Home Safety, Accessibility, and Elderly Health: Evidence from Falls

Michael D. Eriksen
Texas Tech University

Nadia Greenhalgh-Stanley
Kent State University

Gary V. Engelhardt
Syracuse University

September 12, 2014

Abstract

We use rich longitudinal data from the Health and Retirement Study to estimate some of the health benefits to the elderly from safer, more accessible homes. We focus on the role of home safety and accessibility features on the prevention of serious, non-fatal falls for widowed individuals. The presence of such features reduces the likelihood of a fall requiring medical treatment by 20 percentage points, a substantial effect. However, we find that falls are not the type of health shock that is a main driver of housing tenure transitions among the elderly.

Acknowledgements: The research reported herein was supported by a grant from the MacArthur Foundation program on How Housing Matters. The opinions and conclusions are solely those of the authors and should not be construed as representing the opinions or policy of the MacArthur Foundation, Syracuse University, Kent State University, or Texas Tech University. All errors are our own.

1. Introduction

What are the benefits of safer homes? For the elderly, "safer" often means physically easier to navigate. Home safety and accessibility features, such as shower seats, grab bars, railings, and ramps, are designed, in general, to promote function within the residence and, in particular, to prevent falls, which often result in significant injury and medical expenditures. Indeed, Stevens et al. (2006) estimated that falls by older Americans resulted in over $19B in calendar year 2000 dollars in direct medical treatment in 2000, roughly as much as government expenditures on extensively studied programs like Section 8 rental housing, Supplemental Nutrition Assistance Program (SNAP, formerly known as food stamps), and Temporary Assistance for Needy Families (TANF). In current dollars, this translates to $31.8B in direct medical treatment. [1]

In this paper, we use rich longitudinal data from the Health and Retirement Study (HRS) to estimate some of the health benefits to the elderly from safer, more accessible homes. We focus on the role of home safety and accessibility features on the prevention of serious, non-fatal falls—those requiring medical treatment—and the impact of fall reduction on residential transitions.

Our analysis is most closely related to three strands in the existing housing literature. The first has focused on the extent to which housing generates significant benefits in non-housing domains. These include impacts on child well-being and health (Green and White, 1997; Boehm and Schlottmann, 1999; Dietz and Haurin, 2003; Fortson and Sanbonmatsu, 2010; Jacob et al.,

[1] In their Table 2, Currie and Gahvari (2008) calculated expenditures for a large number of programs in 2002. Deflating those expenditures to real calendar-year 2000 dollars using the CPI to be consistent with the calculations in Stevens et al. (2006), there was $19.2B in expenditure for Section 8 and other assisted rental housing, $20.8B for SNAP, and $23.6B for TANF. Englander et al (1996) provides an alternative set of estimates that suggests $20.2B of annual medical expenditure nationally as a result of falls. The $31.8B current dollar figure was calculated by inflating Stevens' figure of $19B using the December, 2000, and July 2014, medical care CPI.

2013). Within this area, little attention has been given to the elderly. The second has focused on the role of health shocks in generating housing tenure transitions and spend-down of home equity at older ages. This includes the well-cited studies by Venti and Wise (1989, 1990, 2001, 2004), as well as work by Feinstein (1993) and Megbolugbe et. al. (1997), among others. The third is work by Kutty (1999, 2000), who has used the Becker-Grossman approach for the production of human and health capital to model the joint production of functionality and the demand for home safety and accessibility modifications among the elderly.[2]

A fundamental empirical challenge in identifying causal impacts on health and other outcomes is that safety features are not assigned randomly across homes. An important contribution of our analysis is that we outline the econometric problems in estimating causal impacts and then propose an instrumental variable (IV) procedure to circumvent these difficulties. Our IV approach, detailed below, can be summarized generally as follows. For older married couples, typically one spouse experiences a functional decline at a faster rate than the other, eventually leading to widowhood. Home safety and accessibility modifications are often made to accommodate the declining spouse, which then become a legacy to the surviving spouse upon widowhood. That is, surviving spouses may find themselves in residences with safety and accessibility features, independent of their own health trajectory.

We apply this logic to a sample of recently widowed homeowners 65 or older, who we can track over time in the Health and Retirement Study (HRS). We use the deceased spouse's functional status when alive, as measured by limits to Activities of Daily Living (ADLs), as an instrumental variable for the presence of home safety and accessibility features for the surviving

[2] There is a large literature examining falls in health services, demography, and gerontology. Gillespie et al. (2012), Wahl et al. (2009) and Heinrich et al. (2010) provide recent reviews of work in those areas.

spouse in the years after widowhood, and then estimate the impact of these features on the likelihood of a serious fall for the widow. There is a strong first-stage relationship: each additional ADL limit of the deceased spouse before death is associated with a 6 percentage point increase in the likelihood that the surviving spouse lives in a home with safety and accessibility features conditional upon their own health and fall history.

Based on our IV approach, we have a number of findings. First, the presence of safety and accessibility features reduces the likelihood of a serious fall for the widowed by 20 percentage points. Given the mean prevalence of falls of 11.6%, this is a substantial effect. The bulk of the effect is concentrated among men and those 75 and older. Therefore, our results suggest that housing investment in safety could significantly reduce serious falls among the elderly. Second, there is suggestive evidence that safety and accessibility features are associated with a reduction in the likelihood of a nursing home stay. There is little evidence, however, that falls are the type of health shock that is a main driver of own-to-rent transitions among the elderly documented by Venti and Wise (1989, 1990, 2001, 2004).

We end the analysis with a description of housing investments in safety and accessibility features. Although somewhat speculative, back-of-the-envelope calculations suggest that over a two-year period on average each dollar of housing investment in home safety and accessibility features is associated with a 93-cent reduction in medical costs from fewer non-fatal falls.

The remainder of the paper is organized as follows. Section 2 gives basic national statistics on falls among the elderly. Section 3 describes the HRS data and econometric specification; section 4 outlines the IV strategy. After the main findings are presented in section 5, extensions are presented in section 6. A large series of robustness checks are chronicled in section 7. The impact on housing outcomes is discussed in the final section. There is a brief conclusion that discusses caveats and presents the investment calculations just described.

2. Background on Falls

Falls are the leading cause of accidental death and non-fatal physical trauma among the elderly. They also can cause substantial psychological trauma. In Table 1, we reproduce data for calendar year 2000, which roughly coincides with the beginning of our analysis sample described below, taken from Stevens et al. (2006). The estimates in their analysis originate from a comprehensive national study of the incidence and medical treatment costs of falls for the elderly, defined as those 65 and older. The data were drawn from the 2000 National Vital Statistics System, 2001 National Electronic Injury Surveillance System, 2000 Health Care Utilization Program National Inpatient Sample, 1999 Medical Expenditure Panel Survey (MEPS), and 2000 Medicare claims data. These estimates understate the true costs of falls, because these data sources exclude costs associated longer-term skilled care usually paid for by Medicaid and acute care costs incurred through Medicare HMOs.

Columns 1-4 of the table show statistics on prevalence and cost for fatal falls. Just over ten-thousand elderly individuals died from falls in 2000 (column 1). Male, older, and widowed individuals were the most likely to die as a result of a fall. The estimated cost of medical treatment for all fatal falls was $179 million in calendar year 2000 dollars. The ratio of the medical care CPI in 2014 to 2000 is 1.67, which implies a cost of fatal falls of $300 million in current dollars. The most common fatality was from traumatic brain injury, which occurred in 46% of the cases and was associated with a similar proportion of total cost.

The data source for our empirical analysis below, the HRS, does not have a sufficiently large sample to study fatal falls. Therefore, we focus on non-fatal falls, national data for which appear in columns 5-8. There were an estimated 2.6 million non-fatal falls that required medical treatment in 2000 (column 5), half of which involved females who were 75 and older.[3] The estimated cost of medical treatment for all non-fatal falls was $19 billion, or an average of $7,300 per fall in calendar year 2000 dollars, or $12,213 in current dollars.[4] Injuries to the extremities were the most common. They accounted for 54% of the cases and 61% of cost. The most common types of injury were fractures, contusions, and sprains, which combined to account for 81% and 84% of all cases and treatment costs, respectively.

3. Data and Specification

The data for our analysis come from the HRS, a stratified random sample of over 25,000 individuals 50 and older, and their spouses (regardless of age). Individuals in the study are interviewed every even-numbered calendar year until they die, at which point an "exit" interview is conducted with their next of kin to gather information on the health and economic circumstances prior to and at the time of death. The study began in 1992, and every six years (e.g., 1998, 2004, 2010, 2016, etc.), a new birth cohort of individuals in their mid-50s enters the study, refreshing the panel.

[3] The data in Table 1 are for falls. In the case of fatal falls (columns 1-4), there is a one-to-one mapping of falls to individuals, as any given individual cannot die more than once from a fall. In contrast, in columns 5-8 what is measured is falls, not individuals, as an individual can have more than one non-fatal fall in a year.
[4] This is smaller than a more recent analysis by Shumway-Cook et al. (2009), who estimated the cost to Medicare per fall of $15,000-$20,000 in current 2014 dollars.

The sample we create from the HRS is a cross-section comprised of "recently" widowed homeowners, defined as respondents who were married 4 years earlier, but lost their spouse within the last 2 to 4 years and remained unmarried. The HRS only asked questions on falls and housing safety modifications to those 65 and older. Therefore, we also restrict our sample to all such widowed individuals who were older than 69 in order to condition on past falls and the legacy of safety modifications 4 years earlier. These restrictions result in a sample of 1,005 such recently widowed individuals in the HRS between 2000 and 2010.[5]

Figure 1 illustrates the HRS data sources and timing used below in the empirical strategy. As a survey administered every other year, its content maps into calendar time in two ways: individuals are asked questions about current socio-economic and health status (point-in-time), as well as behavior over the last two years or since the last wave (retrospective). Although our analysis is essentially a cross-section of widowed individuals, each observation draws upon three actual waves of response in the HRS, or up to 6 calendar years for retrospective questions. Each outcome is drawn from the current wave (t); the focal explanatory variable is drawn from the previous wave when they first experienced widowhood $(t-2)$; and, the instrumental variable and (the majority of) the control variables are drawn from an individual and their spouse's responses two waves prior $(t-4)$.

The primary outcome of our analysis, Y, is based on a retrospective question: it is an indicator that takes on a value of one if the individual had a serious fall that required medical treatment in the last two years, i.e., between calendar years $t-2$ and t. When writing the formal

[5] Specifically, 143 cases have outcomes measured in 2010 (which would correspond to wave 3 in Figure 1). These cases have the focal explanatory variable drawn from the 2008 HRS and the instruments drawn from the 2006 HRS. There are 178 cases with outcomes measured in 2008; 154 cases with outcomes measured in 2006; 196 cases with outcomes measured in 2004; 177 cases with outcomes measured in 2002; and 157 with outcomes measured in 2000.

econometric specification, we adopt the convention that a retrospective variable covering the time interval $(t-2,t)$ is labeled with a subscript t. Then, we model econometrically the probability of such a fall as

$$Y_{it}^{W} = \kappa + \beta D_{it-2}^{W} + \boldsymbol{\pi}\mathbf{X}_{it-k}^{W} + \gamma_t + \alpha_{it-4}^{W} + u_{it}, \qquad (1)$$

where i denotes the individual, W denotes that the variable is measured for the widowed individual, κ is a constant, and the index k runs $k = 2,4$, as explained below. The term γ represents a calendar-year effect for the outcome. The term α represents a full set of dummy variables for single year of age of the widowed individual measured at $t-4$ when the spouse was still alive. The focal explanatory variable is D, a dummy variable that takes on a value of one if the widowed individual lived in a home with any of the following safety and accessibility features to help older persons or the disabled: grab bar, shower seat, railing, ramp, modification for a wheel chair, call device to get help when needed, or other such modifications.[6] Since falls between periods $t-2$ and t may affect housing choices measured at point-in-time t, D is drawn from period $t-2$ to avoid any reverse causality. Therefore, the primary objective is to get consistent estimates of the parameter β, which measures the impact of safety and accessibility features on *subsequent* falls, i.e., falls occurring over the next two years. The central hypothesis is that $\beta = 0$, these features have no impact on falls, versus the alternative that $\beta < 0$, these features reduce falls.

[6] The HRS questions are H140, H141, H143 and H144. H140 states "Sometimes buildings have special features to help older persons or someone with a disability get around. Does your home have features such as a ramp, railings or modifications for a wheelchair?" This is followed up by H141: "Which special features does it have?", which includes a possible response of "Other." H143 states "How about special features to safeguard older persons with a disability? Does your home have features such as grab bars, a shower seat, or a call device or another system to get help when needed?" This is followed up by H144: "What special features does it have to help safeguard older people or someone with a disability?", which includes "Other" as a possible response.

Means of selected socio-economic characteristics for this sample are shown in column 1 of Table 2. Standard deviations for continuous measures are in parentheses; medians are in square brackets. Not surprisingly, most (76%) of the widowed are women. The sample is largely comprised of whites, with less than a college degree, with an average age of 75. Mean income is just over $51,000; median income is just over $38,000.

The first row of panel A in Table 3 shows the frequency of having experienced any type of fall in the last two years. For the full sample in column 1, almost 37% of all individuals had fallen, with the unconditional mean number of falls just under one (row 2). These statistics imply a mean of 2.6 falls, conditional on having fallen. The third row shows the mean of the primary outcome, Y^W: a serious fall in the last two years that required medical treatment. Just over 11.6% of all sample individuals had such a fall (column 1), a far lower percentage than having experienced any fall, which indicates that many falls did not end up requiring medical treatment.[7] Figure 2 plots the nonparametric age profile of the frequency of serious falls for the full sample of surviving spouses, based on lowess smoothing. Starting around age 70, the rate of serious falls rises with age.

The first row of panel B shows the mean for the focal explanatory variable D^W: the presence of any home safety and accessibility feature. In column 1, just over 49% of the sample had such a feature. By far the most common features were grab bars or a shower seat (36%) and railings (20%). Figure 3 plots the nonparametric age profile of the frequency of any home safety

[7] Unfortunately, the HRS does not ask about specific injuries related to falls. Engelhardt, Eriksen, and Greenhalgh-Stanley (2013) provide similar descriptive statistics for all marital statuses in the HRS.

and accessibility features for the full sample of surviving spouses.[8] The incidence of such features rises with age.

Columns 2-3 and 4-5 in both tables give similar statistics for the subgroups of those with and without serious falls and home safety and accessibility features, respectively. Figure 4 shows the nonparametric age profiles of the frequency of serious falls for the subsamples of surviving spouses in residences with and without any safety features, respectively. Generally speaking, the rate of serious falls rises with age and appears very similar for both groups. Although the associated confidence intervals for the profiles are not shown in the figure, the two profiles are not statistically different from each other at standard levels of significance.

4. Identification Strategy

A key concern with simple estimators of β in (1), such as Ordinary Least Squares (OLS), is that D might not be exogenous if there is unobserved heterogeneity in the proclivity to fall that is correlated with prior modifications. For example, those in period $t-2$ who believe they might be prone to falling in the future might modify their residences (in period $t-2$) as a preventative measure. In this case, "modifiers" are also more likely to be "fallers" along unobserved dimensions. This would induce a correlation between D and the error term u and bias upward (toward zero) estimates of β. Indeed, this can be seen in a comparison of means in Table 3. Comparing the third row of columns 4 and 5, those with any home safety and accessibility features are 3 percentage points *more* likely to have experienced a serious fall in the subsequent two years (0.03=0.132-0.102), a correlation of the wrong sign if such features truly reduce falls.

[8] This profile is based on lowess smoothing with a bandwidth of 0.8.

We attempt to circumvent this concern by using an IV approach. For older married couples, typically one spouse experiences a functional decline at a faster rate than the other. Home safety and accessibility modifications are often made to accommodate the declining spouse, which then become a legacy to the surviving spouse upon widowhood. In this case, surviving spouses may find themselves in residences with these features, independent of their own health trajectory. As shown in Figure 1, we use the deceased spouse's functional status from the last HRS interview when alive as an instrumental variable for the later presence of home safety and accessibility features for the surviving spouse. The instrument is drawn from the first wave and measures the behavior of the deceased spouse 4-6 years prior to when the outcome data were gathered for the surviving spouse.

The formal IV estimates below are based on a regression approach. Let S denote the deceased spouse, then the first-stage specification is

$$D_{it-2}^{W} = \mu + \delta ADL_{it-4}^{S} + \boldsymbol{\zeta}\mathbf{X}_{it-k}^{W} + \gamma_{t-2} + \alpha_{it-4}^{W} + v_{it-2} \,. \tag{2}$$

The instrument is ADL, the number of limits to the deceased spouse's Activities of Daily Living (ADLs). The HRS collects information on five activities—bathing, eating, dressing, walking across a room, and getting in and out of bed—each designed to measure various dimensions of an individual's ability to function in his or her residential space. For each of the five tasks, the HRS records a 1 if the respondent had difficulty with that task and a zero otherwise. The scores are summed for the five tasks, so that ADL ranges from 0 (no difficulties with any of the tasks) to 5 (difficulties with all of the tasks). So, a higher value of the instrument ADL in (2) means a worse functional status.

Also included in the outcome (1) and first-stage (2) models are a set of controls $\mathbf{X}^{W}$, where

$$\zeta \mathbf{X}_{it-k}^{W} = \sum_{k=2,4} \left(\theta_{1k} ADL_{it-k}^{W} + \theta_{2k} Mobility_{it-k}^{W} + \theta_{3k} Conditions_{it-2}^{W} + \theta_{4k} Y_{it-k}^{W} \right). \tag{3}$$

The summation in (3) represents the widowed individual's past functional, health, and fall trajectory (covering $t-2$ and $t-4$). In particular, $Mobility$ is the number of limits to five different aspects of mobility: walking several blocks, walking one block, walking across the room, climbing several flights of stairs, and climbing one flight of stairs. For each of the five tasks, the HRS records a 1 if the respondent reports having had difficulty with that task and a zero otherwise. Then the scores are summed for the five tasks, so that $Mobility$ ranges from 0 (no difficulties with any of the tasks) to 5 (difficulties with all of the tasks); a higher value of $Mobility$ means worse physical mobility. The variable *Conditions* is a count of the number of medical conditions a doctor had ever told the widowed individual that he or she had. The eight conditions were high blood pressure, diabetes, cancer, lung disease, heart disease, stroke, psychiatric problems, and arthritis. The index ranges from 0 (the absence of all eight conditions) to 8 (the presence of all eight conditions) where, as before, a larger index value indicates poorer health. Finally, ADL^{W} and Y^{W} measure the ADL limits and serious falls for the widowed individual. In combination, the summation in (3) represents the functional, health, and fall trajectories of the widowed individual in the years prior to the when the outcome is measured. We use these to directly control for any proclivity to fall, so that δ in the first-stage model is interpreted as the impact of the deceased spouse's functional status (when alive) on the *future* presence of safety and accessibility features for the surviving spouse, *controlling* for the surviving spouse's own functional, health, and fall trajectory.

To be valid, the instrument must satisfy three conditions. First, it must be relevant, $Cov(ADL^{S}_{it-4}, D^{W}_{it-2} \mid \mathbf{X}^{W}_{it-k}, \gamma_{t-2}, \alpha^{W}_{it-4}) \neq 0$. In principle, we believe that by the legacy effect outlined above, it is relevant. In practice, the instrument is highly correlated with the presence of home safety and accessibility features. Column 1 of Table 4 shows the first-stage estimate of δ in equation (2). Conditional on age, time, and the surviving spouse's functional, health, and fall trajectory, each additional ADL limit of the deceased spouse (when alive) is associated with a 6 percentage point increase in the likelihood that the surviving spouse subsequently lives in a home with safety and accessibility features (after widowhood). The mean incidence of such features in the sample is 49.2% (Table 3, column 1). Columns 2 and 3 of Table 4 illustrate the robustness of the baseline first-stage estimates to the addition of other control variables. In column 2, we add the socio-economic characteristics listed in Table 2. In column 3, we add a set of housing structural characteristics to the specification: dummy variables for whether all of the living space is on one floor; whether each floor has a bathroom; the number of floors in the structure; whether it is a multifamily structure; and dummies for physical condition (excellent, very good, good, and fair, with poor being omitted). The first-stage estimate remains essentially unchanged. We also report the Kleibergen-Paap (2006) *F*-statistic, which is an indicator of the strength of an instrumental variable that is robust to heteroscedasticity. In all three specifications we estimate the *F*-statistic to be greater than 41, indicative of a strong first-stage relationship.

To corroborate the first-stage findings, we turn in Table 5 to outcomes measured in the exit interview after the spouse's death, which occurred in period $t-2$, at the same time the information on home safety and accessibility features was gathered. In the exit interview, the surviving spouse was asked whether the death was expected or not.[9] Since the mechanism behind the legacy effect is the purposeful accommodation of the functional decline of the deceased spouse, the instrument should be correlated with anticipated or non-rapid-onset deaths, for which there would be a plausible timeframe to adjust housing features. Column 1 of the table shows estimates from a specification isomorphic to that in column 3 of Table 4, but with the dependent variable being a dummy for an expected death. Each additional ADL limit of the deceased spouse is associated with a 3.6 percentage point increase in the likelihood that the death was expected. Column 2 shows a similar result when the dependent variable measures the duration of the final illness/death: a dummy for whether the duration was one year or more.[10] We also examined the relationship between the cause of death reported in the exit interview and the timing variables (results not shown). The two leading causes of death were cancer and heart disease. Cancer deaths were largely expected and long in duration; cardiovascular deaths were largely unexpected and short in duration. Overall, the results in Tables 4-5 are consistent with the legacy effect, whereby married couples accommodate the functional decline of the first-to-die spouse.

Second, the instrument must be excludable. That is, conditional on age, time, and the widowed individual's functional, health, and fall trajectories, $\mathbf{X}^W$, the deceased spouse's functional status 4-6 years prior should not have had an impact on the surviving spouse's current fall behavior, except through home safety and accessibility D^W. In a framework in which functional status and falls are produced jointly using both spouses' inputs (Kutty, 1999; 2000), this instrument surely would not be excludable for a sample of married individuals. However, there is

[9] The HRS question (WA131) is "Was the death expected at about the time it occurred, or was it unexpected?"
[10] The HRS question (WA134) is "About how long was it between the start of the final illness and the death: was it one or two hours, less than a day, less than a week, less than a month, less than a year, or was it more than a year?" The results in column 2 are similar if the dependent variable is for a duration of one month or more.

no reason to believe that, conditional on the surviving spouse's health, functional status, and fall trajectory, the deceased spouse's functional status and fall behavior 4-6 years prior would have any *direct* bearing on the surviving spouse's current fall behavior. In our view, death insures excludability.

Third, the instrument must be exogenous, $Cov(ADL_{it-4}^{S}, u_{it} \mid \mathbf{X}_{it-k}^{W}, \gamma_t, \alpha_{it-4}^{W}) = 0$. Our fundamental identifying assumption is that any proclivity of the surviving spouse to fall, or features of the physical landscape that would have caused both spouses to fall are accounted for by conditioning on $\mathbf{X}^{W}$, the widowed individual's health, functional status, and fall trajectories (and, in the richer specifications, the socio-economic and housing characteristics). So, we treat the instrument as conditionally independent of the error term in (1).

We present the main findings next. Then we present extensions and provide a large series of robustness checks for instrument validity.

5. Main Estimation Results for Falls

The first column of panel A in Table 6 shows the OLS parameter estimate of β from equation (1). Conditional on the surviving spouse's prior health, functional status and fall trajectory, $\hat{\beta}^{OLS} = 0.005$, or the presence of home safety and accessibility features is associated with an *increase* in incidence of serious falls over the next two years of one-half of one percentage point. With a heteroscedasticity-robust standard error of 0.020 in parentheses, the null of $\beta = 0$ (no impact) cannot be rejected at conventional levels of significance.[11]

[11] The marginal effects from probit maximum likelihood estimates were similar in magnitude and significance.

Given the concern about potential upward bias in the OLS estimate outlined above, panel B shows the IV estimate of β from (1).[12] It reverses sign, $\hat{\beta}^{IV} = -0.181$, and indicates the presence of home safety and accessibility features is associated with a decrease in the incidence of a serious fall over the next two years of 18.1 percentage points. Economically, this is a large impact, relative to the mean incidence of serious falls. With a robust standard error of 0.108 in parentheses, the null of $\beta = 0$ (no impact) can be rejected in favor of the alternative that $\beta < 0$ at the 5% level of significance ($p = 0.048$). The *p*-value for the Hausman test that the OLS and IV estimates are the same is 0.078.

Columns 2 and 3 in the panel illustrate the robustness of the baseline IV estimate to the addition of other control variables. In column 2, we add the socio-economic characteristics.[13] In column 3, we add the set of housing characteristics to the specification.[14] The IV estimates remain essentially unchanged, indicating that home safety and accessibility features have statistically and economically significant impacts in reducing serious falls. A Hausman test rejects whether the OLS and IV coefficients are statistical similar at the 2% level of significance with the richest set of control variables.

As a robustness check, panel C presents bivariate probit estimates of β under the assumption that the errors terms in (1) and (2) are jointly normally distributed. Standard errors are in parentheses; marginal effects are in square brackets. The bivariate probit marginal effect in the baseline specification in column 1 indicates that safety and accessibility features reduce the likelihood of a serious fall by 17.7 percentage points. This is very close to the IV estimate in panel

[12] The associated first-stage is shown in column 1 of Table 4.
[13] The associated first-stage is shown in column 2 of Table 4.
[14] The associated first-stage is shown in column 3 of Table 4.

B. In the richest specification in column 3, the marginal effect suggests that safety and accessibility features lower the likelihood of a serious fall by 12.7 percentage points. Although somewhat smaller than the IV estimates in panel B, the two sets of estimates are not statistically different. Overall, the main results are robust to the choice of estimator.

More generally, throughout the remainder of the empirical analysis in the paper, we attempt to make as clear as possible when, and under what conditions, our main results are robust, and to point out when our findings are sensitive. In particular, we estimated all specifications using IV and probit maximum likelihood. To simplify the analysis, we adopt the convention of always reporting the OLS and IV estimates in the remainder of the paper. Estimates from the alternative estimators are not shown unless they differ in a substantive way from the least-squares based estimates.

6. Extensions

We also examined the impact of safety and accessibility features on the incidence of any falls (serious or not) and the number of falls. There were no statistically meaningful impacts for these outcomes (results not shown). This is consistent with the comparison of simple means from above and suggests that safety and accessibility features do not reduce overall fall activity, but instead attenuate the severity of falls. Foss *et al*. (2006) and Bischoff-Ferrari *et al.* (2010) had similar findings in their analyses of falls. One possibility is that safety features, while not preventing all falls, may result in an individual not falling as hard as otherwise would have occurred. Unfortunately, the HRS does not gather any additional information on falls or severity that would allow us to better explain this empirical pattern, so that this is an open question.

Table 7 examines heterogeneity in impacts. Each column of the table shows the IV estimate of the fall-reduction impact β in (1) from the richest specification (in column 3 of Table 6) for the subsample indicated in the column heading. For example, in column 1, the sample is just those individuals 65-74 years old; in column 2, the sample is just those individuals 75 and older. The estimates of β indicate that the fall-reduction impact is concentrated among older individuals. The estimates in the two columns are statistically different from each other at conventional significance levels. Columns 3 and 4 show a similar sample split by gender. The fall-reduction impact is concentrated more on men than women, but the gender-specific estimates are not statistically different from each other. Finally, in the last four columns of Table 7 we explore differences in impact by education and household income relative to the family-size-adjusted federal poverty line (the latter is measured in $t-4$, prior to widowhood). The point estimates suggest larger effects on fall reduction for those with more than a high school education and less than 200% of the poverty line, but these between-group differences are not statistically significant.

7. Robustness Checks

One of our key identifying assumptions was that the instrument is conditionally independent of the error term in (1): $Cov(ADL^S_{it-4}, u_{it} \mid \mathbf{X}^W_{it-k}, \gamma_t, \alpha^W_{it-4}) = 0$. This would fail to hold if the instrument were correlated with any unmeasured or omitted factors that independently might affect falls and were not adequately accounted for by conditioning on $\mathbf{X}^W$, the widowed individual's health, functional, and fall trajectories (and, in the richer specifications, the socio-economic and housing characteristics). For example, if there were measurement error in the conditioning health variables, and the health statuses of the two spouses were correlated, then the instrument would be correlated with any unmeasured portion of the surviving spouse's subsequent health status residing in the disturbance term u, hence violating the assumption of instrument exogeneity. In this section, we present a large set of robustness checks along a variety of dimensions designed to assess the validity of our identifying assumptions.

Subsequent Medical Diagnoses

We begin with Table 8, which focuses on the subsequent health of the surviving spouse as a function of the deceased spouse's limits to ADLs before death. If the instrument is exogenous, it should not predict subsequent non-fall-related changes in health by the surviving spouse, after having conditioned on $\mathbf{X}^W$, the widowed individual's health, functional, and fall trajectories. Each column in the Table represents a separate least squares estimate of ρ based on the following reduced-form specification using the full-sample of 1,005 observations:

$$H_{it}^{W} = \eta + \rho ADL_{it-4}^{S} + \zeta \mathbf{X}_{it-k}^{W} + \gamma_t + \alpha_{it-4}^{W} + \varepsilon_{it}, \qquad (4)$$

where ADL_{it-4}^{S}, the number of limits to the deceased spouse's Activities of Daily Living (ADLs), is the instrument, and H_{it}^{W} is a measure of a self-reported (in t) new medical diagnosis for the surviving spouse that occurred between $t-2$ and t, the same time period as our key outcome variable for falls. The dependent variable for each regression is shown in the column heading. Here, the new diagnoses, H, operate as proxies for any unmeasured, latent health conditions that might be in the original disturbance term u in (1). The robustness check corresponds to a test of the null hypothesis that $\rho = 0$ versus $\rho \neq 0$.

The first row of column 1 in the table shows the estimate of ρ when the dependent variable is an indicator for a self-reported new diagnosis of a stroke between $t-2$ and t. Obviously, an individual suffering a stroke may experience a substantial reduction in functionality that itself may lead to a serious fall. The estimate of ρ is $\hat{\rho} = 0.003$, very small compared to the sample mean of 0.027, or 2.7% (bottom row). With a standard error of 0.003, the null hypothesis that $\rho = 0$ cannot be rejected at conventional levels of significance. Therefore, there is little evidence that the deceased spouse's functional status when alive predicts future strokes for the surviving spouse. This exercise is repeated in columns 2-6 for self-reported new diagnoses of memory disease, diabetes, arthritis, and heart disease, respectively. There is little evidence to suggest that the instrument is correlated with these new diagnoses, supporting the exogeneity of the instrument.[15]

Substance Use

Alcohol consumption affects older individuals faster than younger individuals, and raises the risk of falls (O'Loughlin et al., 1992; Adams, 1995). In addition, the elderly are more prone to alcohol-prescription drug interactions that may contribute to falls more than younger individuals. Table 9 shows estimates of ρ when the dependent variable in (4) measures substance use. The dependent variable in column 1 is an indicator for whether the surviving spouse drinks in period t; the dependent variable in column 2 is the self-reported average number of drinks per day. For both measures of alcohol consumption, there is little correlation with the instrument. The dependent variable in column 3 is an indicator for whether the individual is a "moderate drinker," which the National Institute on Alcohol Abuse and Alcoholism defines as up to one drink per day for women and up to two drinks per day for men; the dependent variable in column 4 is an indicator

[15] "Self-reported" refers to a response by the individual or by a proxy respondent. The HRS designates proxy respondents in situations in which the actual respondent is unable to answer survey questions accurately, for example, due to substantial cognitive decline. Therefore, it would not be unusual to have new diagnoses of, say, memory disease "self-reported" about the individual by a proxy respondent (most typically a child, other relative, legal guardian, or caregiver).

for whether the individual drinks more than this amount per day. There is little correlation with the instrument for these measures as well. The final column shows results for whether the individual smokes at the time of the interview—again, there is little correlation.

Balance

Balance is a key, but typically unmeasured, determinant of falls.[16] To a randomly selected subset of respondents in 2006, 2008, and 2010, respectively, the HRS asked "How often do you have difficulty with balance? Would you say often, sometimes, rarely, or never?" We previously did not use the responses from this question to directly control for balance as a conditioning variable in $\mathbf{X}^W$ in (3), because the question was not asked in all years to all respondents: it is available for only 407 of the 1,005 widowed individuals in our sample. However, we use it in the first column of Table 10 as a robustness check.

The first column of the table shows the least squares estimate of ρ from the following reduced-form specification,

$$B_{it-2}^W = \eta + \rho ADL_{it-4}^S + \boldsymbol{\zeta}\mathbf{X}_{it-k}^W + \gamma_{t-2} + \alpha_{it-4}^W + \varepsilon_{it-2}, \tag{5}$$

where B_{it-2}^W is an indicator for whether the widowed individual self-reported having had "poor" balance, defined as having "often" or "sometimes" difficulty with balance, in period $t-2$, which is after the spouse died, but before any serious fall measured in (1) occurred. If the instrument is exogenous, it should not predict poor balance of the surviving spouse prior to the measurement

[16] See Cesari et al. (2004), Guralnik et al. (1994, 1995), and Laukkanen et al. (1995).

period for falls, after having conditioned on $\mathbf{X}^W$, the widowed individual's health, functional, and fall trajectories.[17] Again, the null hypothesis is that $\rho = 0$ versus $\rho \neq 0$.

The first row of column 1 in the table shows the estimate of ρ, $\hat{\rho} = 0.008$. That is very small compared to the sample mean of 0.438 or 43.8% (bottom row). With a standard error of 0.015, the null hypothesis that $\rho = 0$ cannot be rejected at conventional levels of significance. Therefore, there is little evidence that the deceased spouse's functional status when alive predicts future balance for the surviving spouse.

Of course, a drawback of this measure of balance is that it is self-reported, and, as discussed above, there are situations in which measurement error might render the instrument invalid. Therefore, columns 2 and 3 in the table show additional results based on objective measures of balance. In 2006, 2008, and 2010, the HRS administered a physical balance test to a random subset of respondents. Balance was first evaluated using a semi-tandem stance, the feet position for which is shown in Figure 5.[18] The individual was asked to stand with the side of the heel of the front foot touching the toe of the back foot. The goal of the test was to maintain this stance for 10 seconds. Those who completed the semi-tandem test then were evaluated using a tandem stance, with one foot directly in front of the other, heel to toe. The goal of this second test was to maintain this stance for 60 seconds.[19]

The first row of column 2 in Table 10 shows the estimate of ρ in (5), where the dependent variable, B^W_{it-2}, is an indicator for whether the individual was unable to hold the semi-tandem stance

---

[17] Note that we do not examine poor balance in period *t* as a robustness check, for the obvious reason that poor balance then could have been *because* of a serious fall between *t-2* and *t*. The HRS did not ask the reason(s) for difficulty with balance.

[18] The image for this figure was taken from http://www.ndorms.ox.ac.uk/prove/.

[19] Those unable to complete the semi-tandem test (4.6% of the sample in Table 9) were evaluated subsequently in a feet-together stance (see Figure 5).

for 10 seconds. This test was administered to only 453 of the 1,005 widowed individuals in our full sample, and just under 5% could not complete the test.[20] The estimate of ρ, which measures the correlation of the instrument with this objective measure of balance, is $\hat{\rho} = -0.004$, very small compared to the sample mean. With a standard error of 0.006, the null hypothesis that $\rho = 0$ cannot be rejected at conventional levels of significance.

Column 3 shows the estimate of ρ when the dependent variable, B^W_{it-2}, is the length of time (in seconds) the individual was able to maintain the full-tandem stance. The longer the duration, the better the balance. This test was administered to the 431 individuals who successfully completed the semi-tandem test. The estimate of ρ, which measures the correlation of the instrument with this objective measure of balance, is $\hat{\rho} = -0.075$. This can be interpreted as follows: an additional ADL limit of the deceased spouse is associated with a reduction in the duration of the full-tandem test by 75 one-thousandths of a second—that is, less than a tenth of a second. So, essentially the instrument has no measurable impact on this measure of balance, relative to the sample mean test duration of 7.7 seconds. With a standard error of 0.428 (just under one-half of a second), the null hypothesis that $\rho = 0$ cannot be rejected at conventional levels of significance.[21] In summary, there is little evidence from the results presented in Table 10 that the deceased spouse's functional status when alive predicts future balance for the surviving spouse.

---

[20] Unfortunately, the subsamples for the self-reported balance measure in column 1 and the balance test measures in columns 2 and 3 do not have substantial overlap, since they originate from different random samples of HRS respondents in 2006, 2008, and 2010.

[21] Since the duration of the full-tandem test was bounded by 0 and 60 seconds, respectively, we also estimated two-limit Tobit models for (5) and found results similar to those shown in the table.

Formal and Informal Care

The other key identifying assumption was instrument excludability: the only way in which the deceased spouse's functional status when alive (the instrument) affects the subsequent fall behavior of the surviving spouse (the outcome) is though safety and accessibility features. However, the Becker-Grossman approach is based on the idea that individuals use a variety of inputs, both informal and market-based, to produce functionality. The widowed individual or extended family might change the mix of inputs to produce better functionality in response to the specific timing and manner of the death of the spouse. For example, extended families who experienced long-duration final illnesses might arrange formal and informal care for the surviving spouse differently in a way that also reduces falls independent of the presence of safety and accessibility features in the home. In this scenario, the exclusion restriction fails.

To examine this, Table 11 presents least squares estimates of ρ from the following reduced-form specification,

$$C_{it-2}^{W} = \eta + \rho ADL_{it-4}^{S} + \boldsymbol{\zeta}\mathbf{X}_{it-k}^{W} + \gamma_{t-2} + \alpha_{it-4}^{W} + \varepsilon_{it-2}, \qquad (6)$$

where C_{it-2}^{W} is a specific measure of formal or informal care for the surviving spouse in period $t-2$, which is after the spouse died, but before any serious fall measured in (1) occurred. Under the exclusion restriction, the instrument should not predict the care measure after having conditioned on $\mathbf{X}^{W}$, the widowed individual's health, functional, and fall trajectories.[22] Again, the null hypothesis is that $\rho = 0$ versus $\rho \neq 0$.

[22] Note that we do not examine formal and informal care in period *t* as a robustness check, for the obvious reason that care decisions then could have changed *because* of a serious fall between *t-2* and *t*.

The first row of column 1 in the table shows the estimate of ρ when the dependent variable is an indicator for the spouse's use of home health care. The estimate of ρ is $\hat{\rho} = 0.007$, very small compared to the sample mean of 0.092 or 9.2% (bottom row). With a standard error of 0.006, the null hypothesis that $\rho = 0$ cannot be rejected at conventional levels of significance.

The care measure in column 2 is an indicator for whether the surviving spouse receives help from another individual; in column 3, it is an indicator for whether the surviving spouse reports having someone on which to rely for care in the future. The dependent variable in column 4 is an indicator for whether the spouse receives private income transfers from others. The final two columns measure shared living arrangements: in column 5, whether there were movers in/out from the household in the last two years, and whether co-resides with an adult child. Across the six specifications in the table, there is little evidence that the instrument is correlated with subsequent formal and informal care decisions of the surviving spouse.

Interior Upkeep

The physical condition of the interior of the residence is a key, and typically unmeasured, determinant of falls. Individuals are less likely to fall when their residences are relatively free of clutter and physical obstacles. The widowed individual or extended family might change the interior upkeep to produce better functionality in response to the specific timing and manner of the death of the spouse. For example, extended families might arrange for a cleaning service for the surviving spouse, producing better upkeep and reducing falls. In this scenario, the exclusion restriction fails.

Periodically, the HRS asked interviewers conducting in-person interviews to rate and describe the physical upkeep of the residence. We used this information to make three crude measures of interior upkeep, none of which is mutually exclusive. The first is an indicator for whether "rooms are relatively clear with exits freely accessible." The second is an indicator for whether "rooms are overcrowded with furniture or objects, leaving little free floor space." The final is an indicator for whether "all visible rooms are clean and minimally cluttered." We did not use these measures as conditioning variables in $\mathbf{X}^W$ in (3), because this information was not available in all years to all respondents. In particular, in-person interviews are only conducted every third wave—the other waves are phone interviews—and HRS respondents are randomly assigned into interview-mode rotation groups. Consequently, we only have interior upkeep information for 406 of the 1,005 widowed individuals in our sample.

However, we use it in Table 12 to perform a final robustness check. The first column of the table shows the least squares estimate of ρ from the following reduced-form specification,

$$I_{it-2}^{W} = \eta + \rho ADL_{it-4}^{S} + \boldsymbol{\zeta}\mathbf{X}_{it-k}^{W} + \gamma_{t-2} + \alpha_{it-4}^{W} + \varepsilon_{it-2}, \tag{7}$$

where I_{it-2}^{W} is one of the three indicators for interior upkeep as measured in period $t-2$, which is after the spouse died, but before any serious fall measured in (1) occurred. If the instrument is valid, it should not predict subsequent interior upkeep, i.e., $\rho = 0$. Across the three measures, there is little evidence that the deceased spouse's functional status when alive predicts the future interior upkeep of the surviving spouse's residence.

In summary, through a large number of robustness checks across multiple domains we find little evidence against our maintained assumptions of instrument exogeneity and excludability. While we view none of these tests as definitive, the weight of the evidence lends credence to our instrument being valid.

8. Impacts on Housing

The elderly have a strong desire to live independently and age in place (AARP, 2000). Part of this stems from the familiarity, emotional, and social attachment to a residence and neighborhood (Danigelis and Fengler, 1991). Another part stems from what appear to be high psychic and economic costs of moving (Venti and Wise, 1989). Indeed, there is strikingly low housing mobility among the elderly, and what mobility there is typically is precipitated by an adverse health shock (Venti and Wise, 2001, 2004). From above (Table 12), there was little impact of safety and accessibility features on living arrangements. So, a key remaining question is whether these features are sufficiently important to alter other housing decisions.[23]

We begin by examining housing mobility. The full sample used in our main estimation in Table 6 includes widowed individuals who by period t both stayed in and moved from the home in which the deceased spouse died. However, mobility is potentially an endogenous response to a fall. Indeed, 13.9% of widowed individuals in the sample moved (Table 3). Therefore, in the first two columns of Table 13, we present estimates of β from a specification isomorphic to (1), but where the dependent variable is an indicator for whether the surviving spouse moved permanent residences in the period from $t-2$ to t. In column 1, we control just for calendar year, age, and the surviving spouse's health, functional, and fall trajectories. The IV estimate suggests that safety and accessibility features are associated with a reduction in the fraction moving by six-tenths of one percentage point. Relative to the mean mobility rate, this is a very small response.

[23] There have been numerous studies in the demography, medical, and gerontology literatures that suggest there are significant costs and risks to living alone for the elderly. One pathway is through physical and health risks. For example, Gurley *et al*. (1996), Tromp *et al*. (1998), and Cwikel *et al*. (1989) all document a strong relationship between living alone and the risk of falling, with Gurley *et al*. (1996) and Reuben *et al*. (1992) further linking living alone to incapacitation and death.

With a standard error of 0.115, it is not statistically different than zero at conventional significance levels.[24]

In column 2, we include the full set of controls used in column 3 of Table 6 and all columns of Tables 7-12. Now, the estimated impact on mobility is larger: safety features are associated with a reduction in the mobility rate of 8.4 percentage points. However, with a standard error of 0.104, this estimate is too imprecise to make firm conclusions.[25] Unlike all of the previous results in the paper, a comparison of columns 1 and 2 indicates that the estimated impacts on mobility are sensitive to the set of conditioning variables. Furthermore, a comparison of panels B and C indicates that the results are somewhat sensitive to the estimator used, which further limits our ability to make strong conclusions.

As a companion to column 2, column 3 of the table then shows the impact of safety and accessibility features just for the subsample of stayers. These estimates are nearly identical to those for the full sample in column 3 of Table 6, and are quite robust to changes in the specification and estimator.[26]

Next, we present estimates of the impact of safety and accessibility features on another important outcome: having had a nursing home stay in the last two years. Specifically, the dependent variable in columns 4 and 5 is whether the surviving spouse had a nursing home stay

---

[24] The first-stage for this is shown in column 1 of Table 4.

[25] The first-stage for this is shown in column 3 of Table 4.

[26] The relationship of mobility to falls is complicated. On the one hand, if mobility is exogenous, then limiting the sample to stayers as was done in column 2 of Table 13 should generate a larger estimate of the impact of safety and accessibility features on falls, as the legacy effect should only work through homes in which the deceased spouse resided prior to death. On the other hand, if mobility is endogenous, then there can be a wide range of estimates for the subsample of stayers, depending upon the correlation between moving and the elasticity of fall reduction to safety features. In this situation, who appears in the sample as a stayer is endogenous and there is potential sample selection bias. In column 3, we present the results for stayers for completeness, but do not find a larger estimate for stayers than for the full sample of movers and stayers combined. We caution the reader that the confidence intervals around the estimates in column 2 for mobility and column 3 for stayers admit a wide range of responses that encompass both explanations just outlined.

between $t-2$ and t. Safety features reduce falls, and therefore might reduce nursing home admissions. The results in column 4 of panel B of the table generally support this view: the presence of safety and accessibility features is associated with a 10.4 percentage point reduction in the likelihood of a nursing home stay. With a robust standard error of 5.6 percentage points, this is a statistically significant effect. This effect is robust to additional controls in column 5. However, panel C shows a much smaller effect using the bivariate probit estimator, of around a one percentage-point reduction.[27]

In columns 6 and 7, we similarly present estimates of the impact on having made an own-to-rent transition. It should be emphasized that this outcome is not mutually exclusive of the other outcomes in the table. For example, it is not uncommon for individuals to have a nursing home stay and maintain ownership of a residence. The dependent variable is whether the surviving spouse had transitioned from owning to renting between $t-2$ and t. Here, there appears to be little impact of safety and accessibility features on subsequent tenure transitions, although again the results appear somewhat sensitive to the set of controls and the estimator.[28]

9. Summary, Implications, and Caveats

Housing is unique as a commodity, because of the strong interplay between health and housing demand at older ages. Surprisingly, there have been few studies of the interaction between elderly health and housing in the urban economics literature. In this paper, we have focused on the extent to which housing structural characteristics generate significant benefits to elderly health.

[27] The asterisk in column 5 of panel C indicates that the bivariate probit estimates failed to converge in the richest specification. The first-stage regression for columns 4 and 5 is shown in column 3 of Table 4.
[28] The first-stage regression for columns 6 and 7 is shown in column 3 of Table 4.

The weight of the empirical evidence suggests that home safety and accessibility features have an economically important impact on elderly health through the mitigation of serious falls, but do not substantively alter housing transitions. We temper these conclusions with a series of caveats.

One general drawback of our analysis is that our HRS data are not rich enough to uncover specific mechanisms through which safety and accessibility features reduce falls. We are unable to say which of the many safety and accessibility features matters the most in attenuating serious falls. For example, grab bars and shower seats are far less expensive to install than ramps. It would be very useful to know if cheaper features were more efficacious than more expensive features. The individual features shown in panel B of Table 3 are strongly correlated with each other, resulting in substantial multicollinearity when we attempted to analyze them independently. The corresponding estimates were simply too imprecise to draw any firm conclusions about the efficacy of individual safety and accessibility features. Furthermore, we are unable to say why the impacts appear only for severe falls and not for all falls. Uncovering specific causal mechanisms is an important area for further research.

Another area for exploration is to obtain firmer evidence on housing transitions. We found little definitive evidence linking falls to housing transitions, at least in the short run. This suggests that falls are not the type of health shock that is a main driver of tenure transitions among older homeowners. This is consistent with Engelhardt and Greenhalgh-Stanley (2010), who found that the moderately adverse health shocks associated with the utilization of Medicare home health care were not important drivers of housing transitions at older ages. About 10% of Medicare home health care cases are related to the treatment of falls. However, the results on transitions in the current paper were sufficiently sensitive to the set of conditioning variables and estimators that we feel further work is warranted in this area to make firmer conclusions.

Finally, our analysis brings up a number of issues concerning external validity. First, although we believe that our identification strategy is very strong for the widowed, we are unable to provide separate estimates for the never married, married, and divorced, because a similar identification strategy is neither feasible (e.g., no spouse for the never married) nor plausible (e.g., joint production for the married). Even among widowed individuals, our estimates represent the average impact of safety and accessibility features on falls for widows. Given the large variability in underlying health status, particularly among the younger old, there is likely a great deal of heterogeneity in the need for such features. Our estimates can be thought of as a weighted average of the fall-reduction impact for “high” and “low” need widowed individuals, respectively. However, we are not able to generate separate estimates for the “high” need group, who likely would be the target of public policies promoting safety and accessibility investments. That is an important limitation of our approach. Finally, we only estimate short-run effects. Many of the consequences for health, functioning, living arrangements, and housing decisions associated with falls are dynamic in nature and may take many years to present. We cannot capture those using the two-year window for the outcomes in this paper. So, the short-run impacts may differ from the long-run impacts.

With these caveats in mind, we close with Table 14, which is speculative and explores the possible implications of our findings for medical costs. Column 1 shows the average cost of medical treatment for non-fatal falls based on the figures in columns 5-8 of Table 1 from Stevens et al. (2006). These are for all individuals, not just the widowed.

Average medical expenditure per fall was $7,300 (in calendar year 2000 dollars). Most of this is paid for by public sources. In particular, in separate calculations from the 2010 MEPS (not shown), we found that 72% of medical costs for those 65 and older associated with trauma were paid for by Medicare and 10% by Medicaid. Only 3% of such costs were paid for out of pocket by the elderly. In contrast, housing investment in safety and accessibility modifications is almost solely privately financed. Column 2 shows average modification expenditures over a two-year period in the HRS of $1,700 (also in calendar year 2000 dollars), similarly calculated for all individuals.[29]

Column 3 shows the reduction in expected medical costs per dollar of housing investment, based on the IV estimate from the richest specification in Table 6 of a 21.8 percentage-point reduction in the likelihood of a fall. We make two assumptions for this calculation. First, we assume that the response of falls to features for the never married, married, and divorced is the same as that estimated for the widowed. Second, we assume one fall per person over a two-year period, which precludes the possibility that safety features could prevent multiple serious falls for an individual in that time interval. Under these assumptions, our estimates imply that each dollar of housing investment is associated with a 93-cent reduction in medical costs.[30] Column 4 shows the same calculation using the age and gender group-specific IV estimates from Table 7. Because falls for the older old are relatively more expensive to treat, the expected medical cost savings rise with age. Indeed, these calculations suggest that for those 75 and older, the reduction in medical costs appears to far exceed a dollar-for-dollar return. As discussed in section 2, these cost calculations are most likely underestimates, given that longer-term Medicaid and Medicare HMO costs of falls were not incorporated in Stevens et al (2006) and that once in place, home modifications may reduce falls over a time horizon longer than two years

[29] This is based on HRS questions MH203: "Did you have any out-of-pocket expenses for adding features to your home to make it easier or safer for an older person or someone with a disability to live there? This includes changes to make it easier to get around like a ramp, railings, modifications for a wheelchair and features that make it safer such as grab bars, a shower seat, or a call device to get help when needed," and the follow-up MH204, "If so, how much?"
[30] This is calculated as 0.218 multiplied by column 1, then divided by column 2.

The main takeaway from the table is that from society's point of view, housing investment in safety and accessibility for the elderly might be justified largely on the basis of the static medical cost savings alone. This ignores the money metric value of other costs: for example, the psychic costs of falls to the elderly and loved ones, the market value of formal and informal post-acute care given to those who fall, and any dynamic cost savings. A fundamental challenge, however, is that safety and accessibility may be privately underprovided if the medical cost savings accrue to public programs like Medicare and Medicaid, and do not flow through to reductions in out-of-pocket medical costs for the elderly. Pinning down more fully the cost-benefit analysis and the long-run impacts are important avenues for future research.

References

Adams, W. 1995. Interactions between alcohol and other drugs. Substance Use & Misuse 30, 1903-1923.

American Association of Retired Persons (AARP). 2000. Fixing to Stay: A National Survey of Housing and Home Modification Issues, AARP, Washington, DC.

Bischoff-Ferrari, H., Dawson-Hughes, B., Platz, A., Orav, E., Stahelin, H., Willett, W., Can, U., Egli, A., Mueller, N., Looser, S., Bretscher, B., Minder, E., Vergopoulos, A., Theiler, R. 2010. Effect of high-dosage cholecalciferol and extended physiotherapy on complications after hip fracture. Archives of Internal Medicine 170, 813-820.

Boehm, T., Schlottmann, A. 1999. Does homeownership by parents have an economic impact on their children? Journal of Housing Economics 8, 217–232.

Cesari, M., Penninx, B., Pahor, M., Lauretani, F., Corsi, A., Williams, G., Guralnik, J., Ferrucci, L. 2004. Inflammatory markers and physical performance in older persons: the InCHIANTI study. Journals of Gerontology Series A: Biological Sciences and Medical Sciences 59, M242-M248.

Currie, J., Gahvari, F. 2008. Transfers in cash and in-kind: theory meets the data. Journal of Economic Literature 46, 333-383.

Cwikel, J., Fried, A., Galinsky, D. 1989. Falls and psychosocial factors among community-dwelling elderly persons: a review and integration of findings from Israel. Public Health Review 17, 39-50.

Dangelis, N., Fengler, A. 1991. No Place Like Home, Columbia University Press, New York, NY).

Dietz, R., Haurin, D., 2003. The social and private micro-level consequences of homeownership. Journal of Urban Economics 45, 354–384.

Engelhardt, G., Greenhalgh-Stanley, N. 2010. Home health care and the housing and living arrangements of the elderly. Journal of Urban Economics 67, 226-238.

Engelhardt, G., Eriksen, M., Greenhalgh-Stanley, N. 2013. A Profile of Housing and Health among Older Americans. Research Institute for Housing America, Washington, DC.

Englander, F., Hodson, T., Terregossa, R. 1996. Economic dimensions of slip and fall injuries. Journal of Forensic Science 41, 733-746.

Feinstein, J. 1993. Elderly health, housing, and mobility. In: Wise, D. (Ed.) Advances in the Economics of Aging. University of Chicago Press, Chicago, pp. 275-317.

Fortson, J., Sanbonmatsu, L. 2010. Child health and neighborhood conditions: results from a randomized housing voucher experiment. Journal of Human Resources 45, 840-864.

Foss, A., Harwood, R., Osborn, F., Gregson, R., Zaman, A., Masud. T. 2006. Falls and health status in elderly women following second eye cataract surgery: a randomized controlled trial. Age and Aging 35, 66-71.

Gillespie, L., Robertson, M., Gillespie, W., Sherrington, C., Gates, S., Clemson, M., Lamb, S. 2012. Interventions for preventing falls in older people living in the community. Cochrane Library 11.

Green, R., White, M., 1997. Measuring the benefits of homeowning: effects on children. Journal of Urban Economics 41, 441–461.

Guralnik, J., Simonsick, E., Ferrucci, L., Glynn, R., Berkman, L., Blazer, D., Scherr, P., Wallace, R. 1994. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. Journals of Gerontology Series A: Biological Sciences and Medical Sciences 49, M85-M94.

Guralnik, J., Ferrucci, L., Simonsick, E., Salive, M., Glynn, R., Wallace, R. 1995. Lower extremity function in persons over the age of 70 years as a predictor of subsequent disability. New England Journal of Medicine 332, 556-561.

Gurley, R., Lum, N., Sande, M., Lo, B., Katz, M. 1996. Persons found in their homes helpless or dead. The New England Journal of Medicine 334, 1710-6.

Heinrich, S., Rapp, K., Rissmann, U., Becker, C., Koenig, H.-H.. 2010. Costs of falls in old age: a systematic review. Osteoporosis International 21, 891-902.

Jacob, B., Ludwig, J., Miller, D. 2013. The effects of housing and neighborhood conditions on child mortality. Journal of Health Economics 32, 196-206.

Kleibergen, F., Paap, R. 2006. Generalized reduced rank tests using the singular value decomposition. Journal of Econometrics 133, 97-126.

Kutty, N. 1999. Demand for home modifications: a household production function approach. Applied Economics 31, 1273-1281.

Kutty, N. 2000. The production of functionality by the elderly: a household production function approach. Applied Economics 32, 1269-1280.

Laukkanen, P., Heikkinen, E., Kauppinen, M. 1995. Muscle strength and mobility as predictors of survival in 75-84 year old people. Age and Aging 24, 468-473.

Megbolugbe, I., Sa-Aadu, J., Shilling, J. 1997. Oh yes, the elderly will reduce housing equity under the right circumstances. Journal of Housing Research 8, 53-74.

O'Loughlin, J., Robitaille, Y., Boivin, J., Suissa, S. 1992. Incidence of and risk factors for falls and injurious falls among community-dwelling elderly. American Journal of Epidemiology 137, 342-354.

Reuben, D., Rubenstein, L., Hirsch, S., Hayes, R. 1992. Value of functional status as a predictor of mortality: results from a prospective study. The American Journal of Medicine 93, 663-669.

Shumway-Cook, A., Ciol, M., Hoffman, J., Dudgeon, B., Yorkston, K., Chan, L. 2009. Falls in the Medicare population: incidence, associated factors, and impact on health care. Physical Therapy 89, 324-332.

Stevens, J., Corso, P., Finkelstein, E., Miller, T. 2006. The costs of fatal and non-fatal falls among older adults. Injury Prevention 12, 290-295.

Tromp, A., Smit, J., Deeg, D., Bouter, L., Lips, P. 1998. Predictors for falls and fractures in the Longitudinal Aging Study, Amsterdam. Journal of Bone and Mineral Research 13, 1932-1339.

Venti, S., Wise, D. 1989. Aging, moving, and housing wealth. In: Wise, D. (Ed.) The Economics of Aging. University of Chicago Press, Chicago, pp. 9-48.

Venti, S., Wise, D. 1990. But they don't want to reduce housing equity. In: Wise, D. (Ed.) Issues in the Economics of Aging. University of Chicago Press, Chicago, pp. 13-29.

Venti, S., Wise, D. 2001. Aging and housing equity. In Bodie, Z., Hammond, B., Mitchell, O. (Eds.) Innovations for Financing Retirement. University of Pennsylvania Press and the Pension Research Council, Philadelphia, pp. 254-281.

Venti, S., Wise, D. 2004.Aging and housing equity: another look. In: Wise, D. (Ed.) Perspectives on the Economics of Aging. University of Chicago Press, Chicago, pp. 127-181.

Wahl, H-W., Faenge, A., Oswald, F., Gitlin, L., Iwarsson, S. 2009. The home environment and disability-related outcomes in aging individuals: what is the empirical evidence? The Gerontologist 49, 355-367.

Table 1. The Prevalence Nationally and Cost in 2000 of Fatal and Non-Fatal Falls Requiring Medical Treatment among the Elderly, by Demographic Category and Nature of the Injury

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Fatal Falls				Non-Fatal Falls			
	Cases Annually		Cost of Medical Treatment		Cases Annually		Cost of Medical Treatment	
Category	Number in Thousands	%	$ Millions	%	Number in Millions	%	$ Billions	%
Total	10.3	100	179	100	2.6	100	19	100
Age								
65-74	1.7	17	30	17	0.8	31	4	20
75-84	3.8	37	64	36	1.0	39	8	40
85 and older	4.8	47	85	47	0.8	31	8	40
Sex								
Men	4.7	46	81	45	0.8	31	5	26
65-74	1.0	21	18	20	0.3	38	1	27
75-84	1.9	40	32	40	0.3	38	2	45
85 and older	1.8	38	31	38	0.2	25	1	27
Women	5.6	54	97	55	1.8	69	14	74
65-74	0.7	13	12	12	0.5	28	3	17
75-84	1.9	34	32	33	0.7	39	6	39
85 and older	3.0	54	53	55	0.6	33	6	44
Body region of injury								
Traumatic brain injury	4.7	46	82	46	0.1	4	1	5
Lower extremity	3.3	32	60	34	0.7	27	9	48
Upper extremity	0.0	0	0	0	0.7	27	3	13
Torso	0.8	8	13	7	0.4	15	3	13
Other head or neck	0.3	3	5	3	0.5	19	2	8
Other region	0.6	6	9	5	0.1	4	2	8
Unspecified	0.6	6	10	6	0.1	4	1	4
Type of injury								
Fracture	4.3	42	78	44	0.9	35	12	61
Internal organs	2.9	28	52	29	0.1	4	1	4
Systematic/late effects	0.2	2	2	1	0.0	0	0	0
Superficial/contusions	0.0	0	0	0	0.8	31	3	17
Sprain/strain	0.0	0	0	0	0.4	15	1	6
Open wound	0.0	0	0	0	0.3	12	1	5
Dislocation	0.0	0	0	0	0.1	4	<1	1
Other type	0.1	1	1	1	<0.1	0	1	6
Unspecified	2.8	28	44	25	<0.1	0	0	1

Note: All dollar values in calendar year 2000 dollars. The data in column 1-4 are taken from Stevens et al. (2006), Table 1. The data in columns 5-8 are taken from their Table 2. The figures in subcategories in columns 2, 4, 6, and 8 may not add to 100% for that category due to rounding error.

Table 2. Sample Means for Selected Socio-Economic Characteristics, Standard Deviations in Parentheses, Medians in Brackets

	(1)	(2)	(3)	(4)	(5)
		Subsample			
Characteristics	Full Sample	With Serious Fall	Without Serious Fall	With Any Safety and Accessibility Features	Without Safety and Accessibility Features
Surviving spouse is female	0.762	0.821	0.755	0.755	0.769
Surviving spouse is white	0.889	0.949	0.881	0.895	0.883
Surviving spouse has high school degree	0.397	0.385	0.399	0.383	0.411
Surviving spouse has had some college	0.203	0.188	0.205	0.211	0.196
Surviving spouse has college degree or more	0.134	0.128	0.135	0.154	0.115
Surviving spouse's age	75.2	76.8	74.9	76.3	74.1
	(6.2)	(6.7)	(6.0)	(6.2)	(5.9)
	[75.0]	[77.0]	[74.0]	[76.0]	[74.0]
Deceased spouse's age	77.5	79.1	77.2	78.5	76.5
	(6.7)	(7.1)	(6.6)	(6.6)	(6.6)
	[77.0]	[79.0]	[77.0]	[78.0]	[76.0]
Family Income	51,831	40,494	53,325	51,532	52,120
	(54,131)	(23,673)	(56,782)	(52,097)	(56,077)
	[38,252]	[35,670]	[38,736]	[38,818]	[37,412]
Family Wealth	476,034	396,805	486,473	494,524	458,159
	(805,859)	(688,394)	(819,853)	(857,078)	(753,457)
	[247,487]	[222,789]	[250,443]	[246,788]	[251,823]
Number of Observations	1,005	117	888	494	511

Note: Authors' calculations based on the HRS sample of 1,005 widowed individuals described in the text. All variables are measured in wave 1, which corresponds to *t*-4. In particular, the deceased spouse's age is the age recorded in the last live interview before death.

Table 3. Sample Means for Outcome, Focal Explanatory, and Instrumental Variable, Standard Deviations in Parentheses

	(1)	(2)	(3)	(4)	(5)
		Subsample			
Variable	Full Sample	With Serious Fall	Without Serious Fall	With Any Safety and Accessibility Features	Without Safety and Accessibility Features
A. Outcomes					
Fallen	0.368	1.000	0.285	0.415	0.323
Number of falls	0.939	2.718	0.705	1.071	0.812
	(2.271)	(3.208)	(2.005)	(2.369)	(2.167)
Serious fall	0.116	1.000	0	0.132	0.102
Death was expected	0.610	0.628	0.608	0.620	0.600
Duration of final illness more than one year	0.250	0.190	0.258	0.260	0.241
Had a nursing home stay in the last 2 years	0.038	0.162	0.021	0.051	0.025
Moved	0.139	0.342	0.113	0.154	0.125
Own-to-rent transition	0.090	0.223	0.072	0.101	0.078
B. Focal Explanatory Variable					
Any safety and accessibility feature	0.492	0.556	0.483	1.000	0
Ramp	0.104	0.103	0.104	0.211	0
Railings	0.196	0.256	0.188	0.397	0
Modifications for a wheelchair	0.091	0.043	0.098	0.184	0
Other accessibility features	0.023	0.017	0.024	0.047	0
Grab bars or shower seat	0.364	0.419	0.356	0.735	0
Call system	0.041	0.026	0.043	0.083	0
Other safety feature	0.041	0.026	0.027	0.055	0
C. Instrumental Variable					
Number of limits to the activities of daily living (ADLs) of the deceased spouse	1.048	0.932	1.063	1.389	0.718
	(1.593)	(1.574)	(1.596)	(1.791)	(1.294)
Number of observations	1,005	117	888	494	511

Note: Authors' calculations based on the HRS sample of 1,005 widowed individuals described in the text. Panel A shows means for outcomes used in subsequent tables. Those outcomes are measured in period *t*, with the exception of death was expected and duration of final illness, which were measured in the exit interview at *t*-2. Panel B shows means for the presence of any safety and accessibility feature used as the focal explanatory variables in the specifications below, as well as the constituent features. These features are measured in period *t-2*. Panel C shows the means of the instrument, which is measured in period *t*-4.

Table 4. First-Stage Estimates of the Impact of the Mobility and Fall Behavior of the Deceased Spouse on the Incidence of Home Safety and Accessibility Features for Widowed Individuals, Robust Standard Errors in Parentheses

	(1)	(2)	(3)
Instrumental Variable	Dependent Variable: Dummy if Home Safety or Accessibility Features		
Number of limits to the activities of daily living (ADLs) of the deceased spouse	0.060 (0.009)	0.065 (0.010)	0.066 (0.010)
Kleibergen-Paap F-statistic	41.1	42.9	43.7
Controls			
Calendar year and age effects	Yes	Yes	Yes
Surviving spouse's health, functional status and fall trajectory	Yes	Yes	Yes
Socio-economic characteristics	No	Yes	Yes
Housing structural characteristics	No	No	Yes

Note*:* Each column in the table represents a different specification of the first-stage model. Only the OLS estimates and heteroscedasticity-robust standard error are shown for the instrumental variable. The Kleibergen-Paap F-statistic indicates the strength of the instrumental variable, robust to heteroscedasticity. The other control variables used in each model are listed at the bottom of the table, but their estimates and standard errors are not shown. All estimates are OLS estimates; probit maximum likelihood estimates were very similar. The five activities in the measure of ADLs are bathing, eating, dressing, walking across a room, and getting in and out of bed, so that the instrument ranges from 0 (no difficulties with any of the tasks) to 5 (difficulties with all of the tasks); a higher value of the instrument means a worse functional status.

Table 5. Reduced-Form Estimates of the Relationship between Limits to Activities of Daily Living of the Deceased Spouse and the Speed of their Subsequent Death, Robust Standard Errors in Parentheses

	(1)	(2)
	Dependent Variable:	
Instrumental Variable	Death was Expected	Duration of Final Illness More than One Year
Number of limits to the activities of daily living (ADLs) of the deceased spouse	0.036 (0.010)	0.034 (0.010)

Note*:* Each column in the table represents a different reduced-form specification. Only the OLS estimates and heteroscedasticity-robust standard error are shown for the instrumental variables. The other control variables used in each model are those listed in column 3 of Table 4 that include calendar-year and age effects, surviving spouse's health, functional status and fall trajectory, housing structural characteristics, and socio-economic characteristics., but their estimates and standard errors are not shown. All estimates are OLS estimates; probit maximum likelihood estimates were very similar. The five activities in the measure of ADLs are bathing, eating, dressing, walking across a room, and getting in and out of bed, so that the instrument ranges from 0 (no difficulties with any of the tasks) to 5 (difficulties with all of the tasks); a higher value of the instrument means a worse functional status.

Table 6. Ordinary Least Squares, Instrumental Variable, and Bivariate Probit Estimates of the Effect of Home Safety or Accessibility Features on the Incidence of Serious Falls for Widowed Individuals, Robust Standard Errors in Parentheses, Probit Marginal Effects in Square Brackets

	(1)	(2)	(3)
Explanatory Variable	Dependent Variable: Dummy if Serious Fall in Last Two Years		
A. OLS Estimates			
Dummy if home safety or accessibility features	0.005	0.004	-0.002
	(0.020)	(0.020)	(0.020)
B. IV Estimates			
Dummy if home safety or accessibility features	-0.181	-0.201	-0.218
	(0.108)	(0.100)	(0.101)
p-value for Hausman test	0.078	0.036	0.020
C. Bivariate Probit Estimates and Marginal Effects			
Dummy if home safety or accessibility features	-0.904	-0.914	-0.926
	(0.470)	(0.372)	(0.409)
	[-0.177]	[-0.135]	[-0.127]
Controls			
Calendar year and age effects	Yes	Yes	Yes
Surviving spouse's health, functional status and fall trajectory	Yes	Yes	Yes
Socio-economic characteristics	No	Yes	Yes
Housing structural characteristics	No	No	Yes

Note*:* Each cell in the table shows the parameter estimate of beta in equation (1) in the text from a separate regression using the sample of 1,005 observations described in the text. Panel A presents OLS estimates with heteroscedasticity-robust standard errors; probit maximum likelihood estimates were similar. Panel B shows the associated IV estimates using the first-stage regressions shown in Table 4, with heteroscedasticity-robust standard errors. The p-value for the Hausman test is the exact level of significance for the test of the null hypothesis that the OLS and IV estimates are equal. Panel C shows the parameter estimates from bivariate probit maximum likelihood estimation, with marginal effects shown in square brackets.

Table 7. Instrumental Variable Estimates of the Prevalence of Home Safety or Accessibility Features on the Incidence of Serious Falls for Widowed Individuals, for Subsamples Based on Selected Demographic Groups, Robust Standard Errors in Parentheses

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent Variable: Dummy if Serious Fall in Last Two Years							
Explanatory Variable	Ages 65-74	Ages 75 and Older	Men	Women	High School or Less	More than High School	Less than 200% of Poverty Line	More than 200% of Poverty Line
Dummy if home safety or accessibility features	0.046 (0.145)	-0.386 (0.145)	-0.465 (0.249)	-0.149 (0.134)	-0.163 (0.115)	-0.450 (0.295)	-0.283 (0.207)	-0.155 (0.102)
Number of Observations	464	514	241	764	648	330	288	889

Note*:* Each cell in the table shows the IV parameter estimate of beta in equation (1) in the text from a separate regression using the subsample of observations described in the column heading and measured in period *t-4*, using the richest set of controls shown in column 3 of Table 6 that include calendar-year and age effects, surviving spouse's health, functional status and fall trajectory, housing structural characteristics, and socio-economic characteristics. All standard errors are heteroscedasticity-robust.

Table 8. Reduced-Form OLS Estimates of the Relationship between Limits to Activities of Daily Living of the Deceased Spouse and the Surviving Spouse's Subsequent Medical Diagnoses, Robust Standard Errors in Parentheses

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: New Diagnosis of					
Instrumental Variable	Stroke	Memory Disease	Diabetes	Arthritis	Heart Disease	Cancer
Number of limits to the activities of daily living (ADLs) of the deceased spouse	0.003	-0.004	0.003	0.003	-0.002	-0.001
	(0.003)	(0.003)	(0.004)	(0.005)	(0.004)	(0.003)
Sample Mean	0.027	0.032	0.023	0.054	0.047	0.026

Note*:* Each cell in the table shows the OLS parameter estimate of rho in equation (4) in the text from a separate regression on the full sample of 1,005 observations, where the dependent variable measured in period *t* is described in the column heading, the focal explanatory variable is the instrument, defined as the number of limits to the activities of daily living (ADLs) of the deceased spouse when last alive, using the richest set of controls shown in column 3 of Table 6 that include calendar-year and age effects, surviving spouse's health, functional status and fall trajectory, housing structural characteristics, and socio-economic characteristics. The five activities in the measure of ADLs are bathing, eating, dressing, walking across a room, and getting in and out of bed, so that the instrument ranges from 0 (no difficulties with any of the tasks) to 5 (difficulties with all of the tasks); a higher value of the instrument means a worse functional status. All standard errors are heteroscedasticity-robust.

Table 9. Reduced-Form OLS Estimates of the Relationship between Limits to Activities of Daily Living of the Deceased Spouse and the Surviving Spouse's Subsequent Alcohol and Tobacco Use, Robust Standard Errors in Parentheses

	(1)	(2)	(3)	(4)	(5)
	Dependent Variable:				
Instrumental Variable	Whether Drinks	Number of Drinks Per Day	Whether Moderate Drinker	Whether More than Moderate Drinker	Whether Smokes
Number of limits to the activities of daily living (ADLs) of the deceased spouse	-0.010 (0.010)	-0.011 (0.015)	0.002 (0.006)	0.00003 (0.009)	0.001 (0.006)
Sample Mean	0.397	0.356	0.173	0.223	0.078

Note*:* Each cell in the table shows the OLS parameter estimate of rho in equation (4) in the text from a separate regression on the full sample of 1,005 observations, where the dependent variable measured in period *t* is described in the column heading, the focal explanatory variable is the instrument, defined as the number of limits to the activities of daily living (ADLs) of the deceased spouse when last alive, using the richest set of controls shown in column 3 of Table 6 that include calendar-year and age effects, surviving spouse's health, functional status and fall trajectory, housing structural characteristics, and socio-economic characteristics. The five activities in the measure of ADLs are bathing, eating, dressing, walking across a room, and getting in and out of bed, so that the instrument ranges from 0 (no difficulties with any of the tasks) to 5 (difficulties with all of the tasks); a higher value of the instrument means a worse functional status. All standard errors are heteroscedasticity-robust.

Table 10. Reduced-Form OLS Estimates of the Relationship between Limits to Activities of Daily Living of the Deceased Spouse and the Surviving Spouse's Balance, Robust Standard Errors in Parentheses

	(1)	(2)	(3)
	Dependent Variable:		
Instrumental Variable	Whether Self-Reported Poor Balance	Whether Unable to Complete Semi-Tandem Balance Test	Duration of the Full-Tandem Balance Test (Seconds)
Number of limits to the activities of daily living (ADLs) of the deceased spouse	0.008 (0.015)	-0.004 (0.006)	-0.075 (0.428)
Sample Mean	0.438	0.046	8.094
Number of Observations	407	453	431

Note*:* Each cell in the table shows the OLS parameter estimate of rho in equation (5) in the text from a separate regression on the subsample of observations shown in the bottom row, where the dependent variable measured in period *t*-2 is described in the column heading, the focal explanatory variable is the instrument, defined as the number of limits to the activities of daily living (ADLs) of the deceased spouse when last alive, using the richest set of controls shown in column 3 of Table 6 that include calendar-year and age effects, surviving spouse's health, functional status and fall trajectory, housing structural characteristics, and socio-economic characteristics. The five activities in the measure of ADLs are bathing, eating, dressing, walking across a room, and getting in and out of bed, so that the instrument ranges from 0 (no difficulties with any of the tasks) to 5 (difficulties with all of the tasks); a higher value of the instrument means a worse functional status. All standard errors are heteroscedasticity-robust.

Table 11. Reduced-Form OLS Estimates of the Relationship between Limits to Activities of Daily Living of the Deceased Spouse and the Surviving Spouse's Subsequent Formal and Informal Care, Robust Standard Errors in Parentheses

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable:					
Instrumental Variable	Uses Home Health Care	Receives Help from Another	Able to Rely on Another in Future for Help	Receives Private Transfers	Change in Living Arrangement	Lives with Adult Child
Number of limits to the activities of daily living (ADLs) of the deceased spouse	0.007 (0.006)	-0.003 (0.006)	-0.001 (0.010)	-0.003 (0.006)	-0.002 (0.006)	-0.008 (0.008)
Sample Mean	0.092	0.110	0.690	0.068	0.093	0.173

Note*:* Each cell in the table shows the OLS parameter estimate of rho in equation (6) in the text from a separate regression on the full sample of 1,005 observations, where the dependent variable measured in period *t* is described in the column heading, the focal explanatory variable is the instrument, defined as the number of limits to the activities of daily living (ADLs) of the deceased spouse when last alive, using the richest set of controls shown in column 3 of Table 6 that include calendar-year and age effects, surviving spouse's health, functional status and fall trajectory, housing structural characteristics, and socio-economic characteristics. The five activities in the measure of ADLs are bathing, eating, dressing, walking across a room, and getting in and out of bed, so that the instrument ranges from 0 (no difficulties with any of the tasks) to 5 (difficulties with all of the tasks); a higher value of the instrument means a worse functional status. All standard errors are heteroscedasticity-robust.

Table 12. Reduced-Form OLS Estimates of the Relationship between Limits to Activities of Daily Living of the Deceased Spouse and the Subsequent Physical State inside the Surviving Spouse's Residence, Robust Standard Errors in Parentheses

	(1)	(2)	(3)
	Dependent Variable:		
Instrumental Variable	Dummy if Clear Walkways	Dummy if Overcrowded	Dummy if Minimal Clutter
Number of limits to the activities of daily living (ADLs) of the deceased spouse	-0.008 (0.014)	0.014 (0.112)	-0.020 (0.016)
Sample Mean	0.838	0.126	0.723
Number of Observations	406	406	406

Note*:* Each cell in the table shows the OLS parameter estimate of rho in equation (7) in the text from a separate regression using the subsample observations shown in the bottom row, where the dependent variable is described in the column heading, the focal explanatory variable is the instrument, defined as the number of limits to the activities of daily living (ADLs) of the deceased spouse when last alive, using the richest set of controls shown in column 3 of Table 6 that include calendar-year and age effects, surviving spouse's health, functional status and fall trajectory, housing structural characteristics, and socio-economic characteristics. The five activities in the measure of ADLs are bathing, eating, dressing, walking across a room, and getting in and out of bed, so that the instrument ranges from 0 (no difficulties with any of the tasks) to 5 (difficulties with all of the tasks); a higher value of the instrument means a worse functional status. All standard errors are heteroscedasticity-robust.

Table 13. Ordinary Least Squares, Instrumental Variable, and Bivariate Probit Estimates of the Impact of Home Safety or Accessibility Features on the Housing Transitions of Widowed Individuals, Robust Standard Errors in Parentheses, Probit Marginal Effects in Square Brackets

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dependent Variable:						
Explanatory Variable	Moved	Moved	Serious Fall, Subsample of Stayers	Had a Nursing Home Stay in the Last 2 Years	Had a Nursing Home Stay in the Last 2 Years	Own-to-Rent Transition	Own-to-Rent Transition
A. OLS Estimates							
Dummy if home safety or accessibility features	-0.001	-0.0005	0.017	0.002	0.002	-0.0006	-0.006
	(0.022)	(0.022)	(0.021)	(0.011)	(0.012)	(0.017)	(0.017)
B. IV Estimates							
Dummy if home safety or accessibility features	-0.006	-0.084	-0.189	-0.104	-0.103	0.058	0.008
	(0.115)	(0.104)	(0.108)	(0.056)	(0.051)	(0.096)	(0.085)
C. Bivariate Probit Estimates							
Dummy if home safety or accessibility features	-0.058	-0.295	---	-1.866	*	0.608	*
	(0.537)	(0.604)		(0.124)		(0.519)	
	[-0.009]	[-0.033]		[-0.012]		[0.053]	
Controls							
Calendar year and age effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Surviving spouse's health, functional status and fall trajectory	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socio-economic characteristics	No	Yes	Yes	No	Yes	No	Yes
Housing structural characteristics	No	Yes	Yes	No	Yes	No	Yes
Number of Observations	1,005	1,005	896	1,005	1,005	1,005	1,005

*Denotes that convergence was not obtained.

Note*:* For panel A, each cell shows OLS estimates of the impact of home safety and accessibility features, which is beta in equation (1), but for the respective dependent variable shown in the column heading, on the sample of 1,005 observations described in the text in columns 1, 3, and 4, respectively, and the subsample of 896 stayers in column 2. For panel B, each cell similarly shows IV estimates of the impact of home safety and accessibility features on the respective dependent variable shown in the column heading, using the number of limits to the ADLs of the deceased spouse as the instrument. The associated first-stage regression for columns 1, 3, and 4 is shown in panel B is in column 3 of Table 4. The first-stage regression for column 2 of panel B is not shown in other tables. All standard errors are heteroscedasticity-robust. Panel C shows bivariate probit maximum likelihood estimates of the impact of home safety and accessibility features. Marginal effects are shown in square brackets. An asterisk indicates that the bivariate probit estimates were not able to converge for that specification.

Table 14. Static Comparison of Medical Costs from Falls and Housing Investment in Safety and Accessibility Modifications, by Demographic Category in Thousands of $2000

	(1)	(2)	(3)	(4)
Category	Average Cost of Medical Treatment (in thousands)	Average Housing Investment in Safety and Accessibility Modifications (in thousands)	Reduction in Expected Medical Cost per Dollar of Housing Investment using IV Estimate in Table 6	Reduction in Expected Medical Cost per Dollar of Housing Investment using IV Estimates in Table 7
Total	7.3	1.7	0.93	0.93
Age				
65-74	5.0	1.9	0.57	-0.11
75-84	8.0	1.7	1.03	1.81
85 and older	10.0	1.7	1.28	2.26
Sex				
Men	6.3	1.8	0.76	1.63
Women	7.8	1.9	0.89	0.61

Note: All dollar values are in thousands of real calendar year 2000 dollars. The data in column 1 are for all individual 65 and older, and the quotient of columns 5 and 7 in Table 1, taken from Stevens et al. (2006). The data in column 2 are the authors' calculations for all individuals 65 and older from the HRS, using the respondent-level analysis weights to make them comparable to the national data on medical cost in column 1. Column 3 uses the IV estimate from column 3 of Table 7 of a 21.8 percentage-point reduction in falls to calculate the expected cost. Column 4 uses the IV estimates for each category from Table 7 to calculate the expected cost, where the estimate for 75 and older from Table 7 was applied to medical costs for both the 75-84 and 85 and older groups.

Figure 1. HRS Variables and Timing

HRS Wave	1	1	2	2	3	3
Question Type	Retro-spective	Point-in-time	Retro-spective	Point-in-time	Retro-spective	Point-in-time
Calendar Time	(t-6,t-4)	t-4	(t-4,t-2)	t-2	(t-2,t)	t
Marital Status		Married		Widow		Widow
Death			Spouse Dies			
Outcome (Widow)					Serious Fall	
Focal Variable				Safety & Access		
Instrument (Spouse)		ADLs				
Key Controls (Widow)	Serious Fall	ADLs, Health	Serious Fall	ADLs, Health		
Other Controls		Demog/ Housing				

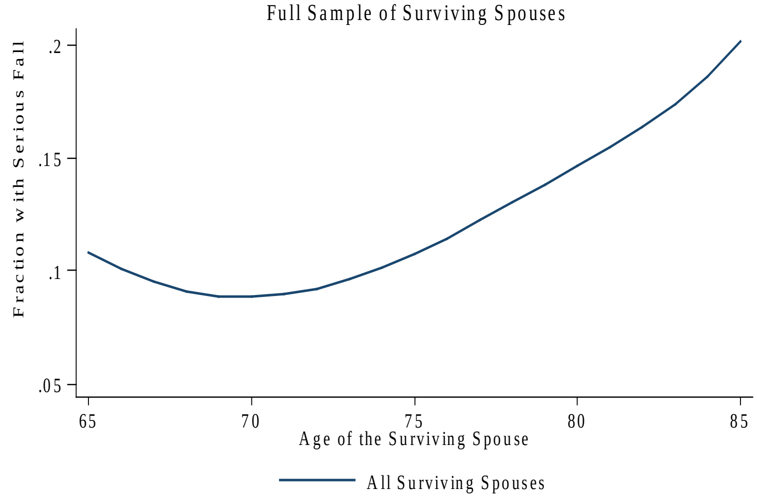
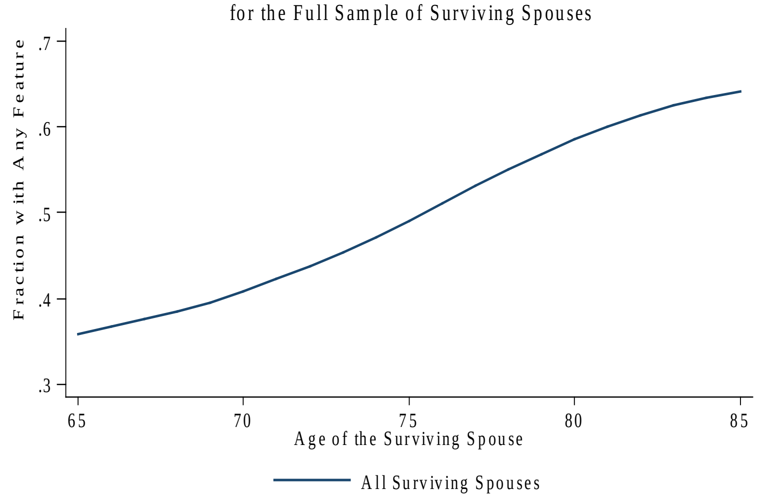


Figure 2. The Age Profile of Serious Falls for the
Full Sample of Surviving Spouses

Figure 3. The Age Profile of Safety and Accessibility Features
for the Full Sample of Surviving Spouses



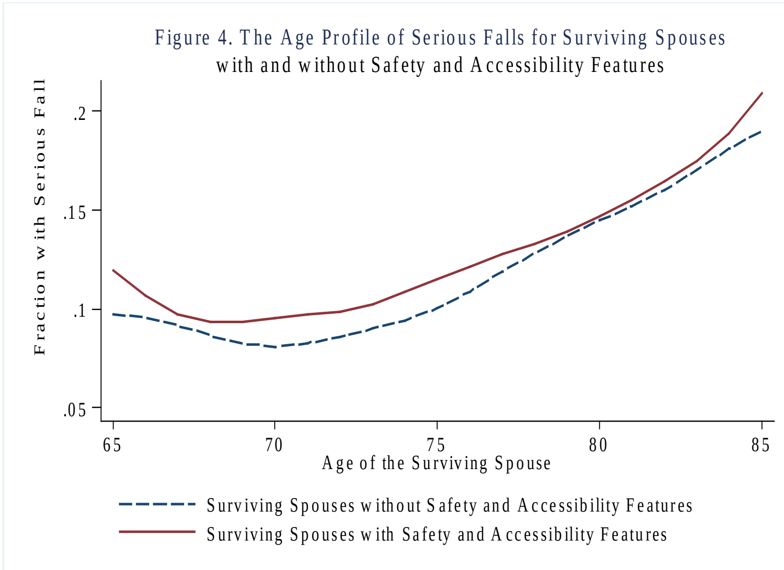
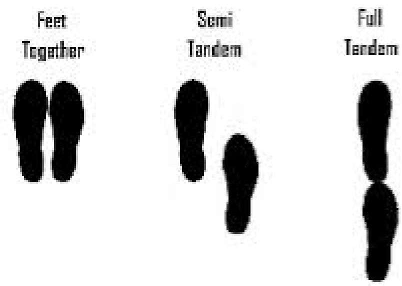


Figure 4. The Age Profile of Serious Falls for Surviving Spouses
with and without Safety and Accessibility Features
Fraction with Serious Fall
.05
.1
.15
.2
65
70
75
80
85
Age of the Surviving Spouse
Surviving Spouses without Safety and Accessibility Features
Surviving Spouses with Safety and Accessibility Features

Figure 5. Feet Position for Balance Tests



Note: Image taken from http://www.ndorms.ox.ac.uk/prove/