Dementia Mortality, Economic Insecurity, and Social Welfare Spending (1979-2014)

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Dementia Mortality, Economic Insecurity, and Social Welfare Spending as Mediator (1979-2014)

Abstract

Economic downturns appear to be good for health at the population level. This counterintuitive finding has precipitated calls to consider the impact of economic crises on vulnerable populations. Dementia afflicts 47.5 million people worldwide (World Health Organization, 2016), and population aging means it is an ever-growing group. But, research on social predictors of dementia mortality remains sparse. I hypothesize that elders with dementia may be particularly vulnerable to macroeconomic shock. Using mortality data from the US Center for Disease Control and Prevention (1979-2014), I estimate the association between the age-adjusted dementia mortality rate and gross state product, the unemployment rate, and the Economic Security Index. I test whether state-level Medicaid/Medicare funding for eldercare mediates these associations (1999-2008). I find that dementia mortality is significantly related to economic insecurity, but not the unemployment rate or gross state product. State-years that cut eldercare spending streams relative to their spending trends experience significantly higher dementia mortality rates compared to state-years with greater spending increases. Further research on mechanisms linking crises with dementia mortality is key to developing interventions, as post-recession austerity measures do appear to negatively impact this vulnerable population.

KEY WORDS: Alzheimer's; Dementia; Mortality; Macroeconomic Shock; Economic Insecurity; Procyclicality; United States

1. Introduction

2008 ushered in the deepest and longest economic recession since the Great Depression, leading to a doubling of the unemployment rate and massive government spending cuts. The Great Recession's negative effects continue to course through the population in terms of lost income, foreclosures, depleted savings and investments, and ongoing unemployment, but what of the health effects? Much evidence shows all-cause mortality is procyclical in wealthy countries (Ruhm, 2015a). This counterintuitive finding—that at the population level people are *less* likely to die during economic recessions—has precipitated calls to investigate the effects of economic crises on vulnerable populations and to explore if fiscal austerity measures exacerbate these recessionary effects (Bacigalupe, Escolar-Pujolar, & Escolar, 2014; Colledge, 1982).

Existing research has focused on people marginalized by mental illness, socioeconomic status, or race/ethnicity. I suggest we might also expect profound impacts on elders with dementia. Research is still just scratching the surface of understanding social predictors of memory diseases even though Alzheimer's disease (AD) is now the sixth leading cause of death in the U.S. (Alzheimer's Association, 2015). Approximately 5.4 million people, that is an estimated 11% of elders over age 65 and 32% over age 85, have AD (Alzheimer's Association, 2016). People with Alzheimer's disease live an average of eight to ten years after diagnosis, and even those over age 90 average survival times of four years post-diagnosis (Xie, Brayne, & Matthews, 2008). I hypothesize elders with dementia are particularly vulnerable to recessions because of familial stress, institutionalization, and austerity measures that decrease quality of care and quality of life, thus shortening life expectancy.

State-level variation in severity of recessions provides opportunity to test whether a state's dementia mortality rate is associated with economic downturn. Furthermore, though there

is a growing body of work demonstrating the negative health effects of austerity measures in Europe (Karanikolos et al., 2013; McKee, Karanikolos, Belcher, & Stuckler, 2012), there is little U.S.-based research examining Medicaid and Medicare austerity measures specific to eldercare. I predict states that enact harsher austerity measures experience greater spikes in dementia deaths. To test these hypotheses, I assemble state-level data on dementia mortality (1979-2014), unemployment rates (1980-2014), per capita real gross state product (GSP) adjusted to the 2014 Consumer Price Index (1979-2014), the Economic Security Index (ESI) (1986-2012), and Medicare and Medicaid funding for eldercare services (1999-2008).

I conduct a time-trend analysis of elders' age-adjusted dementia mortality rate (DMR) comparing recessionary and non-recessionary periods. I then use state-level unemployment rate, annual percent change in GSP, and the ESI to test the hypothesis that macroeconomic contraction is associated with increased rates of dementia mortality. Finally, I investigate whether annual trends in the DMR are associated with fluctuations in state-level Medicaid and Medicare funding for nursing homes, home health care, assisted living, and hospitals, and whether state-level funding mediated the association between economic insecurity and dementia mortality from 1999-2008. Not only is it integral to understand the health consequences of macroeconomic fluctuations on those most vulnerable, but finding a mediating effect of social welfare spending would have broad implications for the role of such resources in buffering the negative effects of recession on vulnerable populations.

Background

The debate over whether economic recessions are "good for your health" *in general* is irresolvable because recessions' associations with mortality are undoubtedly both cause- and

subpopulation-dependent (Ruhm, 2003). Thus, studying recessions' impacts on specific causes of death and vulnerable populations is important. Dementia mortality is increasingly relevant as Alzheimer's alone is estimated as the cause of death for more than a third of those over age 75 (James et al. 2014). I first briefly review the associations between health and macroeconomic factors. I then draw from the dementia literature to construct the underlying logic for the hypothesis that elders afflicted with dementia may be particularly vulnerable to economic crises.

Economic crises & community-living elders

There is a significant body of research showing that all-cause mortality is procyclical, decreasing during economic downturns (Burgard & Kalousova, 2015; Gerdtham & Ruhm, 2006; Ruhm, 2003, 2005; Tapia-Granados, 2005; Toffolutti & Suhrcke, 2014).[1] Gross domestic product (GDP), specifically, is associated with increasing all-cause mortality rate (Ruhm, 2003), cardiovascular disease, motor vehicle accidents (Gerdtham & Ruhm, 2006), and ischemic heart disease and hypertension (Quast & Gonzalez, 2014). In contrast, mental health morbidity and mortality appear to be countercyclical. The Great Recession (GR) is associated with increases in attempted and completed suicides (De Vogli, 2013; Phillips & Nugent, 2014), increased risk of mental disorders like episodes of major depression and psychological distress (Cagney, Browning, Iveniuk, & English, 2014; Mark, Hodgkin, Levit, & Thomas, 2016), and elevated self-reported stress and antidepressant use in elders (McInerney, Mellor, & Nicholas, 2013).

Some propose more illnesses during the GR will follow the countercyclical trend because the GR was such a dramatic event (Ruhm, 2015b). For example, during the GR years of 2008-2010, approximately 20% of U.S. residents lost over a quarter of their available income without

[1] Researchers propose the mechanism is partially behavioral, for example, less road traffic and reduced alcohol and tobacco consumption. In contrast, others find minimal support for behavioral factors as the mechanism (Nandi, Charters, Strumpf, Heymann, & Harper, 2013).

financial assets to cover those losses (Hacker, Huber, Nichols, Rehm, & Craig, 2012). The recession was so deep that the median loss of those considered insecure was actually about half of their income (Hacker, Huber, Nichols, Rehm, & Craig, 2011). Indeed, the first set of studies to emerge after the Great Recession do show a wider variety of negative health outcomes (Ruhm, 2015b), including tuberculosis incidence and mortality (Arinaminpathy & Dye, 2010) and worse cognitive function (Herl, Hessel, Leist, & Berkman, 2015).

Despite this large body of research, there has been less emphasis on how macroeconomic factors affect elders. This is partly attributable to assumptions that spikes in unemployment rates primarily impact working-aged adults. Stevens et al. (2011) actually find, in contrast, that own-group employment rates do not drive mortality. Furthermore, children are dependent on their adult caregivers for their wellbeing, and children experience negative developmental effects of recessions (Kalil, 2013). Adults with dementia are similarly caregiver-dependent, but researchers have neglected them.

Elders with dementia are particularly vulnerable to household stressors. 70-81% of U.S. elders afflicted with dementia continue to live in the community, mostly supported by spouses/partners or children (Brodaty & Donkin, 2009). At the same time as caregivers attempt to protect their elders from the stress of institutionalization, 60% of caregivers have to balance jobs outside the home, and two-thirds take time off from paid work to provide care, plausibly increasing risk of being laid off (Brodaty & Donkin, 2009). Financial strain for households, therefore, could be transmitted to dependent elders.

For those in the early stages of dementia, awareness of the economic crisis may directly increase allostatic load (harmful physiological dysregulation related to stress) (McEwen, 1998). Although those with dementia may seem impervious to their surroundings, even in later

dementia stages, research shows "caregiver burden" (financial, physical, emotional, and social) and the quality of the elder-caregiver relationship ("mutuality") impacts a range of outcomes (Kunik et al., 2010). These include aggressive behavior, which is a common precursor to institutionalization, and earlier mortality (Kunik et al., 2010). As caregivers have the emotional and economic stress of a high-needs dependent over and above weathering the global financial crisis, "caregiver burden" may increase and "mutuality" suffer. Thus, I hypothesize economic crisis will impact elders with early-stage dementia *directly* through knowledge of the crisis and those with more advanced dementia *indirectly* through their caregivers.

Whereas one might assume that this vulnerability would be restricted to low-SES caregivers, risk of dementia mortality may be more evenly distributed across the SES spectrum than most mortality-risk (Phelan, Link, & Tehranifar, 2010). At mid- to lower-SES, families encountering financial hardship may become less able to contribute to elders' care (low quality of care is associated with shortened life). When families no longer have resources for care, they may institutionalize elders (shortening life expectancy). At the upper end of the wealth distribution, the stock market crash saw many elders lose their retirement savings. Since 38% of elders are cared for by their spouses or partners (Alzheimer's Association, 2015), this could increase stress exposure even for those wealthy enough to have had retirement investments.

In short, because most families care for afflicted elders at home as long as possible (Navarro-Gil et al., 2014), elders are exposed to heightened allostatic load in times of familial stress. Caregiver burden, both psychological and financial, leads to shorter period to death and to earlier institutionalization (Gaugler, Kane, & Newcomer, 2007; Karlawish, Casarett, Klocinski, & Clark, 2001). Institutionalization is also associated with shorter life expectancy (Aneshensel et

al. 2000; Brodaty et al. 1993). It follows from this research that there may be indirect and direct effects of macroeconomic shock on elders with dementia. This motivates my first hypothesis.

> *Hypothesis 1. At the state-level, higher unemployment rates, percent decreases in gross state product, and higher economic insecurity will be associated with increases in the dementia mortality rate.*

Social welfare spending & institution-living elders

Interest in policy interventions motivates researchers to explore how social protection programs may mitigate the possible negative health impacts of the Great Recession (Banks, Muriel, & Smith, 2010; Kaplan, 2012; McKee et al., 2012; Stuckler, Basu, Suhrcke, Coutts, & McKee, 2009). For example, in the European context, Karanikolos et al. (2013) find that austerity measures - more so than the crisis itself - affect health through budgetary cuts that limit healthcare. Institutionalized elders' quality of care and quality of life are subject to institutional austerity measures responding to federal and state budget cuts.

Although most elders with dementia stay at home as long as possible, the nature of the disease means that the majority eventually do have paid caregivers, starting at home, then in an institution (Navarro-Gil et al., 2014). The length of time an elder suffers Alzheimer's disease averages eight-to-ten years of declining ability to perform activities of daily living (e.g., bathing, toileting). The level of care required becomes implausible for a single caregiver, especially if the caregiver is an aged spouse, if they are working, or if they experience financial strain (Brodaty & Donkin, 2009; Brodaty, McGilchrist, Harris, & Peters, 1993). Caregiver's psychological morbidity is a leading cause of institutionalization (Brodaty & Donkin, 2009). Rates of depression and anxiety are already much higher in caregivers (e.g., 23%-85% in "developed countries" and 40%-75% in "developing countries"), and caregiver burnout often results in institutionalization of the elder (Brodaty & Donkin, 2009).

In addition to the general population's economic woes during the GR, financial strain for caregivers is likely compounded because long-term care (LTC) is prohibitively expensive. Dementia care averages $41,000-$56,000 annually, making it one of the most expensive diseases (Hurd, Martorell, Delavande, Mullen, & Langa, 2013). Due to high costs inhibiting private-pay options for most families, Medicare and Medicaid comprise most LTC spending. Medicaid covers 60 percent of nursing home costs and 40 percent of LTC (Center on Budget and Policy Priorities, 2015). In fact, most LTC expenses are not covered by Medicare, leading financial advisers to recommend all but the wealthiest to "spend down assets" until the elder qualifies for Medicaid, adding additional economic stress for the surviving family (American Elder Care Research Organization, 2014). Families may institutionalize elders as a result of economic stressors exacerbated by recessions.

Elders face increased risk of mortality post-institutionalization. Aneshensel, Pearlin, et al. (2000) find a two-fold increase in mortality of elders with dementia after nursing home admission, even controlling for sociodemographic and health factors (OR = 2.21). That is, those admitted to nursing homes experience earlier mortality than "similarly impaired" community-living elders, and more than a quarter die within just six months of nursing home admission (Aneshensel et al., 2000). As risk of death increases just after institutionalization, it is likely any exogenous shock that increases risk of institutionalization will also increase mortality rate.

For elders who successfully transition or for those already in institutions at the onset of recessions, a key mitigating factor to the influence of institutionalization on mortality is participation in leisure activities (Navarro-Gil et al., 2014) and social interaction (The PLoS Medicine Editors, 2010). If institutions enact fiscal austerity measures, the most vulnerable to layoffs may be those considered "non-essential" staff, e.g., leisure activities coordinators.

Furthermore, community-based volunteers often serve in the role of socializing with institutionalized elders. In the wake of a recession, volunteerism declines (Piatak, 2016). The combination of fewer staff and volunteers is likely to negatively impact quality of life (QOL), thus increase mortality risk (Navarro-Gil et al., 2014). Even if care facilities hire additional workers during recessions due to the glut of low-paid labor available on the market (Stevens et al., 2011), there may be some question as to the quality of care (QOC) administered by people who work in dementia care only because of other industries' layoffs (Diamond, 1992).

End-of-life medical care is extremely expensive and often takes place in the hospital or institutional settings (Gozalo et al., 2011), so there should be an increase in Medicare and Medicaid reimbursements in years when more people died. However, Medicare and Medicaid reimbursements are also dictated by the federal and state governments' budgets. In times of worse economic decline, federal and state governments may allocate less money per enrollee, impacting QOC. This literature leads to the second and third hypotheses.

> *Hypothesis 2. Percent change in Medicare and Medicaid funding for nursing homes, home health, assisted living, and hospital services will be negatively associated with the change in dementia mortality rate.*
>
> *Hypothesis 3. Medicare and Medicaid funding will attenuate the association between the macroeconomic factors and the dementia mortality rate.*

I argue that elders with dementia constitute a class especially vulnerable to economic stressors, leading to increased allostatic load (Seeman, Epel, Gruenewald, Karlamangla, & McEwen, 2010), and subsequently placing them at higher risk of mortality. I exploit state variation in impact of recessions (1980-2014) and in fiscal austerity for healthcare (1999-2008) to evaluate the association between macroeconomic fluctuations and dementia mortality and whether social welfare spending attenuates that association.

Methods

Data and Measures

I extracted mortality and population data (1979-2014) from the Center for Disease Control and Prevention (CDC) WONDER Online Database's Underlying Cause-of-Death data, compiled from the Compressed Mortality Files. I use the CDC's *total age-adjusted dementia-mortality rate* (DMR) per 100,000 aged 65 and over, and the same measure by sex. I also calculate *first differences of DMR*. Dementia mortality rate (DMR) from 1979-1998 follows the International Classification of Diseases Version 9 (ICD-9) and includes codes 290-Senile and presenile organic psychotic conditions, 331.0-Alzheimer's disease, 331.2-Senile degeneration of brain, and 797-Senility without mention of psychosis (Center for Disease Control and Prevention National Center for Health Statistics, 2003). DMR from 1999-2014 follow the ICD-10 and includes sub-classifications: F01-Vascular Dementia, F03-Unspecified Dementia, and G30-Alzheimer's disease (Centers for Disease Control and Prevention National Center for Health Statistics, 2015).[2] I seperate the periods for trend anlayses to account for the change in 1999 from ICD-9 to ICD-10 (Fig. 1). In models, I incorporate a binary indicator for *ICD* (ICD-10=1). Henceforth, I use the more succinct "dementia" as inclusive of all of the above sub-classifications.

The CDC tags state-years as unreliable or suppressed if estimates are based on small populations (DMR of 0-9 per 100,000) (Center for Disease Control and Prevention National Center for Health Statistics, 2003). In the earlier era of 1979-1998, some less-populated states (e.g., Alaska and North Dakota) had several years of unreliable total estimates. To be

[2]I did not include any dementia codes related to alcohol use (e.g. G31), as alcohol use is otherwise linked with economic recession.

conservative, I substitute the previous year's rate for suppressed values, so estimates from the earlier era should be interpreted with slightly more caution. All estimates may be downwardly biased because dementia is underreported on death certificates as an underlying cause-of-death (James et al., 2014).

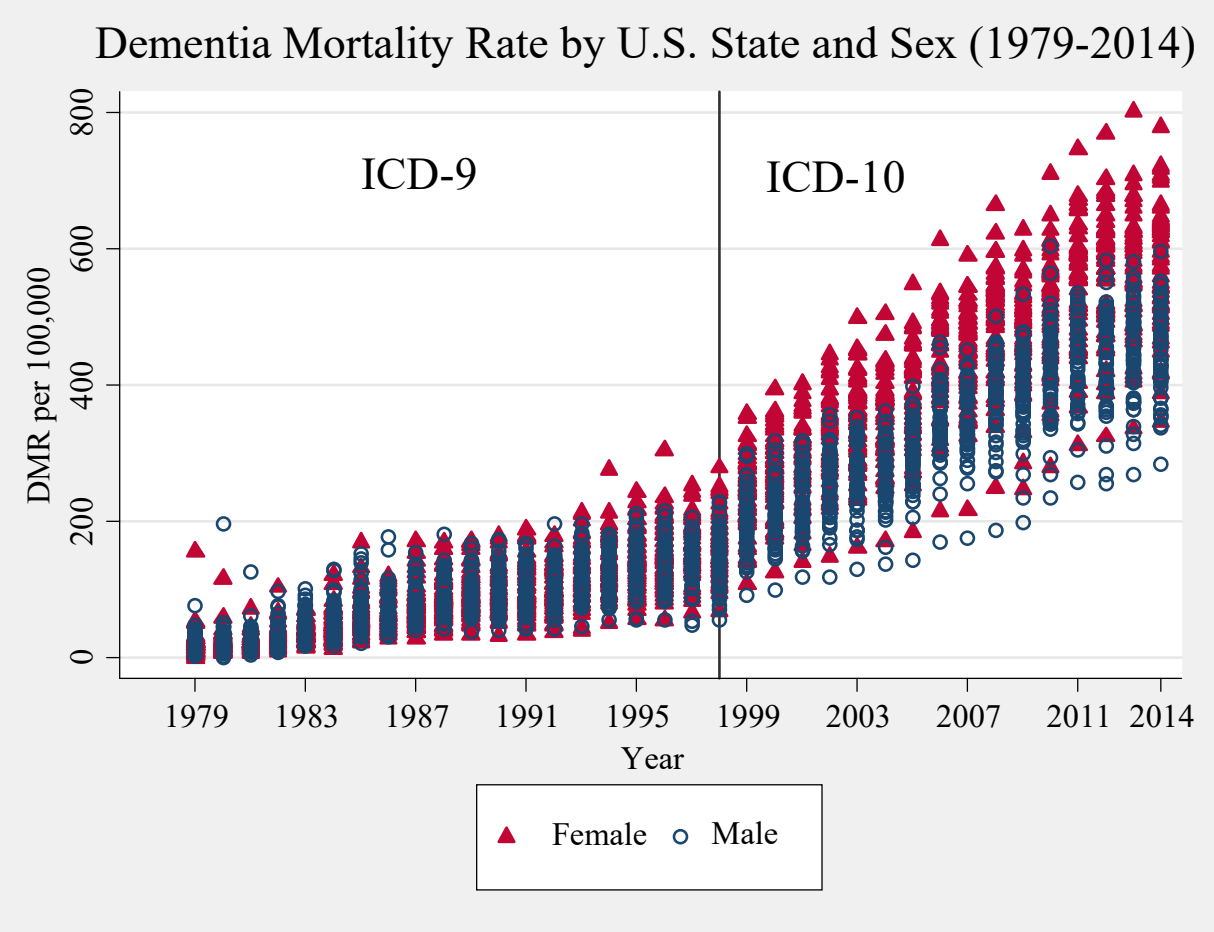

Fig. 1 Trend of age-adjusted dementia mortality rate per 100,000 aged 65+ by state and sex (1979-2014)

In supplemental analyses, I also use the CDC's Underlying Cause-of-Death data (1979-2014) for age-adjusted all-cause mortality rate (ACM) per 100,000 for females, males, and total age 65 and older.

Independent Variables

The health impact of recessions is often measured with a simple binary for whether or not it is a recession year in the entire country or, less commonly, whether there is deep, shallow, or no recession (Ruhm, 2015b). Although almost all U.S. states experienced a peak in economic insecurity during the Great Recession, levels of economic insecurity were higher in the South and West than the Northeast and North Central (Hacker et al., 2011, 2012). Also, rising economic insecurity predates the the Great Recession (Hacker et al., 2011). To capture a more precise measure of economic health, I instead use state-level unemployment rate, changes in gross sate product (GSP), and the Economic Security Index (ESI). There is significant state variation in all three measures over the period.

Unemployment Rates (UR.) URs from 1980-2014 are from the U.S. Bureau of Labor Statistics database (University of Kentucky Center for Poverty Research, 2015). I generate a categorical variable for *UR* (<4, 4-6.9, 7-8.9, and 9+) to manage floor and ceiling effects and allow for a non-linear relationship between deaths and unemployment (Glymour, Tzourio, & Dufouil, 2012).

Gross State Product (GSP). Data for state-level real GSP (1979-2014) are from the U.S. Bureau of Economic Analysis (U.S. Bureau of Economic Analysis, 2015). I divide GSP by the total population (University of Kentucky Center for Poverty Research, 2015) to get GSP per capita, then multiply by the Consumer Price Index (Bureau of Labor Statistics, 2016) and 1000 to adjust to thousands of 2014 dollars. I calculate the percent change in GSP by dividing the first difference of GSP by the lagged value of GSP, then multiplying that by 100 (*%Δ GSP*). Using percent change in lieu of first differences is to account for the differential impact of losing *x* dollars for large versus small state economies. I generate *quintiles of %Δ GSP*.

Economic Security Index. The ESI was developed by Yale's Institution for Social and Policy Studies (ISPS) to measure the share of a state population that has lost at least a quarter of their "available household income" (income available after debt and major medical costs) since the previous year, and who do not have adequate liquid financial resources to fill the gap (Hacker et al., 2011). The measure is derived from the Census Bureau's Current Population Survey, the Survey on Income and Program Participation, the Panel Study of Income Dynamics, and the Consumer Expenditure Survey. ESI takes into consideration wages and salaries, asset income, private retirement benefits, unemployment insurance, Social Security, and other cash transfers, is adjusted for inflation, and accounts for household resource-pooling (see Hacker et al. 2011). ESI excludes Alaska and D.C. I also generate *categories of ESI* (10.4-13.9, 14-15.9, 16-18.9, 19-21.9, 22-24). Fig. 2 shows the variation of this less-common measure across state and year. Note that the measure is the percent of the population that is *in*secure.

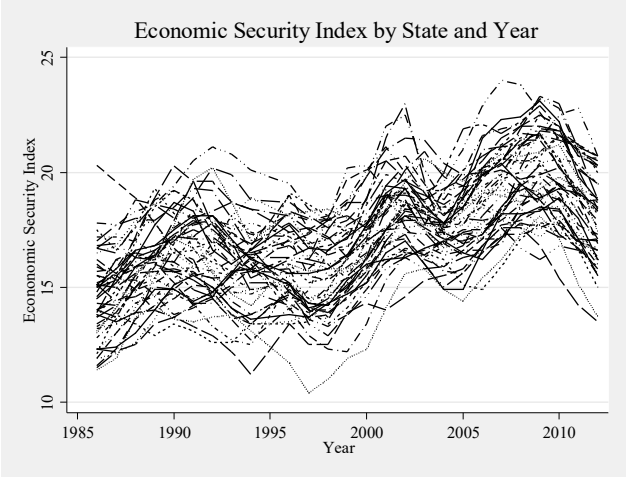

Fig. 2 Economic Security Index by state and year (1986-2012)

Medicaid/Medicare. The Centers for Medicare and Medicaid Services (CMS) report state-level annual expenditures per enrollee on hospital, nursing homes (including Veterean's

Affairs), home health services, and "non-traditional settings" from 1991-2009 (Centers for Medicaid & Medicare Services, 2014). The last, henceforth "assisted," includes non-nursing home residential facilities, and senior citizens' centers. It does include non-senior services such as ambulance services, but I posit the dollars spent across these services represent the funding climate. State fixed effects account for interstate variation. As with GSP, I calculate percent change in funding differences *(% Δ Medicare & Medicaid*) to capture changes in funding over time.

Analytic Strategy

Analyses are in three stages. First I examine the general trends of whether dementia-mortality during recessions deviated from the non-recession trends. Second, I estimate the association between DMR and state-level UR, GSP, and ESI, controlling for year to manage the secular trend of increasing DMR. Third, I examine whether percent change in state-level Medicaid and/or Medicare spending (1999-2008) for nursing homes, home health care, assisted living, and hospital services is associated with mortality and then test whether this social welfare spending mediates macroeconomic factors' association with dementia mortality.

I use time-trend analysis with state fixed effects and robust standard errors to predict an ICD-9 and ICD-10 trendlines based on the non-crisis years (1986-1998 or 1999-2007). I also estimate regressions where I include a categorical variable adapting Ruhm's (2015b) definition for no crisis, shallow, or deep recession.

To test Hypothesis 1, I estimate fixed effects models (accounting for state heterogeneity in sociopolitical factors, demographics, and geographic location), regressing DMR on UR, GSP, ESI (β_1 = UR, GSP, or ESI), and year (centered at 1995) to account for the secular trend in rising DMR.

$$Y_{it} = \alpha_i + \beta_1 Macro_{it} + \beta_2 Year_{it} + \varepsilon_{it} \quad \text{[Eq 1]}$$

For Hypothesis 2 and 3, Mundlak tests suggest random effects models are appropriate when estimating the association between first differences in DMR and percent change in Medicare and Medicaid spending. I compare models with only macroeconomic factors and year, only Medicare/Medicaid spending and year, then a model that includes macroeconomic factors, Medicare/Medicaid spending, and year to see if the social welfare spending attenuates associtaions with macroeconomic indicators. Equation 2 is similar to the above, but μ_i represents the between-state error.

$$\Delta Y_{it} = \alpha + \beta_1 Macro_{it} + \beta_2 Medicare/Medicaid_{it} + \beta_3 Year_{it} + \mu_i + \varepsilon_{it} \quad \text{[Eq 2]}$$

For all analyses I used Stata 14 and robust standard errors clustered by state to adjust for the non-independence of time-series data. I calculate predictive margins and average marginal effects for ease of interpretation. Results from all analyses available upon request.

Results

Descriptive Results

Table 1 shows descriptive statistics. UR, GSP, ESI, and Medicaid/Medicare show dips in economic recession years. Population aging is evident.

Table 1 Descriptive statistics of state-level dementia mortality rate, macroeconomic indicators, and Medicare/Medicaid funding for selected years

	1982	1992	2002	2008	2010	2012	2014	Total 1979-2014
Dementia Mortality Rate (65+)								
Mean	32.0	104.0	304.0	458.1	482.9	518.0	530.7	225.2
SD	15.8	30.8	58.1	68.6	76.2	78.6	82.0	177.6
Min.	10.3	39.6	140.1	229.4	266.4	306.6	326.1	3.9
Max.	99.8	170.0	405.9	613.9	661.9	705.8	715.3	726.0
State Unemployment Rate								
Mean	9.2	7.0	5.3	5.3	8.8	7.3	5.8	6.1
SD	2.3	1.6	1.0	1.3	2.0	1.7	1.3	2.1
Min.	5.5	2.9	3.3	3.0	3.8	3.0	2.8	2.3
Max.	15.6	11.3	7.6	8.3	13.8	11.5	7.8	17.4

% Δ Real Gross State Product Per Capita (in 1000s)								
Mean	–6.3	1.0	0.2	–1.1	3.7	0.3	–0.3	1.1
SD	2.7	2.5	2.1	3.6	2.0	2.8	2.4	3.9
Min.	–13.9	–9.9	–4.3	–7.8	0.1	–7.5	–5.7	–30.7
Max.	–0.6	5.6	10.6	13.5	10.1	15.8	5.0	20.8
Economic Security Index								
Mean		16.0	18.5	19.8	19.7	17.8		17.2
SD		1.9	1.6	1.7	1.9	1.9		2.3
Min.		12.6	14.6	16.7	15.4	13.5		10.4
Max.		21.1	23.0	23.8	23.0	20.7		24.0
% Δ State Medicare & Medicaid Funding for NHC, HHC, Assisted, and Hospital (per enrollee)								
Mean		6.0	2.8	2.8				4.4
SD		6.9	4.0	2.6				5.9
Min.		–8.9	–7.1	–2.0				–29.2
Max.		27.6	10.7	9.3				69.2
Population (Age 65+)								
Mean	525,243	634,431	696,514	760,346	789,568	846,371	906,730	666,457
SD	562,328	684,668	755,438	818,922	851,244	916,191	985,393	728,919
Min.	13,326	25,077	38,868	50,322	54,938	62,502	69,413	11,077
Max.	2,555,755	3,240,123	3,692,105	4,056,760	4,246,514	4,608,829	4,993,047	4,993,047

Sources: CDC (2003, 2015), Bureau of Economic Analysis (2015), Bureau of Labor Statistics (2014), University of Kentucky Poverty Research Center (2014), Centers for Medicare & Medicaid Services (2011)

Fig. 1 displays the increasing trend in DMR. Some of the increase is related to the coding transition from the ICD-9 to ICD-10, and some of the secular trend also may be attrributed to increased dementia awareness. Based on the non-recessionary years of 1986-1998, it appears that males have lower DMR during the 1980s recession than predicted by the trendline, while the female rate seems consistent with the trend (Fig. 3, left panel). In contrast, the predicted 1999-2007 trendline shows both females and males experience an immediate spike in mortality rate at the onset of the Great Recession (Fig. 3, right panel). The female rate then falls, but the male rate continues to hover above the trendline until 2013. There is also a peak in 2006.

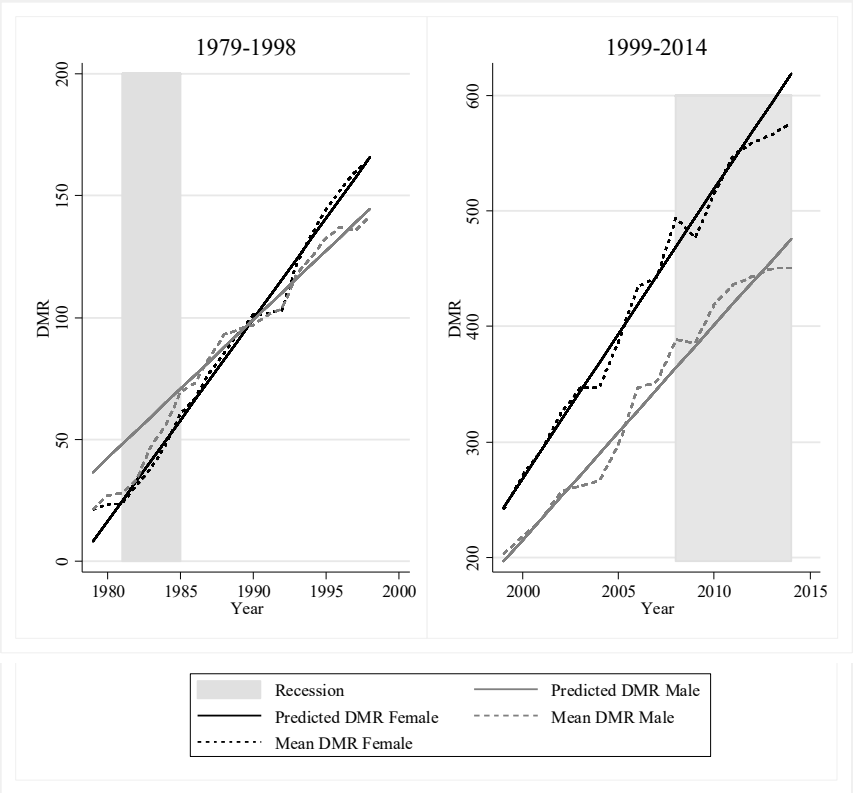

Fig. 3 Non-recessionary years' trend vs. actual dementia mortality rate (1979-2014)

The descriptive results that there is a recessionary spike is supported by the regression equation using the categorical definition of crisis years. In the 1979-1998 period, DMR is procyclical (shallow $b = -7.1$, deep $b = -6.2$, ref.: no recession), controlling for year. The regression equation for the years 1999-2014 shows a small increase in DMR during shallow recessions ($b = 9.6$) and a significant increase during deep recession years ($b = 19.1$). These trends are not mirrored in all-cause mortality (ACM). In the first period, consistent with procyclicality, ACM decreases during recession years (shallow $b = -85.1$, deep $b = -14.6$). In the later period, ACM increases in shallow recession years ($b = 42.0$), but deep recession years reflect procyclicality ($b = -44.2$) (see Appendix Fig. 7 for details on all-cause mortality rate).

Hypothesis 1. Are Macroeconomic Indicators Associated with Dementia Mortality?

I exploit the state variation in DMR and the recessions' uneven impact on state-level economic indicators to evaluate the hypothesis that dementia mortality rates are associated with macroeconomic factors. Table 2 presents multivariate models for each of the macroeconomic indicators, controlling for year. DMR is positively associated with unemployment rate for males and females (Fig. 4). Supplemental analysis of categorical UR shows that if unemployment is 9% or higher, the DMR is predicted to be 1.37 times greater than if unemployment was below 4% (Appendix **Error! Reference source not found.**). Wald tests show all categories of UR are associated with a statistically significantly higher DMR than the next lowest UR category (though the difference is smaller between the two highest categories).

Table 2 Fixed-effects regressions of dementia mortality rate on state-level macroeconomic variables by sex

	Female DMR			Male DMR		
Unemployment	11.91***			9.74***		
	(1.49)			(1.09)		
% Δ GSP		–1.84**			–1.37***	
		(0.41)			(0.24)	
ESI			7.67***			6.33***
			(1.76)			(1.39)
Observations†	1,734	1,683	1,274	1,734	1,683	1,274
States†	51	51	49	51	51	49
R-squared	0.86	0.924	0.932	0.86	0.910	0.913

Net of year; robust standard errors in parentheses; *** $p < .001$, ** $p < .01$, * $p < .05$

†Sample sizes differ by time period of available data

Percent change in GSP is negatively correlated with DMR, meaning that in state-years where GSP decreases from the previous year, relative to its previous level of GSP, DMR increases beyond the annual trend (Table 2, Fig. 4). Supplementary analysis demonstrates that states in the first quintile of GSP losses (the greatest losses) predicted 11% and 7% higher DMR, respectively, than the two highest quintiles of GSP increases (Appendix **Error! Reference source not found.**).

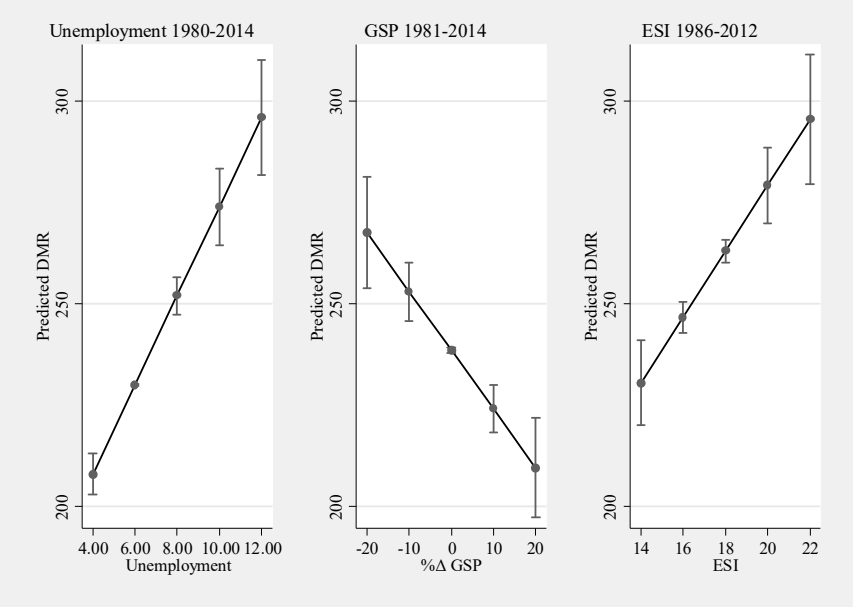

Fig. 4 Predicted dementia mortality rate by state-level macroeconomic variables, net of year and ICD

The ESI is not yet available during the earlier recession, but from 1986 to 2012, state-years that have the highest percentage of economically insecure families have significantly higher dementia mortality rates (Table 2, Fig. 4). Each additional percent increase of families losing a quarter of their available income predicts a DMR increase of 7.67 (females) or 6.33 (males). While this increase may seem minor, this translates to a 30 percent increase in DMR if families' economic insecurity moves from 14% to 22%.

Hypothesis 2. Is Medicare/Medicaid eldercare spending associated with dementia mortality rate, and does it mediate the association between economic insecurity and dementia mortality?

I next estimated a series of regressions of first differences of the age-adjusted DMR on state-level Medicaid/Medicare annual funding fluctuations per enrollee (1999-2008), including

funding for nursing homes (NHC), home health (HHC), assisted living, and hospital services, as well as an aggregate measure to represent the general funding climate. As noted above, because spending is reimbursements for services rendered in a particular year, all else being equal, one would expect that higher spending would actually be associated with more deaths. The reason that may not be the case is that as governments adjust their budgets in times of economic prosperity or crisis, their allowances for healthcare change over time, with some states implementing fiscal austerity measures during the Great Recession.

In the aggregate measure of Medicaid/Medicare funding for NHC, HHC, assisted, and hospital services, DMRs are lower when funding increases are greater (Table 3), evidence for Hypothesis 2a. In terms of the separate measures of Medicare/Medicaid funding, the associations are consistently negative, though not all are statistically significant. Coefficients for Medicaid plus Medicare for assisted living and hospital services, total Medicare, total Medicaid (with and without hospital services), and total Medicare plus Medicaid (with and without hospital services) are all negative and significant (not pictured).

Table 3 Regressions of first differences in DMR on Medicare/Medicaid funding (1999-2008)

	ESI	SE	Med	SE	Full	SE
ESI	1.252**	(0.48)			1.237*	(0.49)
%Δ Medicare/aid			–1.06***	(0.23)	–1.06***	(0.23)
Year	1.50***	(0.34)	1.77***	(0.31)	1.45***	(0.34)
Constant	–11.09***	(7.85)	13.91***	(2.99)	–5.86	(7.95)
Observations	441		441		441	
States	49		49		49	
Robust standard errors in parentheses						
*** $p < .001$, ** $p < .01$, * $p < .05$						

In testing Hypothesis 2b that fluctuations in this Medicare/Medicaid spending attenuates the association between economic insecurity and DMR, I find that the effect is minimal if Medicare/Medicaid is measured linearly (Table 3). However, in supplementary analyses using quintiles of funding, states that continue to increase funding of Medicare and Medicaid at the

highest quintile regardless of the crisis (i.e., those states that were not as negatively affected by the Great Recession or, in terms of Medicare/Medicaid, did not enact fiscal austerity measures) have a weaker association between ESI and DMR. Spending mediates the association between economic insecurity and dementia mortality rates by about 11% (not pictured).[3]

Discussion

The literature suggests three mechanisms that form the background for these analyses: 1) Direct effects of caregivers' un- or under-employment and indirect effects of the stress of economic crisis lead to reduced quality of care and quality of life (QOC/QOL) for community-living elders, increasing risk of death; 2) Financial strain on the family and/or stress-related cognitive decline results in institutionalization, a transition which increases risk of death; 3) Fiscal austerity measures lead to reduced staffing combined with lower rates of community-based volunteers, reducing or eliminating leisure activities at institutions, which leads to reduced QOC/QOL for those institutionalized, increasing risk of death.

I exploit state-level variation in unemployment rate, fluctuations in real GSP per capita, and families' economic insecurity to test whether macroeconomic factors affect the dementia mortality rate (DMR). I next test the hypothesis that annual percent change in state Medicaid/Medicare spending for nursing homes, home health, assisted living, and hospital services is associated with DMR and will attenuate the deleterious effect of economic insecurity on DMR in the era 1999-2008.

Hypothesis 1 that DMR will be associated with the unemployment rate, percent change in GSP, and economic insecurity is supported by the evidence. Higher unemployment and more

[3] Mediation of unemployment rate on DMR is nonsignificant, but percent change in gross state product is similarly mediated by total Medicare/Medicaid funding by 12%.

economic insecurity are positively associated with the DMR and larger percent decreases in GSP are associated with increases in dementia deaths. In other words, state-years with the worst economies predict the largest increases in dementia mortality.

Findings partially support the second hypothesis. State-years that cut these particular Medicare/Medicaid funding streams, relative to their prior level of funding, have statistically and substantively significant increases in dementia mortality rates compared to state-years that maintained the trend of funding increases. I find limited evidence for Hypothesis 2b. Medicare/Medicaid spending attenuated the association between economic insecurity (ESI) and DMR and percent change in GSP and DMR by just over 10%.

Limitations

Although I attempt to determine whether elders with dementia are particularly vulnerable to macroeconomic shock, my analyses are somewhat limited by the available data sources. First, I use the CDC's data for the rate of dementia as underlying-cause-of-death, despite the fact that dementia is underreported (James et al. 2014). This source of error is unavoidable in datasets that rely on death certificates. Second, there is no data on the annual population of those who suffer from dementia by state. Therefore, as the denominator for the DMR, I use the total population of elders age 65 and over. This means I am technically studying not the vulnerability of elders who already have dementia, but the proportion of dementia deaths to the whole elder population. As noted above, because dementia progresses slowly, this limitation is less problematic—elders are unlikely to both develop and die from dementia over the course of a recession. However, using smaller datasets to examine outcomes for the subpopulation already diagnosed with dementia is a clear next step in this research. Third and relatedly, although I use aggregate data, the mechanisms I propose operate at the individual level. Thus, while this study provides a first step

in discovering whether there may be a trend linking macroeconomic shock with a vulnerable population's mortality, a qualitative project or a smaller quantitative dataset that includes the relevant individual-level factors is a necessary follow-up project.

Conclusion

Already 47.5 million people worldwide suffer some type of dementia (World Health Organization, 2016). In this era of dramatic population aging, understanding social correlates of dementia is increasingly important. Research has consistently demonstrated that population-level mortality is procyclical, but I posit that recessions, especially dramatic economic crises like the Great Recession, could have harmful health effects on vulnerable populations, such as elders with dementia.

I set forth three plausible mechanisms linking economic recessions with dementia mortality to clarify the underlying logic for the study. First, community-living elders may face higher stress. Elders with early-stage dementia may directly experience the crisis, elevating allostatic load, which negatively impacts their (already compromised) immune systems and increases risk of mortality. Elders afflicted with later-stage dementia might be unaware of the economic crisis, but community-living caregivers under financial strain may have a harder time providing adequate levels of care for this dependent, high-needs population (Brodaty et al., 1993; Karlawish et al., 2001). Because non-institutionalized elders are extremely sensitive to their caregivers' stress levels (Gaugler et al., 2007; Kunik et al., 2010), they may absorb familial stress, raising allostatic load.

Second, elders may be more likely to be institutionalized during recessions. Although caregivers tend to support their elders in the community as long as possible (Navarro-Gil et al., 2014), families who are directly affected by job loss may not be able to financially support an

additional person. Most institutional care is covered by a combination of Medicare and Medicaid, thus institutionalizing an elder may relieve the family of some economic burden. Furthermore, even if the family does not directly experience layoffs or cut wages, recession-related stressors may drive caregivers to institutionalize their elders. Despite efforts to shelter elders, the transition to institutionalization increases elders' risk of death, even controlling for pre-institutionalization health and dementia severity (Aneshensel et al., 2000; Brodaty et al., 1993).

Third, for elders who do survive the adjustment to institutionalization or who were already in institutions, recession-driven austerity measures are likely to 1) decrease staff-patient ratios, and 2) limit or layoff "non-essential" staff, while 3) volunteerism declines (Piatak, 2016). Regardless of whether staff is able to provide adequate quality of care (and arguably with limited staff they are not), these cuts decrease sources of engagement for institutionalized elders, affecting quality of life (Shippee, Hong, Henning-Smith, & Kane, 2015; Terada et al., 2013). Quality of life is strongly predictive of life expectancy in general (Sirgy et al., 2006) and time-to-death for elders with dementia in particular (Aneshensel et al., 2000).

These analyses show spikes in dementia mortality rates during the Great Recession, providing evidence for the above theoretical argument that elders with dementia may be particularly vulnerable to macroeconomic shocks. Austerity measures fuelling cuts in state-level social welfare spending do appear to negatively impact this vulnerable population. Eldercare spending may buffer some of the negative effects of economic insecurity. Further research is needed to understand the mechanisms linking crises with dementia mortality to help institutions and caregiver support groups establish ways to mitigate harm.

References

Alzheimer's Association. (2015). 2015 Alzheimer's disease facts and figures. *Alzheimer's & Dementia*, *11*(3), 332–84. https://doi.org/10.1016/j.jalz.2015.02.003

Alzheimer's Association. (2016). 2016 Alzheimer's facts and figures. *Alzheimer's & Dementia*, *12*(4).

American Elder Care Research Organization. (2014). "Costs of Senior Care" [Web Page]. Retrieved from http://www.payingforseniorcare.com/

Aneshensel, C. S., Pearlin, L. I., Levy-Storms, L., & Schuler, R. H. (2000). The Transition From Home to Nursing Home Mortality Among People With Dementia. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *55*(3), S152–S162. Journal Article. https://doi.org/10.1093/geronb/55.3.S152

Arinaminpathy, N., & Dye, C. (2010). Health in financial crises: economic recession and tuberculosis in Central and Eastern Europe. *J R Soc Interface*, *7*(52), 1559–1569. Journal Article. https://doi.org/10.1098/rsif.2010.0072

Bacigalupe, A., Escolar-Pujolar, A., & Escolar, A. (2014). The impact of economic crises on social inequalities in health: what do we know so far? *International Journal for Equity in Health*, *13*(1), 52. Journal Article. https://doi.org/10.1186/1475-9276-13-52

Banks, J., Muriel, A., & Smith, J. P. (2010). Disease prevalence, disease incidence, and mortality in the United States and in England. *Demography*, *47 Suppl*, S211-31. Journal Article.

Brodaty, H., & Donkin, M. (2009). Family caregivers of people with dementia. *Dialogues in Clinical Neuroscience*, *11*(2), 217. Journal Article.

Brodaty, H., McGilchrist, C., Harris, L., & Peters, K. E. (1993). Time until institutionalization and death in patients with dementia. Role of caregiver training and risk factors. *Arch Neurol*, *50*(6), 643–650. Journal Article.

Bureau of Labor Statistics. (2016). Consumer Price Index. Retrieved April 30, 2016, from http://www.bls.gov/cpi/

Burgard, S. A., & Kalousova, L. (2015). Effects of the Great Recession: Health and Well-Being. *Annual Review of Sociology*, *41*(1). https://doi.org/10.1146/annurev-soc-073014-112204

Cagney, K. A., Browning, C. R., Iveniuk, J., & English, N. (2014). The onset of depression during the Great Recession: Foreclosure and older adult mental health. *American Journal of Public Health*, *104*(3), 498–505. https://doi.org/10.2105/AJPH.2013.301566

Center for Disease Control and Prevention National Center for Health Statistics. (2003). *Compressed Mortality File, 1979-1998 (Series 20, No. 2A, 2000 & Series 20, No. 2E, 2003)*. Hyattsville, Maryland. Retrieved from http://wonder.cdc.gov/cmf-icd9.html

Center on Budget and Policy Priorities. (2015). "Policy Basics: Introduction to Medicaid" [Web Page]. Retrieved from http://www.cbpp.org/cms/index.cfm?fa=view&id=2223

Centers for Disease Control and Prevention National Center for Health Statistics. (2015). Compressed Mortality File 1999-2014 on CDC WONDER Online Database (Series 20 No. 2T, 2015). Retrieved from Accessed at http://wonder.cdc.gov/cmf-icd10.html on Mar 17, 2016 1:42:41 PM

Centers for Medicaid & Medicare Services. (2014). *Health Expenditures by State of Residence, Summary Tables, 1991-2009*. Retrieved from https://www.cms.gov

Colledge, M. (1982). Economic cycles and health. Towards a sociological understanding of the impact of the recession on health and illness. *Soc Sci Med*, *16*(22), 1919–1927. Journal Article.

De Vogli, R. (2013). Unemployment and suicides during the recession in Italy. *BMJ (Clinical Research Ed.)*, *347*(August), f4908. https://doi.org/10.1136/bmj.f4908

Diamond, T. (1992). *Making gray gold: Narratives of nursing home care*. Book, Chicago: University of Chicago Press.

Gaugler, J. E., Kane, R. L., & Newcomer, R. (2007). Resilience and transitions from dementia caregiving. *J Gerontol B Psychol Sci Soc Sci*, *62*(1), P38-44. Journal Article.

Gerdtham, U.-G., & Ruhm, C. J. (2006). Deaths rise in good economic times: Evidence from the OECD. *Economics & Human Biology*, *4*(3), 298–316. Journal Article. https://doi.org/http://dx.doi.org/10.1016/j.ehb.2006.04.001

Glymour, M. M., Tzourio, C., & Dufouil, C. (2012). Is cognitive aging predicted by one's own or one's parents' educational level? Results from the three-city study. *American Journal of Epidemiology*, *175*(8), 750–759. https://doi.org/10.1093/aje/kwr509

Gozalo, P., Teno, J. M., Mitchell, S. L., Skinner, J., Bynum, J., Tyler, D., & Mor, V. (2011). End-of-life transitions among nursing home residents with cognitive issues. *New England Journal of Medicine*, *365*(13), 1212–1221. https://doi.org/10.1056/NEJMsa1100347.End-of-Life

Hacker, J. S., Huber, G. A., Nichols, A., Rehm, P., & Craig, S. (2011). *Economic Insecurity and the Great Recession: Findings from the Economic Security Index*. New Haven, CT. https://doi.org/10.1007/s10834-015-9442-7

Hacker, J. S., Huber, G. A., Nichols, A., Rehm, P., & Craig, S. (2012). *Economic Insecurity Across the American States: New state estimates from the Economic Security Index*. New Haven, CT. Retrieved from http://economicsecurityindex.org/assets/state_reports/ESI_cross_state.pdf

Herl, C. J. R., Hessel, P., Leist, A., & Berkman, L. F. (2015). Recessions , unemployment and the brain : Do individual and aggregate economic shocks prior to retirement leave a cognitive " scar "? Authors Affiliations : London School of Economics and Political Science , Department of Social Policy , LSE University of. In *Population Association of America* (pp. 1–7).

Hurd, M. D., Martorell, P., Delavande, A., Mullen, K. J., & Langa, K. M. (2013). Monetary Costs of Dementia in the United States. *New England Journal of Medicine*, *368*(14), 1326–1334. Journal Article. https://doi.org/doi:10.1056/NEJMsa1204629

James, B. D., Leurgans, S. E., Hebert, L. E., Scherr, P. A., Yaffe, K., & Bennett, D. A. (2014). Contribution of Alzheimer disease to mortality in the United States. *Neurology*. Journal Article. https://doi.org/10.1212/wnl.0000000000000240

Kalil, A. (2013). Effects of the great recession on child development. *The ANNALS of the American Academy of Political and Social Science*, *650*(1), 232–250. https://doi.org/10.1177/0002716213500453

Kaplan, G. A. (2012). Economic crises: Some thoughts on why, when and where they (might) matter for health—A tale of three countries. *Soc Sci Med*, *74*(5), 643–646. Journal Article. https://doi.org/10.1016/j.socscimed.2011.12.013

Karanikolos, M., Mladovsky, P., Cylus, J., Thomson, S., Basu, S., Stuckler, D., … McKee, M. (2013). Financial crisis, austerity, and health in Europe. *The Lancet*, *381*(9874), 1323–1331. https://doi.org/10.1016/S0140-6736(13)60102-6

Karlawish, J. H. T., Casarett, D., Klocinski, J., & Clark, C. M. (2001). Alzheimer ' s Disease Patients ' Quality of Life , Disease Severity , *14*, 1066–1070.

Kunik, M. E., Snow, a. L., Davila, J. a., Steele, A. B., Balasubramanyam, V., Doody, R. S., … Morgan, R. O. (2010). Causes of aggressive behavior in patients with dementia. *Journal of Clinical Psychiatry*, *71*(9), 1145–1152. Journal Article. https://doi.org/10.4088/JCP.08m04703oli

Mark, T. L., Hodgkin, D., Levit, K. R., & Thomas, C. P. (2016). Growth in Spending on and Use of Services for Mental and Substance Use Disorders After the Great Recession Among Individuals With Private Insurance. *Psychiatric Services (Washington, D.C.)*, (11), appips201500034. https://doi.org/10.1176/appi.ps.201500034

McEwen, B. S. (1998). Stress, adaptation, and disease: Allostasis and Allostatic Load. *Annals of the New York Academy of Sciences*, *53*(9), 1689–1699. https://doi.org/10.1017/CBO9781107415324.004

McInerney, M., Mellor, J. M., & Nicholas, L. H. (2013). Recession depression: Mental health effects of the 2008 stock market crash. *Journal of Health Economics*, *32*(6), 1090–1104. Journal Article. https://doi.org/http://dx.doi.org/10.1016/j.jhealeco.2013.09.002

McKee, M., Karanikolos, M., Belcher, P., & Stuckler, D. (2012). Austerity: a failed experiment on the people of Europe. *Clin Med*, *12*(4), 346–350. Journal Article.

Nandi, A., Charters, T. J., Strumpf, E. C., Heymann, J., & Harper, S. (2013). Economic conditions and health behaviours during the "Great Recession." *J Epidemiol Community Health*, *67*(12), 1038–1046. Journal Article. https://doi.org/10.1136/jech-2012-202260

Navarro-Gil, P., González-Vélez, A. E., Ayala, A., Martín-García, S., Martínez-Martín, P., & Forjaz, M. J. (2014). Which factors are associated with mortality in institutionalized older adults with dementia? *Archives of Gerontology and Geriatrics*. https://doi.org/10.1016/j.archger.2014.07.007

Phelan, J. C., Link, B. G., & Tehranifar, P. (2010). Social conditions as fundamental causes of health inequalities: Theory, evidence, and policy implications. *Journal of Health and Social Behavior*, *51*(S), S28–S40. Journal Article. https://doi.org/10.1177/0022146510383498

Phillips, J. A., & Nugent, C. N. (2014). Suicide and the Great Recession of 2007-2009: The role of economic factors in the 50 U.S. states. *Social Science and Medicine*, *116*, 22–31. https://doi.org/10.1016/j.socscimed.2014.06.015

Piatak, J. S. (2016). Time Is on My Side: A Framework to Examine When Unemployed Individuals Volunteer. *Nonprofit and Voluntary Sector Quarterly*. https://doi.org/10.1177/0899764016628295

Quast, T., & Gonzalez, F. (2014). Economic cycles and heart disease in Mexico. *Social Science and Medicine*, *109*, 19–25. https://doi.org/10.1016/j.socscimed.2014.03.013

Ruhm, C. J. (2003). Good times make you sick. *Journal of Health Economics*, *22*(4), 637–658. Journal Article. https://doi.org/http://dx.doi.org/10.1016/S0167-6296(03)00041-9

Ruhm, C. J. (2005). Healthy living in hard times. *Journal of Health Economics*, *24*(2), 341–363. Journal Article. https://doi.org/http://dx.doi.org/10.1016/j.jhealeco.2004.09.007

Ruhm, C. J. (2015a). Health Effects of Economic Crises. *NBER Working Paper*, *Oct*(21604). https://doi.org/10.1017/CBO9781107415324.004

Ruhm, C. J. (2015b). Recessions, healthy no more? *Journal of Health Economics*, *42*, 17–28. https://doi.org/10.1016/j.jhealeco.2015.03.004

Seeman, T., Epel, E., Gruenewald, T., Karlamangla, A., & McEwen, B. S. (2010). Socio-economic

differentials in peripheral biology: Cumulative allostatic load. *Annals of the New York Academy of Sciences*, *1186*(1), 223–239. Journal Article. https://doi.org/10.1111/j.1749-6632.2009.05341.x

Shippee, T. P., Hong, H., Henning-Smith, C., & Kane, R. L. (2015). Longitudinal Changes in Nursing Home Resident-Reported Quality of Life: The Role of Facility Characteristics. *Res Aging*, *37*(6), 555–580. https://doi.org/10.1177/0164027514545975

Sirgy, M. J., Michalos, A. C., Ferriss, A. L., Easterlin, R. A., Patrick, D., & Pavot, W. (2006). The Quality-of-Life (QOL) Research Movement: Past, Present, and Future. *Social Indicators Research*, *76*(3), 343–466. Journal Article. https://doi.org/10.2307/27522565

Stevens, A. H., Miller, D. L., Page, M. E., & Filipski, M. (2011). *The best of times, the worst of times: Understanding pro-cyclical mortality* (Report). National Bureau of Economic Research.

Stuckler, D., Basu, S., Suhrcke, M., Coutts, A., & McKee, M. (2009). The public health effect of economic crises and alternative policy responses in Europe: an empirical analysis. *The Lancet*, *374*(9686), 315–323. Journal Article. https://doi.org/10.1016/S0140-6736(09)61124-7

Tapia-Granados, J. A. (2005). Increasing mortality during the expansions of the US economy, 1900–1996. *Int J Epidemiol*, *34*(6), 1194–1202. Journal Article.

Terada, S., Oshima, E., Yokota, O., Ikeda, C., Nagao, S., Takeda, N., … Uchitomi, Y. (2013). Person-centered care and quality of life of patients with dementia in long-term care facilities. *Psychiatry Research*, *205*(1–2), 103–108. Journal Article. https://doi.org/http://dx.doi.org/10.1016/j.psychres.2012.08.028

The PLoS Medicine Editors. (2010). Social Relationships Are Key to Health, and to Health Policy. *PLoS Medicine*, *7*(8), 2. https://doi.org/doi:10.1371/journal.pmed.1000334

Toffolutti, V., & Suhrcke, M. (2014). Assessing the short term health impact of the Great Recession in the European Union: a cross-country panel analysis. *Prev Med*, *64*, 54–62. Journal Article. https://doi.org/10.1016/j.ypmed.2014.03.028

U.S. Bureau of Economic Analysis. (2015). *Table 1. Per Capita real GDP by state (chained 2009 dollars): All Industry Total (NAICS)*. Retrieved from http://www.bea.gov/iTable

University of Kentucky Center for Poverty Research. (2015). *UKCPR National Welfare Data, 1980-2014*. Lexington, KY. Retrieved from http://www.ukcpr.org/data

World Health Organization. (2016). *Dementia*. Retrieved from http://www.who.int/mediacentre/factsheets/

Xie, J., Brayne, C., & Matthews, F. E. (2008). Survival times in people with dementia: analysis from population based cohort study with 14 year follow-up. *Bmj*, *336*, 258–262. https://doi.org/10.1136/bmj.39433.616678.25

Appendix I. Additional Figures

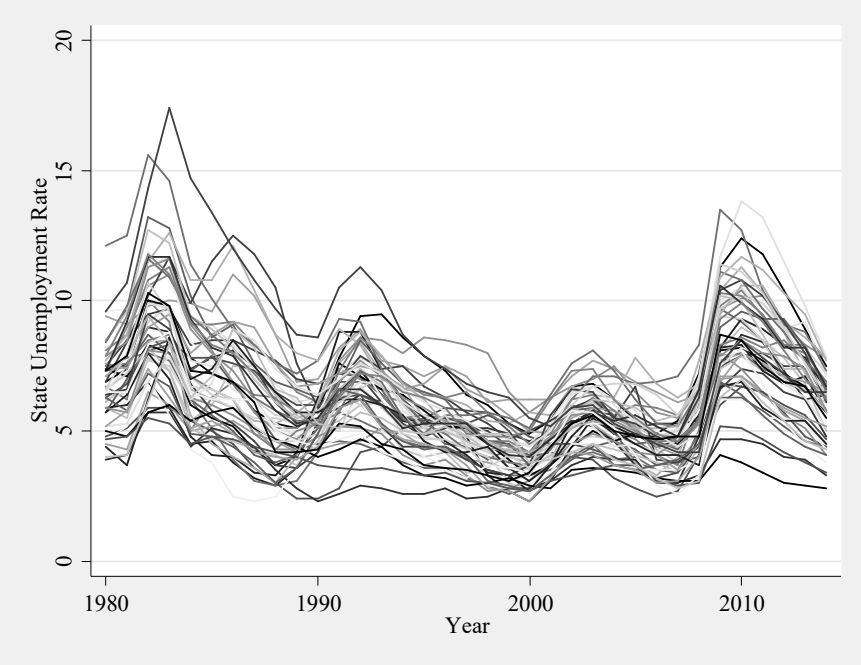

Fig. 5 Unemployment rate by state and year

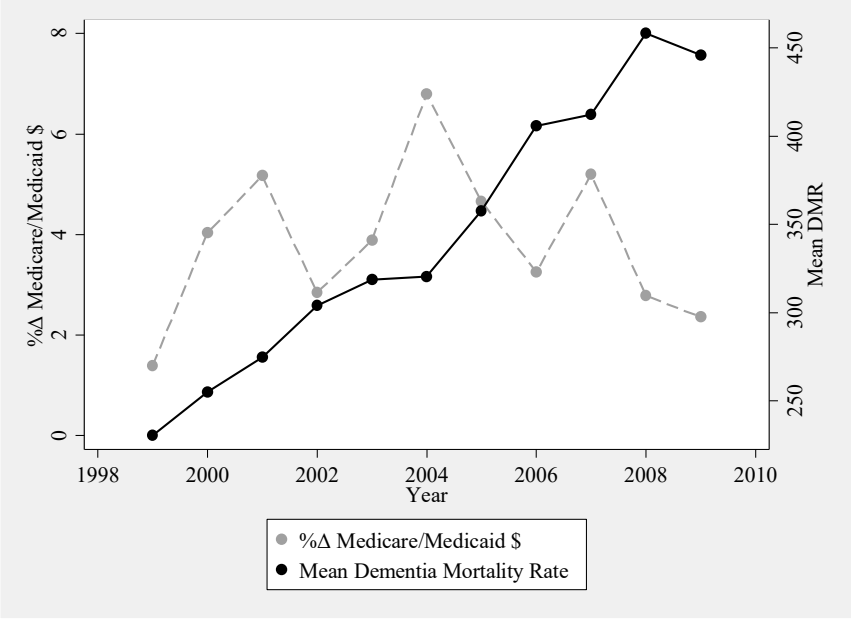

Fig. 6 Medicare/Medicaid eldercare spending and dementia mortality rate by year

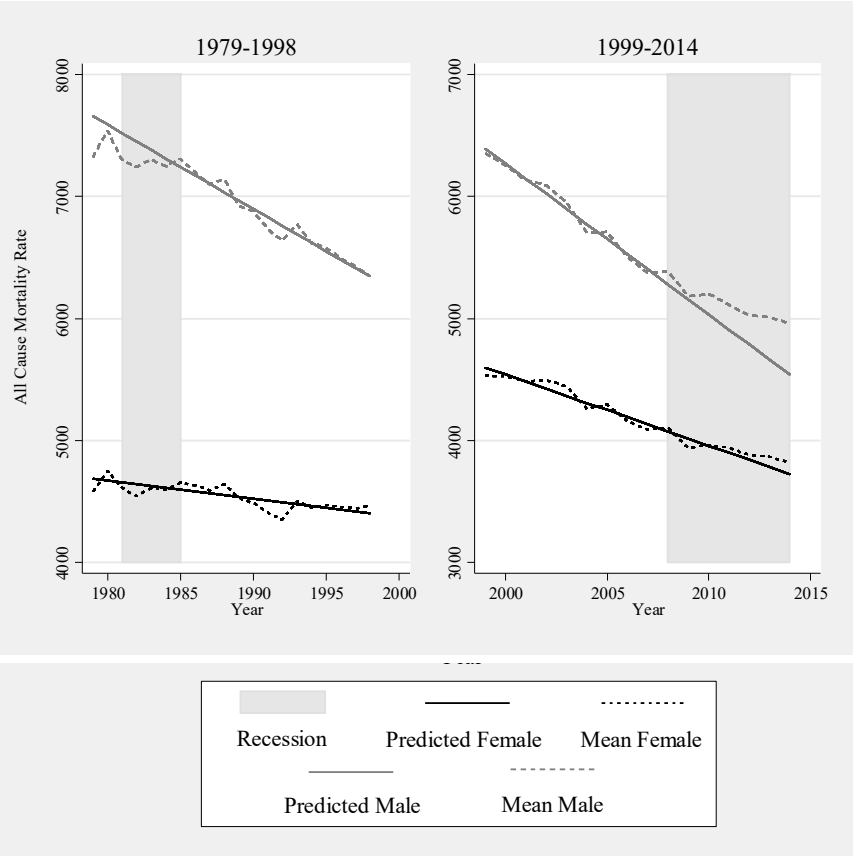

Fig. 7 Predicted and mean all-cause mortality rate for elders age 65+

Appendix II. Sensitivity Analyses

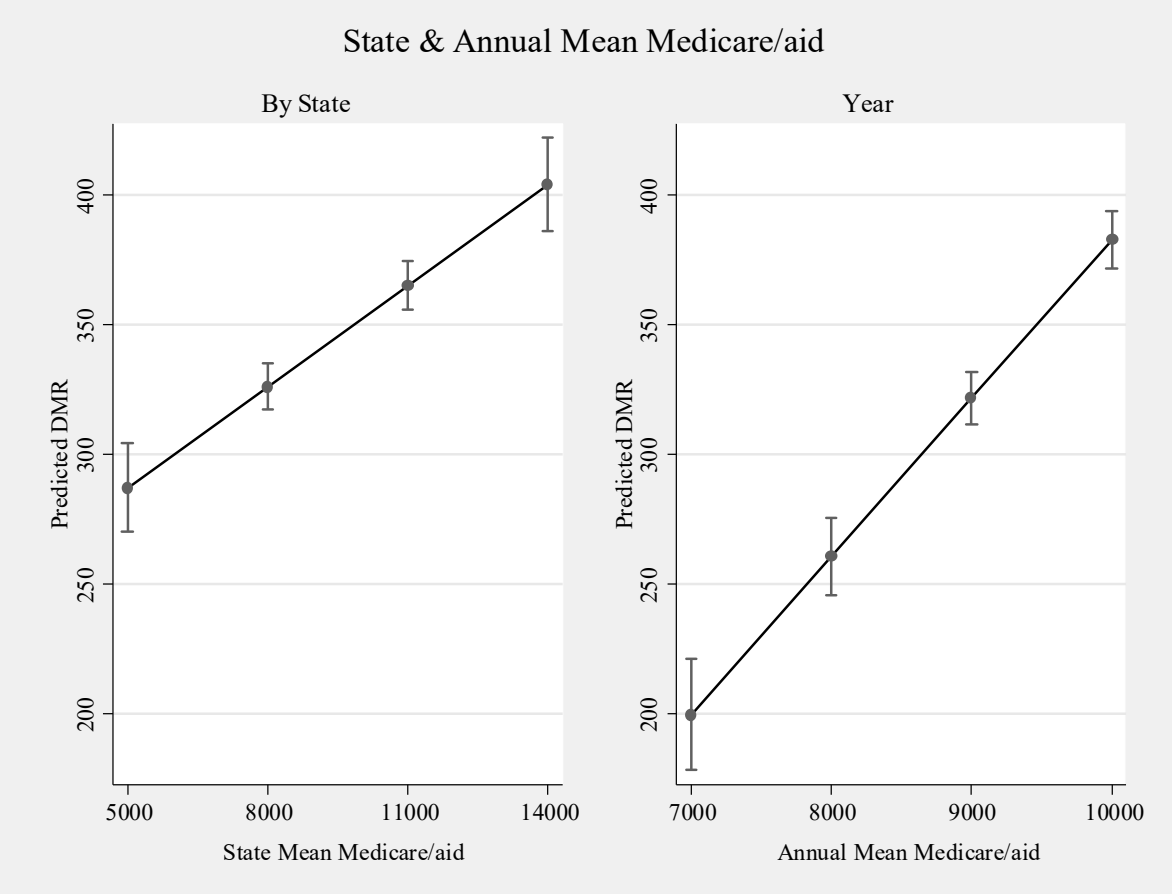

Figure 8 Showing that, in general, higher dementia mortality rates are associated with higher Medicare/Medicaid spending