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Time inconsistency and retirement planning

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HIGHLIGHTS

- The degree of retirement planning is a key determinant of household saving.
- This paper quantifies the welfare gains associated with improved retirement planning.
- A modest increase in the planning horizon length can generate large welfare gains.

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ABSTRACT

We *quantify* the welfare gains from better retirement planning using a model in which retirement planning is time inconsistent. A modest increase in a household's planning horizon by just a few years generates large aggregate and individual welfare gains.

1. Introduction

Typical households appear to struggle when it comes to preparing for retirement. A common mistake is waiting too long to get started. Studies document and intuition suggests an important connection between the degree of retirement planning and the level of saving at retirement; and, low levels of financial literacy appear to be one reason why many households fail to plan very far into the future (Lusardi and Mitchell, 2007, 2008, 2009, 2011).[1]

As a result, Lusardi, Mitchell, and many others are part of a world-wide effort to measure financial literacy and to teach and encourage people to prepare more efficiently for their retirement years.[2] In this paper we seek to *quantify* the welfare gains associated with improved retirement planning. In particular, we ask the following question: how large are the welfare gains from a modest increase in the length of the household planning horizon? Our answer: the welfare gains are large by typical standards.

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1 For example, Lusardi and Mitchell (2007) show that Baby Boomers who understand the effects of compound interest are more likely to plan ahead for retirement and in turn tend to accumulate more financial wealth. The impact of financial literacy on planning persists even after controlling for many key demographic factors, and the impact of planning on wealth accumulation likewise survives even after controlling for many of the conventional determinants of household saving. For similar results see Lusardi (1999, 2002, 2003, 2008), Ameriks et al. (2003), and van Rooij et al. (2011, 2012) among many others.

2 We cannot adequately describe all the details of this major effort in this short paper. We direct readers to the *Financial Literacy Center*, whose mission is "to develop and test innovative programs to improve financial literacy and promote informed financial decision making," to the OECD *Financial Education Project* to improve financial literacy among member countries, and to the *Jump$tart Coalition for Personal Financial Literacy* which is "dedicated to improving the financial literacy of pre-kindergarten through college-age youth by providing advocacy, research, standards and educational resources."

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We arrive at this conclusion by studying the dynamically-inconsistent model of Caliendo and Aadland (2007). Individuals in this model make plans that span a short horizon, but then they abandon those plans as age advances and the planning horizon slides forward along the time scale. Essentially, an individual goes through the early stages of the life cycle without even thinking about retirement. Yet eventually his planning horizon slides across the retirement threshold and more of the retirement period comes into view. The individual reacts by planning and saving aggressively before it is too late. Such sub-optimal retirement planning sharply contrasts with the standard neoclassical model in which the individual begins planning the moment he enters the workforce, though it is consistent with Campbell's (2006, p. 1554) view that mistakes in household financial decision making "are central to the field of household finance" and with the finding that many Americans have not given much thought to retirement planning even when they are 50+ years of age (Lusardi and Mitchell, 2007, 2008, 2011). In sum, the short horizon model is a convenient, reduced form construct to study imperfections and improvements in retirement planning.

We assume individuals differ according to the length of their planning horizons and we calibrate the distribution of planning horizons so that the current US social security tax rate of 10.6% is in fact the optimal tax rate for the model economy. This calibration strategy ensures that the welfare gains from operating a social security program are maximized: a benevolent policymaker recognizes that people struggle when it comes to retirement planning, knows the distribution of planning horizons, and designs a social security program to best cope with this problem. By maximizing the welfare gains that can come from social security, we are intentionally understating the welfare gains that come from better retirement planning since social security is already optimally calibrated to combat shortsightedness. Yet, even with this bias in place, we still find significant welfare gains from better retirement planning. For instance, the aggregate welfare gain from a modest increase in the mean planning horizon from 5 to 10 years, so that the average individual starts saving at age 55 rather than at age 60, is equivalent to 2% of aggregate consumption. By conventional macroeconomic standards, this is a large welfare gain given that it is as large or larger than the gains traditionally ascribed to eliminating business cycle fluctuations (Lucas, 2003) and idiosyncratic health and financial risks (Vidangos, 2009).

We interpret our paper as a companion to Lusardi et al. (2011). Unlike our time-inconsistent setting, they construct a time-consistent model where financial literacy is an endogenous variable. Households invest time and monetary resources to become more financially literate, and literacy increases the expected returns on risky stocks. They conduct a policy experiment which compares wealth holdings in a world with heterogeneity in financial literacy to an ideal world in which everyone is financially sophisticated (or at least has free access to a financial advisor). They find that financial literacy has the potential to generate very large gains in wealth accumulation and also has the potential to reduce wealth differences across education groups. Just like Lusardi et al. we too show that improved financial literacy and hence better retirement planning can generate large welfare gains, though we come to this conclusion with a very different model. Taken together, the two papers tell a consistent story: whether it is the costly (and rational) acquisition of financial literacy that prevents households from obtaining the first-best consumption/saving allocations as in Lusardi et al. or whether it is time-inconsistent shortsightedness that prevents households from reaching the first-best as in our paper, improvements in financial literacy and retirement planning can have large economic consequences in theoretical models.

Of course, documenting large welfare gains from more efficient retirement planning (as we have done in this paper) is the easy part. The hard part is to figure out exactly how to induce such behavior. We leave it to Lusardi, Mitchell, and other experts to develop and test the effectiveness of financial education mechanisms and to identify low cost methods of delivery. Our purpose is to provide a *theoretical foundation* to help justify their efforts.[3]

2. Model

In this section we add two features to the short-term planning model of Caliendo and Aadland (2007). We add a social security program and we add heterogeneity in planning horizons. Findley and Caliendo (2009) add these features as well, and they endogenize factor prices. Here we focus our attention on an endowment economy, which biases our welfare gains downward because better retirement planning would have the added effect of higher GDP in a production economy. In this sense, our results can be interpreted as a lower bound on the welfare effects of improved retirement planning. Neither of these other papers examine the question that we consider in this study.

Age is continuous and is indexed by t. All individuals start work at $t = 0$, retire at $t = T$, and pass away at $t = \bar{T}$. They receive the real economy-wide wage w for $t \in [0, T]$ and pay social security taxes at rate θ. With R workers for every retiree in the economy, pay-as-you-go social security benefits are $b = R\theta w$ for $t \in [T, \bar{T}]$. Consumption is $c(t)$, and savings $k(t)$ grows at rate r. We assume $k(0) = k(\bar{T}) = 0$. Finally, there is no economic or population growth, so $R = T/(\bar{T} - T)$.

The length of an individual's planning horizon is x, which varies across the population according to the density function $f(x)$ with support $[x^-, x^+]$. Individuals are identical in all other respects. To improve the tractability of the model we impose the restriction $x^+ \leq \bar{T} - T$. This allows us to neatly separate the lifetime of all individuals into four distinct phases: Phase 1 is $[0, T - x]$, Phase 2 is $[T - x, T]$, Phase 3 is $[T, \bar{T} - x]$, and Phase 4 is $[\bar{T} - x, \bar{T}]$.

Phase 1 is the portion of the working period for which retirement is not yet in view. Phase 2 is the portion of the working period when retirement is in view. Phase 3 is the portion of the retirement period when the planning horizon does not yet reach all the way to the date of death. And Phase 4 is the portion of the retirement period when the date of death is in sight. The degree to which individuals plan for retirement is a function of how early they transition from Phase 1 to Phase 2.

At every age $t_0 \in [0, \bar{T}]$ the agent makes a consumption/saving plan that spans a short horizon $t \in [t_0, \min\{t_0 + x, \bar{T}\}]$:

$$\max \int_{t_0}^{\min\{t_0+x,\bar{T}\}} e^{-\rho(t-t_0)} \frac{c(t)^{1-\phi}}{1-\phi} dt, \tag{1}$$

where ρ is the discount rate, subject to the law of motion

$$\frac{dk(t)}{dt} = rk(t) + (1-\theta)w - c(t),$$
$$\text{for } t \in \{[0, T] \cap [t_0, \min\{t_0 + x, \bar{T}\}]\}, \tag{2}$$

$$\frac{dk(t)}{dt} = rk(t) + b - c(t),$$
$$\text{for } t \in \{[T, \bar{T}] \cap [t_0, \min\{t_0 + x, \bar{T}\}]\}, \tag{3}$$

and boundary conditions

$$k(t_0) \text{ given}, \tag{4}$$

$$k(\min\{t_0 + x, \bar{T}\}) = 0. \tag{5}$$

The solution to this problem is the *planned* consumption path for $t \in [t_0, \min\{t_0 + x, \bar{T}\}]$. But this model features time-inconsistent

[3] Our paper complements the empirical foundation provided by Lo Prete (2013). In a series of cross-country regressions, she shows that the economic benefits of a more advanced financial system are contingent on the financial literacy of the population.

dynamic optimization during Phases 1 through 3 since the individual's planned consumption program continues to become invalid and sub-optimal with the progression of time as his short planning horizon slides forward along the time scale. The actual consumption program is the envelope of infinitely many initial values from a continuum of planned time paths. Because this mathematical procedure is already described in Caliendo and Aadland (2007) and Findley and Caliendo (2009), we suppress the details of deriving the planned paths and the details of converting the planned paths into the actual paths. In the Appendix we report the closed-form consumption paths actually followed.

We assume the goal of a benevolent policymaker is to select the social security tax rate to maximize utilitarian life-cycle welfare.[4] Therefore,

$$\theta^* \equiv \arg\max \int_{x^-}^{x^+} \int_0^{\bar{T}} f(x) e^{-\rho t} \frac{c(t)^{1-\phi}}{1-\phi} dt\, dx, \tag{6}$$

subject to the given distribution of planning horizons

$$f(x) = e^{-\mu(\gamma x - 1)^2} \times \left(\int_{x^-}^{x^+} e^{-\mu(\gamma x-1)^2} dx \right)^{-1}, \tag{7}$$

and subject to individual decision making

$$c(t) \text{ defined by problem (1)–(5).} \tag{8}$$

This completes the description of our model.

3. Quantitative experiments

3.1. Calibration

All individuals start work at age 25, retire at 65, and pass away at 80. Therefore we set $T = 40$ and $\bar{T} = 55$. The wage rate is normalized to $w = 1$. We set the interest and discount rates to the same value $r = \rho = 3.5\%$, and we assume $\phi = 1.25$. Our calibration strategy is to choose the parameters of the density function $f(x)$ so that θ^* from the policymaker's problem above equals the actual tax rate of 10.6% in the US. The values $x^- = 1$, $x^+ = 15$, $\mu = 1.52$, and $\gamma = 0.22$ deliver $\theta^* = 10.47\%$, which is quite close to the target rate. The mean of the density is 5 years at this calibration.

Note that our calibration strategy makes the welfare gains from social security as large as possible: the benevolent policymaker understands that people struggle when it comes to retirement planning, knows the distribution of planning horizons, and then designs the social security program to best cope with this problem.[5] By maximizing the welfare gains that can come from social security, we are intentionally understating the welfare gains from better retirement planning because social security is already optimally calibrated to combat shortsightedness. For example, if we set the social security tax and benefit levels at values that are smaller than the optimal pay-as-you-go levels, then an increase in the length of the planning horizon would have an even larger welfare effect than what we report below.

3.2. Aggregate welfare

Our first experiment is to compute the aggregate welfare gains from an increase in the length of the average planning horizon, holding the variance of the planning horizon fixed and holding the social security tax rate at its baseline level. We consider a modest increase from a mean planning horizon of 5 to a mean of 10 (see Fig. 1), which occurs when $\mu = 9.2071$ and $\gamma = 0.0989$. This implies that the average individual starts saving at age 55 rather than waiting until age 60 to start saving.

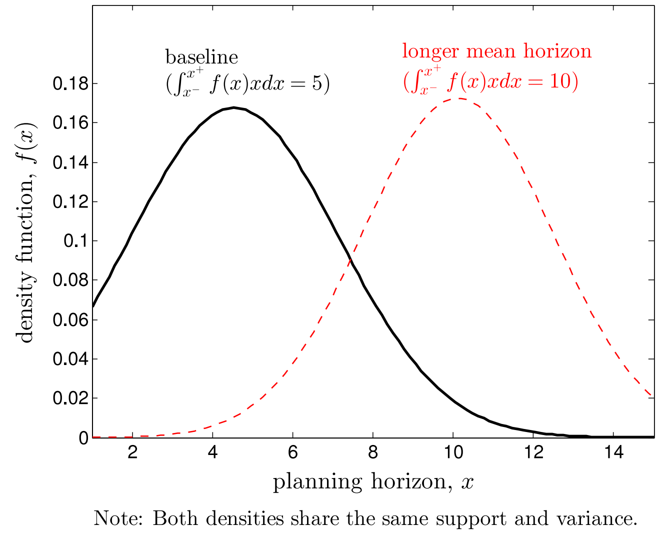


Fig. 1. The distribution of planning horizons.

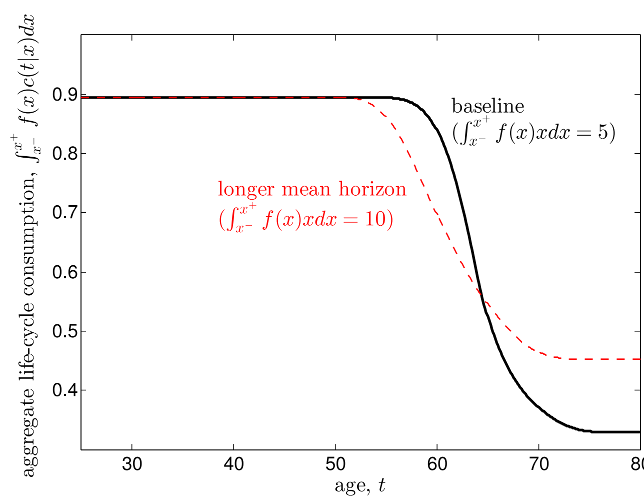


Fig. 2. Aggregate consumption over the life cycle.

While most financial education initiatives aim at larger improvements than this, we find that such a modest increase in the mean planning horizon provides a large aggregate welfare gain. The compensating variation (CV) – the percentage increase in the consumption of individuals of all ages and planning horizons in the baseline calibration (mean 5) that is required to match the aggregate welfare associated with longer horizons (mean 10) – is 1.9%. Fig. 2 shows the aggregate consumption profiles in this experiment and highlights the better consumption smoothing that comes from improvements in the average horizon length.[6] The CV remains significant even for smaller improvements in retirement planning; for example, if the mean horizon increases from 5 to 8, then the CV is still above 1%.

To put these calculations into context, recall that the welfare gains typically ascribed to the elimination of business cycle

[4] Notice that "true utility" is not what the shortsighted individual naturally maximizes, though it is indeed what the policymaker seeks to maximize.

[5] The welfare gains from social security are huge in this model. If we turn off the social security program but keep everything else the same, the economy-wide wage rate must increase by 31% to achieve the level of social welfare conferred by social security. However, social security is not a Pareto policy. Those with the longest horizons dislike the program.

[6] The welfare gains from better planning are underestimated here because we have ignored the general equilibrium benefits of better planning on aggregate capital and GDP.

fluctuations (Lucas, 2003) as well as the gains from eliminating idiosyncratic shocks to health, unemployment, and wage income (Vidangos, 2009) are similar in magnitude to the gains that we report. Thus, even if policymakers design a social security system that captures all available welfare gains along this policy dimension, a modest increase in the mean planning horizon can still be as valuable as the gains that come from eliminating key macro- and microeconomic risks that have received so much attention from researchers and policymakers.

We also consider a second aggregate experiment to illustrate the value of better retirement planning. Consider the counterfactual case in which there is no social security program in place. We now iterate over (μ, γ) ordered pairs until we achieve the same social welfare conferred by an optimal social security program, subject to the constraint that the variance of x stays the same as in the baseline parameterization. Holding the variance fixed allows us to focus on the compensating change to the mean planning horizon. This exercise produces $\mu = 7.2728$ and $\gamma = 0.1158$, which implies a new mean planning horizon of 8.62 years. Thus, a modest increase in the length of the mean planning horizon (3.62 years) – so that the average individual starts saving at about age 56 rather than age 60 – would produce welfare gains equal to the gains conferred by operating a social security program with an optimal replacement rate.

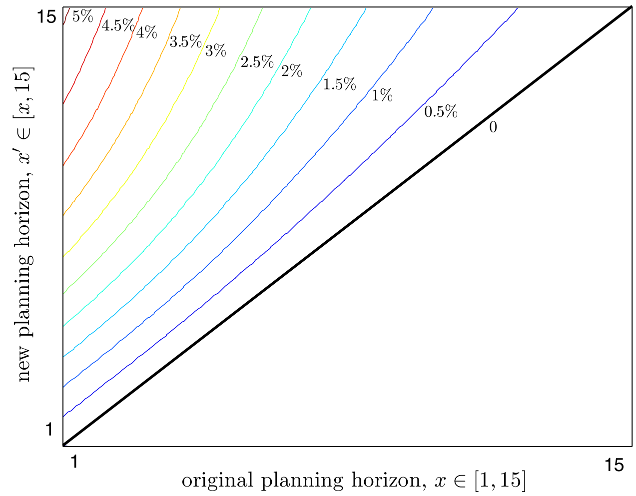
3.3. Individual welfare

In this section we disaggregate the welfare effects of better retirement planning to understand the full distribution of the individual welfare gains. Of course, an increase in the planning horizon will be welfare improving as long as the planning horizon falls short of the full lifespan. But the gains to better retirement planning are non-linear in the initial planning horizon.

Fig. 3 is a contour plot of the individual welfare gains from an increase in the planning horizon from x to x', for many values of x and x'. The contour lines represent the individual CV, which is the percentage increase in consumption across the entire life cycle that is required to bring the lifetime utility of an individual with horizon x up to the level of utility when the horizon is $x' > x$. This figure illustrates that the large aggregate welfare gains from better planning are driven primarily by those with the shortest planning horizons. For instance, a 5 year increase in the planning horizon (as in the aggregate welfare calculations above) translates to a CV of 2.6% if the initial planning horizon is $x = 1$ but the CV is 1.0% if $x = 10$. Clearly, the aggregate welfare gains reported above are tilted primarily toward those with the shortest horizons. It is not particularly surprising that the gains to better retirement planning exhibit diminishing returns. Yet what is important is that even those with longer horizons (10 years) can also benefit significantly from modest improvements in planning.

4. Conclusion

The welfare gains from modest improvements in retirement planning are significant in our model. Even if the social security program is optimally calibrated to combat sub-optimal retirement planning, small improvements in planning can still generate welfare gains on the order of 2% of aggregate consumption. To put this into context, the welfare gains from modest improvements in retirement planning are similar to (or larger than) the gains typically ascribed to the elimination of business cycle fluctuations (Lucas, 2003) as well as the gains from eliminating idiosyncratic shocks to health, unemployment, and wage income (Vidangos, 2009). Given the volume of effort spent studying these topics and the financial resources publicly committed to capturing the gains from eliminating such uncertainty, it seems quite reasonable to conclude that societies should also identify efficient methods of delivering financial education to harness the large welfare gains from better retirement planning.



Note: CV solves $\int_0^{\bar{T}} e^{-\rho t} \frac{[c(t|x)(1+CV)]^{1-\phi}}{1-\phi} dt = \int_0^{\bar{T}} e^{-\rho t} \frac{[c(t|x')]^{1-\phi}}{1-\phi} dt$

Fig. 3. Compensating Variations (CV) from better planning.

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Appendix

To facilitate replication and extension of our analysis, we report the closed-form solution consumption paths actually followed by the time-inconsistent individual. See Caliendo and Aadland (2007) and Findley and Caliendo (2009) for a detailed derivation of this model.

Phase 1, $t \in [0, T - x]$:

$$c(t) = k(t)z_1 - z_2, \tag{A.1}$$

$$k(t) = \frac{(1-\theta)w + z_2}{z_1 - r}\left[1 - e^{(r-z_1)t}\right], \tag{A.2}$$

where

$$z_1 \equiv \frac{g - r}{e^{(g-r)x} - 1}, \tag{A.3}$$

$$z_2 \equiv \frac{(1-\theta)w\,[1 - e^{rx}]\,(g - r)}{r\,[e^{gx} - e^{rx}]}, \tag{A.4}$$

and $g \equiv (r - \rho)/\phi$ are used to compress notation.

Phase 2, $t \in [T - x, T]$:

$$\begin{aligned} c(t) &= k(t)z_1 + z_1 \frac{(1-\theta)we^{rt}}{r}\left[e^{-rt} - e^{-rT}\right] \\ &\quad + z_1 \frac{R\theta we^{rt}}{r}\left[e^{-rT} - e^{-r(t+x)}\right], \end{aligned} \tag{A.5}$$

$$\begin{aligned} k(t) &= k\,(T - x)\, e^{(r-z_1)(t-T+x)} \\ &\quad + \frac{w(1-\theta)e^{(r-z_1)t}}{z_1 - r}\left[e^{(z_1-r)t} - e^{(z_1-r)(T-x)}\right] \\ &\quad + [R\theta + \theta - 1]\,\frac{we^{(r-z_1)t-rT}}{r}\left[e^{z_1(T-x)} - e^{z_1 t}\right] \\ &\quad + \left[1 - \theta - R\theta e^{-rx}\right]\frac{z_1 w}{r\,(r - z_1)} \\ &\quad \times \left[1 - e^{(r-z_1)t+(z_1-r)(T-x)}\right]. \end{aligned} \tag{A.6}$$

Phase 3, $t \in [T, \bar{T} - x]$:

$$c(t) = k(t)z_1 - z_3, \tag{A.7}$$

$$k(t) = k(T)\, e^{(z_1 - r)(T-t)} + \frac{R\theta w + z_3}{z_1 - r}\left[1 - e^{(r - z_1)t + (z_1 - r)T}\right], \tag{A.8}$$

where

$$z_3 \equiv \frac{R\theta w\,[1 - e^{rx}]\,(g - r)}{r\,[e^{gx} - e^{rx}]}. \tag{A.9}$$

Phase 4, $t \in [\bar{T} - x, \bar{T}]$:

$$c(t) = \frac{e^{gt}\left\{k(\bar{T} - x)e^{rx} - R\theta w\,[1 - e^{rx}]/r\right\}(g - r)}{e^{g\bar{T}} - e^{g(\bar{T} - x) + rx}}. \tag{A.10}$$

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