))}{u_c(c^*(t))} \frac{1}{(1+r)^{t-a}} \left[\prod_{s=a}^{t} \lambda(s)\right] \\ \approx& \sum_{t=a}^{L} \frac{u(c^*(t))}{u_c(c^*(t))} \frac{1}{(1+r)^{t-a}} \left[\prod_{s=a}^{t} \lambda(s)\right] \end{aligned} \tag{8}$$

where the approximation uses that $\lambda(a) \approx 1$ (annual survival rates among prime-age adult men are high). Combining (7) and (8) allows us to relate the value of a life from year a to the value of quality of life adjustments:

$$\frac{V_{\lambda(a)}}{\mu} \approx \sum_{t=a}^{L} \frac{V_{H(t)} \times H(t)}{\mu} \tag{9}$$

Equation 9 allows us to relate an estimate for the value of life to the year-specific values of a proportional change in quality of life. Combined with some structure on how those year-specific values of quality of life can differ (as we ues in Section 5.1, we can back out estimates for them.