Survivors' Mental Health and the Protective Role of Income Stability*

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We use administrative records on the healthcare utilization and economic outcomes of the universe of Danish households to characterize survivors' mental health following their spouse's death. We provide visually clear evidence for the inevitable immediate, large, and lingering adverse impacts and focus on studying the role of potential mediators: economic conditions and the presence of children. We find no evidence of heterogeneity in family composition. As for economic outcomes, baseline levels of income and net wealth play only a modest role: there is no meaningful cross-household inequality gradient in mental health declines, so that spousal death is devastating for both the rich and the poor. Rather, a key source of heterogeneity in the decline in mental health is the household's degree of income insurance, that is, the within-household income variation. Specifically, the least-insured households experience an immediate decline in mental health that is 80 percent larger. Our findings suggest that the consumption smoothing welfare gains from income protection policies can have important spillovers to improved mental health in the context of severe household events.

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1. Introduction

The death of a spouse is one of the most devastating events that all married households eventually experience and, accordingly, the mental health declines of surviving spouses have been a key object of interest in economics, psychology, and health sciences.[1] While adverse mental health effects of a spousal death are inevitable, the question remains of whether there are effective ways to mitigate them. A natural question is whether additional stress from financial strain or economic uncertainty is in itself a driving factor.[2] If so, income stability and consumption smoothing in the presence of adverse shocks may also affect well-being through improved mental health. To the best of our knowledge, there is no prior work that was able to assess the role of income security in shaping survivors' adverse health effects. More broadly, there is limited work in the context of developed economies on the role of income security in mental health effects following severe adverse household events.[3]

Such an investigation requires healthcare data (to identify death events and to analyze mental health outcomes), information on household linkages (to be able to identify couples), and rich financial information with comprehensive measures of household income and wealth (to accurately measure households' degree of income security). In this paper, we leverage household-level administrative data in the Danish context, which offers this set of necessary elements for the universe of households. We first provide new estimates for the immediate and longer-run effects of spousal death on survivors' mental health, whose careful identification and quantification (using rich, accurate, high-frequency data) has been absent in prior work. This analysis then sets the stage for our investigation of the role of economic vulnerability in the adverse health impacts and whether income security can help improve survivors' mental health.

We use high-frequency administrative data on take-up of mental health medication, as

[1] See, e.g., Stroebe and Stroebe (1987), Turvey et al. (1999), Lindeboom et al. (2002), Luoma and Pearson (2002), Wittstein et al. (2005) Stroebe et al. (2007), Espinosa and Evans (2008), Clark et al. (2008), Frijters et al. (2011), van den Berg et al. (2011), Schultze-Florey et al. (2012), Simeonova (2013) Siflinger (2017), Tseng et al. (2018), Einiö et al. (2023).

[2] See, e.g., Browning et al. (2006), Kuhna et al. (2009), Christian et al. (2019), Cutler and Sportiche (2022), Andersen et al. (2022),Hamilton et al. (2024), Majlesi et al. (2024).

[3] One recent important study on health outcomes more broadly is Gelber et al. (2023), who use a regression kink design to show that higher payments from US Social Security Disability Insurance reduce mortality of beneficiaries. Relatedly, important work highlights the role of health insurance in improving mental (e.g., Cuellar and Markowitz 2007, Finkelstein et al. 2012, Lang 2013, Ayyagari and Shane 2015, Kruse et al. 2022).

well as rich demographic and economic information on bereaved households who experienced a sudden health shock that led to a spousal death. Specifically, we follow survivors of spouses who died of a heart attack or a stroke over the horizon of four years before and four years after the spousal death event using data spanning years 1995-2017. To investigate the role of economic vulnerability, we investigate patterns along the household "income replacement rate" as an aggregate measure of financial stability, which takes into account changes in income from *any* source or insurance scheme due to the shock. We benchmark the estimated magnitude for income stability as a mediator against inequality gradients in baseline household income and net wealth, which have been the focus of the active work on health inequalities.[4]

To study the dynamic causal effects on survivors' mental health, we follow our previous work in Fadlon and Nielsen (2019a, 2021) and compare the outcomes of "treated" survivors to an explicit control group of households that experience the same types of shocks only a few years later. Our analysis is therefore not subject to potential challenges involved in having units that switch in and out of experimental arms as posed by recent work (De Chaisemartin and d'Haultfoeuille, 2024). This basic setup provides a clean dynamic difference-in-differences design relying on the assumption that the exact timing of health events could be as good as random. To best meet this assumption, our analysis focuses on households in which one partner experiences a heart attack or a stroke for the first time in our hospitalization data and dies within the first year of this event. We validate our research design by verifying parallel pre-trends and by showing the robustness of our findings to the gap chosen in the number of years that separate the event timing across treatment and control households.

We document that spousal death has large, immediate, and lingering mental health effects. Take-up of mental health medication more than doubles, from a baseline of 10 percentage points (pp), in the first month after the death event. Even four years after spousal death, take-up remains about 17 percent higher relative to the counterfactual. In a further investigation of the nature of these dynamic effects, we find two patterns that have potential policy implications. First, we find the lingering effect is driven by surviving spouses who initiate mental health medication in the first year of bereavement

[4]We note that our work particularly relates to the recent active work on family health spillovers, most recently studied in Arteaga et al. (2024) on the broader health consequences of spousal health events; Hoagland (2024) on beliefs updating; and Jensen and Zhang (2024) on career and mental health consequences for adult children who experience parental death events.

and still consume this medication four years out (rather than by a delayed "roll-out" of medication initiation). This suggests that effective mediation policies may choose to target the initiation margin, addressing survivors' conditions at the onset of the shock. Second, we consider the severity of the spousal health event. We study mental health along a declining health trajectory of a spouse by analyzing heart attacks and strokes that led to a death after one, two, and three years. We document that 1/4 of the increase in mental health medication is induced by the initiation of the health shock and the declining trajectory, and that the remaining bulk share of 3/4 can be attributed to fatality. This in turn suggests directing resources to fatal events in effective targeting of policies that aim to mitigate adverse outcomes in the context of severe family shocks.

We then conduct mediation analysis showing that economic vulnerability can account for a sizable share of the immediate decline in survivors' mental health. Households with an income replacement rate that is 10 pp lower initiate consumption of mental health medication by an additional 1.96 pp, with the least-insured households experiencing an increase in take-up that is 80 percent higher relative to the most-insured. In comparison, higher baseline income or wealth ranks mediate the consumption of mental health only moderately, so there is no meaningful underlying inequality gradient in survivors' mental health. A key takeaway from our analysis is that financial security that allows households to maintain a given standard of living has potential soothing impacts on mental health beyond the welfare gains from consumption smoothing. Therefore, policies that aim to reduce financial uncertainty can also lead to important welfare effects via improved mental health. While intuitive, clear results that provide evidence in support of this conjecture have been limited as discussed above.

We conclude our analysis by studying hypotheses from the literature which conjecture that gender and the presence of young or adult children could have heterogeneous effects on health outcomes around adverse life events.[5] We persistently estimate that none of these factors play an additional role in the context of take-up of mental health medication of surviving spouses within our Danish setting.

[5]For example, family members can reallocate resources (Dalton and LaFave 2017, Autor et al. 2019, Persson 2020, Marion 2023, Arrieta and Li 2023, Jensen and Zhang 2024) and provide emotional and instrumental support which may be associated with better mental health (House et al. 1988, Zunzunegui et al. 2001, Golden et al. 2009).

2. Institutional Background and Data Sources

Institutional Setting. In the event of a spousal death, two types of insurance schemes are relevant to consider: *health insurance* covering medical care and *income insurance* covering income losses. Our setting of Denmark has a single-payer, tax-funded, universal health insurance scheme that provides free access to healthcare for all residents. The universal coverage in health insurance enables us to document mental health effects of spousal death that are not confounded by access to or affordability of care. Income insurance relevant for our context includes Social Security (disability and old-age pensions); additional government income assistance programs (e.g., sick-pay and early retirement); and privately-purchased insurance policies. These programs and policies are broadly similar to those in other developed countries, and we describe in Appendix A their main institutional features and benefit schedules.

Our setting allows us to use administrative individual-level data with family linkages which cover detailed information on demographics, income, and healthcare utilization for the entire Danish population from 1995 to 2018. The data sources we use are as follows.

Income and Demographic Data. We construct our main sample from the Population Registry (Statistics Denmark, 2024a) with yearly observations on individuals' demographic characteristics. Crucially, family linkages enable us to identify partners (either married or cohabiting) and children. We merge data from the Income Registry (Statistics Denmark, 2024c), which contains annual flows of all sources of household income, including earnings, government transfers from all programs (e.g., disability insurance, sick-pay, early retirement, old-age pension, and unemployment insurance), payouts from retirement savings accounts, payouts from insurance companies, and capital income. It also holds information on bank deposits, market value of shares, bonds, and mortgage deeds in deposits, as well as debt to banks, mortgage debt, and market value of bond debt. We define net wealth as the sum of debt (in banks, mortgage, and bonds) subtracted from the sum of deposits (in banks and mortgage deeds) as well as values of shares and bonds. All monetary values are reported in nominal Danish Kroner (DKK) deflated to 2000 prices using the consumer price index. In 2000, the exchange rate was approximately DKK 8 per US $1.

Healthcare Data. To identify fatal health events, we use two complementary reg-

istries. The first is the Death Registry (Statistics Denmark, 2024b) that includes death dates. The second is the National Patient Registry (Statistics Denmark 2024d, Statistics Denmark 2024e) with comprehensive records on all visits to (public or private) hospitals and clinics, including dates, location, and diagnoses (using the International Statistical Classification of Diseases and Related Health Problems [ICD] system). The health shocks that we focus on are heart attacks and strokes, which are commonly studied as likely sudden and severe events whose timing is less likely to be expected (Chandra and Staiger 2007, Doyle 2011). We identify an individual as having died of one of these health shocks if they experience the event and die within the next twelve months.

To identify the mental health effects of spousal death, we use the Pharmaceutical Database (Statistics Denmark, 2024f), which contains information on prescription pick-up dates and Anatomical Therapeutic Chemical Classification (ATC) codes of all prescription drugs purchased from pharmacies in Denmark. Our measure of mental health is based on redeemed prescriptions for psychotropic drugs, specifically those classified as psycholeptic (N05) and psychoanaleptic (N06) drugs according to the ATC system (more than 99% of these drugs are purchased in pharmacies and can be linked directly to the consumer). We note that the responses in mental healthcare that we observe will also incorporate the surviving spouses' decision to seek care since our measures are based on utilization. Furthermore, there may be a provider effect, as evidenced by the work on physician practice styles and patient healthcare utilization (e.g., Fadlon and Van Parys 2020; Albertini, Bakx, and Mazzonna 2024). As we group broad classes of mental health drugs, we focus on studying the extensive margin of their consumption, which indicates a broad demand for mental health medication (rather than the narrower medical treatment of a specific symptom).[6]

3. Research Design

Our empirical analysis aims to estimate the dynamic causal effects of spousal death on mental health and how financial circumstances may alter these effects.

[6]Appendix Figure B.5 plots the consumption of mental health medications over age by gender.

3.1 Dynamic Effects of Spousal Death

To mimic an experimental ideal that compares exante similar couples that do and do not experience the death of one spouse, we take the approach we developed in Fadlon and Nielsen (2019a) and Fadlon and Nielsen (2021). Specifically, we consider only couples who experience a spousal death at some point in our sample period and identify the treatment effect based on the timing of the death event. Specifically, we construct counterfactual outcomes for affected households based on couples from the same cohorts that experience a death event but a few years later. That is, we split our sample into a treatment group, composed of individuals whose spouse experiences a fatal health event in year τ, and a matched control group, composed of individuals from the same cohorts whose spouse experiences a fatal health event in year $\tau + \Delta$ (who are assigned a placebo event in year τ). We then identify the treatment effect by comparing changes in outcomes across these two experimental groups over time through traditional event studies, which we combine into a straightforward dynamic difference-in-differences estimator.[7]

Specifically, we estimate the following dynamic difference-in-differences equation for the mental health effect of spousal death for individual i in period r relative to the event (in either a monthly or an annual frequency):

$$y_{it} = \alpha_i + \sum_{r \neq -1} \gamma_r \times I_r + \sum_{r \neq -1} \delta_r \times I_r \times Treat_i + \lambda X_{it} + \varepsilon_{it}, \tag{1}$$

where y_{it} denotes an indicator for individual i redeeming prescription for mental health drugs in time t; $Treat_i$ denotes an indicator for i belonging to the treatment group; I_r denotes indicators for time relative to the index health event (the actual event among the treatment group and the placebo event among the control group); α_i is a vector of household fixed effects (which account for any time-invariant characteristics); X_{it} is a vector of controls including year fixed effects (which absorb potential time trend in medication consumption) and a quadratic in age; and ε_{it} is the idiosyncratic error term. The coefficients of interest are δ_r, which measure the mental health effect of spousal

[7] When choosing Δ, we face a trade-off between household similarity (which is declining in Δ) against analysis horizon (which is increasing in Δ). Our choice in the analysis is $\Delta = 5$, which provides comparable treatment and control groups (as evidenced by closely parallel pre-trends) and allows us to identify effects up to four years after the spousal death (because the control group experiences an actual event and becomes "treated" Δ years after the treatment group). Appendix Table B.3 replicates the analysis by varying Δ from 3 to 7 and shows the robustness of our findings to this choice.

death in period r relative to the baseline period -1. Since the same household may by design appear in both the treatment and the control groups (but can never be a control unit to itself), we cluster standard errors at the household level to avoid including the same couple in multiple clusters. Column 6 of Appendix Table B.3 further repeats our main analysis using treatment and control households that do not overlap by randomizing households to appear only in one experimental group. We find similar results.

The identifying assumption is that, absent the death of the spouse, the mental health outcomes of the treatment and control groups would have followed the same trend in the *post*-period. The credibility of this assumption builds upon the conjecture that within a time window of Δ the specific year of spousal death is as good as random. We assess the validity of this common trends assumption through differences in trends in the pre-period. We visually illustrate the two groups' behavior in the four years before the (actual or placebo) event based on raw data and we formally test if $\delta_r = 0$ for all $r < 0$ based on regression estimates of equation (1) that includes controls. We will demonstrate that parallel pre-trends tightly hold across specifications in support of our design.

Analysis Sample. With this design, our sample consists of individuals whose spouse experiences a heart attack or stroke and dies within the next 12 months.[8] We restrict the sample to households in which both spouses are between the ages 45 and 80 in the year if the index event. We define spouses based on marriage or cohabitation as of 5 years prior to the health event to freely allow for changes in marital status. Appendix Table B.2 summarizes statistics on key variables for both spouses in our analysis sample which is based on three additional restrictions. First, we only consider Danish residents. Second, we exclude self-employed individuals as the data only contain information on wages and net profits, leaving us with an incomplete picture of income for the self-employed. Third, we balance our sample of surviving spouses over our nine-year observation period from four years before to four years after the index death event. This in turn implies that our sample comprises surviving spouses who do not die within the analysis horizon. Appendix Table B.4 replicates the main analysis on an unbalanced sample, where we also include surviving spouses who are in the sample for any number of periods within the nine-year analysis horizon (including spouses who die within the first 4 years of their spouse's death). The results and conclusions remain similar using these specifications.

[8] Appendix Figure B.6 shows the distribution of deaths 0-11 months after the health event.

3.2 Mediation Analysis

After establishing the dynamic causal effects of spousal death on mental health, we investigate the potential mitigating role of income security. Spousal death leads to household income declines since the surviving spouse becomes the sole provider and as economies of scale within a household implies that the surviving spouse would need more than half of the household-level income to maintain a similar standard of living as an individual. The common square-root adult equivalence scale suggests the surviving spouse would need 0.71 of the income of a two-person household. With previous work showing that financial distress is associated with mental health issues (e.g., Browning et al. 2006, Ruhm 2015, Cutler and Sportiche 2022), we could expect that declines in household income upon a spousal death would amplify any adverse mental health effects of the event.

To investigate the potential mediating role of economic circumstances, we estimate the following difference-in-differences equation that assesses heterogeneity in treatment effects:

$$\begin{aligned} y_{it} = {} & \alpha_i + \gamma Post_{it} + \delta Treat_i \times Post_{it} \\ & + \eta_d Post_t \times D_i + \phi_d Treat_i \times Post_{it} \times D_i \\ & + \mu f(Age_{it}) + \tau_t + \varepsilon_{it}, \end{aligned} \tag{2}$$

where $Post_{it}$ is an indicator for observations belonging to the post-period; $f(Age_{it})$ is a quadratic in the surviving spouse's age; α_i is a household fixed effect; τ_t is a year fixed effect; and ε_{it} is the idiosyncratic error term. The household characteristics vector D_i captures the main heterogeneity dimensions of interest: income replacement rate; baseline household income or net wealth rank (in period -1); and the presence of young or adult children. The vector ϕ_d captures our coefficients of interest that quantify the mitigating role of the characteristics in D_i.

As a key measure of household income security, we construct the household income replacement rate, capturing the ratio of household income in period $r = 1$ (first full income/calendar year following the death event) and period $r = -1$. We account for endogeneity through behavioral responses by holding constant the surviving spouse's labor income and government benefits at their levels in period $r = -1$. Our replacement

rate measure is calculated as:

$$RepRate_i = \frac{HhInc_{i,1}^{Adj}}{HhInc_{i,-1}}, \tag{3}$$

where $HhInc_{i,-1}$ is household income at baseline and $HhInc_{i,1}^{Adj}$ is the adjusted household income in period 1 that holds fixed behavior and benefits. Appendix B.1 details the calculations of the replacement rate. In Appendix Figure B.11 we plot the association between actual income and the adjusted income measure (the "first stage"). Finally, Appendix Figure B.10 plots the distribution of replacement rates in our sample of surviving spouses.

4. Empirical Evidence

We now turn to our empirical analysis of characterizing the mental health of surviving spouses. We start by studying the immediate and longer-run responses in survivors' take-up of mental health medication. To understand the nature of the treatment effects, we follow up with an investigation of whether the effects are driven by the morbidity or fatality of the spousal health shock, and whether the longer-term impacts are driven by persistent utilization by those whose initiation of mental health medication immediately follows the event or by delayed "roll-out" of medication take-up as mental health deficits build up. We then study whether better economic circumstances of the surviving spouse can partially cushion these adverse effects.

4.1 Dynamic Effects of Spousal Death

For visual clarity, Figure 1a first plots the raw data of take-up of mental health medication for our treatment and control groups in monthly frequency over the 24-month period around the index event. In this figure, the spousal event is defined as a hospitalization with a heart attack or a stroke as the main diagnosis in which the hospitalized partner dies within the first 12 months of the hospitalization.[9] The red line and full circles plot outcomes for our treatment group, where time zero represents the month of

[9] Appendix Figure B.7 replicates Figure 1a and Figure 1b when restricting the sample to events where the hospitalized partner dies within the same month as the hospitalization. These graphs show similar patterns, yet an amplified impact on mental health medication, indicating that our main results could reflect a conservative estimate of treatment effects. We go into deeper detail on the fatality of the shock in Section 4.2.

the spousal event. The gray line plots the monthly raw means among survivors in our control group who experience the same types of spousal events 60 months later. The blue line and hollow squares plot our counterfactual for the treatment group: it shifts in parallel the dynamics of the control group to the level of the treatment group in month -1.

Figure 1b presents the estimates for the effects of spousal death on survivors' mental health based on equation (1) at a monthly frequency. The figure first provides strong support for our design, validating parallel trends in outcomes across treatment and control groups prior to the health event. Second, it pinpoints the survivors' sharp and persistent increase in the take-up of mental health medication. The immediate increase in the first month amounts to 12.5 percentage points (pp), corresponding to a 124 percent increase (=12.5pp/10.1pp) relative to the month prior to the event. 24 months later, the increased take-up still persists at 2.5 pp above the counterfactual, corresponding to a 25 percent of baseline levels.

The monthly data allow us to study the immediacy of the spousal response. In the longer run, however, the high-frequency data may mask the magnitudes of consumption, e.g., if drug purchases are made in bulk and prescriptions are filled for consumption covering several months. Figure 1c replicates Figure 1a at an annual level and expands the evaluation horizon to nine years around the index spousal event, allowing us to determine the causal effect for up to four years after the event. In this analysis, an event is defined at an annual level, meaning that the spouse experiencing a hospitalization for a heart attack or stroke dies within the same calendar year. Figure 1d presents the estimated treatment effects from equation (1) at an annual frequency, showing that the adverse effects linger for at least four years. From an annual baseline of 23 pp in year -1, take-up of mental health medication increases by 19.5 pp (85%) in the first year. Four years later, the persistent effect amounts to 4 pp, which represents a 17% increase relative to the baseline year -1.[10]

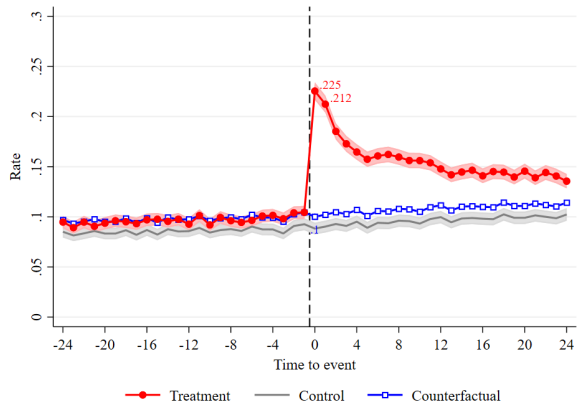
4.2 Nature of the Treatment Effects

We further dissect the nature of these treatment effects along two dimensions. First, we study the extent to which the changes in survivors' mental health are triggered by the

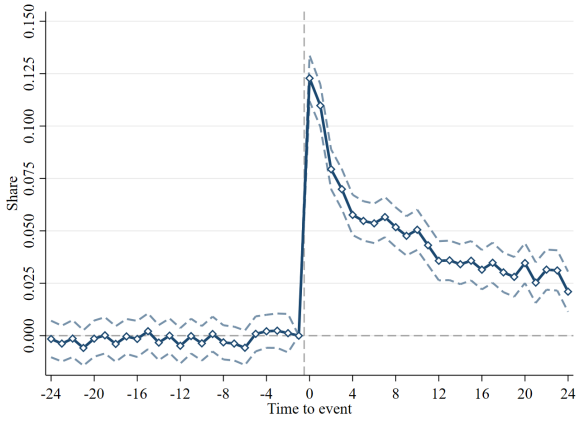
[10]Appendix Figure B.9 replicates Figure 1c and Figure 1d by age groups.

FIGURE 1: TAKE-UP OF MENTAL HEALTH MEDICATION AROUND SPOUSAL DEATH

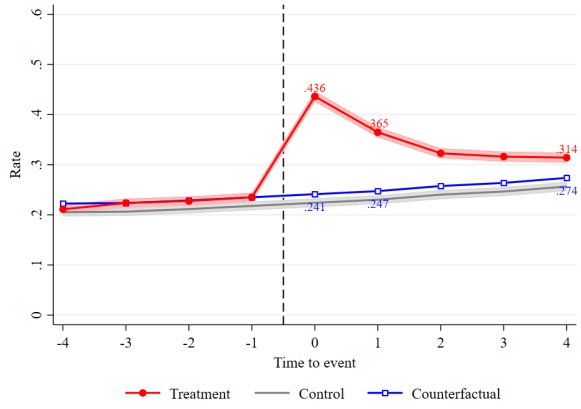
(A) MONTHLY, RAW MEANS



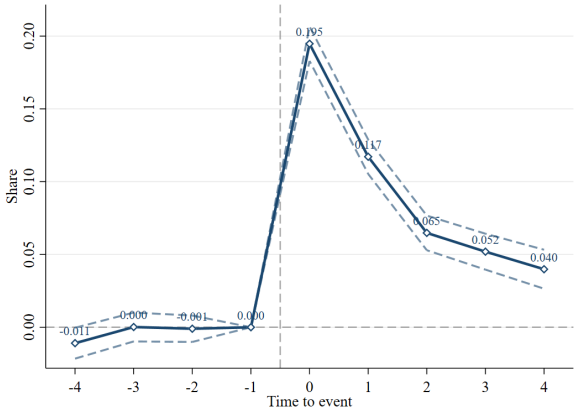
(B) MONTHLY, TREATMENT EFFECTS



(C) YEARLY, RAW MEANS



(D) YEARLY, TREATMENT EFFECTS

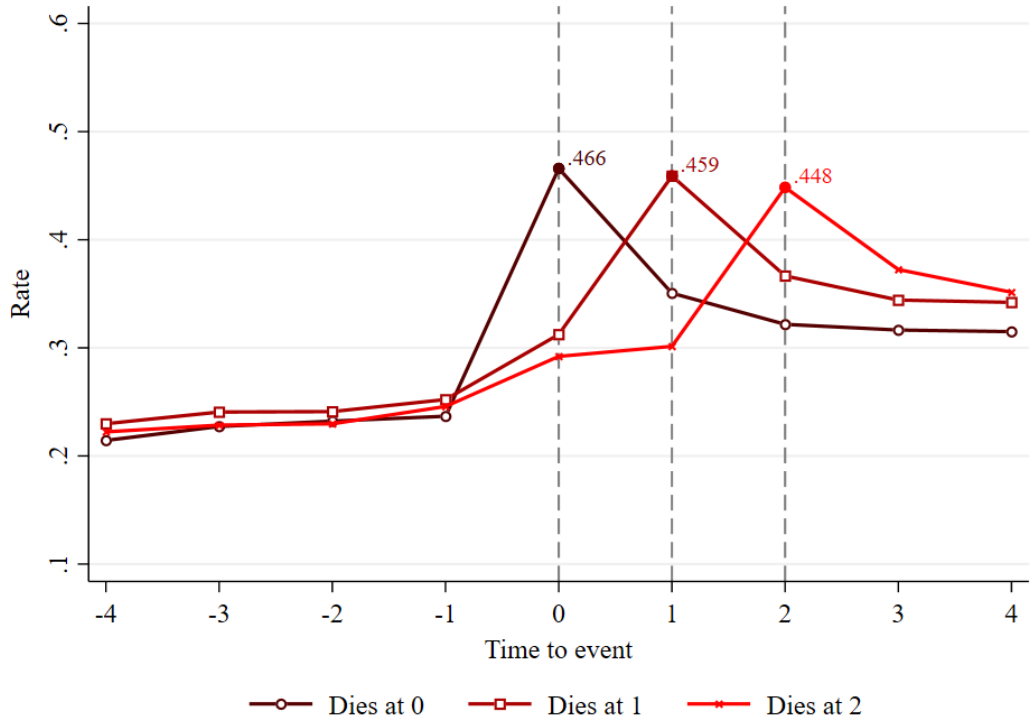


Notes: This figure studies the take-up of mental health medication around a spousal death. The sample includes households in which one spouse experiences a health event between 1999 and 2018 and dies within one year. The treatment group consists of individuals whose spouse experiences a health event in 1999-2013 when both spouses are aged 45-80. The control group consists of individuals whose spouse experiences an actual health event in 2004-2018 when both spouses are aged 45-80, to whom we assign a placebo event five years earlier ($\Delta = 5$). The sample is balanced between periods $r = -4$ and $r = 4$. Panels A and B study responses at a month frequency for a time range of 24 months before and after the event, and panels C and D study responses at an annual frequency for a time range of four years before and after the event. Panel A and C show the mean take-up rate by time relative to the index event for the treatment group in red circles (along with the corresponding 95 percent confidence intervals), the control group in gray (along with the corresponding 95 percent confidence intervals), and the counterfactual where the control group's outcomes are normalized to the pre-event level of the treatment group in blue squares. Panels B and D present estimates from the dynamic difference-in-differences specification in equation (1). They plot the estimates for δ_r along with their 95 percent confidence intervals. The regressions include household fixed effects, time fixed effects, and a quadratic in the surviving spouse's age.

shock from the hospitalization event and by the subsequent spousal death. We investigate the mental health of three groups of treated survivors whose spouses were all hospitalized in year τ, but where the spousal death occurred with varying timing in years τ, $\tau + 1$, or $\tau + 2$. Figure 2 depicts the take-up rates of mental health medication for the three groups. For all groups the take-up rate hovers over 25 pp in the year prior to the spousal

hospitalization. The rate then peaks at around 45 pp in the year of the death regardless of which of the three groups we are investigating (so that the overall effect is again around 20pp). The households that experience the spousal death with a delay, i.e., one and two years after the hospitalization, increase take-up to around 30 pp in the year of the hospitalization. Hence, around 1/4 (=5pp/20pp) of the treatment effect could be attributed to the hospitalization (morbidity), and the remaining 3/4 (=15pp/20pp) could be attributed to the death of the spouse (fatality).

FIGURE 2: TAKE-UP OF MENTAL HEALTH MEDICATION BY SURVIVAL TIME BETWEEN HEALTH EVENT AND DEATH



Notes: The figure shows raw means of surviving spouses' take-up of mental health medication four years before and after their spouse's health event. The sample includes households in which one spouse experiences a health event between 1999 and 2014 and dies within three years. Both spouses are aged 45 to 80 in the year of the health event. The sample is balanced between periods $r = -4$ and $r = 4$. Couples are split into groups of those in which the spouse suffering the health event dies in the same year, the next year, or two years later.

Second, we examine whether the lingering effects are driven by new consumers of mental health medication, who initiate consumption immediately and stay on the medication for years; or survivors, who do not increase consumption immediately, but have a delayed take-up following the spousal death. To study this, we estimate equation (1) on a set of outcomes indicating if survivors either initiate or cease to use mental health medication in a given year. Note that in this analysis we "lose" period -4 since we need

at least one pre-period in these outcome definitions.

Figure 3 shows the results. In Figure 3a we define the outcome to be an indicator for initiating consumption, i.e., an indicator for taking the medication in a given year without having consumed it in the previous year. We see a spike in initiation of 17.5 pp in the year of the spousal death, followed by a sharp decline in period 2 down to 2.1 pp and zero thereafter. Figure 3b captures the impacts on cessation, i.e., it plots an indicator for having zero consumption in a given year, but positive consumption in the previous year. This measure peaks at 10 pp in year 1 (the year after the spousal death) and gradually declines in subsequent years. By summing up the estimated effects for event times 0-4, we calculate an accumulated 20 pp increase in initiation and an accumulated 15 pp in cessation. With the dynamics identified in Figure 3, this 5 pp differential implies that 25 percent of individuals starting medication consumption immediately following the event do not stop within our observation period of four years. In turn, it implies that the lingering effects in Figure 1 are not driven by a delayed take-up (which we would have observed if mental health deficits accumulated over a longer period), but rather by survivors who continue to consume mental health medication for at least four years after their spouse passed away.

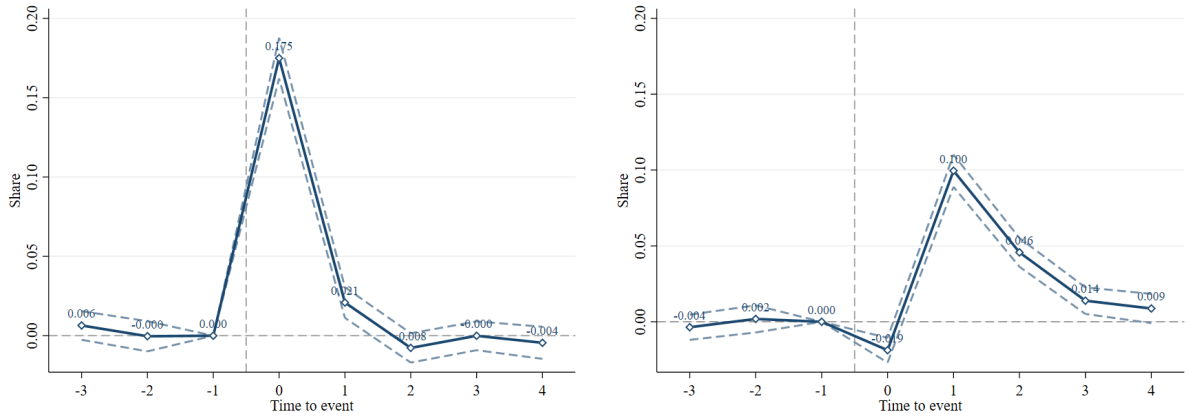
4.3 Role of Economic Circumstances

We next analyze whether better economic circumstances can alleviate the adverse effects on the mental health of survivors. To do so, Figure 4 sorts the population of survivors into twenty equal-sized bins based on different measures of surviving households' income. The average of this measure for each bin is plotted on the x-axis. The y-axis plots the average take-up of mental health medication within each bin for three periods—period -1 (black dots, lower part), period 0 (blue dots, middle part), and period 1 (gray dots, upper part)—along with the linear fit for each period. Average differences across periods can be seen in level shifts across the linear fitted lines, and heterogeneity in income is captured by the slopes.

Mental Health Inequality. We first study potential inequality in survivors' mental health based on income gradients in the consumption of mental health medication. Figure 4a splits households based on the household income replacement rate. In period -1, we estimate a slope of -.0699, which means that households that are better insured

Figure 3: Starting and Stopping Mental Health Medication Take-Up

(a) Starting, Treatment Effects (b) Stopping, Treatment Effects



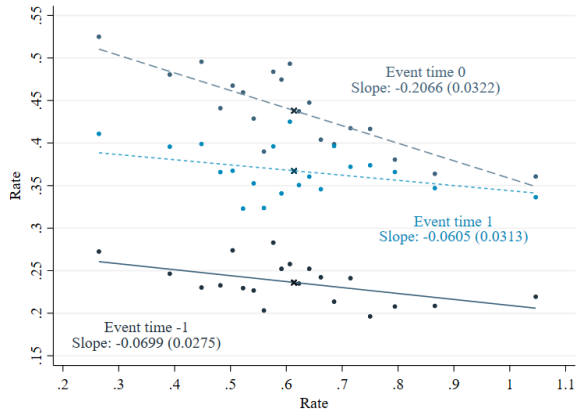
Notes: The figures show surviving spouses' probability of starting and stopping mental health medication take-up in a given year relative to the previous year. The sample includes households in which one spouse experiences a health event between 1999 and 2018 and dies within one year. The treatment group consists of individuals whose spouse experiences a health event in 1999-2013 when both spouses are aged 45-80. The control group consists of individuals whose spouse experiences an actual health event in 2004-2018 when both spouses are aged 45-80, to whom we assign a placebo event five years earlier ($\Delta = 5$). The sample is balanced between periods $r = -4$ and $r = 4$. The figures present estimates from the dynamic difference-in-differences specification of equation (1) with two different outcome variables. They plot the estimates for δ_r along with their 95 percent confidence intervals. The regressions include household fixed effects, calendar year fixed effects, and a quadratic in the surviving spouse's age. Panel A plots the effects of spousal death on the probability of starting take-up of mental health medication in a given year relative to the previous year. Starting take-up is defined as consuming medication in the current year but not in the previous year. Panel B plots the effects of spousal death on the probability of stopping take-up of mental health medication in a given year relative to the previous year. Stopping take-up is defined as consuming medication in the previous year but not in the current year. Appendix Figure B.8 plots the raw rates of starting and stopping mental health medication consumption.

have a lower mental health medication take-up already at baseline. In the year of spousal death (time zero), the gradient almost triples to -.2066, revealing that households with a low income replacement rate are particularly sensitive to the mental health impacts of a spousal death. In period 1, the gradient returns to the same order of magnitude as that in the baseline period. These patterns reveal that the initial spike in the take-up of mental health medication is particularly pronounced for survivors with an unstable income profile, that is, survivors with a low degree of income security.

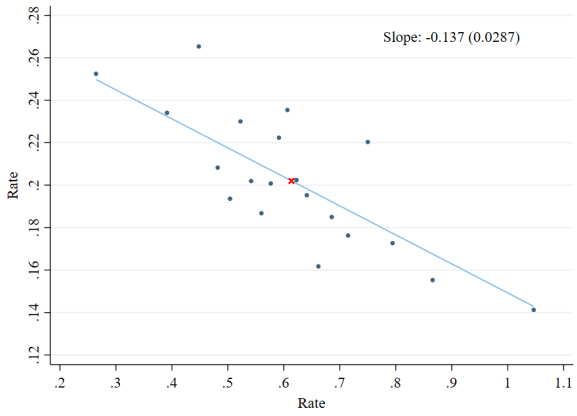
To better understand whether spousal death shapes health inequality, in Figure 4c we change the income measure to the survivors' rank in the household income distribution at baseline. This allows us to benchmark the income stability results against results for income levels, which are frequently studied in the context of health disparities. We see a fairly steep baseline inequality in the consumption of mental health drugs, so that lower income households are significantly more likely to experience adverse mental health. The estimated slope is -.0904, meaning that going from the bottom to the top of the

Figure 4: Take-Up of Mental Health Medication by Surviving Spouses' Economic Circumstances

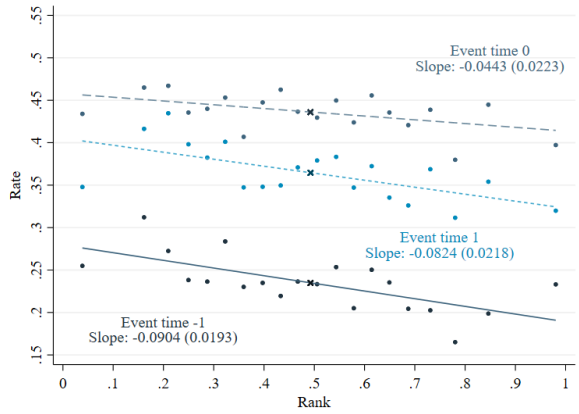
(a) Levels by Replacement Rate



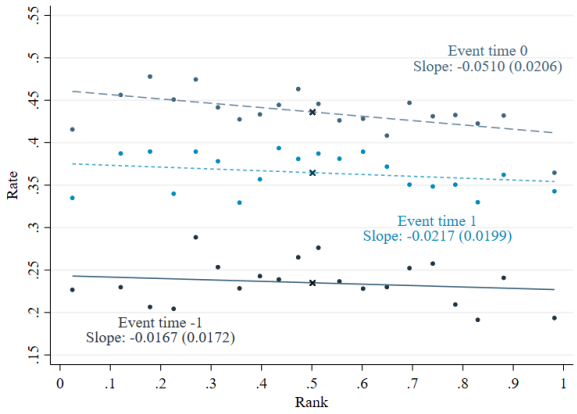
(b) Changes by Replacement Rate



(c) Levels by Household Income Rank



(d) Levels by Household Net Wealth Rank



Notes: The figures depict associations between surviving spouses' take-up of mental health medication and financial circumstances around spousal death. Household income is the sum of spouses' personal income, including labor income, social security benefits, capital income, and other types of income that can be directly connected to an individual. The replacement rate measures the relative change in adjusted household income (holding fixed the surviving spouse's labor income and government benefits at their period $r = -1$ values) from period $r = -1$ to $r = 1$. A 98% winsorization has been performed for the replacement rate. Net wealth is defined as liquid wealth minus liabilities. Liquid wealth consists of bank deposits, market value of shares, bonds, and mortgage deeds in deposits. Liabilities comprise debt to banks, mortgage debt, and market value of bond debt. The sample includes households in which one spouse experiences a health event between 1999 and 2013 and dies within one year when both spouses are aged 45-80 (the treatment group). The baseline sample is balanced between periods $r = -4$ and $r = 4$. Panel A plots the take-up rate of mental health medication among surviving spouses in periods $r = -1, 0, 1$ as a function of their household income replacement rate. Panel B presents changes in surviving spouses' take-up of mental health medication from period $r = -1$ to $r = 0$ as a function of the household income replacement rate. Appendix Figure B.12 plots these relationships among younger and older spouses. Panel C plots the take-up rate of mental health medication among surviving spouses in periods $r = -1, 0, 1$ as a function of their household income rank in period $r = -1$. Panel D plots the take-up rate of mental health medication among surviving spouses in periods $r = -1, 0, 1$ as a function of their household net wealth rank in period $r = -1$.

income distribution reduces the probability of taking up mental health medication by 9 pp.[11] Interestingly, however, the gradient in income rank if anything flattens in period

[11]To compare this estimate with the baseline health inequality in replacement rates from Figure 4a,

zero. Then, in the year after spousal death (period 1), the inequality is back to baseline magnitudes. This implies that it is *not* the case that lower income household are more prone to the mental health effects of a spousal death. For completeness, Figure 4d replicates Figure 4c but by splitting households based on net wealth ranks instead.[12]

To summarize these patterns we note that: first, lower income households are at a higher baseline risk of mental health issues, but are not more exposed to the mental health effects of a spousal death; second, households with lower insurance (i.e., lower income replacement rates) are exposed to the mental health effects of a spousal death to a much greater degree. That is, the mental health effects of spousal death are mediated by variation in income within households around the event (i.e., the degree of insurance) rather than by heterogeneity in income levels across households (i.e., underlying inequality). This underscores the role of income security, which we turn to focus on below.

Income Security. Figure 4b provides a deeper investigation of the role of income stability, by studying the *changes* in the consumption of mental health medications from period -1 to the year of the event. For interpretation, we note that a household that maintains the same level of adjusted household income after the death of a spouse will have a replacement rate of 1; and a household with, say, a 80% income drop will have a replacement rate of 0.2. As a benchmark for "sufficient" equivalent income when comparing one vs. two-person households, we refer to the square-root income replacement rate of .71, i.e., so that a one-person household needs 71% of a two-person household's total income to maintain the same per-person level of consumption. [13]

The figure clearly shows a negative relationship between the change in the consumption of mental health medication around spousal death and the household degree of income insurance. The slope of the the fitted line is -.137. To interpret magnitudes, this slope implies that a household with "full" income coverage of 71% would incur a lower effect by 9.7 pp ($= .137 \times .71$), cutting down the average treatment effect of 19.5 pp by

we compare the inter-quartile distances for the two income measures. The first and third quartiles in replacement rates are 0.5 and 0.7, respectively, so that the predicted inter-quartile difference in mental health consumption at baseline is 1.4 percentage points (=100×(0.7-0.5)×-0.0699). For income level ranks, a similar calculation amounts to 4.5 percentage points (=(50×-.0904), i.e., three times the gradient in replacement rates.

[12]A higher wealth rank captures survivors better prepared for emergencies. The gradient is flat at baseline but steepens (to a negative gradient) in period zero. However, the gradient shifts from period -1 to period 0 in Figure 4d and Figure 4c are not nearly as pronounced as in Figure 4a.

[13]For investigation of the insurance value of Social Security for consumption smoothing around these types of events, see Fadlon and Nielsen (2019b), Fadlon and Nielsen (2021), and Coyne et al. (2024).

half.

Figure 4b offers a simple decomposition exercise of the treatment effects. Consider households at the bottom of the income replacement rate distribution. Their take-up increase following the spousal death is on the order of 25 pp. Households with the highest degree of insurance still experience a large "baseline" increase of 14 pp (e.g., from the bereavement itself). The least-insured households therefore experience an increase in take-up that is about 80 percent higher (=11pp/14pp). A naive calculation would imply that 44 percent (=11pp/25pp) of the effect among the least-insured households may be attributed to their severe financial insecurity. We must bear in mind, however, that our slope estimates are those of income mediation alone and are *not* causal.

In this regard, it is important to note that the strong relationship in the raw data is closely persistent in the estimation of equation (2). This holds regardless of the controls and interaction terms that we include by adding more variables to the vector D_i, which allows us to further isolate the partial correlation with the household's degree of income insurance. The results are reported in Table 1. Higher income replacement rates are the strongest financial mediator of the mental health declines following a spousal death. The estimates imply that households with a 10 pp higher income replacement rate experience an increase in mental health medication following a spousal death that is approximately 1.96 pp lower (see column 9).

These findings raise potential avenues for a more efficient design of survivors insurance schemes. First, in terms of program targeting, one easy way to identify households with differential replacement rates is the degree to which the deceased had been the primary or secondary earner. The analysis points to the intuitive notion that survivors to spouses who had been the primary earner are more exposed to the adverse risks of the spousal death. Appendix Table B.5 corroborates this idea. The first column shows that households in which the primary earner dies have a replacement rate that is 12.3 pp lower, and the second column shows that survivors in these households are 4.35 pp more likely to take-up mental health medication following the event (where this heterogeneity is above and beyond associations with gender). Second, the results point to effective ways of designing the benefit structure. Specifically, they offer strong support for the feature of the US Social Security survivors benefits program, in which survivors benefits are determined based on the deceased spouse's earnings history (Coyne et al. 2024).

Table 1: Heterogeneity in Mental Health Effects of Spousal Death

Interaction terms	(1) *None*	(2)	(3)	(4) *Financial changes around event*	(5)	(6)	(7) *Demographic background characteristics*	(8)	(9) *All*
Post	0.0667**	-0.0149	0.0018	-0.0150	-0.0152	-0.0031	-0.0034	-0.0078	-0.0252
	(0.0307)	(0.0106)	(0.0041)	(0.0107)	(0.0107)	(0.0060)	(0.0153)	(0.0158)	(0.0194)
Treat × Post	0.1953***	0.2114***	0.1951***	0.2111***	0.2109***	0.1856***	0.1965***	0.1895***	0.2024***
	(0.0075)	(0.0125)	(0.0075)	(0.0125)	(0.0125)	(0.0125)	(0.0314)	(0.0326)	(0.0349)
Treat × Post × Replacement rate		-0.1876***		-0.2057***	-0.2011***				-0.1963***
		(0.0465)		(0.0468)	(0.0469)				(0.0471)
Treat × Post × Income rank			0.0615**	0.0772***	0.0727***				0.0758**
			(0.0257)	(0.0259)	(0.0263)				(0.0300)
Treat × Post × Net wealth rank					-0.0425				-0.0396*
					(0.0258)				(0.0235)
Treat × Post × Female						0.0136		0.0122	0.0085
						(0.0153)		(0.0154)	(0.0155)
Treat × Post × Young child							0.0164	0.0170	0.0019
							(0.0352)	(0.0352)	(0.0355)
Treat × Post × Adult child							0.0099	0.0077	0.0002
							(0.0333)	(0.0333)	(0.0335)
Observations	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
R-squared	0.7696	0.7700	0.7697	0.7703	0.7704	0.7696	0.7698	0.7698	0.7706
Number of households	12992	12992	12992	12992	12992	12992	12992	12992	12992
Pre-shock mean	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218

Notes: The table reports estimates from the average difference-in-differences specification of equation (2). All specifications include household fixed effects, calendar year fixed effects, and a quadratic in the surviving spouse's age. The sample includes households in which one spouse experiences a health event between 1999 and 2019 and dies within one year. The treatment group consists of individuals whose spouse experiences a health event in 1999-2013 when both spouses are aged 45-80. The control group consists of individuals whose spouse experiences an actual health event in 2004-2018 when both spouses are aged 45-80, to whom we assign a placebo event five years earlier ($\Delta = 5$). The sample is balanced between periods $r = -4$ and $r = 4$. Household income is the sum of spouses' personal income, including labor income, social security benefits, capital income, and other types of income that can be directly connected to an individual. The replacement rate measures the relative change in adjusted household income (holding fixed the surviving spouse's labor income and government benefits at their period $r = -1$ values) from period $r = -1$ to $r = 1$. A 98% winsorization has been performed for the replacement rate. Net wealth is defined as liquid wealth minus liabilities. Liquid wealth consists of bank deposits, market value of shares, bonds, and mortgage deeds in deposits. Liabilities comprise debt to banks, mortgage debt, and market value of bond debt. The replacement rate as well as income and net wealth ranks have been normalized at the mean among individuals in the treatment group (respectively 0.163, 49.27, and 50.23). Finally, we test whether mental health effects differ across demographic groups. We specifically look at gender and the presence of young or adult children in period -1 (where young/adult is based on age 18 as a cutoff). Robust standard errors clustered at the household level are reported in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

A final note speaks to researchers' priors brought up in prior work. We see that, across specifications, there are no correlations of treatment effect intensity with gender or with the presence of young or adult children (as summarized in Table 1).

5. Conclusion

Spousal death causes large and immediate declines in the mental health of the surviving spouse. These effects linger for at least four years, driven by survivors who immediately initiate mental health medication following the spousal death and still consume these medications for several years. Whereas these mental health declines are inevitable, the literature has not yet investigated whether there are effective ways to mitigate them. We provide novel evidence that income stability has the potential to meaningfully reduce the adverse mental health declines upon a spousal death. Our analysis illustrates more broadly that the welfare gains from income security programs can come not only in the traditional form of the targeted goal of consumption smoothing, but also in the form of improved mental health of significant economic magnitudes.

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Online Appendix for "Survivors' Mental Health and the Protective Role of Income Stability"

A. Institutional Background

This appendix describes the Danish institutional setting. In the event of a spousal death, two types of insurance schemes are relevant to consider: health insurance covering medical care, and income insurance covering income losses.

Health Insurance. Denmark has a single-payer, tax-funded, universal health insurance scheme that provides free access to healthcare for all Danish residents. Primary care is provided by primary care physicians (PCPs), specialists, psychiatric doctors, home care, and care centers. Visits to PCPs are free, while treatments by other providers come with varying, yet limited out-of-pocket costs. Secondary care is almost entirely provided by public hospitals free of charge. Private hospitals accounted for only 9.8% of medical procedures in 2021 and mostly conduct routine procedures (Skovgaard, 2022). Patients who seek care at private hospitals pay either out-of-pocket or through a private insurance, but in most cases patients who utilize private hospitals are referred from public hospitals as a result of long waitlists. In such cases of referrals, patients incur no out-of-pocket expenses.

Prescription drugs are heavily subsidized through two channels. First, most prescription drugs (including consumption of psycholeptics and psychoanaleptics, which constitutes our main outcome of interest) are subsidized with reimbursement rates between 49.8 and 74.7 percent (Danish Medicines Agency, 2019). Second, patients are reimbursed based on their total annual spending on subsidized prescription drugs (Weiss, 1997). The structure of reimbursement scheme is broadly similar to Medicare Part D (Medicare, 2024): reimbursement rates range from 0 to 100 percent, increase with spending, and are independent of income (Danish Medicines Agency, 2023).

Income Insurance. Similar to other developed economies, Denmark has three types of income insurance that are relevant for our context of health shocks: a) Social Security (Disability Insurance and Old-Age Pension); b) additional government income assistance programs (e.g., sick-pay and a early retirement); and c) privately-purchased insurance policies. We provide a description of their main features and benefit schedules below.

Social Security (Disability Insurance and Old-Age Pensions). Similar to the US Social Security system, the Danish law of Social Pensions (Retsinformation (2024)) establishes Disability Insurance benefits for individuals younger than retirement age with a documented limitation in work capacity, and Old-Age Pension (OAP) income for all Danish residents that reached the full retirement age (which is incrementally increasing from 65 to 67 for cohorts born after 1954). In both schemes benefits are means-tested against current (own and partner's) income. Unlike the US, benefits are independent of earnings history. The benefit rates are set centrally, but the schemes are administrated at the municipality level.

Individuals younger than the old-age pension age, who experience a health shock that permanently reduces their ability to work, are covered by Social Disability Insurance (Social DI). Eligibility for benefits requires loss in work capacity of at least 50 percent, which is determined at the local municipality level. If an application is approved, individuals receive benefits until they reach the Old-Age Pension retirement age. In 2023, for example, annual benefits from Social Disability Insurance amounted to DKK 207,780 (US$30,200) for individuals in a couple (married of cohabiting) and DKK 244,440 (US$35,500) for single individuals (Ældresagen, 2024c).

While the Danish Social DI incorporates the traditional disability benefits scheme for medical reasons, it can also be awarded for "social" reasons to individuals who are unable to maintain a sufficient standard of living on their own (Bingley et al. 2011). In practice, it therefore also acts as the relevant social insurance program for surviving spouses who have financial needs in lieu of an explicit government survivors benefits scheme in the Danish system. Fadlon and Nielsen (2021) document that the share of surviving spouses younger than the Old-Age Pension age who end up on Social DI in the year of spousal death is 25.5%.

At the statutory pension age of 65-67 (where the cut-off age varies by birth cohort as mentioned above), all Danish residents become eligible for the Old-Age Pension (OAP). In 2024, benefits amounted to DKK 179,328 ($26,000) for single individuals and 132,360 DKK ($19,200) for married or cohabiting individuals (Ældresagen, 2024b). The OAP has a poverty combating element leaving local municipalities with the opportunity to reward pensioners, who are in poor health and have limited savings, additional subsidies to cover medical expenses for prescription drugs, dental care, foot care, physiotherapy,

chiropractics, psychology support, and hearing aids. Eligibility for health-related coverage must be renewed annually.

Additional Government Assistance Programs. Other social insurance programs that can potentially provide protection for households experiencing a health shock include sick-pay and a voluntary early retirement program. Sick-pay targets individuals experiencing a somatic or a mental health condition that temporarily reduces their ability to work. Individuals self-report their illness to their employers and upon approval receive benefits for a maximum of 22 weeks within 9 months. Benefits are based on working hours and income during the three months prior to the onset of the illness. In 2023, for example, they amounted to a maximum of DKK 236,600 (US$34,300) per year (Borger.dk, 2023). In addition, from age 60 and until the OAP age, individuals who have voluntarily been a member of an unemployment insurance fund for a sufficiently long period are eligible for the Voluntary Early Retirement Pension (VERP). In 2024, benefits amounted to DKK 165,024 ($24,000) and DKK 244,308 ($35,500) per year for those partially and fully insured, respectively (Ældresagen, 2024a). Note that a person receiving VERP cannot receive Social DI simultaneously.

Private Insurance. In recent years, the life insurance coverage rate has been increasing as a result of expansions of schemes through labor market pensions. However, older and unhealthy households are still largely uncovered by the private market for two reasons. First, their applications are often rejected based on required health screenings. Second, life insurance payouts decline with age. It is common in both group and non-group markets that even when life-insurance products are purchased by younger and healthy households, the coverage sharply declines with age. For example, some large white-collar group-market policies guarantee DKK 1,076,000 ($162,050) if the insured employees die before age 45, DKK 853,000 ($128,460) if they die between ages 45 and 54, and DKK 538,000 ($81,025) if they die between ages 55 and 66, with no transfers if the insured die at or after they reach age 67 (Fadlon and Nielsen 2021).

B. Variable Definitions and Additional Analyses

B.1 Calculating the Income Replacement Rate

The income replacement rate measures the relative change in household income around spousal death, holding fixed the surviving spouse's behavior prior to the event. It is calculated based on an adjusted measure of household income, which accounts for the surviving spouse's potential responses in terms of labor market outcomes and take-up of welfare. It does so by holding fixed survivors' labor income and social security in the period prior to the spousal death. Adjusted household income for surviving spouse i in relative year 1 is accordingly calculated by:

$$\begin{aligned} HhInc_{i,1}^{Adj} = HhInc_{i,1} - Wages_{i,1} + Wages_{i,-1} \\ - SP_{i,1} + SP_{i,-1} - DI_{i,1} + DI_{i,-1}, \end{aligned}$$

where $HhInc_{i,1}$ is the household's income from any source (inclusive of labor income, social security benefits, and capital income) in period 1; $Wages_{i,r}$ is the surviving spouse's total labor income in period r; $SP_{i,r}$ is sick-pay benefits paid to the surviving spouse in period r; and $DI_{i,r}$ is the surviving spouse's payouts from social disability insurance in period r. The income replacement rate is then calculated as the relative change between the household's income in period -1 (denoted by $HhInc_{i,-1}$) and the household's adjusted income in period 1:

$$RepRate_i = \frac{HhInc_{i,1}^{Adj}}{HhInc_{i,-1}}.$$

B.2 Tables

Table B.2: Summary Statistics of Key Variables

		Treatment		Control	
		Mean	*Std. Dev.*	*Mean*	*Std. Dev.*
	Year of obs.	2003.9	4.2	2004.0	4.3
Healthy spouse	Age	65.5	8.4	65.4	8.5
	Female	69.0	46.3	65.5	47.6
	Medication	23.5	42.4	21.8	41.3
	Young child	13.5	34.2	9.2	29.0
	Adult child	86.2	34.5	87.1	33.5
Deceased spouse	Age	67.4	8.3	66.9	8.3
	Female	31.0	46.2	34.5	47.6
Number of households		8,296		8,726	

Notes: The table presents the mean and standard deviation of key variables in our analysis. The sample includes households in which one spouse experiences a health event between 1999 and 2018 and dies within one year. The treatment group consists of individuals whose spouse experiences a health event in 1999-2013 when both spouses are aged 45-80. The control group consists of individuals whose spouse experiences an actual health event in 2004-2018 when both spouses are aged 45-80, to whom we assign a placebo event five years earlier. The values of the variables are measured in period $r = -1$ (the year of the actual event for treatment households and the year of the placebo event for control households).

Table B.3: Mental Health Effects of Spousal Death - Different Values of the Bandwidth Δ and Randomization

	Value of bandwidth Δ					Randomization
	3	4	5	6	7	
Treat × Event time						
-4	-0.0084	-0.0068	-0.0109**	-0.0107*	-0.0078	-0.0115*
	(0.0058)	(0.0054)	(0.0054)	(0.0055)	(0.0055)	(0.0062)
-3	-0.0000	-0.0006	0.0002	-0.0048	0.0005	0.0013
	(0.0051)	(0.0051)	(0.0051)	(0.0053)	(0.0053)	(0.0059)
-2	-0.0034	-0.0024	-0.0010	-0.0043	-0.0047	-0.0001
	(0.0047)	(0.0047)	(0.0046)	(0.0048)	(0.0050)	(0.0055)
-1	0	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)	(0)
0	0.1904***	0.1949***	0.1948***	0.1940***	0.1990***	0.1965***
	(0.0061)	(0.0061)	(0.0060)	(0.0062)	(0.0062)	(0.0070)
1	0.1136***	0.1140***	0.1171***	0.1139***	0.1193***	0.1183***
	(0.0061)	(0.0061)	(0.0060)	(0.0061)	(0.0062)	(0.0069)
2	0.0654***	0.0662***	0.0648***	0.0674***	0.0687***	0.0669***
	(0.0064)	(0.0061)	(0.0061)	(0.0061)	(0.0062)	(0.0069)
3		0.0518***	0.0519***	0.0495***	0.0572***	0.0520***
		(0.0067)	(0.0063)	(0.0064)	(0.0065)	(0.0072)
4			0.0399***	0.0372***	0.0404***	0.0413***
			(0.0068)	(0.0067)	(0.0068)	(0.0075)
Observations	155,862	154,233	153,198	147,339	141,120	118,467
R-squared	0.6433	0.6477	0.6583	0.6550	0.6531	0.6829
Pre-shock mean	0.230	0.230	0.230	0.220	0.220	0.230
Number of households	12,061	12,588	13,163	13,088	12,948	13,163

Notes: The table shows the results from estimating equation (1) for varying values of Δ as well as for non-overlapping treatment and control groups. The specifications include household fixed effect, calendar year fixed effects, and a quadratic in the surviving spouse's age. The sample includes households in which one spouse experiences a health event between 1999 and 2018 and dies within one year. The treatment group consists of individuals whose spouse experiences a health event in 1999-2013 when both spouses are aged 45-80. The control group consists of individuals whose spouse experiences an actual health event in 2002-2018 when both spouses are aged 45-80. We construct various control groups for different choices of Δ that range from 3 years to 7 years of gap in event time relative to treatment households. The sample is balanced between periods $r = -4$ and $r = 4$. The first five columns report estimates for the mental health effects of spousal death for the different choices of Δ. To ensure that the treatment group stays constant and only the control group varies across values of Δ, we require that the calendar year interval in which households experience a spousal death is the same across values of Δ. The last column reports estimates for the mental health effects of spousal death for non-overlapping treatment and control groups. As some households may appear in both the treatment and control groups (not simultaneously and not after actual spousal death), we randomize households to only one experimental group. Robust standard errors clustered at the household level are reported in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table B.4: Mental Health Effects of Spousal Death - Different Values of the Bandwidth Δ with Unbalanced Samples

	Value of bandwidth Δ				
	3	4	5	6	7
Treat × Event time					
-4	-0.0066	-0.0070	-0.0114**	-0.0098*	-0.0058
	(0.0058)	(0.0054)	(0.0055)	(0.0056)	(0.0056)
-3	0.0014	-0.0013	0.0004	-0.0049	0.0004
	(0.0051)	(0.0051)	(0.0051)	(0.0053)	(0.0054)
-2	-0.0010	-0.0017	0.0004	-0.0030	-0.0037
	(0.0047)	(0.0047)	(0.0047)	(0.0048)	(0.0050)
-1	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)
0	0.1851***	0.1872***	0.1921***	0.1873***	0.1955***
	(0.0061)	(0.0061)	(0.0060)	(0.0062)	(0.0062)
1	0.1082***	0.1096***	0.1148***	0.1142***	0.1182***
	(0.0062)	(0.0062)	(0.0062)	(0.0062)	(0.0063)
2	0.0646***	0.0611***	0.0642***	0.0665***	0.0717***
	(0.0067)	(0.0063)	(0.0063)	(0.0063)	(0.0064)
3		0.0515***	0.0516***	0.0497***	0.0595***
		(0.0070)	(0.0066)	(0.0067)	(0.0068)
4			0.0392***	0.0351***	0.0414***
			(0.0072)	(0.0070)	(0.0071)
Observations	154,070	151,809	149,867	144,276	138,440
R-squared	0.6516	0.6551	0.6630	0.6597	0.6584
Pre-shock mean	0.250	0.250	0.240	0.240	0.240
Number of households	12,233	12,628	13,099	13,054	12,937

Notes: The table shows the results from estimating equation (1) for varying values of Δ. We repeat the analysis in columns 1-5 of Appendix Table B.3, but without requiring the sample of households to be balanced. Robust standard errors clustered at the household level are reported in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

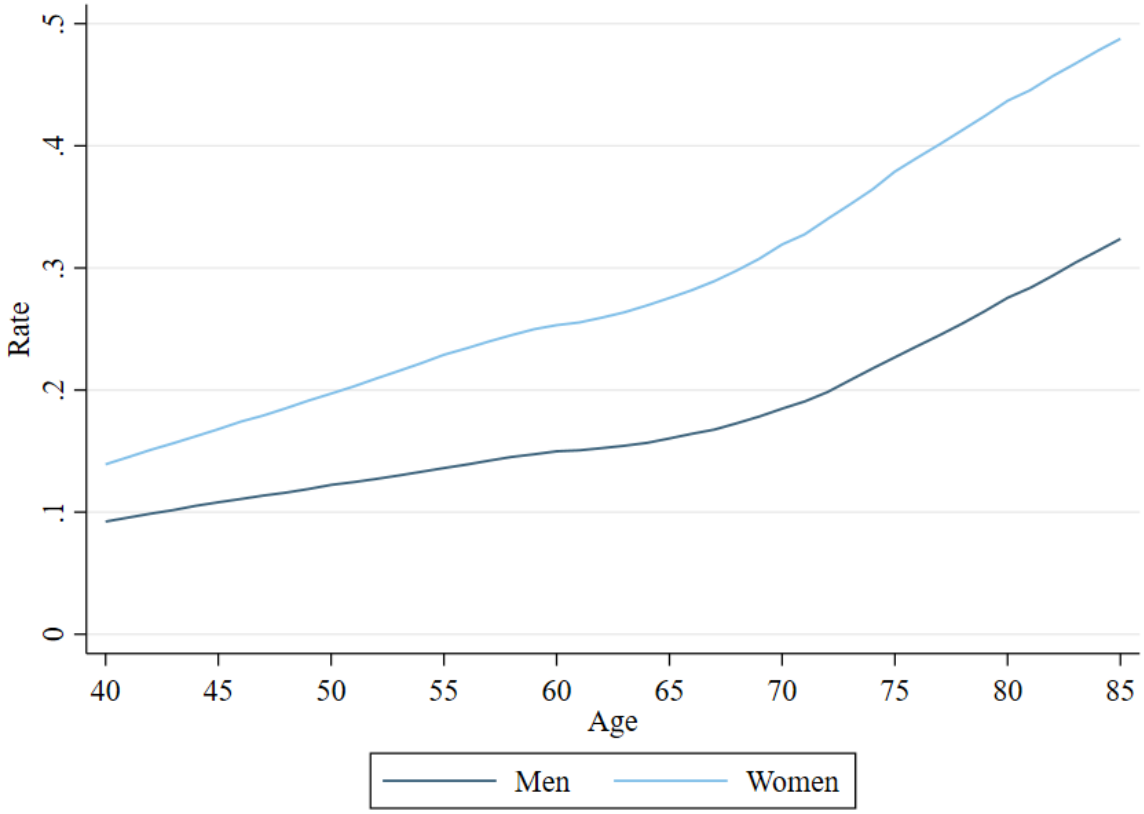
Table B.5: Heterogeneity in the Mental Health Effects of Spousal Death by Primary Earner Status

Outcome	(1) *Replacement Rate*	(2) *Mental Health Medication Take-Up*
Post		-0.0042
		(0.0062)
Treat × Post		0.1805***
		(0.0127)
Treat × Post × Deceased primary earner		0.0435**
		(0.0191)
Treat × Post × Female		0.0093
		(0.0155)
Deceased primary earner	-0.1229***	
	(0.0052)	
Female	-0.0332***	
	(0.0040)	
Constant	0.9069***	0.3230
	(0.0945)	(0.6745)
Observations	8,101	33,362
R-squared	0.0856	0.7699
Number of households	8,101	12,992
Pre-shock mean		0.218
Deceased primary earners		0.192

Notes: The table studies heterogeneity in the mental health effects of spousal death by the primary earner status of the deceased spouse. We define the primary earner in a couple as the one whose wage income makes up more than 50 percent of total household wage income in the baseline period -1. We also define that the deceased is not the primary earner if the total household wage income is zero in the year. Column 1 runs a regression of the household's income replacement rate on the deceased's primary earner status and an indicator for whether the surviving spouse is female. The replacement rate measures the relative change in adjusted household income (holding fixed the surviving spouse's labor income and government benefits at their period $r = -1$ values) from period $r = -1$ to $r = 1$. Appendix B.1 details the calculations of the replacement rate. A 98% winsorization has been performed for the replacement rate, which we additionally normalize relative to the mean among individuals in the treatment group (0.163). Column 2 reports estimates from the average difference-in-differences specification of equation (2). We include household fixed effect, calendar year fixed effects, and a quadratic in the surviving spouse's age. The sample includes households in which one spouse experiences a health event between 1999 and 2018 and dies within one year. The treatment group consists of individuals whose spouse experiences a health event in 1999-2013 when both spouses are aged 45-80. The control group consists of individuals whose spouse experiences an actual health event in 2004-2018 when both spouses are aged 45-80, to whom we assign a placebo event five years earlier ($\Delta = 5$). The sample is balanced between periods $r = -4$ and $r = 4$. Robust standard errors clustered at the household level are reported in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

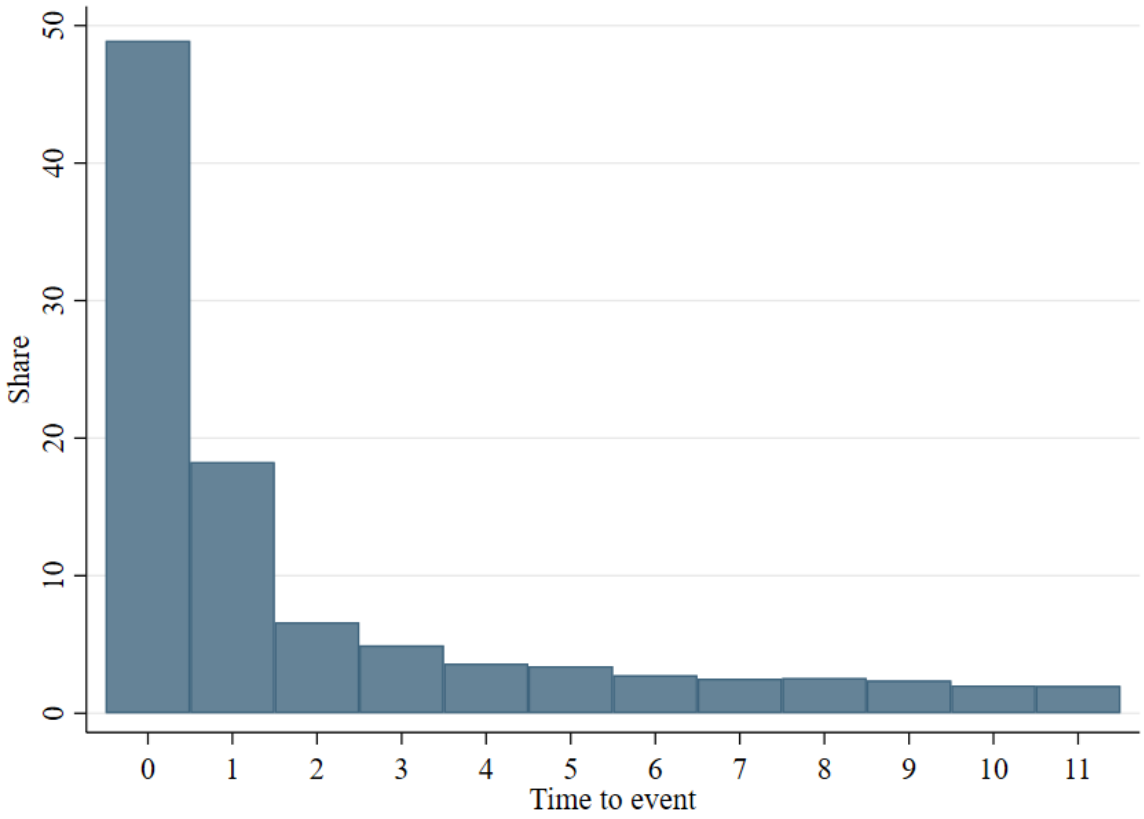
B.3 Figures

Figure B.5: Mental Health Medication Consumption over Age by Gender



Notes: The figure plots the consumption of mental health medication by age. The sample includes all individuals in the Danish population aged 40-85 in the years 1995-2017. Mental health medication is defined as psycholeptic drugs (ATC code N05) and psychoanaleptic drugs (ATC code N06).

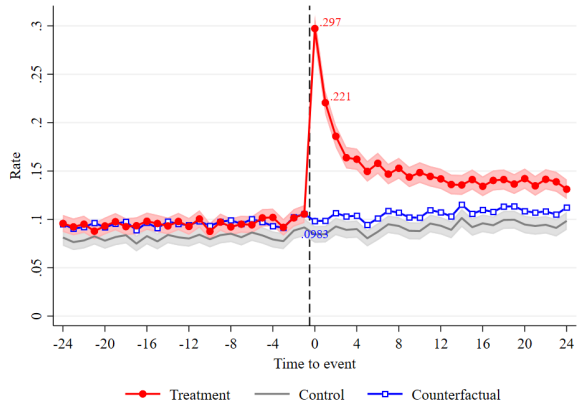
Figure B.6: Spousal Deaths 0-11 Months After Health Event



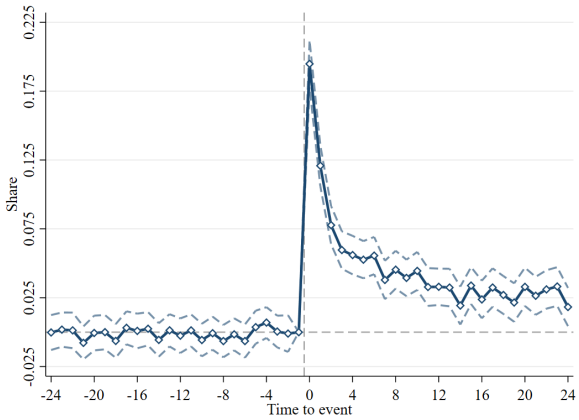
Notes: The figure plots the distribution of the month of death among households in which one spouse experiences a heart attack or a stroke and dies in the same year. The data cover the years 1999 to 2013, and the sample includes households that experienced the event when both spouses were between ages 45 and 80 and for whom we have a balanced sample for years -4 to 4 relative to the event year.

Figure B.7: Monthly Take-Up Rate of Mental Health Medication After Spousal Health Event with Immediate Death

(a) Raw Means



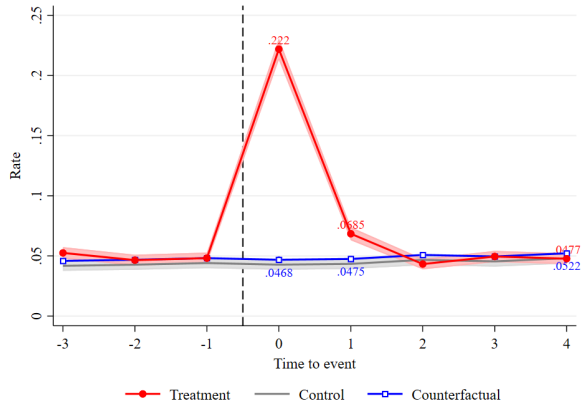
(b) Treatment Effects



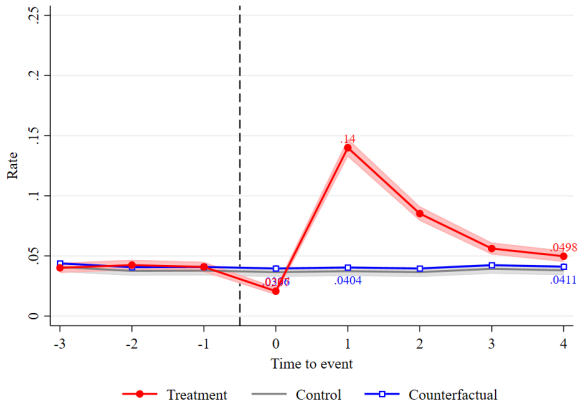
Notes: The figures plot take-up of mental health medication in response to spousal death, when restricting the sample to events in which the hospitalized partner dies within the same month of the hospitalization. The treatment group consists of individuals whose spouse experiences a fatal health event in 1999-2012 when both spouses are aged 45-80. The control group consists of individuals whose spouse experiences an actual fatal health event in 2004-2017 when both spouses are aged 45-80, to whom we assign a placebo event five years earlier ($\Delta = 5$). The sample is balanced between months periods $r = -24$ and $r = 24$. Panel A shows the mean take-up rate by month relative to the index event for the treatment group in red circles (along with the corresponding 95 percent confidence intervals), the control group in gray (along with the corresponding 95 percent confidence intervals), and the counterfactual where the control group's outcomes are normalized to the pre-event level of the treatment group in blue squares. Panel B presents the results from the dynamic difference-in-differences estimation of equation (1). It plots the estimates for δ_r along with their 95 percent confidence intervals. The regression includes household fixed effects, calendar year fixed effects, and month fixed effects, as well as a quadratic in the surviving spouse's age.

Figure B.8: Starting and Stopping Mental Health Medication around Spousal Death

(a) Starting, Raw Means



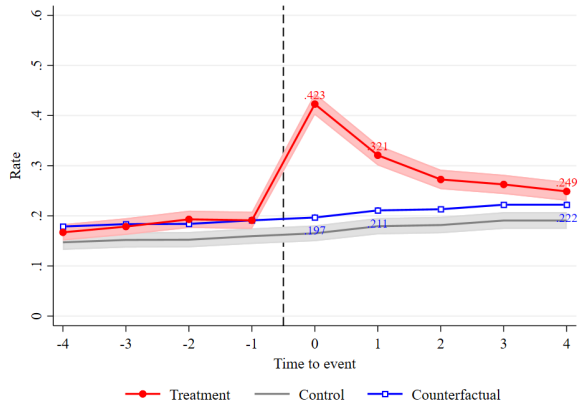
(b) Stopping, Raw Means



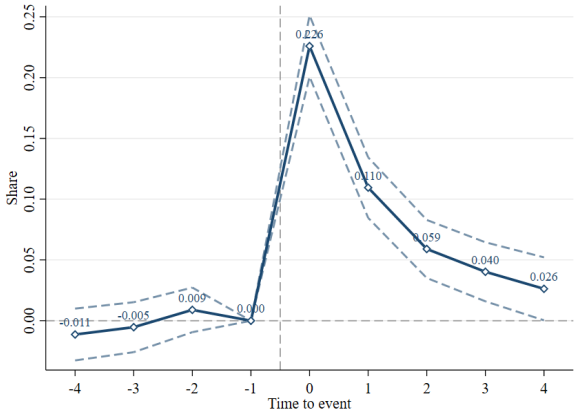
Notes: The figures plot the share of individuals who start and stop taking up mental health medication around spousal death. The sample includes households in which one spouse experiences a health event between 1999 and 2018 and dies within one year. The treatment group consists of individuals whose spouse experiences a health event in 1999-2013 when both spouses are aged 45-80. The control group consists of individuals whose spouse experiences an actual health event in 2004-2018 when both spouses are aged 45-80, to whom we assign a placebo event five years earlier ($\Delta = 5$). The sample is balanced between periods $r = -4$ and $r = 4$. The figures show the mean take-up rate by year relative to the event for the treatment group in red circles (along with the corresponding 95 percent confidence intervals), the control group in gray (along with the corresponding 95 percent confidence intervals), and the counterfactual where the control group's outcomes are normalized to the pre-event level of the treatment group in blue squares. Panel A depicts the share of individuals who start taking up mental health medication. Starting take-up is defined as consuming medication in the current year but not consuming medication in the prior year. Panel B depicts the share of individuals who stop consuming mental health medication. Stopping is defined as consuming medication in the prior year but not consuming medication in the current year.

Figure B.9: Take-Up of Mental Health Medication around Spousal Health Event by Age Group

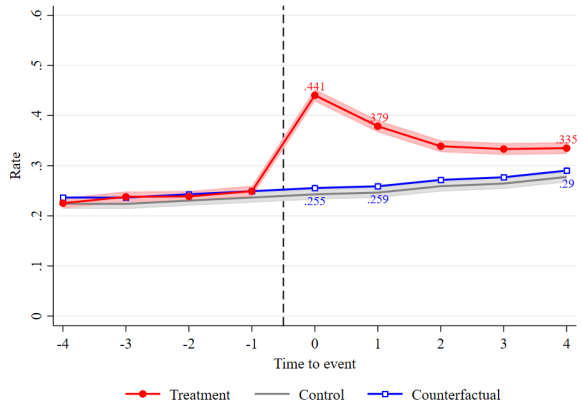
(a) Younger, Raw Means



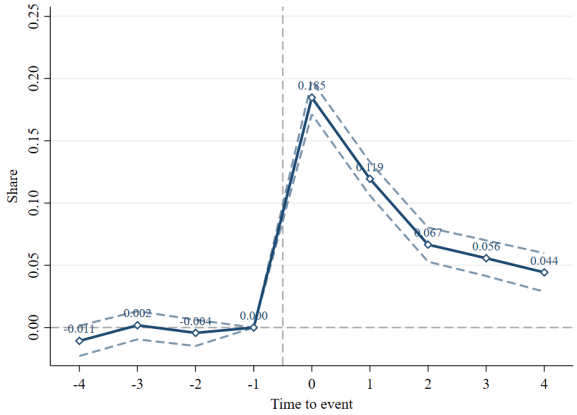
(b) Younger, Treatment Effects



(c) Older, Raw Means

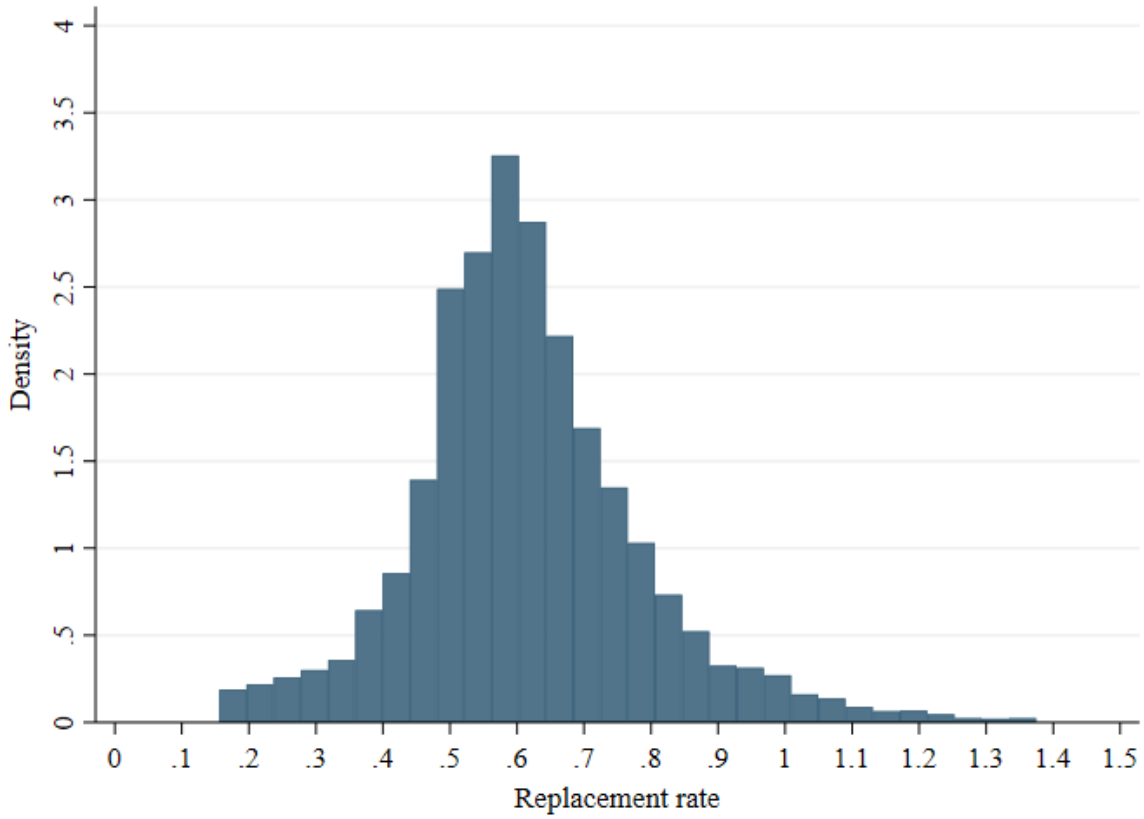


(d) Older, Treatment Effects



Notes: This figure studies the take-up of mental health medication around a spousal death, split by age at the time of the event. The sample includes households in which one spouse experiences a health event between 1999 and 2018 and dies within one year. The treatment group consists of individuals whose spouse experiences a health event in 1999-2013 when both spouses are aged 45-80. The control group consists of individuals whose spouse experiences an actual health event in 2004-2018 when both spouses are aged 45-80, to whom we assign a placebo event five years earlier ($\Delta = 5$). The sample is balanced between periods $r = -4$ and $r = 4$. Panels A and B depict responses among those aged 45-60 in the year of the index event, and panels C and D depict responses among those aged 61-80 in the year of the index event. Panels A and C show the mean take-up rate by year relative to the index event for the treatment group in red circles (along with the corresponding 95 percent confidence intervals), the control group in gray (along with the corresponding 95 percent confidence intervals), and the counterfactual where the control group's outcomes are normalized to the pre-event level of the treatment group in blue squares. Panels B and D present estimates from the dynamic difference-in-differences specification of equation (1). They plot the estimates for δ_r along with their 95 percent confidence intervals. The estimations include household fixed effects, calendar year fixed effects, and a quadratic in the surviving spouse's age.

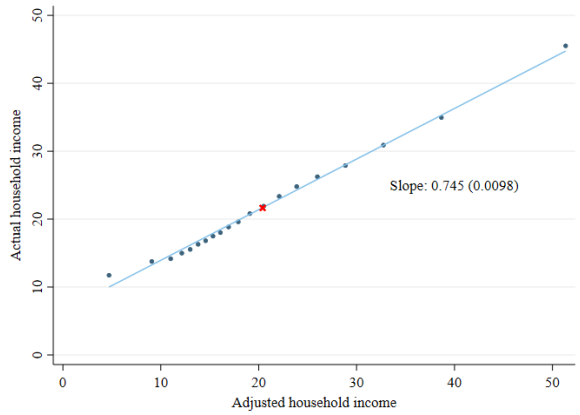
Figure B.10: Distribution of Household Income Replacement Rate



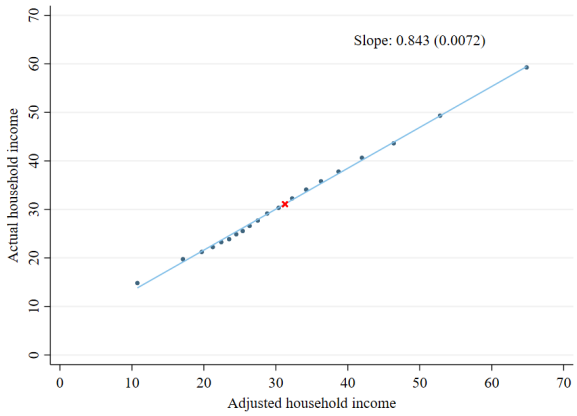
Notes: The figure illustrates the distribution of household income replacement rates. The sample includes households in which one spouse experiences a health event between 1999 and 2013 and dies within one year when both spouses are aged 45-80 (the treatment group). The sample includes households for whom we have a balanced panel between periods $r = -4$ and $r = 4$. Household income is the sum of spouses' personal income, i.e. labor income, social security benefits, capital income, and other types of income that can be directly connected to an individual. The replacement rate measures the relative change in adjusted household income (holding fixed the surviving spouse's labor income and government benefits at their period $r = -1$ values) from period $r = -1$ to $r = 1$. Appendix B.1 details the calculations of the replacement rate. A 98% winsorization has been performed for the replacement rate.

Figure B.11: Association between Actual and Adjusted Household Income

(a) Treatment Group



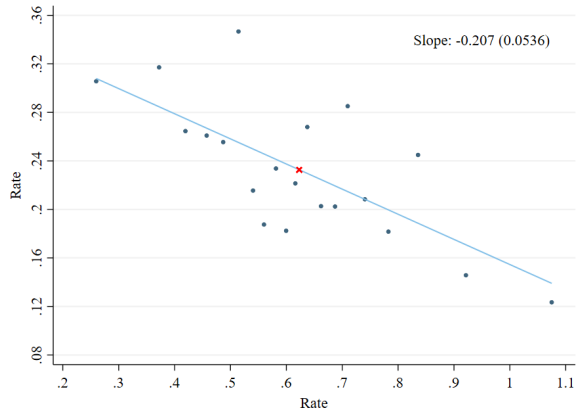
(b) Control Group



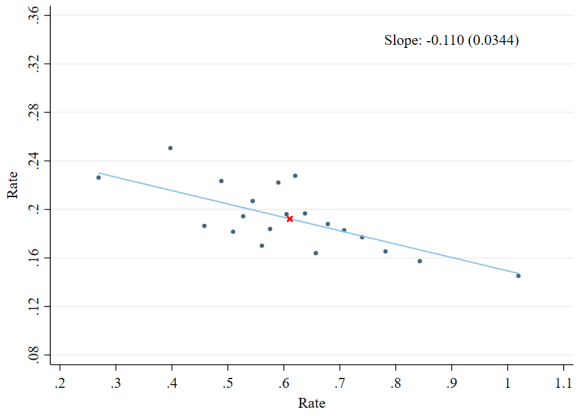
Notes: The figures show first stage results for our measure of adjusted household income one year after spousal death (period $r = 1$). The sample includes households in which one spouse experiences a health event in the same year between 1999 and 2018 and dies within one year. The treatment group (in panel A) consists of individuals whose spouse experiences a health event in 1999-2013 when both spouses are aged 45-80. The control group (in panel B) consists of individuals whose spouse experiences an actual health event in 2004-2018 when both spouses are aged 45-80, to whom we assign a placebo event five years earlier ($\Delta = 5$). The sample includes households for whom we have a balanced panel between periods $r = -4$ and $r = 4$. Household income is the sum of spouses' personal income, i.e. labor income, social security benefits, capital income, and other types of income that can be directly connected to an individual. Adjusted household income holds fixed the surviving spouse's labor income and social security in period $r = -1$. A 98% winsorization has been performed for both the actual and adjusted household income. The data are residualized of age using a quadratic in the surviving spouse's age. The figures provide scatter plots of the relationship between actual and adjusted household income in period $r = 1$, along with lines for the linear fit and slope estimates (and their standard errors).

Figure B.12: Mental Health Drug Take-Up by Household Income Replacement Rate and Age Group

(a) Younger



(b) Older



Notes: The figures depict associations between changes in the take-up of mental health medication and household income replacement rate one year after spousal death (in period $r = 1$). The sample includes households in which one spouse experiences a health event between 1999 and 2013 and dies within one year when both spouses are aged 45-80 (the treatment group). The sample includes households for whom we have a balanced panel for the periods $r = -4$ to $r = 4$. Panel A includes survivors aged 45-60 in the year of the index event, and panel B includes survivors aged 61-80 in the year of the index event. Household income is the sum of spouses' personal income, i.e. labor income, social security benefits, capital income, and other types of income that can be directly connected to an individual. The replacement rate measures the relative change in adjusted household income (holding fixed the surviving spouse's labor income and government benefits at their period $r = -1$ values) from period $r = -1$ to $r = 1$. Appendix B.1 details the calculations of the replacement rate. A 98% winsorization has been performed for the replacement rate. The data are residualized of age using a quadratic in the surviving spouse's age.

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