



University of Pennsylvania  
**ScholarlyCommons**

---

Wharton Pension Research Council Working  
Papers

Wharton Pension Research Council

---

9-22-2017

## Enhancing Risk Management for an Aging World

Olivia S. Mitchell

*University of Pennsylvania*, [mitchelo@wharton.upenn.edu](mailto:mitchelo@wharton.upenn.edu)

Follow this and additional works at: [https://repository.upenn.edu/prc\\_papers](https://repository.upenn.edu/prc_papers)

 Part of the [Economics Commons](#)

---

Mitchell, Olivia S., "Enhancing Risk Management for an Aging World" (2017). *Wharton Pension Research Council Working Papers*. 689.

[https://repository.upenn.edu/prc\\_papers/689](https://repository.upenn.edu/prc_papers/689)

This paper was prepared for presentation at the Geneva Risk Economics Lecture for the European Group of Risk and Insurance Economists (EGRIE) meetings, London, September 18-20, 2017.

This paper is posted at ScholarlyCommons. [https://repository.upenn.edu/prc\\_papers/689](https://repository.upenn.edu/prc_papers/689)  
For more information, please contact [repository@pobox.upenn.edu](mailto:repository@pobox.upenn.edu).

---

## Enhancing Risk Management for an Aging World

### Abstract

As the world confronts unprecedented global aging, academics and policymakers are growing increasingly aware of the need for better risk management tools to handle the demographic transition. It is therefore imperative to identify innovative insurance and financial market products that can enrich the range of options for households, firms, and governments facing the challenge of an aging population. After outlining thoughts on how rising longevity might shape financial markets, we discuss opportunities for the finance and insurance industries in this arena. We also highlight how policymakers could respond to improve efforts to better manage risk.

### Keywords

aging, longevity, risk management

### Disciplines

Economics

### Comments

This paper was prepared for presentation at the Geneva Risk Economics Lecture for the European Group of Risk and Insurance Economists (EGRIE) meetings, London, September 18-20, 2017.

# **Enhancing Risk Management for an Aging World**

Olivia S. Mitchell

September 22, 2017

**PRC WP2017-18**

**Pension Research Council Working Paper**

**Pension Research Council**

The Wharton School, University of Pennsylvania

3620 Locust Walk, 3302 SH-DH

Philadelphia, PA 19104-6302

Tel: 215.573.3414 Fax: 215.573.3418

Email: [prc@wharton.upenn.edu](mailto:prc@wharton.upenn.edu)

<http://www.pensionresearchcouncil.org>

This paper was prepared for presentation at the Geneva Risk Economics Lecture for the European Group of Risk and Insurance Economists (EGRIE) meetings, London, September 18-20, 2017. The author appreciates research support from the Pension Research Council and Boettner Center for Retirement Research at The Wharton School of the University of Pennsylvania. Valuable comments were provided by Monika Bütler. This research is part of the NBER programs on Aging and Labor Economics, and the Household Finance working group. Opinions expressed herein are those of the author and not those of any institution with which the author is affiliated. ©2017 Mitchell. All Rights Reserved.

## **Enhancing Risk Management for an Aging World**

### Abstract

As the world confronts unprecedented global aging, academics and policymakers are growing increasingly aware of the need for better risk management tools to handle the demographic transition. It is therefore imperative to identify innovative insurance and financial market products that can enrich the range of options for households, firms, and governments facing the challenge of an aging population. After outlining thoughts on how rising longevity might shape financial markets, we discuss opportunities for the finance and insurance industries in this arena. We also highlight how policymakers could respond to improve efforts to better manage risk.

*Keywords:* aging, longevity, risk management

### **Olivia S. Mitchell**

International Foundation of Employee Benefits Professor  
Professor of Insurance/Risk Management and Business Economics/Policy  
The Wharton School of the University of Pennsylvania  
3620 Locust Walk, Steinberg Hall-Dietrich Hall  
Philadelphia, PA 19104  
E-mail: [mitchelo@wharton.upenn.edu](mailto:mitchelo@wharton.upenn.edu)

# Enhancing Risk Management for an Aging World

Olivia S. Mitchell

## I. Introduction

A recent World Economic Forum report warned that the largest economies around the world were sitting on “pension time bombs” requiring massive financing to defuse, to the tune of \$400 trillion by 2050 (WEF 2017). In the report release, WEF’s head of financial and infrastructure systems asserted that the twin challenges of falling fertility and rising longevity are bringing the world the “financial equivalent of global climate change” (Meredith 2017). Against this dismal backdrop of failing pension system finances, it is crucial to evaluate what can be learned from the risk management, finance, and economics literature regarding how financial and insurance markets might help the world better handle the risks of global aging. The present paper takes on this challenge, seeking to broaden perspectives about better ways to manage risk as the world ages.<sup>1</sup>

We begin with a brief overview on the compression of mortality and morbidity, so as to set the stage for a discussion of how population aging might influence labor, capital, and housing markets. Next we indicate how developments in insurance and financial markets can help manage key risks borne primarily by the elderly, particularly longevity, sickness, and frailty. These can include annuities, pensions, and long term care protection, as well as longevity risk securitization and derivative contracts on residential property as well as reverse mortgages. We then turn to some warnings about how governments might exacerbate old-age risk, as well as some suggestions as to how they can potentially mitigate, help finance, and insure against the vagaries of old age.

---

<sup>1</sup> This discussion updates and substantially extends Mitchell et al. (2006).

## II. The Demography of Longer and Healthier Worklives

Two demographic trends have served as the engines of population aging: falling birthrates and rising longevity. There is little disagreement about the persistence of the first trend: women in most nations have been having fewer offspring for many years, attributed to women's improved access to education and birth control over time (Barro et al., 2015). An outstanding question is what persistently low fertility will imply in terms of long-term economic and social consequences. International evidence indicates that decreased fertility has been associated with much higher rates of women's attachment to the paid labor force (Bloom et al. 2009; Bloom and Canning 2008; Bloom and Sousa-Poza, 2010). In turn, declining fertility also tends to drive up labor earnings and per capita income, particularly when the workforce is well-educated and trained to meet changing skill needs. In other words, falling birthrates have had, and are likely to continue to have, a positive impact on long run labor earnings (Ashraf et al. 2013).

Evaluating the impact of rising longevity is more complicated. It is clear that more people are living longer in most developed and emerging nations, yet debates rage over aspects of this phenomenon. For instance, Dong et al. (2016) and Lenart and Vaupel (2017) recently crossed swords in the scientific journal *Nature* regarding whether there is an upper limit to the human lifespan, or whether people may eventually live to age 500 or beyond. Another controversy regards the degree to which longevity extension has accrued to the population at large versus only some subgroups. For instance, in the US, premature mortality rates are well above average for non-Whites and the least-educated (e.g., Shiels et al. 2017). The OECD (2016a) has also documented what it calls "fragmentation" of life expectancy tables by socio-economic status (see also Currie and Schwandt 2016). And it is as yet unclear whether rising rates of obesity and attendant health

problems around the world will be offset by medical advances that treat these and other chronic problems besetting the aging population (e.g., Korevaar et al. 2016).

A closely-related dispute has to do with whether longer lifespans will be accompanied by more years of good versus poor health. Some analysts confirm that the number of healthy life years has risen (Chernew et al. 2016), but others argue that more people are living longer with a variety of diseases (Crimmins and Beltrán 2011). In an influential recent cross-national study (Wise 2017), experts deployed a variety of approaches and datasets to estimate peoples' ability to remain gainfully employed at older ages, or what the authors termed the "health capacity to work." The authors concluded that substantial additional capacity to work – at least until age 70 – is feasible in much of the developed world.

What will these trends imply from a macroeconomic perspective? The National Academy of Sciences (NAS 2012) identified several approaches to better manage the world's rapidly aging populations. First, it will be necessary for people to work longer and retire later, since the tax-financed old age programs on which the elderly traditionally relied face insolvency. Second, workers will need to save more, invest more efficiently, and insure themselves more thoughtfully, if they are to thrive at older ages. And at the aggregate level, nations must find ways to boost labor productivity so as to ensure continued economic growth despite low (or even negative) population growth.<sup>2</sup> The good news is that declining fertility and rising longevity are apparently endowing many with additional years of good health during which they can work. Moreover, it is now evident that extending older persons' worklives does not "crowd out" labor market opportunities for younger workers (Gruber and Wise 2010; Munnell and Wu nd), so delayed retirement is a

---

<sup>2</sup> Also there is little evidence that pro-fertility policies in the context of democracies would reverse the long-term decline in fertility rates (Sundström, 2001), even if it were deemed socially and economically desirable.

reasonable and viable option for many. The main challenge, then, is to encourage longer and more productive worklives, more efficient saving and insurance, and government policy that enhances growth rather than curtailing it.

### **III. Population Aging and Wellbeing at Older Ages**

Older persons in most countries rely on a mix of family transfers, labor earnings, asset drawdowns and owner-occupied housing, and pension income from employer plans and government social security programs. Each of these may be shaped by potentially important consequences of population aging, as we discuss in turn.

Family Transfers. In the past, family transfers of time and money were often a key source of older persons' support, and the tradition of "filial piety" is still pronounced in some Asian countries (e.g., Japan, China) and in Latin American (more so than in Western Europe and North America). Yet these traditional family relationships have eroded over time in many societies, partly as a result of lower fertility. Indeed China's tradition of a one-child policy implies that today's youth will need to support six or more elderly relatives (Reynolds 2007). Moreover, the upward trend in divorce rates is also leaving older women more exposed to poverty, compared to the past (Smeeding et al. 2008). And in many nations, especially in Asia, the elderly have become increasingly geographically separated as the young have migrated to urban areas for work (Gong et al. 2013, Remes 2017). These trends, taken together, imply that older persons must look to different risk pools such as their communities and insurers, rather than to family relationships as in the past.

Labor Earnings. Longer lifespans afford more years of paid employment, particularly when older people are healthier at older ages, as noted above. Moreover, jobs have also grown less physically



demanding over time, such that delayed retirement and work at older ages are increasingly feasible. The rise of the so-called “gig economy” also offers older persons ways to engage in flexible, part-time, and other on-demand work opportunities (AARP 2016). Interestingly, the trend to early retirement among older men in the US has reversed itself, and older women are far more likely to remain employed now than at any time in the past (Quinn and Cahill, forthcoming; Lusardi and Mitchell forthcoming). This is likely to be a continuing trend as there is growing evidence that deferring retirement may enhance older persons’ health (Fitzpatrick and Moore 2016; Wu et al. 2016).

Pension and Social Security Income. The pension and social security programs on which older persons traditionally relied are in relatively poor shape, as attested to by the WEF report cited at the outset. Public pension systems often were operated as pay-as-you-go systems (PAYGO), and they relied on current tax revenue to pay benefits to today’s elders. Even when they had a partially-funded component, they still required ongoing tax financing. But as many countries are now discovering, unfunded pension promises are weighing heavily on aging economies (Elmendorf and Sheiner 2015). For instance, the U.S. Social Security System is projected to run short of cash required to pay benefits within 15 years; if the system is not reformed, benefits for everyone will need to be cut by about one-third or taxes raised 50-80% (Social Security Trustees 2017). In some instances (e.g., Australia, Chile, and Singapore), defined contribution systems have generated substantial assets to cover promised retiree benefits, and the Japanese government’s partially funded pension scheme has accumulated close to \$2.7 trillion or 43% of Japan’s pension assets (WTW 2016). Yet even so, people reaching old age with little savings in the majority of nations will turn to welfare (means-tested) social transfer programs operated on a PAYGO basis, and the

pressures on these systems will increase. Accordingly, population aging represents an existential threat to many national social security systems around the world.

Corporate and public sector pensions in many countries fare little better, as they too face deep financial problems which threaten their ability to make good on their old-age promises. In the US, for instance, it has been estimated that retirement systems operated by states and municipalities are underfunded by \$4 trillion (Rauh 2017). While no US states have yet declared bankruptcy, several cities have reduced benefits for retired public sector employees, and Puerto Rico's 2017 bankruptcy may result in substantial retiree benefit cuts (Coto 2017). And while funded pensions are growing over time (see Figure 1), these appear unlikely to be able to meet expectations in what appears to be a permanently low-return environment. In fact, only a 1% lower long-term return can cut final pension amounts by approximately 25%, and today many industrialized countries have negative interest rates, including Japan, Denmark, Sweden, and Switzerland (Clark et al. 2010, forthcoming). In other words, personal saving and delayed retirement are likely to become increasingly important for improving older people's economic wellbeing.

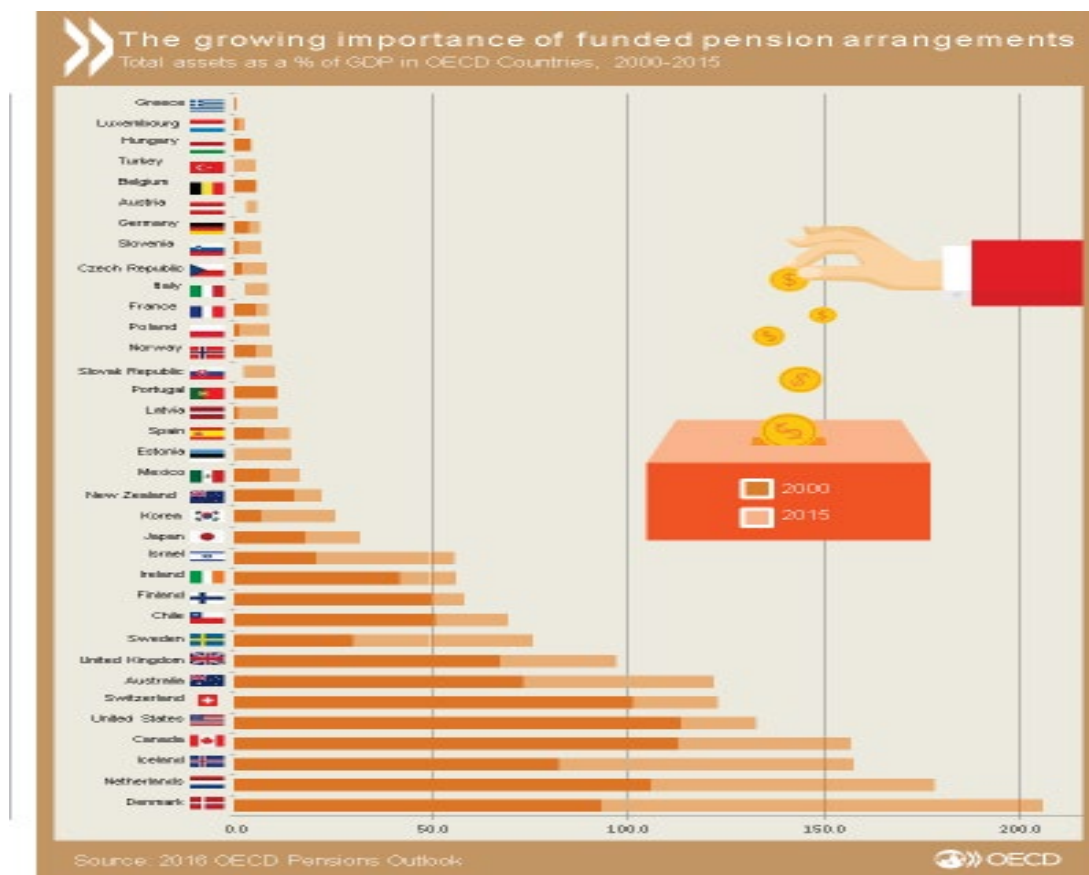


Figure 1. The Growing Importance of Funded Pension Arrangements (Total Assets as % of GDP in OECD Countries, 2000 versus 2015).

Source: OECD (2016b).

Asset Drawdowns and Owner-Occupied Housing. Older households in most countries tend to reduce their reliance on labor earnings as they age, turning instead to asset drawdowns to cover retirement consumption needs. Accordingly, it is useful to evaluate how population aging may affect older persons' ability to manage these assets into a potentially longer retirement. Not surprisingly, there is a large literature on the topic, which we summarize briefly next.

The traditional life cycle model familiar to economic analysts holds that individuals save and invest during their worklives so they can decumulate their assets to finance retirement consumption. Logically, older persons would also dispose of net home equity (i.e., the value of the owner-occupied home minus the mortgage) at older ages, to help finance their old-age needs. The

extent to which people actually draw down their assets in old age is, however, a matter of some debate. Poterba et al. (2011) used data from the Health and Retirement Study (HRS) to update previous analyses of US household wealth patterns in old age, reporting that very little home equity was tapped to support consumption by the elderly. Similarly, the longitudinal nature of the HRS permits long-term tracking of other assets held by the elderly, and here too, households did not generally draw down their financial assets over time. Instead, there was a relatively stable pattern of household net worth overall, with two-person households even increasing their net asset positions at older ages.

Despite the overall indication of asset preservation at older ages, health and other shocks may dramatically alter older households' spending patterns, depending on how well they are insured. For instance DeNardi et al. (2010) and Hubbard et al. (1995) found that medical out-of-pocket costs could erode lifetime savings dramatically, particularly when the household lacked good medical insurance coverage. Long-term care can also be extremely expensive, currently costing over \$60,000 per year in the US. Moreover, between 50 and 70 percent of Americans will require long-term care at some point, with an average 65-year old requiring long-term care for about three years on average (Hurd et al., 2013; 2014; Brown and Finkelstein, 2008). Accordingly, it is rather surprising that only about eight percent of the older US population has purchased long-term care insurance (RWJ 2014). Various explanations have been offered for the lack of insurance coverage among the elderly, prominent among them the belief that means-tested government programs will pick up a large portion of these costs. Another reason may be "narrow framing," or peoples' tendency to view insurance premiums as expensive up-front costs versus the far-off and uncertain chance of receiving the insurance payoff (Gottlieb and Mitchell, 2015).

The evidence cited above undermines the notion that population aging will generate massive equity sales, precipitating a “market meltdown” as Baby Boomers unwind their investments. Moreover, economic theory and evidence provide only limited support for the meltdown prediction. For instance Poterba (2001, 2005), Abel (2001) and Brooks (2003) draw on various models to simulate possible outcomes, with the more elaborate overlapping generations (OLG) approach of Geanakoplos et al. (2004) implying some depressive effect of Baby Boomer retirement on equity prices. Nevertheless, that evidence indicated that demographic cycles could account for at most half of observed volatility in the equity market, and mainly in the context of a “closed economy” where international trade was disallowed. In a setting that allowed for cross-national capital flows, regions with an aging populations are predicted to export capital to younger regions, providing a cushion to equity returns (Brooks 2003, 2006; Davis 2006). Moreover, immigration flows can further reduce the drag on equity returns.

While it is reasonable to argue that equity markets are flexible enough to ensure that international flows will equalize returns globally, the impact of aging on housing markets is unclear inasmuch as housing is less fungible than other assets. This is particularly important since, around the world, the elderly tend to have most if not all of their savings in the form of owner-occupied housing. Early research on the topic by Mankiw and Weil (1989) related U.S. housing values to homeowners’ age, and it concluded that housing demand and hence values would decline dramatically due to population aging. Subsequent economic studies with more complex specifications of the model come to weaker and even null results regarding the relationship between housing prices and population age structure (c.f., Hamilton 1991 and other studies cited in Mitchell et al. 2006). Additionally, a report by Takáts (2012) used data on 22 developed nations and the author concluded that population aging over the next four decades may erode housing

values by about 0.8 percent per annum, though there was little danger of a housing price “meltdown.” Accordingly, there is little reason to believe that population aging will greatly depress housing values, particularly if longer and healthier lifetimes induce people to “trade up” instead of downsizing later in life.

#### **IV. How Insurance and Financial Markets Can Protect Against Aging Risks**

Global aging confronts growing segments of the population with numerous often-expensive surprises that befall an older population, including longevity risk, healthcare cost risk, and other shocks to peoples’ standard of living. Though rational and foresighted individuals can save, invest, and therefore self-finance much of their consumption needs in old age, there remains an important role for risk-pooling to help cover idiosyncratic, or individual-level, risks. More complex is the question of how to protect against systematic risk affecting the overall economy. In this section we discuss how insurance and financial markets can enhance old-age wellbeing.

Longevity Protection. An important role for insurers in an aging world is to help individuals pool their longevity risk by offering payout annuities. These are financial products which pay to the policyholder a lifetime income stream contingent on his survival, in exchange for an up-front premium payment. In the past, many employers offered defined benefit (DB) pension promises which met this need for longevity protection, but now DB plans are increasingly being phased out, and replaced with defined contribution (DC) plans which usually pay lump sums rather than income streams.

Though this trend might suggest that private annuity markets would grow to fill the gap, the reality has been disappointing to date (Mitchell et al. 2011b). Explanations for the shortfall in annuity demand include the possibility that people fail to understand longevity risk (Brown et al.

2001), as well as the fact that annuity products are simply too complex for people to understand (Brown et al. 2017). Other authors have noted that, in a voluntary purchase market, only those expecting to live long would buy the product, leading to adverse selection and hence higher pricing (Finkelstein and Poterba 2002, 2014; McCarthy and Mitchell 2002a). And still other analysts have noted the fact that most industrialized nations provide the elderly with a subsistence floor in the form of means-tested benefits, which disincentives retirees from converting their retirement nest eggs into annuities (Bütler et al. 2016).

Not only is longevity rising, but there is also substantial uncertainty around future survival distributions. This point was nicely made by Blake et al. (2008) with “fan charts” representing the degree of uncertainty regarding survival to a given age over a future forecast period. Figure 2 shows the central 10% prediction intervals (heaviest shading) followed by successively greater intervals (20%, 30%,..., 90%) for survival probabilities of males at the given ages. As is clear from these charts (based on data from England and Wales), longevity risk is not particularly dispersed during the first 20 years. Thereafter, the range of uncertainty regarding survival rises markedly between ages 75 and 90: at age 90, for instance, the 90% prediction interval lies between 0.15 and 0.45. This highlights the very wide age range over which older persons would have to plan to finance longevity if they were to do it on their own.

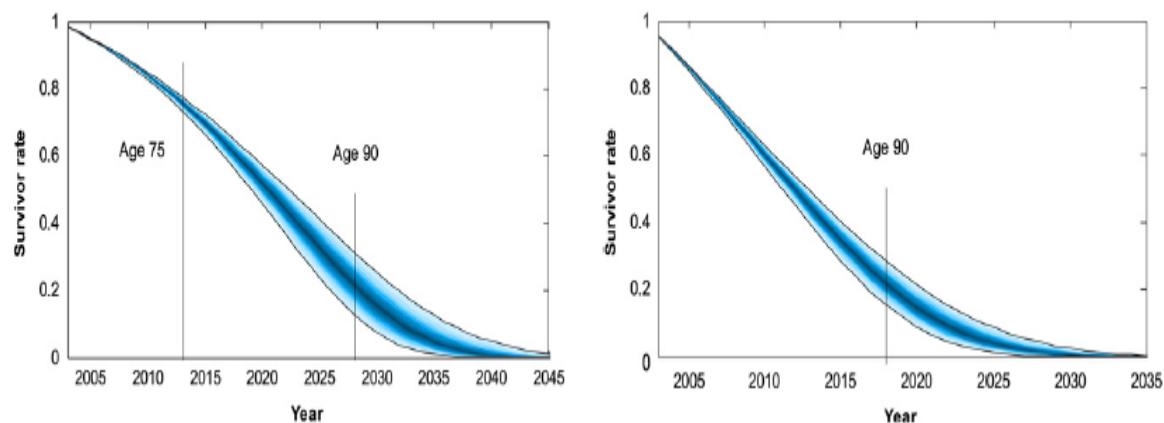


Figure 2. Survivor Fan Charts for Men Age 55 (L) and Age 75 (R)  
 Source: Derived from Blake et al. (2008), Figures 2 and 3 with uncertain parameters

Annuity providers could explore more ways to protect themselves against the uncertainty of future prospective survival density functions. One way is that life insurers, which pay off in the event of premature death, might exchange risk with annuity providers who will make money if too few people survive. Yet McCarthy and Mitchell (2006) found that this risk exchange was not easy to do, due to differential adverse selection: that is, people who voluntarily buy life insurance differ from those who voluntarily purchase annuities. Other approaches garnering recent attention include a wide range of mortality derivatives including survivor (or mortality) swaps, longevity bonds, and other financial instruments (e.g., Blake and Burrows 2001; Blake et al. 2006; Cairns et al. 2004; Cox and Lin 2005, 2007). Recently, a market overview by Blake and Morales (2017) reported some important new product developments in this arena over the past several years, though there have also been some notable failures due to insufficient demand. A key explanation for the slow development of this marketplace has been a concern over insurer insolvency (MacMinn and Brockett 2017); similarly Biffis et al. (2016) note that counterparty risk in this marketplace has become a growing concern in the wake of the 2008-9 financial crisis.



Still another different way to manage systematic longevity risk in the annuity market would be for policyholders to share mortality shocks using payout adjustments in a risk-pooling fund. In the “group self-annuitization” approach (Piggott et al. 2005), policyholders would take on their own systematic mortality risk, while the participant pool would share idiosyncratic risk. In such a case, no insurance company would be needed to hedge mortality shocks. A tontine-like model with similar features has been explored by Milevsky (2005) and Milevsky and Salisbury (2016), where annuitants bear both the systematic and unsystematic components of longevity risk.

A different approach uses “participating” or “with-profit payout life annuities” (PLAs), where retirees are promised both a guaranteed lifetime income as well as variable (non-guarantee) payments that vary with investment returns and mortality experiences of the insurance pool (Maurer et al. 2012, 2013, 2016 a and b). Here the insurer avoids taking systematic longevity risk by adjusting benefits in response to unanticipated mortality shocks. PLAs require insurers to hold much less equity capital than would normally be the case with fixed annuities, so premiums on these products are much lower. As a result, even risk-averse households are much better off than they would be in a nonparticipating annuity market: for instance, younger households average one-third more consumption and 80-year-olds about 75 percent more consumption, compared to the no-PLA alternative. Moreover, the smoothing techniques used by insurance company actuaries and accountants yield PLAs that also satisfy insurer profitability requirements and regulator solvency guidelines.

Retirees can also gain enhanced protection against longevity risk if DC plan sponsors would add deferred annuities into the defined contribution menu. This could be spurred by a recent regulatory change in the US which supports including longevity income annuities (LIAs) in the DC menu when purchased around age 65, and if they start paying benefits not later than age 85.

Additionally the rules require that they cost less than 25% of the retiree's account balance up to a limit. An analysis using a lifecycle portfolio setup reveals that these greatly enhance retiree welfare, even after taking account of mortality heterogeneity by education and sex. In the optimal case, a worker who devoted devote 8-15% of his 401(k) plan balance to a LIA that paid out from age 85 would experience a welfare improvement of 5-20% of average retirement plan accruals, compared to not having access to the LIA (Horneff et al. 2015, 2017; also see Figure 3). Moreover, plan sponsors can sensibly default workers into a LIA worth 10% of the account value over a dollar threshold automatically, which would improve wellbeing almost as much as would the fully optimal solution.

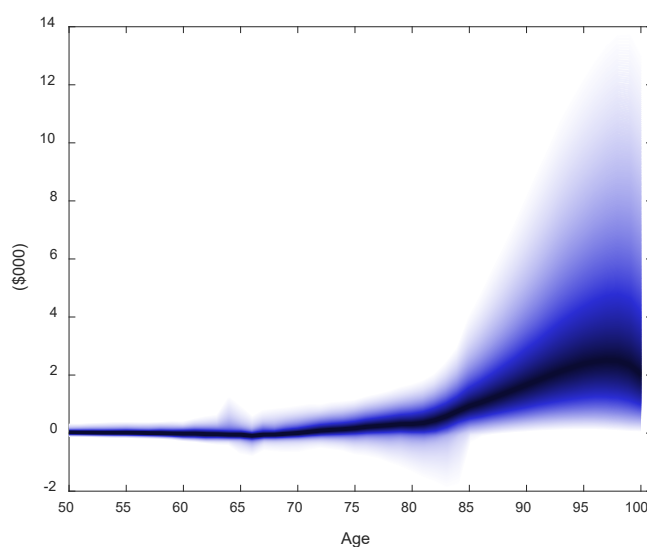


Figure 3. Consumption Differences over the Life Cycle With Versus Without Access to a Longevity Income Annuity (LIA)

Note: This figure shows the 95th% and 5th% iles of consumption differences for 100,000 life-cycles for average US workers with 401(k) plans, with and without access to LIAs starting benefits at age 85. Darker areas represent higher probability mass. Males and females of three educational groups (College+, High School, and less than High School) are modeled.

Source: Horneff et al. (2017)

Protection from Health Cost Shocks. As the world's population ages, this is sure to drive increased healthcare costs, which are already high in many countries. Yet these costs are far from fully insured around the world. In the US, for instance, older persons having government-run Medicare

and Medicaid insurance receive coverage for hospital care, doctor visits, and prescription drugs, but their lifetime exposure to out-of-pocket medical costs (premiums and co-pays) remains very high, estimated at \$350,000 (Fronstein and VanDerhei 2017).<sup>3</sup> In other words, elderly medical care insurance is quite partial in the US, and, as noted above, very few retirees have private long-term care insurance coverage. Other countries have implemented different models for managing extreme healthcare costs of the elderly, but these too are proving to be imperfect and increasingly expensive over time. For instance, Japan established a national means-tested long-term care system financed by taxes on workers and premiums/copays from beneficiaries in 2000 (Mitchell et al. 2006). Initially it was anticipated that 2.7 million people would receive benefits, but that estimate proved to be 60% too low within the first five years of the program, and concerns regarding cost increases continue (Rhee et al. 2015). Germany instituted a LTC program in 1995 covering all disabled individuals – that is, not just the elderly – financed by payroll taxes, with benefits intended to cover a portion but not all of care costs. Then in 2013, the government began subsidizing private purchases of supplemental LTC insurance as a means to fill the gap between public benefit payments and LTC costs (Nadash and Cuellar 2017).

It is clear that population aging will boost demand for medical care and LTC coverage in the coming years, depending in part on how effectively costs can be controlled and how sensitive demand is to the cost of coverage. Notably, Finkelstein and McGarry (2005) reported little evidence of a link between peoples' LTC coverage and their self-assessed chances of needing nursing home coverage. Additionally, the relative roles of public versus private insurance protection will continue to vary across countries. There has been some interesting US

---

<sup>3</sup>This represented the expected value of Medicare premiums and out of pocket costs for a 65-year old couple age 65 seeking to cover a 90% expense with 90% confidence.

experimentation on this front via the “Partnership Program,” whereby individuals in some states have been encouraged to buy a relatively limited and hence inexpensive private LTC insurance policy (Ahlstrom et al. 2004). This, in turn, allows policyholders to access the means-tested Medicaid program without having to exhaust all of their assets (as would be the case otherwise). While this would seem to be an interesting example of public/private collaborative ventures in the LTC insurance arena, there is some concern that it will boost LTC insurance coverage by only a small amount (Sun and Webb 2013). Moreover, it also appears that subsidized private purchases of LTC insurance go mainly to the wealthy who would have bought unsubsidized coverage anyhow (Lin and Prince 2013). In sum, this approach may not do a better job of protecting those at most financial risk of expensive medical costs in their later years.

A different approach to the problem could be to embed LTC coverage into annuity products, called by Brown and Warshawsky (2013) the “life care annuity.” This product would seem to be appealing in that it could attract those concerned about longevity as well as those worried about healthcare cost risk. Accordingly, it would reduce the potential for adverse selection that otherwise serves as a barrier to life annuity sales (Brown et al. 2001). This idea has been in the literature for some time (Murtaugh et al. 2001), and four insurers have recently brought to market hybrid deferred annuities consistent with this approach (Phipps 2010). Understanding how this emerging market works and how insurers evolve the products over time would be a useful topic of future research.<sup>4</sup>

Protection Against Wealth Shocks. Worldwide ageing will surely imply that markets and policymakers must devote renewed attention to the factors driving wealth shocks, inasmuch as those unable to work rely heavily on their assets to finance consumption at older ages. In particular,

---

<sup>4</sup> A description of several European nations’ LTC systems is provided by Bocquaire (2016).

it will be important to better manage and protect the elderly against sudden changes in capital market returns, interest rates, and inflation, as well as the value of peoples' homes (their main asset).

One risk-management tool especially relevant in recent years is to delay retirement and save more, in response to low market returns and lower labor earnings levels (Horneff et al. forthcoming). Many Americans who lived through the Global Financial Crisis of 2008-9 are also delaying retirement due to their elevated debt, higher than seen in the past (Lusardi et al. 2017).

Another tool might be retirement plan guarantees, particularly in light of the global move toward DC retirement schemes where workers and retirees bear the investment risk associated with their investment portfolios. This topic has attracted a number of researchers around the world including Maurer and Schlag (2004) in the German context, Lachance and Mitchell (2003) and Lachance et al. (2003) in the US public pension setting, and Mitchell (2015b) in the US corporate pension environment, among others. Yet a problem with such guarantees is that they are generally quite expensive to provide: a recent review by Golub-Sass et al. (2009) concluded that they were prohibitively costly and hence unlikely to be adopted without government subsidies.

Reverse mortgages have also been proposed by numerous housing experts as a means to help older persons 'unlock' the value of their homes without having to move out (c.f., McCarthy et al. 2002b; Alai et al. 2004). The idea is that people who are "house rich but cash poor" could use this financial vehicle to tap their home equity to pay for old-age consumption; in turn, the lender earns interest and receives a return of principal when the borrower leaves the home. These should be particularly appealing to the elderly in the US, since reverse mortgages operate in a non-recourse setting, meaning that if the value of the loan exceeds the sale price of the house, the borrower (and his heirs) are not liable. Despite the theoretical appeal of these products, there has been little

demand for them around the world.<sup>5</sup> One explanation may be that lenders are reluctant to offer the products as they bear longevity risk, interest rate risk, and house price risk, and in the US at least, insurers offering such products have experienced substantial defaults (McKim 2017). Another explanation is that consumers lack adequate information about the financial contract, including the fact that reverse mortgage give them a put option protecting them from home price risk (Davidoff et al. 2016).<sup>6</sup>

Other innovations could also be envisioned that would help the elderly better protect against shocks to their home values, as in many countries this comprises their primary, albeit illiquid, asset. Fabozzi et al. (2012) and Shiller (2014) review a variety of real estate derivatives that, if developed, could help with real estate risk management and improve the efficiency of the housing market. Though the financial crisis of 2008-9 indicated that some of these derivatives may have been mispriced, there is sure to be rising demand for better methods to price residential (as well as commercial) real estate risk.

Finally, it is worth touching on the problem of inflation risk in this section on protection against wealth shocks. Depending on the inflationary environment, this may be of central interest to retirees who confront the possibility that they may not earn enough on their assets to keep up with the cost of living. Bodie (1990) proposed that governments should issue bonds linked to the Consumer Price Index (CPI-linked bonds), arguing that these are needed to help protect retirees against falling consumption due to inflation. In a recent study building on Campbell et al. (2003),

---

<sup>5</sup> See the useful literature reviews in Davidoff (2004) and Davidoff et al. (2016).

<sup>6</sup> A related problem is that lenders will foreclose if the borrowers fail to stay current on their insurance premiums, property taxes, and maintenance. This causes negative publicity for obvious reasons. The US Housing and Urban Development (HUD) agency has determined that 18 percent of reverse mortgages taken out in the 2009-2016 time span will default, and HUD's program is already almost \$8B in deficit (McKim 2017).

Illeditsch (2017) concluded that investors should hold only Treasury inflation-protected bonds (TIPS) in order to avoid cash flow and residual inflation risk, rather than holding any nominal bonds in their investment portfolios. Doing so, he argued, would increase welfare substantially, such that risk averse investors would be willing to give up from 15-50% of their wealth to access TIPS. While that study focused on the US, the author noted that households in countries with higher inflation risk would benefit even more.

## **V. The Growing Importance of Financial Literacy, Cognitive Aging, and Finance Advice**

Another reason that population aging will require better risk management flows from the global trend toward *disintermediation* in financial and insurance markets. That is, in many nations, employers, financial institutions, and governments promised lifetime pension and healthcare coverage in the past, but they now realize they cannot make good on all promises made. In turn, individuals are increasingly having to manage their own life cycle saving, investment, and decumulation responsibilities, without the benefit of institutional guidance. This, in turn, has given rise to ever-greater access to financial credit, new and complex financial products, and many more opportunities to spend instead of save (Lusardi et al. 2017).

This confluence of factors is especially challenging given evidence that many people lack the financial know-how to transact such challenges. One area in which they fall notably short is in planning for retirement. Indeed, Lusardi and Mitchell (2007) reported that fewer than one-third of Americans over the age of 50 had ever tried to figure out how much they needed to save for retirement, and fewer than one-fifth believed that they succeeded in developing a saving plan. When people were asked where they went for financial advice, most tended to rely on their “own judgment” or asked relatives and friends.

Such shortcomings are compounded by profound and widespread illiteracy regarding basic financial economics. Lusardi and Mitchell (2014) summarized peoples' answers to the 'Big Three' Financial Literacy questions which they fielded on a wide range of respondents around the world. These questions were as follows (Lusardi and Mitchell 2007; correct responses indicated in **bold**):

- Suppose you had \$100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow: [**more than \$102**, exactly \$102, less than \$102? Do not know, refuse to answer.]
- Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, would you be able to buy: [more than, exactly the same as, or **less than today** with the money in this account? Do not know; refuse to answer.]
- Do you think that the following statement is true or **false**? 'Buying a single company stock usually provides a safer return than a stock mutual fund.' [Do not know; refuse to answer.]

The first question measures the capacity to undertake a simple calculation related to interest rate compounding; the second focuses on understanding inflation; and the third is a joint test of knowledge about 'stocks' and 'stock mutual funds' as well as risk diversification. All three are critical to being able to save, invest, and decumulate one's assets successfully. Sadly, results summarized in Figure 3 show that very few people can answer all three of these questions correctly. Moreover, proportionately more women than men respond that they "do not know" the answers to the questions, highlighting the need for more financial education for women – who after all, usually outlive their spouses. Follow-on surveys by Lusardi et al. (2013) and Lusardi and



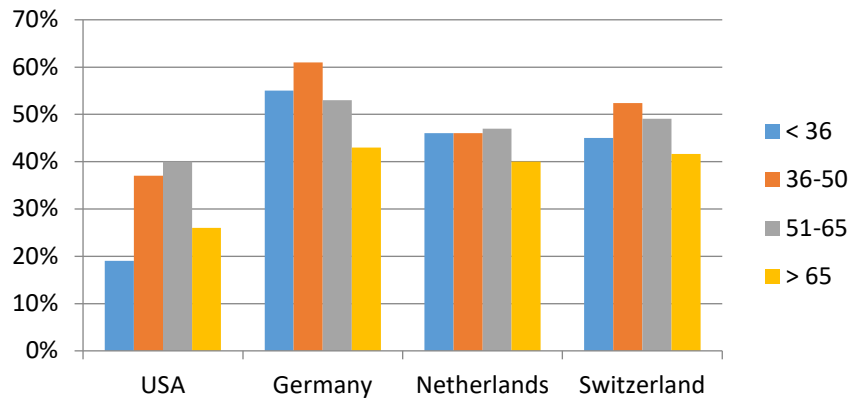
Tufano (2009) as well as many others delved further into peoples' knowledge of risk, debt, and the terms and conditions of consumer loans and mortgages. Overall, this research shows that the more financially informed are also much more likely to save, avoid expensive debt, protect against longevity risk, and accumulate more retirement wealth.<sup>7</sup>

---

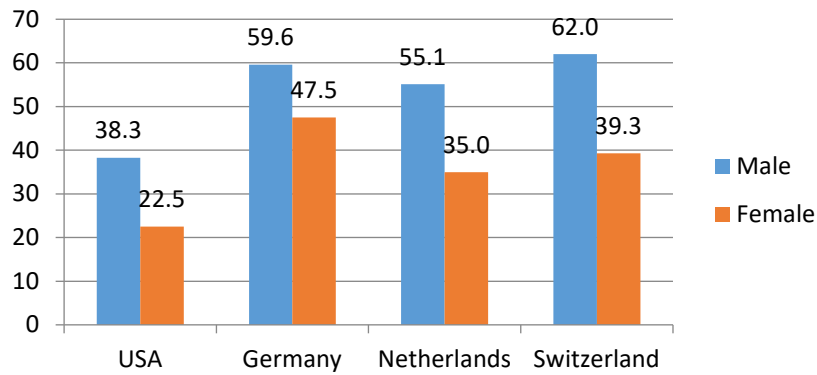
<sup>7</sup> Several studies reviewed in Lusardi and Mitchell (2014) examine whether the measured impact could be attributable to reverse causality. They conclude, with others, that the preponderance of the evidence is consistent with the directional effects running from financial knowledge to better retirement preparedness.

**Figure 3: Financial Literacy Scores in Four Nations**

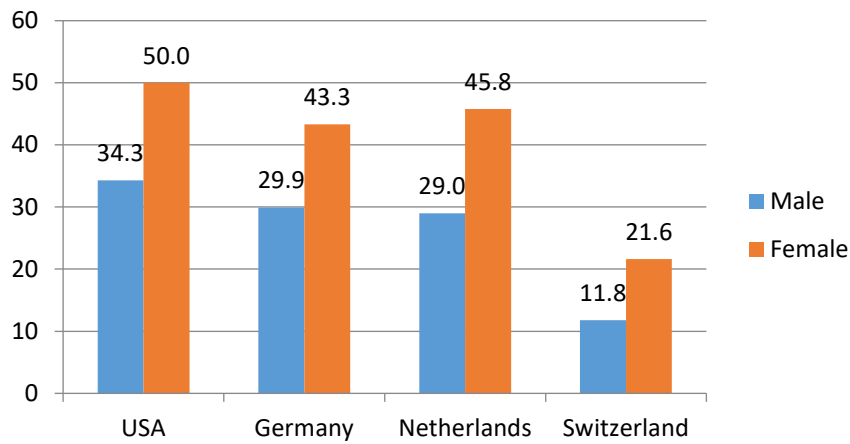
**Panel A. By Age Group: % providing correct answers to all three financial literacy questions**



**Panel B: By Sex: (% providing correct answers to all three financial literacy questions)**



**Panel C. % responding “do not know” at least once to any of the three financial literacy questions)**



Source: Lusardi and Mitchell (2014), Figure 1.

A related and growing concern for policymakers is that peoples' cognitive ability tends to decline at older ages. Though the medical profession is strenuously working to mitigate this pattern, about half of all adults age 80+ already suffer from cognitive impairment (Bernard 2015), making it difficult for them to process and follow up on financial decisions. Moreover, research suggests that older individuals may be more likely to act on poor advice or accept fraudulent offers (DeLiema and Deevy forthcoming). And behavioral traits such as overconfidence, ambiguity aversion, lack of self-control, regret aversion, and impatience make it more difficult for people to manage investments and withdraw sensibly from their retirement savings (Mitchell et al. forthcoming; Dimmock et al. 2016). Studies on these behavioral attributes to date have mainly been conducted on prime-age individuals, so more research is needed on how older people make many of the most consequential financial decisions of their lives (e.g., Huffman et al. 2017). In tandem, it will be important to formulate methods to ensure greater consumer financial protection as the population ages (Campbell et al. 2011).

We recognize that an alternative to educating workers and retirees on fundamental economic and finance questions could be to “outsource” the job, turning to either human or “robo” financial advisors. Indeed Kim et al. (2016) pointed out that workers should engage financial advisors to manage their money for them when self-management is costly in terms of foregone on-the-job skill investment. Nonetheless, very few people indicate that they are willing to use professional investment advice, and of those, most state they might implement only those recommendations that conform to their own ideas (Hung and Yoong 2013). Indeed Collins (2011) and Finke (2013) have found that financial literacy and financial advice tend to be complements rather than substitutes, so advice absent knowledge may not help shape financial decisions and behavior.

## VI. Discussion

Our goal in this paper has been to highlight some of the key risks facing an aging world, as well as to draw implications for ways in which financial and insurance markets could improve the wellbeing of an older population. As we have emphasized, it will be imperative for more people to work longer, during which period they must save more, continue to invest in capital markets and in themselves, and delay decumulation. Efforts to boost labor productivity, including enhancing health, education, and financial literacy, will be complementary to this process.

Another need is to devise better products that help value, price, and insure against old-age risk. This includes hybrid mechanisms that can cover longevity as well as healthcare cost shocks, inflation risk, and wealth shocks. There is much room for improvement in this arena, inasmuch as households have little experience with the sorts of longevity that are forecasted, and also because the products themselves are complex. There is also information asymmetry on the side of finance and insurance providers who have not yet built up extensive information needed to price reverse mortgages, long-deferred annuities, housing derivatives, and other related tools.

In turn this highlights important roles for policymakers who can assist in making markets function better for old-age risk management. Of paramount importance is the need to reform failing social insurance systems on which many older persons rely. “Parametric” system reforms often involve cutting benefits and raising contributions, as well as increases in retirement ages and the number of years required to become eligible for benefits (OECD 2016b). Yet more profound and system-wide restructuring may also be needed, and diverse new possibilities are available. For instance, Chile, Australia, Singapore, and several other countries have moved to funded private account defined contribution schemes. Ever here, however, these programs have been challenged

by those who favor redistributing accumulated assets and returning to a PAYGO system, as occurred in Argentina (Rofman 2015) and as is now threatened in Chile (Mitchell 2015a). The Dutch advocate a combination approach they have adopted termed a “defined ambition” plan where workers are promised variable deferred annuities based on pension assets and a mortality risk pool (Bovenberg et al. 2016). Other new models include some favored by labor unions (Blitzstein 2016), public sector entities (Rappaport and Peterson 2016), and many others detailed in Mitchell and Shea (2016).

Thinking even more broadly, an alternative approach suggested by Valdes-Prieto (2005) might be to find a way to securitize future tax revenues and formally dedicate them to national PAYGO pension plans. Implementing such a proposal would likely require government support for the development of a national wage index (Shiller 1993, Athanasoulis et al. 1999). Other products that would help protect households against political risk include longer-dated inflation-indexed bonds, as in the UK, and private/public sector collaboration in generating data for the purpose of creating mortality indexes. Exciting new technological and digital technologies also offer ways to enable insurers to narrow gaps in insurance protection around the world by cutting costs, curtailing information asymmetries, and limiting moral hazard (Geneva Association nd). Recently the World Bank joined with private insurer Swiss Re to issue catastrophe bonds covering epidemics in Mexico (Swiss Re 2017), and it stands to reason that other ways to manage mortality shocks could benefit from international agencies’ insights and oversight.

Finally, it is worth emphasizing that additional research and much better data will be required to inform industry and policymakers seeking to manage risks in an aging world. While this will be expensive, so too will be the costs of doing nothing. Without reforms, many nations will face rising numbers of under-insured and over-extended elderly.

## References

- AARP. (2016). “The Upside of the On-Demand Economy.” <http://bit.ly/2wHx4pa>
- Abel, Andrew B. (2001). ‘Will Bequests Attenuate the Predicted Meltdown in Stock Prices when Baby Boomers Retire?’ *The Review of Economics and Statistics*, 83(4): 589-595.
- Ahlstrom, Alexis, Anne Tumlinson, Emily Clements, and Jeanne Lambrew. (2004). “The Long-Term Care PartnerShip Program: Issues and Options.” *Brookings.blog*. <http://brook.gs/2vtTN47>.
- Alai, Daniel A., Hua Chen, Daniel Cho, Katja Hanewald and Michael Sherris. (2004). “Developing Equity Release Markets: Risk Analysis for Reverse Mortgages and Home Reversions.” *North American Actuarial Journal*. 18 (1): 217-241.
- Ashraf, Quamrul H., David N. Weil, and Joshua Wilde. (2013). “The Effect of Fertility Reduction on Economic Growth.” *Population and Development Review*. 39(1): 97-130.
- Athanasoulis, Stefano, Robert Shiller, and Eric van Wincoop. (1999). “Macro Markets and Financial Security.” *Economic Policy Review*. Federal Reserve Bank of New York 5(1): 21–39
- Barro, Robert J., Jong-Wha Lee, and Chong-hwa Yi. (2015). *Education Matters: Global Schooling Gains from the 19th to the 21st Century*. Oxford: Oxford University Press.
- Bernard, Tara S. (2015). “As Cognition Slips, Financial Skills Are Often the First to Go.” *New York Times*. April 24.
- Biffis, Enrico, David Blake, Lorenzo Pitotti, and Ariel Sun. (2016). “The Cost of Counterparty Risk and Collateralization in Longevity Swaps.” *Journal of Risk and Insurance* 83(2):387-419.
- Blake, David and William Burrows (2001). “Survivor Bonds: Helping to Hedge Mortality Risk.” *Journal of Risk and Insurance*, 68(2): 339-348.
- Blake, David, Andrew J.G. Cairns, and Kevin Dowd. (2006). “Living With Mortality: Longevity Bonds and Other Mortality-Linked Securities.” *British Actuarial Journal*. 12 (1): 153-228.
- Blake, David, Kevin Dowd, and Andrew J.G. Cairns. (2008). “Longevity Risk and the Grim Reaper’s Toxic Tail: The Survivor Fan Charts.” *Insurance: Mathematics and Economics*. 42: 1062-1066.
- Blake, David and Marco Morales. (2017). “Longevity Risk and Capital Markets: The 2014–15 Update.” *Journal of Risk and Insurance*. 84(S1): 279–297

- Bloom, David E. and David Canning. (2008). "Global Demographic Change: Dimensions and Economic Significance." *Population and Development Review*, 34(S): 17-51.
- Bloom, David E., David Canning, Gunther Fink, and Jocelyn Finlay. (2009) "Fertility, Female Labor Force Participation, and the Demographic Dividend." *Journal of Economic Growth*. 14(2): 79-101,
- Bloom, David E. and Alfonso Sousa-Poza. (2010). "Economic Consequences of Low fertility in Europe." FZID Discussion Paper No. 11-2010.
- Blitzstein, David. (2016). "United States Pension Benefit Plan Design Innovation: Labor Unions as Agents of Change." In *Reimagining Pensions: The Next 40 Years*. Olivia S. Mitchell and Richard Shea, eds. Oxford: Oxford University Press: 123-128.
- Bocquaire, Edith. (2016). "Long-Term Care Coverage in Europe." Society of Actuaries. Cited in <http://bit.ly/2xEztxo>
- Bodie, Zvi. (1990). "Inflation, Index-Linked Bonds, and Asset Allocation." *Journal of Portfolio Management*. 16(2): 48-53.
- Bovenberg, A. Lans, Roel Mehlkopf, and Theo E. Nijman. (2016). "The Promise of Defined Ambition Plans: Lessons for the United States." In *Reimagining Pensions: The Next 40 Years*. Olivia S. Mitchell and Richard Shea, eds. Oxford: Oxford University Press: 161-173.
- Brooks, Robin. (2003). "Population Ageing and Global Capital Flows in a Parallel Universe." IMF Staff Papers 50(2).
- Brooks, Robin. (2006). "Demographic Change and Asset Prices." Presented at the G-20 Workshop on Demography and Financial Markets, Sydney, July.
- Brown, Brown, J. and A. Finkelstein. (2008). "The Interaction of Public and Private Insurance: Medicaid and the Long-Term Insurance Market." *American Economic Review*. 98(3): 1083-1102.
- Brown, Jeffrey R., Arie Kapteyn, Erzo Luttmer, and Olivia S. Mitchell. (2017). "Cognitive Constraints on Valuing Annuities." *Journal of the European Economic Association*. 15(2): 429-462.
- Brown, Jeffrey, Olivia S. Mitchell, James Poterba, and Mark Warshawsky (2001). *The Role of Annuity Markets in Financing Retirement*, Cambridge, MA: MIT Press.
- Brown, Jason and Mark Warshawsky. (2013). "The Life Care Annuity: A New Empirical Examination of an Insurance Innovation That Addresses Problems in the Markets for Life Annuities and Long-Term Care Insurance." *Journal of Risk and Insurance*. 80(3): 677-703.

- Bütler, Monika, Kim Peijnenburg, and Stefan Staubli. (2016). "How Much Do Means-Tested Benefits Reduce the Demand for Annuities?" *Journal of Pension Economics and Finance*. 16(4): 419-449.
- Cairns, Andrew J.G., David Blake, and Kevin Dowd (2004), "Pricing Death: Frameworks for the Valuation and Securitization of Mortality Risk." *ASTIN Bulletin*. 36(1): 79-120.
- Campbell, John, Yueng L. Chan, and Luis M. Viceira. (2003). "A Multivariate Model of Strategic Asset Allocation." *Journal of Financial Economics*. 67: 41–80.
- Campbell, John, Howell Jackson, Brigitte Madrian, and Peter Tufano. (2011). Consumer Financial Protection. *Journal of Economic Perspectives* 25(1): 91-114.
- Chernew, Michael, David M. Cutler, Kaushik Ghosh, and Mary Beth Landrum. (2016). "Understanding the Improvement in Disability Free Life Expectancy in the US Elderly Population." NBER WP 22306.
- Clark, Robert and Olivia S. Mitchell, eds. (2010). *Reorienting Retirement Risk Management*. Oxford: Oxford University Press.
- Clark, Robert, Raimond Maurer, and Olivia S. Mitchell, eds. (forthcoming). *How Persistent Low Returns Will Shape Saving and Retirement*. Oxford: Oxford University Press.
- Collins, J. Michael. (2011). "Improving Financial Literacy: The Role of Nonprofit Providers." In *Financial Literacy: Implications for Retirement Security and the Financial Marketplace*. Olivia S. Mitchell and Annamaria Lusardi, eds. Oxford: Oxford University Press: 268-187.
- Coto, Danica. (2017). "Board to Puerto Rico: Cut Pension System, Impose Furloughs." USNews.com March 12 <http://bit.ly/2wdX60c>
- Cox, Samuel H. and Yijia Lin. (2007). 'Natural Hedging of Life and Annuity Mortality Risks.' *North American Actuarial Journal*. 11(3): 1-15.
- Cox, Samuel H. and Yijia Lin. (2005). 'Securitisation of Mortality Risks in Life Annuities,' *Journal of Risk and Insurance*. 72(2): 227-252.
- Crimmins, Eileen and H. Beltrán (2011). "Mortality and Morbidity Trends: Is There Compression of Morbidity?" *Journal of Gerontology: Social Sciences*. 66(1): 75-86.
- Currie, Janet and Hannes Schwandt. (2016). "Mortality Inequality: The Good News from a County Level Approach." *Journal of Economic Perspectives*. 30(2): 29-52.
- Davidoff, Thomas and Gerd Welke. (2004). "Selection and Moral Hazard in the Reverse Mortgage Market." UBC Working Paper.



- Davidoff, Thomas, Patrick Gerhard, and Thomas Post. (2016). "Reverse Mortgages: What Homeowners (Don't) Know and How It Matters." *Journal of Economic Behavior and Organization*. 233: 151-171.
- Davis, E. Philip. (2006). "How Will Ageing Affect the Structure of Financial Markets?" Presented at the G-20 Workshop on Demography and Financial Markets, Sydney, July.
- DeLiema, Marguerite and Martha Deevy. (Forthcoming). "Aging and Exploitation: How Can the Financial Service Industry Respond?" In Olivia S. Mitchell, P. Brett Hammond, and Stephen P. Utkus, eds. *Financial Decision Making and Retirement Security in an Aging World*. Oxford: Oxford University Press.
- DeNardi, Mariacristina, Eric French and John Bailey Jones. (2011). "Why Do the Elderly Save? The Role of Medical Expenses." *Journal of Political Economy* 118(1): 39–75.
- Dimmock, Stephen G., Roy Kouwenberg, Olivia S. Mitchell and Kim Peijnenburg. (2016). "Ambiguity Attitudes and Economic Behavior: Results from a US Household Survey." *Journal of Financial Economics*. 119(3): 559–577.
- Dong, Xiao, Brandon Milholland, and Jan Vij. (2016). "Evidence for a Limit to Human Lifespan." *Nature*. 538(7624): 257-265.
- Elmendorf, Douglas W. and Louise M. Sheiner. (2015). "Federal Budget Policy with an Aging Population and Persistently Low Interest Rates." *Journal of Economic Perspectives*. 31(3): 175-94).
- Fabozzi, Frank J., Robert J. Shiller, and Radu S. Tunaru. (2012). "A Pricing Framework for Real Estate Derivatives." *European Financial Management*. 9(3): 762-789.
- Finke, Michael. (2013). "Financial Advice: Does It Make a Difference?" In *The Market for Retirement Financial Advice*. Olivia S. Mitchell and Kent Smetters, eds. Oxford, UK: Oxford University Press: 229-248.
- Finkelstein, Amy and Kathleen McGarry (2005). "Private Information and its Effect on Market Equilibrium: New Evidence from Long-Term Care Insurance." *American Economic Review*. 96(4): 938-958.
- Finkelstein, Amy and James Poterba. (2002). "Selection Effects in the UK Individual Annuities Market." *The Economic Journal*. 112: 28-50.
- Finkelstein, Amy and James Poterba. (2014). "Testing for Asymmetric Information Using "Unused Observables" in Insurance Markets: Evidence from the U.K. Annuity Market." *Journal of Risk & Insurance* 81(4): 709-734.
- Fitzpatrick, Maria D. and Timothy J. Moore (2016). "The Mortality Effects of Retirement: Evidence from Social Security Eligibility at Age 62." CRR Working Paper 2016-7.

- Fronstein, Paul and Jack Vanderhei. (2017). "Savings Medicare Beneficiaries Need for Health Expenses." *EBRI Notes*. 38(1).
- Geanakoplos, John, Michael Magill, and John Quinzii. (2004). "Demography and the Long-run Predictability of the Stock Market." *Brookings Papers on Economic Activity*. 1: 241-325.
- Geneva Association. (nd). "Harnessing Technology to Narrow the Insurance Protection Gap." Geneva: Geneva Association. <https://bit.ly/GATechGapReport>
- Golub-Sass, Alex, Alicia Munnell, Anthony Webb, and Richard Kopcke. (2009). "What Does It Cost to Guarantee Returns?" BCRRC Brief IB#9-4.
- Gong, Peng, Song Liang, Elizabeth J. Carlton, Qingwu Jiang, Jianyong Wu, Lei Wang, and Justin V. Remais. (2013). "Urbanization and Health in China." *The Lancet*. 379(9818): 843-852.
- Gottlieb, Daniel and Olivia S. Mitchell. (2015). "Narrow Framing and Long-Term Care Insurance." NBER WP 21048.
- Gruber, Jonathan and David A. Wise, eds. (2010). *Social Security Programs and Retirement around the World: The Relationship to Youth Employment*. Chicago, IL: The University of Chicago Press and NBER.
- Hamilton, Bruce W. (1991). "The Baby Boom, the Baby Bust, and the Housing Market. A Second Look." *Regional Science and Urban Economics* 21: 547-552.
- Horneff, Vanya, Raimond Maurer, and Olivia S. Mitchell. (Forthcoming). "How Persistent Low Expected Returns Alter Optimal Life Cycle Saving, Investment, and Retirement Behavior." In *How Persistent Low Returns Will Shape Saving and Retirement*. Robert Clark, Raimond Maurer, and Olivia S. Mitchell, eds. Oxford: Oxford University Press.
- Horneff, Vanya, Raimond Maurer, Olivia S. Mitchell, and Ralph Rogalla. (2015). "Optimal Life Cycle Portfolio Choice with Variable Annuities Offering Liquidity and Investment Downside Protection." *Insurance: Mathematics and Economics*. 63: 91–107.
- Horneff, Vanya, Raimond Maurer and Olivia S. Mitchell. (2017). "Putting the Pension Back in 401(k) Plans: Optimal Retirement Plan Design with Longevity Income Annuities." Pension Research Council WP.
- Hubbard, Glen, Jonathan Skinner, and Steven Zeldes (1995). "Precautionary Saving and Social Insurance." *Journal of Political Economy*. 103(2): 360-399.
- Huffman, David, Olivia S. Mitchell, and Raimond Maurer. (2017). "Time Discounting and Economic Decision-making among the Elderly." *Journal of the Economics of Ageing*. Online 19 May.

- Hung, Angela, and Joanne Yoong. (2013). "Asking for Help: Survey and Experimental Evidence on Financial Advice and Behavior Change." In Olivia S. Mitchell and Kent Smetters, eds. *The Market for Retirement Advice*. Oxford: Oxford University Press: 182-212.
- Hurd, Michael, Paco Martorell, Adeline Delavande, Kathleen J. Mullen, and Kenneth M. Langa. (2013). "Monetary Costs of Dementia in the United States." *New England Journal of Medicine*. 368: 1326-34.
- Hurd, M., P-C. Michaud, and S. Rohwedder. (2014). "The Lifetime Risk of Nursing Home Use. In *Discoveries in the Economics of Aging*. D. Wise, ed. Chicago: University of Chicago Press: 81-209.
- Illeditsch, Phillipp Karl. (2017). "Residual Inflation Risk." *Management Science*. Online 16 August.
- Kim, Hugh, Raimond Maurer, and Olivia S. Mitchell. (2016). "Time is Money: Rational Life Cycle Inertia and the Delegation of Investment Management." *Journal of Financial Economics*. 121(2): 231-448.
- Korevaar, J. C, F.G. Schellevis, H. Picavet, et al. (2016). "Time Trends in Prevalence of Chronic Diseases and Multimorbidity Not Only due to Aging: Data from General Practices and Health Surveys." *PLoS ONE* 11(8): e0160264. doi:10.1371/journal.pone.0160264.
- Lachance, Marie-Eve and Olivia S. Mitchell. (2003). "Understanding Individual Account Guarantees." *American Economic Review P&P*. 93(2): 257-260.
- Lachance, Marie-Eve, Olivia S. Mitchell, and Kent Smetters. (2003). "Guaranteeing Defined Contribution Pensions: The Option to Buy Back a Defined Benefit Promise." *Journal of Risk and Insurance*. 70(1): 1-16.
- Lenart, A. and J. W. Vaupel. (2017). "Questionable Evidence for a Limit to Human Lifespan." *Nature*. 546(7660): E13-E14.
- Lin, Haizhen and Jeffrey Prince. (2013). "The Impact of the Partnership Long-Term Care Insurance Program on Private Coverage." *Journal of Health Economics*. 32(6): 1205-1213.
- Lusardi, Annamaria, Pierre-Carl Michaud, and Olivia S. Mitchell. (2017). "Optimal Financial Literacy and Wealth Inequality." *Journal of Political Economy*. 125(2): 431-477.
- Lusardi, Annamaria and Olivia S. Mitchell. (2007). "Baby Boomer Retirement Security: The Roles of Planning, Financial Literacy, and Housing Wealth." *Journal of Monetary Economics*. 54(1): 205-224.
- Lusardi, Annamaria and Olivia S. Mitchell. (2014). "The Economic Importance of Financial Literacy: Theory and Evidence." *Journal of Economic Literature*. 52(1): 5-44.

- Lusardi, Annamaria and Olivia S. Mitchell. (Forthcoming). "Older Women's Labor Market Attachment, Retirement Planning, and Household Debt." In C. Goldin and L. Katz. *Women Working Longer*. Chicago: University of Chicago Press and NBER.
- Lusardi, Annamaria, Olivia S. Mitchell, and Vilsa Curto. (2013). "Financial Literacy and Financial Sophistication among Older Americans." *Journal of Pension Economics and Finance*. 13: 347-366.
- Lusardi, Annamaria, Olivia S. Mitchell, and Noemi Oggero. (2017). "Debt and Financial Vulnerability on the Verge of Retirement." NBER WP 23664.
- Lusardi, Annamaria and Peter Tufano. (2009). "Teach Workers about the Peril of Debt." *Harvard Business Review*. November: 22–24.
- MacMinn, Richard, and Patrick Brockett. (2017). "On the Failure (Success) of the Markets for Longevity Risk Transfer." *Journal of Risk and Insurance*. 84(S1): 299-317.
- Mankiw, Gregory M. and David N. Weil (1989). "The Baby Boom, the Baby Bust, and the Housing Market." *Regional Science and Urban Economics*. 19(2): 235-258.
- Maurer, Raimond, Olivia S. Mitchell, Ralph Rogalla, and Ivonne Siegelin. (2016a). "Accounting-based Asset Return Smoothing in Participating Life Annuities: Implications for Annuitants, Insurers, and Policymakers." In Olivia S. Mitchell, Raimond Maurer, and J. Michael Orszag, eds. *Retirement System Risk Management: Implications of the New Regulatory Order*. Oxford: Oxford University Press: 40-50.
- Maurer, Raimond, Olivia S. Mitchell, Ralph Rogalla, and Ivonne Siegelin. (2016b). "Accounting and Actuarial Smoothing of Retirement Payouts in Participating Life Annuities." *Insurance: Mathematics and Economics*. 71: 268–283.
- Maurer, Raymond, Olivia S. Mitchell, Ralph Rogalla, and Vasily Kartashov. (2013). "Lifecycle Portfolio Choice with Stochastic and Systematic Longevity Risk, and Variable Investment-Linked Deferred Annuities." *Journal of Risk and Insurance*. 80(3): 649–676
- Maurer, Raimond, Ralph Rogalla, and Ivonne Siegelin. (2012). "Participating Payout Life Annuities: Lessons from Germany." PRC Working Paper 2012-03. Wharton School.
- Maurer, Raimond and Christian Schlag. (2004). "Money Back Guarantees in Individual Pension Accounts: Evidence from the German Pension Reform." In *The Pension Challenge: Risk Transfers and Retirement Income Security*. Olivia S. Mitchell and Kent Smetters, eds. Oxford: Oxford University Press, 187-213.
- McCarthy, David and Olivia S. Mitchell. (2002a). "Estimating International Adverse Selection in Annuities." *North American Actuarial Journal*. 6(4): 38-54.

- McCarthy, David and Olivia S. Mitchell. (2006). "International Adverse Selection in Life Insurance and Annuities." In Shripad Tuljapurkar, Naohiro Ogawa, and Anne Gauthier, eds. *Riding the Age Waves: Responses to Ageing in Advanced Industrial States*. Amsterdam: Elsevier: 119-135.
- McCarthy, David, Olivia S. Mitchell, and John Piggott. (2002b). "Asset Rich and Cash Poor in Singapore? Retirement Provision in a National Defined Contribution Pension Fund" *Journal of Pension Finance and Economics*. 1(3):197-222.
- McKim, Jenifer. (2017). "More Seniors Are Taking Loans against Their Homes and It's Costing Them." *WashingtonPost.com*. August 25.
- Meredith, Sam. (2017). "Pensions Time-bomb for World's Biggest Economies Could Explode to \$400 Trillion, says WEF." *CNBC.com*. <https://www.cnbc.com/2017/05/26/pensions-time-bomb-for-worlds-biggest-economies-could-explode-to-400-trillion-says-wef.html>
- Milevsky, Moshe. (2005). "Real Longevity Insurance with a Deductible: Introduction to Advanced-life Delayed Annuities (ALDA)." *North American Actuarial Journal*. 9: 109-122.
- Milevsky, Moshe and Thomas A. Salisbury. (2016). "Equitable Retirement Income Tontines: Mixing Cohorts without Discriminating." *ASTIN Bulletin*. 46(3): 571-604.
- Mitchell, Olivia S. (2015a). "Chile's Fabled Retirement System: Why Fix It?" *Forbes.com*, Sept. 29. <http://bit.ly/2wDMKtg>
- Mitchell, Olivia S. (2015b). "Overviewing the Findings: the Technical Panel Review of the Pension Insurance Modeling System" *Journal of Pension Economics and Finance*. 14(12): 114-124.
- Mitchell, Olivia S., P. Brett Hammond, and Stephen P. Utkus, eds. (Forthcoming). *Financial Decision Making and Retirement Security in an Aging World*. Oxford: Oxford University Press.
- Mitchell, Olivia S. and Richard Shea, eds. (2016). *Reimagining Pensions: The Next 40 Years*. Oxford: Oxford University Press.
- Mitchell, Olivia S., John Piggott, Michael Sherris, and Shaun Yow. (2006). "Financial Innovations for an Aging World." In *Demography and Financial Markets*. C. Kent, A. Park, and D. Rees, eds. Report of the G-20 Meetings. Reserve Bank of Australia/Australian Treasury: Pegasus Press: 299-336.
- Mitchell, Olivia S., John Piggott, and Noriyuke Takayama, eds. (2011b). *Revisiting Retirement Payouts: Market Developments and Policy Issues*. Oxford: Oxford University Press.

- Munnell, Alicia H. and April Y. Wu. (nd). "Do Older Workers Squeeze Out Younger Workers?" SIEPR Discussion Paper 13-011.
- Murtaugh, Christopher, Brenda Spillman, and Mark Warshawsky (2001). "In Sickness and In Health: An Annuity Approach to Financing Long-Term Care and Retirement." *Journal of Risk and Insurance*. 68(2): 225-254.
- Nadash, Pamela and Alison Evans Cuellar. (2017). "The Emerging Market for Supplemental Long Term Care Insurance in Germany in the Context of the 2013 Pflege-Bahr Reform." *Health Policy*. 121: 588-593.
- National Academy of Science (NAS) Committee on the Long-Run Macro-Economic Effects of the Aging (2012). *U.S. Population. Aging and the Macroeconomy: The Long-Term Implications of an Older Population*. For the National Research Council of the National Academy of Science. Washington, DC: National Research Council.
- OECD (2016a). "Fragmentation of Retirement Markets due to Differences in Life Expectancy." Chapter 6 in *OECD Business and Finance Outlook 2016*. Paris: OECD. <https://www.oecd.org/pensions/private-pensions/BFO-2016-Ch6-Retirement-Markets.pdf>
- OECD (2016b). *OECD Pensions Outlook 2016*. Paris: OECD. <http://bit.ly/2wHP2YG>
- Phipps, Jeannie. (2010). "New: A Hybrid Annuity with LTC Coverage." Bankrate.com <http://bit.ly/2xp2RbB>
- Piggott, John, Emiliano A. Valdez, and Bettina Detzel. (2005). "The Simple Analytics of a Pooled Annuity Fund." *Journal of Risk and Insurance*. 72(3): 497-520.
- Poterba, James M. (2001). "Demographic Structure and Asset Returns." *The Review of Economics and Statistics*. 83(4): 565-584.
- Poterba, James M. (2005). "The Impact of Population Aging on Financial Markets." In Gordon H. Sellor, Jr., ed. *Global Demographic Change: Economic Impact and Policy Challenges*. Kansas City: Federal Reserve Bank of Kansas City: 163-216.
- Poterba, James M., Steven Venti, and David Wise. (2011). "The Composition and Drawdown of Wealth in Retirement." *Journal of Economic Perspectives*. 25(4): 95-117.
- Quinn, Joseph and Kevin Cahill. (Forthcoming). In *How Persistent Low Returns Will Shape Saving and Retirement*. Robert Clark, Raimond Maurer, and Olivia S. Mitchell, eds. Oxford: Oxford University Press.
- Rappaport, Anna and Andrew Peterson. (2016). "Risk Sharing Alternatives for Pension Plan Design: An Overview and Case Studies." In *Reimagining Pensions: The Next 40 Years*. Olivia S. Mitchell and Richard Shea, eds. Oxford: Oxford University Press: 95-123.

- Rauh, Joshua. (2017). "Hidden Debt, Hidden Deficits: 2017 Edition: How Pension Promises Are Consuming State and Local Budgets." Palo Alto, CA: Hoover Institution.
- Remes, Jaana. (2017). "Aging and Urban Divergence." Brookings.edu <http://brook.gs/2jWdNHA>
- Reynolds, James. (2007). "China's Elderly Care Conundrum." BBC News. <http://news.bbc.co.uk/2/hi/asia-pacific/6222586.stm>
- Rhee, Jong Chul, Nicolae Done, and Gerard F. Anderson. (2015). "Considering Long Term Care Insurance for Middle Income Countries: Comparing South Korea with Japan and Germany." *Health Policy*. 116: 1319-1329.
- Robert Wood Johnson. (RWF 2014). Robert Wood Johnson (RWJ) Foundation. (2014). "Long-Term Care: What Are the Issues?" *Health Policy Snapshot*. Issue Brief. [www.rwjf.org/healthpolicy](http://www.rwjf.org/healthpolicy)
- Rofman, Rafael. (2015). "Argentina's Pension Policy in the Last 20 Years: Chronicle of a Death Foretold." *Forbes.com* April 27. <http://bit.ly/2gjOvFz>
- Shiels, M. S, P. Chernyavskiy, W.F. Anderson, et al. (2017). "Trends in Premature Mortality in the USA by Sex, Race, and Ethnicity from 1999 to 2014: An Analysis of Death Certificate Data." *The Lancet*. January 25. [http://dx.doi.org/10.1016/S0140-6736\(17\)30187-3](http://dx.doi.org/10.1016/S0140-6736(17)30187-3)
- Shiller, Robert J. (1993) *Macro Markets: Creating Institutions for Managing Society's Largest Economic Risks*. Oxford: Oxford University Press.
- Shiller, Robert J. (2014). "Why Is Housing Finance Still Stuck in Such a Primitive Stage?" *American Economic Review*. 104(5): 73-76.
- Smeeding, Timothy, J. Gornick, and E. Sierminska. (2008). "The Social and Economic Vulnerability of Older Women in Rich Countries." Powerpoint presentation for the Population Reference Bureau Policy Seminar. <http://bit.ly/2gecGoV>
- Social Security Trustees (2017). "Annual Report of the Board of Trustees of the Federal Old-Age and Survivors Insurance and Federal Disability Insurance Trust Funds." [www.ssa.gov](http://www.ssa.gov)
- Sun, Wei and Anthony Webb. (2013). "Can Long Term Care Insurance Partnership Programs Increase Coverage and Reduce Medicaid Costs?" BCRRC Working Paper 2013-8.
- Sundström, Kajsa. (2001). "Can Governments Influence Population Growth?" OECD Observer. [http://oecdoobserver.org/news/archivestory.php/aid/563/Can\\_governments\\_influence\\_population\\_growth\\_.html](http://oecdoobserver.org/news/archivestory.php/aid/563/Can_governments_influence_population_growth_.html)
- Swiss Re. (2017). "World Bank Launches First Ever Bonds to Combat Pandemic Outbreaks – Swiss Re Capital Markets Joint Structure and Sole Book Runner for Transaction." Swiss Re Publication. <http://bit.ly/2vyC8rK>

- Takáts, Elod. (2012). “Aging and House Prices.” *Journal of Housing Economics*. 21:131-141.
- Valdés-Prieto S. (2005). “Securitization of Taxes Implicit in PAYGO Pensions.” *Economic Policy*. 20: 215–265.
- Willis Towers Watson (WTW 2016). *Global Pension Assets Study 2016*. London: WTW.
- Wise, David, ed. (2017). *Social Security Programs and Retirement around the World: The Capacity to Work at Older Ages*. Chicago, IL: University of Chicago Press.
- World Economic Forum. (WEF 2017). “We’ll Live to 100 – How Can We Afford It?” White Paper. [http://www3.weforum.org/docs/WEF\\_White\\_Paper\\_We\\_Will\\_Live\\_to\\_100.pdf](http://www3.weforum.org/docs/WEF_White_Paper_We_Will_Live_to_100.pdf)
- Wu, Chenkai, Michelle C. Odden, Gwenith G. Fisher, and Robert S. Stawski. (2016). “Association of Retirement Age with Mortality: A Population-based Longitudinal Study among Older Adults.” *Journal of Epidemiology and Community Health*. 70 (9): 917-923.