The Excess Burden of Government Indecision

Francisco Gomes, Laurence J. Kotlikoff and Luis M. Viceira[1]

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Comments are most welcome.

[1]Gomes: London Business School and CEPR. Email: *fgomes@london.edu.* Kotlikoff: Boston University and NBER. Email:*kotlikof@bu.edu.* Viceira: Harvard Business School, Boston MA 02163, CEPR and NBER. Email: *lviceira@hbs.edu.* We are grateful for helpful comments and suggestions by ... We thank the Social Security Administration for research support. All views expressed and mistakes made are entirely our own.Viceira also thanks the Division of Research at HBS for generous financial support.

The Excess Burden of Government Indecision

Abstract

Governments are known for procrastinating when it comes to resolving painful policy problems. Whatever the political motives for waiting to decide, procrastination distorts economic decisions relative to what would arise with early policy resolution. In so doing, they engender excess burden. This paper posits, calibrates, and simulates a life cycle model with earnings, lifespan, investment return, and future policy uncertainty. It then measures the excess burden from delayed resolution of policy uncertainty. The first uncertain policy we consider concerns the level of future Social Security benefits. Specifically, we examine how an age-25 agent would respond to learning at an early age whether she will experience a major Social Security benefit cut starting at age 65. We show that having to wait to learn materially affects consumption, saving, and portfolio decisions. It also reduces welfare. Indeed, we show that the excess burden of government indecision can, in this instance, range as large as 0.6 percent of the agent's economic resources. This is a significant distortion in of itself. It's also significant when compared to other distortions measured in the literature.

1 Introduction

Virtually all U.S. policymakers, budget analysts, and academic experts agree that the U.S. faces a very serious, if not a grave, long-term fiscal problem. Yet few officials will publicly say how or when they would fix it. Delaying the resolution of fiscal imbalances incurs two costs. First, it leaves a larger bill for a smaller number of people to pay. Second, and of primary interest here, it perpetuates uncertainty, leading economic agents to make saving, investment, and other decisions that are suboptimal from an ex-post perspective. Take, as an example, the prospect facing the baby boomers of having their Social Security retirement benefits cut. The likelihood of this outcome may be leading them to save more, buy more life insurance, and to invest in safer assets than would otherwise be true.

Whatever are the political gains to government indecision and whatever are the decisions being deferred, it's clear that delays in policymaking distort economic choices and, as such, engenders excess burden. This paper provides some sense of the magnitude of this excess burden. Specifically, we posit, calibrate, and simulate a life cycle model featuring optimal consumption and portfolio choice in the face of uncertainty in earnings, lifespan, investment returns, and government policy. We then measure the welfare gain of early resolution of policy uncertainty. The size of this gain is also the size of the excess burden associated with delayed policy resolution.

The main policy we consider concerns the level of future Social Security benefits. Specifically, we examine how agents respond to learning prior to age 65 whether or not they will experience a major Social Security benefit cut starting at age 65. We show that having to wait to learn materially affects their consumption, saving, and portfolio decisions. Most important, it reduces welfare. Indeed, the excess burden of government indecision, in this instance, can exceed more than .5 percent of agents' resources. In considering this finding, note that we are comparing two scenarios with the *same* expected social security income and the *same* ex-ante uncertainty. Therefore this welfare loss stems not from a change in the agent's expected income, or even from a change in the agent's future income risk. Rather it comes exclusively from delay in resolving policy uncertainty, i.e. from government's indecision. Excess burdens in the range of .5 percent of resources are significant in of themselves. They are also significant in comparison to other distortions measured in the public finance literature such as those reported by Auerbach and Kotlikoff (1987) arising form maintaining an inefficient tax structure.

In addition to considering delays in determining/announcing future Social Security benefit policy, we also consider delays in determining/announcing future tax rate changes. The quantitative findings here are similar to those with respect to Social Security once one scales for the magnitude of the net income at stake. So too are the welfare costs of simultaneous indecision with respect to both future Social Security benefit and tax rate levels.

Our study appears to be the first to identify and measure the excess burden of government indecision. Previous work has examined the impact on consumption and saving of early resolution of uncertainty (e.g., Blundell and Stoker, 1999 and Eeckhoudt, Gollier, and Treich 2001) and the manner in which governments should optimally spread risk across generations (e.g., Judd, 1989; Chari, et. al., 1994; Diamond, 1997; Bohn, 1998; and Auerbach and Hassett, 2002).

We proceed in section 1 by laying out a simple model of policy indecision and clarifying the source of its excess burden. Section 2 introduces our life cycle model. Section 3 discusses its calibration. Section 4 simulates the model assuming uncertainty about future retirement income, shows how saving and investment are affected by delay in retirement policy resolution, and reports the excess burden arising from waiting to resolve this uncertainty. Section 5 repeats these analyses except it assumes the uncertainty involves future tax rates rather than retirement benefit levels. Section 6 jointly considers uncertainty about future retirement income and tax rates and calibrates the benefits of joint early resolution of these uncertainties. Finally, section 7 summarizes and concludes.

2 A Stylized Model of Policy Delay

Consider an agent who lives between time 0 and time T and has initial assets A_0 There is one riskless investment instrument. The agent's time preference rate and riskless rate of return are both zero. There are no borrowing constraints. The agent learns at time $L \leq T$ whether she gets high or low benefits, B, per period in retirement. The receipt of these benefits begin at time R. Initial assets are A_0, and consumption preferences are CRRA.

We solve this model via backward recursion starting from the point where the agent learns the size of her future benefits. Let A_L be assets accumulated by the agent at the time, L, of the announcement of future benefits . Since there is no uncertainty about future benefits after L and the time preference and interest interest rates are equal, the agent's consumption is constant between times L and T. Wealth is simply assets plus the present value of retirement benefits, $A_L + B(T - R)$.

Therefore optimal consumption is given by

$$A_L + \overline{B}(T - R) = \overline{C}(T - L), \tag{1}$$

when retirement benefits $B = \overline{B}$, and

$$A_L + \underline{B}(T - R) = \underline{C}(T - L), \tag{2}$$

when retirement benefits $B = \underline{B}$.

We now solve for C – optimal consumption before time L. Given our assumptions about the interest rate and the time preference rate, the agent will choose a constant level of consumption C prior to learning the outcome of B. The agent sets C to maximize expected utility at time 0, which is given by

$$EU = \frac{C^{1-\gamma}}{1-\gamma}L + (T-L)\left(p\frac{\overline{C}^{1-\gamma}}{1-\gamma} + (1-p)\frac{\underline{C}^{1-\gamma}}{1-\gamma}\right), \tag{3}$$

where p is the probability of a high benefit. This maximization is subject to the constraint that assets at time L satisfy

$$A_L = A_0 - CL. \tag{4}$$

Substitution of the budget constraint (4), (1) and (2) into (3) gives

$$EU = \frac{C^{1-\gamma}}{1-\gamma}L + (T-L)\left(p\frac{\left(\frac{A_0-CL+\overline{B}(T-R)}{T-L}\right)^{1-\gamma}}{1-\gamma} + (1-p)\frac{\left(\frac{A_0-CL+\underline{B}(T-R)}{T-L}\right)^{1-\gamma}}{1-\gamma}\right).$$

The first order condition is

$$C^{-\gamma} = p\overline{C}^{-\gamma} + (1-p)\underline{C}^{-\gamma}. \tag{5}$$

Equations (4), (1), (2), and (5) determine optimal consumption C between 0 and L.

The derivative of expected utility with respect to L is given by

$$\frac{\partial EU}{\partial L} = \frac{\gamma}{1-\gamma}\left[C^{1-\gamma} - (p\overline{C}^{1-\gamma} + (1-p)\underline{C}^{1-\gamma}\right] < 0 \quad \text{for all } \gamma. \tag{6}$$

That is, early resolution of uncertainty about the future value of B is unambiguously welfare improving.

To see this, insert (5) in (6). This yields

$$\frac{\partial EU}{\partial L} = \frac{\gamma}{1-\gamma}\left[\left(p\overline{C}^{-\gamma} + (1-p)\underline{C}^{-\gamma}\right)^{1-1/\gamma} - p\overline{C}^{1-\gamma} + (1-p)\underline{C}^{1-\gamma}\right]. \tag{7}$$

The expression in parenthesis is a function of the form $f(x) = x^{1-1/\gamma}$, whose second derivative is negative for $\gamma > 1$ and positive for $\gamma < 1$.[2] Therefore, by Jensen's inequality we have that $f(E(z)) > Ef(z)$ for $\gamma > 1$, and $f(E(z)) < Ef(z)$ for $\gamma < 1$. A direct application of this result to equation (7), with $E(z) \equiv p\overline{C}^{-\gamma} + (1-p)\underline{C}^{-\gamma}$, implies that $\partial EU/\partial L < 0$ when $\gamma < 1$, and positive when $\gamma > 1$.

It remains to show that $\partial EU/\partial L < 0$ in the special case $\gamma = 1$. In that case, expected utility is given by

$$EU = L\log C + (T-L)\left(p\log\overline{C} + (1-p)\log\underline{C}\right),$$

and the first order condition for consumption is

$$C = p\overline{C}^{-1} + (1-p)\,\underline{C}^{-1},$$

which implies that

$$\frac{\partial EU}{\partial L} = -\log\left(p\overline{C}^{-1} + (1-p)\,\underline{C}^{-1}\right) - \left(p\log\overline{C} + (1-p)\log\underline{C}\right).$$

Note that $-\log(x)$ is a convex function for which $f(E(z)) < Ef(z)$. Therefore we have

$$\begin{aligned} -\log\left(p\overline{C}^{-1} + (1-p)\,\underline{C}^{-1}\right) &< p\log\overline{C}^{-1} + (1-p)\underline{C}^{-1} \\ &< -\left(p\log\overline{C} + (1-p)\underline{C}\right), \end{aligned}$$

which implies that $\partial EU/\partial L < 0$ when $\gamma = 1$.

Clearly, the sooner an agent learns about her future benefits, the sooner she can make the consumption and saving decisions appropriate to that information. The longer she is

[2] Note that

$$\frac{\partial f(x)}{\partial x} = \left(1 - \frac{1}{\gamma}\right)x^{-1/\gamma},$$

and

$$\frac{\partial^2 f(x)}{\partial x^2} = -\frac{1}{\gamma}\left(1 - \frac{1}{\gamma}\right)x^{-(1+1/\gamma)}.$$

forced to wait, the longer she must consume and save defensively, thereby making more ex-post mistakes. Understanding the economic costs of these mistakes requires a more realistic framework, to which we now turn.

3 A Life-Cycle Model of Policy Delay

As indicated, our calibrated model features four types of uncertainty – earnings, longevity, returns, and government policy. The policy uncertainty, which involves the level of government-provided retirement income as well as the level of labor income taxation, is resolved either prior to or at retirement. We use this model to study the effects on consumption, portfolio choice, and welfare of changes in the age at which uncertainty about future retirement income, uncertainty about future tax rates, or uncertainty about both future retirement income and future tax rates is resolved.

3.1 Model Specification

3.1.1 Time parameters and preferences

Let t denote age and assume agents work their first K periods and live for a maximum of T periods. We allow for lifespan uncertainty in the manner of Hubbard, Skinner and Zeldes (1995). Let p_t denote the probability that the investor is alive at date $t+1$, conditional on being alive at date t. The investor's preferences over consumption are given by

$$E_1 \sum_{t=1}^{T} \delta^{t-1} D_t \left(\prod_{j=0}^{t-2} p_j \right) \frac{C_t^{1-\gamma}}{1-\gamma}, \tag{8}$$

where $\delta < 1$ is the discount factor, C_t is time-t consumption, $\gamma > 0$ is the coefficient of relative risk aversion, and

$$D_t = \begin{cases} 1 \text{ for } t < 18 \\ \overline{D} \text{ for } t \geqslant 18 \end{cases} \tag{9}$$

The term D_t captures the change in household size when adult children leave the household. We calibrate $\overline{D}$ to produce a 30% drop in household consumption at age 45 ($t = 18$).

3.1.2 The labor income process and retirement income

Before retirement ($t \leq K$), age-t labor income, Y_t, is exogenously given by the sum of a deterministic component that is calibrated to capture the hump shape of earnings over the life cycle and two random components, one transitory and one permanent.[3] More precisely,

$$\log(Y_t) = f(t) + v_t + \varepsilon_t \quad \text{for} \quad t \leq K \ , \tag{10}$$

where $f(t)$ is a deterministic function of age, and v_t is a permanent component given by

$$v_t = v_{t-1} + u_t, \tag{11}$$

where u_t is distributed as $N(0, \sigma_u^2)$, and ε_t is a transitory shock uncorrelated with u_t, which is distributed as

$$\begin{cases} N(0, \sigma_\varepsilon^2) & \text{with probability } 1 - \pi \\ Ln(0.1) & \text{with probability } \pi \end{cases} . \tag{12}$$

Thus our model includes the probability of a large negative income shock as in Heaton and Lucas (1997), Carroll (1992), and Deaton (1991).

[3] This is the same process as in Carroll (1997) and Gourinchas and Parker (2002). Hubbard, Skinner and Zeldes (1995) replace the permanent shocks with a very persistent first-order autoregressive process.

We model government-provided retirement income as a fraction λ of permanent labor income in the last working-year. Specifically,

$$\log(Y_t) = \log(\lambda) + f(K) + v_K \qquad \text{for } t > K. \tag{13}$$

This specification facilitates the model's solution by reducing by one the number of state variables. Section 5 introduces uncertainty about λ and studies the implications for welfare, optimal consumption, and optimal portfolio choice of learning about λ at different ages.

3.1.3 Financial assets

There are two assets – one risky and one riskless. The riskless asset, which we call *Treasury bills* or *bonds* indistinctly, has a constant gross real return of $\overline{R}_f$. We denote the dollar amount of T-bills the investor has at time t by B_t. The risky asset, which we will call *stocks*, has a gross real return R_t given by:

$$\ln(R_t) \sim N(\mu + \overline{r}_f, \sigma_R^2), \tag{14}$$

where $\overline{r}_f = \ln(\overline{R}_f)$, μ denotes the expected log return on stocks in excess of the log return on bonds, and σ_R^2 denotes the volatility of log stock returns. We allow stock returns to be correlated with innovations to the aggregate component of permanent labor income (u_t), and write the correlation coefficient as ρ. We denote the dollar amount the investor holds in stocks at time t by S_t.

We assume the investor faces the following borrowing and short-sales constraints:

$$B_t \geq 0, \tag{15}$$

$$S_t \geq 0. \tag{16}$$

Letting α_t denote the proportion of assets invested in stocks at time t, these constraints imply that $\alpha_t \in [0, 1]$ and that wealth is non-negative.

3.1.4 Taxes

We assume flat taxes for all sources of income to preserve the scalability/homogeneity of the model. We assume that labor income is taxed at a rate τ_L, that retirement income is taxed at a rate τ_R, and that asset income is taxed at a rate τ_C. We calibrate these tax rates to roughly match the effective income tax rates currently faced by a typical household. Section 4.2 discusses the calibration of these tax rates. Section 6 introduces uncertainty about future tax rates, and studies the implications for welfare, consumption, and portfolio choice of learning about future tax rates at different ages.

3.2 The investor's optimization problem

The investor starts the period with wealth W_t. Then labor income Y_t is realized. Durable goods, and in particular housing, can provide an incentive for higher spending early in life. Modelling these decisions directly is beyond the scope of the paper, but nevertheless we take into account their impact on the life cycle pattern of spending. We model the percentage of household income that is dedicated to housing expenditures (h_t) as an exogenous process and subtract it from the measure of disposable income.

Following Deaton (1991) we denote *cash-on-hand* in period t by X_t:

$$X_t = W_t + (1 - h_t)(1 - \tau)Y_t,$$

where $\tau = \tau_L$ during working life and $\tau = \tau_C$ during retirement.

The investor must decide how much to consume, C_t, and how to allocate the remaining cash-on-hand (savings) between stocks and T-bills. Next period wealth, before earning period $t + 1$'s labor income, is given by:

$$W_{t+1} = R^p_{t+1}(W_t + (1 - h_t)(1 - \tau)Y_t - C_t), \tag{17}$$

where R^p_{t+1} is the net return on the portfolio held from period t to period $t+1$:

$$R^p_{t+1} \equiv 1 + (1-\tau_C)(\alpha_t R_{t+1} + (1-\alpha_t)\overline{R}_f - 1). \tag{18}$$

The control variables of the problem are $\{C_t,\ \alpha_t\}_{t=1}^{T}$. The state variables are $\{t,\ X_t, v_t\}_{t=1}^{T}$. Given the set-up, the value function is homogeneous with respect to current permanent labor income. Exploiting this scalability allows us to normalize v_t to one and to reduce the dimensionality of the state space.

The Bellman equation for this problem is given by:

$$\begin{aligned} V_t\left(X_t\right) &= \underset{C_t \geq 0, 0 \leq \alpha_t \leq 1}{Max} \left[U(C_t) + \delta p_t E_t V_{t+1}(X_{t+1})\right] \text{ for } t < T && (19) \\ \text{where } X_{t+1} &= (1-h_t)(1-\tau)Y_{t+1} + (X_t - C_t)\left[1 + (1-\tau_C)(\alpha_t R_{t+1} + (1-\alpha_t)\overline{R}_f - 1)\right] \end{aligned}$$

We solve this problem numerically via backward induction.

4 Calibration

4.1 Labor Income Process

The labor income profile is taken from Cocco, Gomes and Maenhout (2005). They estimate age profiles for three different education groups (households without high school education, households with high school education, but without a college degree, and finally college graduates) and we take the weighted average of the three. Cocco, et. al. (2005) also estimate the fraction of permanent income replaced by retirement income λ to be 83%. In sections 5 and 7, where λ is uncertain, we set the probability distribution of λ so that its median is equal to 0.8, which is close to their value. In section 6, where there is no uncertainty about future retirement income, we fix λ at a constant 0.8.

We set the probability of a large negative income shock at 2.0%. Following Heaton and Lucas (1997), we set the magnitude of the shock at 10% of the household's expected income. The values of σ_u and σ_ε are 10.95% and 13.89% respectively.[4] Finally, we set the correlation between stock returns and innovations in the permanent component of income (ρ) equal to 0.15 (Campbell, Cocco, Gomes and Maenhout 2001), and we assume the same housing expenditure profile ($\{h_t\}_{t=1}^{T}$) as in Gomes and Michaelides (2005).

4.2 Other Parameters

We assume that agents are initially age 28, retire at 65, and die with probability one at age 100. Prior to this age we use the mortality tables of the National Center for Health Statistics to parameterize the conditional survival probabilities, p_j for $j = 1, ..., T$. We choose age 28 as the initial age of adulthood to roughly match the age at which working Americans marry and start having children. For example, the average U.S. ages of first marriage are 27 for males and 25 for women. Age 25 is also the average age of first birth.

We set the discount factor δ to 0.95 and the coefficient of relative risk aversion γ to 5. The mean equity premium (in levels) is set at 4.00% per annum, the risk-free rate is set at 1.00% p.a., and the annualized standard deviation of innovations to the risky asset is set at 20.5%. This equity premium is lower than the historical equity premium based on a comparison of average stock and T-bill returns, but it's in line with the forward-looking estimates reported in Fama and French (2002). Also, a higher premium generates unrealistically high equity portfolio shares.

Finally, in the baseline case we set the tax rate on labor income (τ_L) to 30% and the tax

[4] Following Carroll (1997), we divide the estimated standard deviation of transitory income shocks by 2, to take into account measurement error.

rate on retirement income (τ_R) to 15% during retirement (τ_R). Asset income is taxed at a 20% rate (τ_C). These rates roughly match the effective income tax rates currently faced by a typical household. In section 6 we incorporate uncertainty in these rates.

5 Model with uncertainty about retirement income

5.1 Retirement income uncertainty

As indicated in (13), retirement income equals the product of a fixed replacement ratio (λ) and permanent income at age 65. We assume throughout this section that at age 28 the household does not yet know the value of λ. She only knows that the realization of λ is governed by the following distribution:

$$\lambda = \begin{cases} \overline{\lambda} & \text{with probability} \quad 1-p \\ \overline{\lambda}(1-\xi) & \text{with probability} \quad p \end{cases}, \tag{20}$$

where ξ represents a potential percentage cut in the (expected) replacement ratio.

In the baseline calibration we set the probability p of a cut in the replacement ratio at 1/3 and the magnitude ξ of this cut at 0.3. A 30 percent future cut in future U.S. Social Security retirement benefits strikes us as quite plausible. With this choice of parameter values, $\overline{\lambda}$ represents the median replacement ratio—the mean is about $0.9 \cdot \overline{\lambda}$. As previously mentioned, we set $\overline{\lambda}$ equal to 0.8, which is close to the 83% value in Cocco et al. (2005).

We assume that this uncertainty remains until age A (with $A \leq K$, naturally), when the exact value of the replacement ratio is revealed. The relevant variables determining the uncertainty in retirement benefits will then be ξ (the level of uncertainty) and A (inversely related to the duration of uncertainty).

5.2 Optimal consumption and portfolio choice with late resolution of uncertainty about retirement income

Our baseline model assumes that uncertainty about retirement income—or more precisely, the fraction λ of permanent income to be replaced in retirement—is not resolved until the household retires at age 65. That is, we set $A = 65$. Figure 1 shows the life-cycle pattern of financial wealth, income and optimal consumption generated by the baseline model. The units in this figure are thousands of 1992 dollars – the year to which Cocco, et. al. (2005) calibrate their income profiles. Figure 2 shows the percentage portfolio allocation to stocks. More precisely, these figures plot the average life-cycle profile of wealth, income, consumption and portfolio allocations based on 10,000 simulations of the model.

Figure 1 shows that both household consumption and portfolio allocations exhibit an inverted hump-shaped pattern, with two humps. The consumption profile early in the life cycle is typical for a liquidity constrained investor. Optimal consumption grows until age 45, when it falls sharply as adult children leave the household. Through roughly age 40 consumption remains below labor earnings as the household saves a small fraction of its income for precautionary reasons. Figure 2 shows that this asset accumulation is also associated with an increasing allocation to stocks until about age 35. By age 40, accumulated assets exceed annual consumption.

The pronounced, short-lived decline in consumption at age 45 captures the effect on household consumption of a one-time reduction in the size of the household. Consumption starts growing again after this event, and keeps doing so until retirement at age 65. However, the household chooses not to consume all available income between age 45 and age 58. Instead, it chooses to save for retirement and in response to the uncertainty about retirement benefits, which the household will not know until retirement at age 65. These savings, coupled with an aggressive allocation to stocks, allow the household to accumulate assets rapidly.

Interestingly, Figure 2 shows that the allocation to stocks reaches a peak of about 98% at age 47, and declines until age 65, when the household allocates about 65% of its financial wealth to stocks. It then increases the stock allocation again, which eventually reaches 100% of assets and stays there until death. Changes in the resource-share of the household's human capital, which from a financial perspective is essentially similar to an implicit investment in bonds, explain this pattern. The rapid accumulation of financial wealth that starts at age 45 raises the household's resource share of financial assets and correspondingly reduces the resource share represented by human capital. Thus, as the relative weight of "bond-like" human capital in remaining household resources declines, the household optimally starts allocating a smaller fraction of financial wealth to stocks. This trend continues until retirement, when the household starts depleting assets to finance consumption in retirement. Consumption declines and approaches retirement income as assets dwindle. The declining trend in assets during retirement increases the relative weight of riskless retirement benefits in total wealth, which leads the household to optimally increase its allocation to stocks.

5.3 The benefits of early resolution of uncertainty about retirement income

5.3.1 Welfare analysis

We next explore the impact on welfare, optimal consumption, and portfolio decisions of letting households learn in advance the size of their retirement benefits. The results are shown in Table 1. The table reports welfare gains for different values of A, the age at which the household learns about the retirement income it will receive at age 65, relative to the case in which the household learns at age 65. The table has five panels, each of which entails a change from the baseline model along a different dimension. In particular, we consider welfare gains as we vary the coefficient of relative risk aversion γ (Panel A); the potential percentage cut ξ in the replacement ratio (Panel B); the volatility to shocks to permanent income σ_u (Panel C); the ability to invest in equities (Panel D); and a combination of some of the previous cases (Panel E).

The welfare calculations are standard consumption-equivalent variations: For each case (i.e., for each value of A) we compute the constant consumption stream that makes the household as well-off in expected utility terms as under the consumption stream that it will actually obtain. Relative utility gains are measured as the change in this equivalent consumption stream relative to the case $A = 65$. Thus we can interpret the numbers in the table as the percentage annual consumption loss that a household is willing to accept in order to learn at age A about the replacement income ratio it will receive at age 65 when it retires. The Appendix gives a detailed description of the procedure we use to compute our welfare metric.

The rows labelled "Baseline" in Table 1 report the annual welfare gains from learning at age A, instead of age 65, the exact realization of the replacement ratio λ in our baseline model. As expected, the gains are larger the earlier the household learns about its retirement income. Most important, these gains are economically significant. For example, our baseline household is willing to pay an annual fee equivalent to 0.117% of annual consumption in order to learn at age 35 the income replacement ratio it will experience at retirement. With consumption averaging about $30,000 per annum in 1992 prices in our baseline model, this is equivalent to a one-time fee of about $906 at age 35 in 1992 prices – or about $1371 in today's prices –, or an annual fee which is similar to the annual expense ratio on a typical index mutual fund. Even at ages as late as 50 and 55, this household is still willing to pay

0.084% and 0.056% of its annual consumption in order to eliminate the uncertainty about retirement income.

Panel A in Table 1 shows that the benefit of learning early about future retirement income changes dramatically with risk aversion. Our baseline case assumes a coefficient of relative risk aversion equal to 5. A household with a coefficient of relative risk aversion of 7 is willing to reduce consumption by almost three times as much as our baseline household in order to learn at age 35 its income replacement ratio. By contrast, a household with a coefficient of relative risk aversion of 3 is willing to pay only a tenth of what our baseline household is willing to pay to learn its retirement income at age 35.

Panel B shows that welfare gains from learning early increase dramatically with the magnitude of the potential cut in retirement benefits. For example, when the size of the potential cut in benefits is 40% of the replacement income ratio instead of 30% — or in other words, when the replacement ratio is 48% of permanent income instead of 56% in the event of a cut —, the welfare gains from learning about the cut in retirement benefits in advance are at least twice as large as in the baseline case for all ages A. When the size of the potential cut in benefits is 45% instead of 30%, a household is willing to pay 0.394% of annual consumption in order to learn at age 35 the income replacement ratio it will obtain at retirement. This fee is more than three times the 0.117% fee the household is willing to pay when the size of the potential cut is 30%. Conversely, welfare gains decrease dramatically when the size of the potential cut decreases.

Panel C explores the effect of changes in the volatility of shocks to permanent income (σ_u) on the household's willingness to pay to learn about its retirement benefits in advance. Since the level of retirement benefits depends on the level of permanent income at retirement, an increase in the volatility of shocks to permanent income makes retirement income more uncertain. This uncertainty compounds with the uncertainty about the replacement ratio that will be applied to the level of permanent income to determine actual retirement benefits. Panel C shows that the welfare gains from learning early about the income replacement ratio are increasing in σ_u. These gains are between 43% and 50% larger when σ_u is 15% than when it is 10.95%.

The welfare gains we have reported so far are based on the assumption that the household can adjust both its consumption and its asset allocation in response to learning early about retirement benefits. In practice, however, many households do not participate in the stock market. While our model is not designed to explain optimal non-participation in the stock market, it is still interesting to explore within the model the welfare gains from early resolution of uncertainty when the household is fully invested in bonds at all times and can only adjust consumption — or equivalently saving — in response to learning early about retirement benefits. Panel D explores this scenario. It shows that welfare gains are about 20% larger when the household is unable to invest in stocks. In other words, there is a 20% marginal benefit of being able to invest in both bonds and stocks. The marginal benefit of being able to modify the investment policy, while large, is not as large as the effect of being able to modify the level of consumption and savings.

Panel E shows that the effects of higher risk aversion and a larger cut in benefits interact. A household with a coefficient of relative risk aversion of 7 facing a potential 40% cut in the income replacement ratio at retirement is willing to pay 0.666% of annual consumption in order to learn about the replacement ratio at age 35. These welfare gains are very large, both in absolute terms and relative to the cases that consider changes in each factor in isolation. They are 165% larger than the effect when risk aversion is 5, and 93% larger than the effect when the potential cut is 30%. Of course, limiting the access of the household to the stock market increases the welfare gains even more. For example, with risk aversion at 7 and a 40% potential benefit cut, the welfare gain to learning at age 35, rather than 65, whether or not the cut will happen is the equivalent of 0.733% of annual consumption.

5.3.2 Effect on consumption and portfolio choice

Table 1 shows that households are willing to pay a non-trivial fraction of their resources in order to eliminate uncertainty about their future retirement income. Early learning is advantageous for them because they can modify their consumption and asset allocation plans in response to news about their future retirement income. We now examine these changes for the cases considered in Table 1.

Table 2 summarizes the effect on optimal consumption — or, equivalently, saving — of early resolution of uncertainty about retirement income. To facilitate interpretation, the table reports the percentage change in consumption for a household that does not learn about the income replacement ratio in retirement until age A, relative to a household who learns about it at the earliest possible age (i.e., age 28). For example, the number in the baseline row corresponding to $A = 55$ indicates that, relative to a household who knows the exact value of its retirement income replacement ratio by age 28, a household facing uncertainty about retirement benefits until age 55 will on average consume 0.1% less per year between age 28 and age 55 — of course, after that age the uncertainty has been resolved for both households.[5] Since there are two possible realizations of the income replacement ratio, we compute optimal consumption under each and then average across the two using their probabilities. The table reports the results for our baseline case as well as the cases we examine in Table 1.

Our results indicate that households respond optimally to a delay in the resolution of uncertainty by reducing consumption. The magnitude of the effect increases with the delay

[5] We report percentage changes in consumption only to the first decimal digit, because digits beyond that are undistinguishable from approximation error.

in the resolution of uncertainty. In our baseline model, a household who does not learn its income replacement ratio until age 55 does not change consumption significantly relative to a household who learns at age 28. However, a household who learns only at age 65, when it retires, will consume between age 28 and age 65 about 0.4% *per year* less than a household who learns at age 28. A 0.4% reduction in annual consumption over 37 years is not extremely large, but it is still economically significant.

The reduction in consumption caused by a delay in resolution of uncertainty increases with risk aversion, the size of the potential cut in benefits, and the volatility of shocks to permanent income. Increasing risk aversion leads to a reduction in consumption even for small delays in the resolution of uncertainty, and to a large reduction for long delays. A household with a coefficient of relative risk aversion of 7 who does not learn until age 65 reduces consumption by about 0.9% per year relative to a household who learns at age 28. Increasing the size of the potential cut in benefits does not have a large impact for small delays in the resolution of uncertainty, but it leads to a large reduction in consumption for long delays. A household who does not learn until age 65 reduces consumption by about 1.3% per year relative to a household who learns at age 28 when the potential cut in the replacement ratio is 45%. Finally, Panel E shows that the combination of increased risk aversion coefficients and increased size of the potential cut in the retirement benefits leads to the largest reduction in consumption, which are significant even for small delays in the resolution of uncertainty.

We have also examined the impact on portfolio allocations of a delay in the resolution of uncertainty. Consistent with our finding of the relatively low marginal value of being able to modify the investment policy, we find that these effects are all very small.[6]

[6] We do not report them for this reason, but they are readily available upon request.

6 The benefits of early resolution of uncertainty about tax rates

Section 5 has considered the impact on welfare, optimal consumption and portfolio choice of early resolution of uncertainty about retirement income. But households also face uncertainty about future tax rates. This section examines the impact on welfare, optimal consumption, and portfolio choice of early resolution of uncertainty about future labor income tax rates. Throughout this section we assume that the income replacement ratio λ is known in advance and equal to 0.8.

6.1 Labor income tax uncertainty

We assume that the new tax rate takes effect at age 50 but, as in sections 5.1 and 5.2, the exact value is unknown until some age A (with $A \leqslant 50$). The tax rate uncertainty applies to both the tax rate during working life and during the retirement period. Both face the same level of uncertainty and both are revealed at exactly the same time.

We first consider a symmetric uncertainty case:

$$\tau_L = \begin{cases} \tau_L(1+\xi) & \text{with probability} \quad p \\ \tau_L & \text{with probability} \quad 1-2p \\ \tau_L(1-\xi) & \text{with probability} \quad p \end{cases}, \tag{21}$$

and the same for τ_R.

In our baseline experiment the labor income tax rate might increase or decrease with an equal 25% probability ($p = 0.25$) or remain constant with a 50% probability. As in section 5.2, we are interested in measuring the welfare costs and distortions associated with delaying the announcement of the (new) tax rate. In our calibration, the labor income tax rate is 30% during working life (τ_L) and 15% during retirement (τ_R). As a result, in the baseline uncertainty case, the labor income tax rate may increase (decrease) from 30% to 39% (21%) between ages 50 and 65 and from 15% to 19.5% (10.5%) between ages 65 and 100 with a 25% probability.

6.2 Welfare analysis and consumption distortions

Table 3 reports welfare gains from learning early about the future change in the labor income tax rate, while Table 4 reports the percentage change in optimal consumption for a household who does not learn about the labor income tax rate change until age A, relative to a household who learns about it at the earliest possible age (i.e., age 28).[7]

The baseline row in each table reports results for the basic experiment. We consider four variants of the baseline experiment, which are reported in Panels A through D. Panel A examines the effect of considering different coefficients of relative risk aversion. Panel B considers the effect of changing the size of the shock to the labor income tax rate. Panel C considers the effect of allowing the investor to invest only in bonds. Finally, Panel D considers the case in which the uncertainty about the income tax rate is asymmetric. In the asymmetric case, the tax rate can only increase (decrease) by 30% from 30 percent to 39% (19.5%) during working life (retirement) with a probability of 1/3. This case is similar in spirit to our case of a change in retirement benefits, where we have considered only cuts in retirement income.

Table 3 shows that the baseline welfare gains from early resolution of labor income tax uncertainty increase as we consider earlier announcement dates. In the baseline case the welfare loss is as high as 0.03% of annual consumption, and this increases to 0.084% for the

[7] Once again, the effect on portfolio choice is very small, and accordingly we do not report it.

more risk-averse households. These magnitudes are commensurate with the welfare gains from knowing early about future retirement benefits shown in Table 1. To see this, note that a household is willing to pay an annual fee equivalent to 0.03% of consumption between age 35 and age 50 for eliminating at age 35 a 30% uncertainty over 30% of its income between ages 50 and 65, and 15% of its income between ages 65 and 100. This is essentially equivalent to eliminating a 9% uncertainty over 100% of the household's income between ages 50 and 65, and a 4.5% uncertainty over 100% of the household's income between ages 65 and 100.

By contrast, the uncertainty that it is eliminated in the retirements benefits case is proportionally much larger, since it implies a 30% uncertainty over 100% of the household's income between ages 65 and 100. Accordingly, the welfare gain from knowing early is also proportionally larger—about 0.12%. Thus, *for the same level of uncertainty*, the benefits from early resolution of uncertainty in labor income taxes are similar to those derived from early resolution of uncertainty about future retirement benefits.

Table 3 also shows that, similar to the retirement benefits case, welfare gains are most sensitive to changes in the coefficient of relative risk aversion and to the magnitude of the uncertainty about the future labor income tax change, while preventing households from accessing the stock market does not have a large impact. Interestingly, Panel E shows that considering an asymmetric change in the labor income tax rate in lieu of a symmetric change does not have a significant effect on welfare gains. This is an important result and it highlights, once again, that the welfare costs are due to the late resolution of uncertainty and not to the nature of uncertainty.

The changes in optimal consumption reported in Table 4 are also commensurate with the changes in consumption reported in Table 2. As expected, a delay in learning about future changes in labor income tax rates causes households to reduce their consumption.

The reduction is largest for those households who bear the longest delay in learning.

6.3 Capital income tax uncertainty

Finally, we have also explored the implications of early resolution of uncertainty about future capital income tax rates. We find that the welfare gains from early resolution of this uncertainty are empirically very small for the typical household that we consider in our calibration exercise.

Figure 1 is helpful to understand why moderate uncertainty about future capital income tax rates is less costly than uncertainty about future labor income tax rates or retirement income. This figure shows that income finances most of the consumption of the typical household, and suggests that the household uses wealth, particularly during the working life of the household, to smooth the impact of income shocks on consumption.

Our baseline interest rate is 1%, and our baseline real return on equities is 5%. Our baseline 20% capital income tax rate implies that the after-tax return on the household portfolio is between 0.8% and 4%. A 30% uncertainty in this tax rate implies that the after-tax return on the household portfolio could be further reduced 6 basis points to 30 basis points. This is small compared to a potential reduction of 9% of labor income caused by a 30% uncertainty on the 30% baseline labor income tax rate. Thus, a change in the labor income tax rate or a change in retirement income are likely to have a more significant impact on future consumption than a change of similar magnitude in the capital tax rate.

7 Simultaneous uncertainty about retirement income and tax rates

Our exercises so far have considered the welfare costs, and their impact on consumption and portfolio choice, of delays in several policy decisions each considered in isolation. It is, however, plausible that these decisions might occur concurrently, particularly if they result from situations of fiscal crises. Hence, it's interesting to explore the implications for welfare and optimal consumption and portfolio choice of early joint resolution of uncertainty about future tax rates and the replacement ratio of permanent income in retirement.

We consider a scenario in which there is a 1/3 probability that both the baseline 30% labor income tax rate increases by 30% at age 50 and the 80% replacement ratio of permanent income in retirement declines by 30% at age 65. There is a 2/3 probability that they do not change. We assume that, in the default scenario, the household does not learn whether these changes actually occur until age 50.

We also consider a special case where the uncertainty about future tax rates and the uncertainty about future retirement income are uncorrelated. In particular, we consider the welfare gains from early resolution of uncertainty about future labor income tax rates when the income replacement ratio λ is uncertain and not known until age 65. (Section 6 explores the case where λ is known to the household in advance).

7.1 Welfare analysis

Table 5 reports the welfare gains from resolving this uncertainty at an earlier age A relative to learning at age 50. Table 6 reports the change in optimal consumption relative to a household who resolves this uncertainty at age 28. We omit the results for the changes in optimal portfolios because they are, once again, quantitatively small. Both tables also explore some variants of the basic exercise: Panel A examines scenarios in which the household coefficient of relative risk aversion changes relative to the baseline model; Panel B considers changes in the size of the potential percentage increase in the income tax rate and decrease in the income replacement ratio; Panel C considers households who can only invest in bonds; finally, Panel D considers the case with uncorrelated uncertainty.

Table 5 shows that the welfare changes from adding uncertainty about retirement benefits to uncertainty about the income tax rate—shown in Table 3—are very large, both when uncertainty about retirement benefits is correlated with uncertainty about the future income tax rate and when it is uncorrelated. For example, a household that learns at age 40 about the income tax rate prevailing at age 50 instead of learning at age 50 experiences a utility gain of 0.028% per annum. If the household also has uncertainty about future retirement benefits, and learn about them at age 40, the welfare gain is more than twice at large, at 0.069% per annum.

The welfare gains are proportionally even larger when the household is more risk averse or faces more uncertainty. In both cases, the gains are about three times as large relative to the case where there is uncertainty only about the labor income tax rate. Interestingly, the gains for non-equity investors are now larger than the gains for households who can invest in both bonds and equities. This suggests that the ability to change portfolio allocations increases as we consider scenarios with increasing uncertainty about non-capital income.

7.2 Consumption distortions

Consistent with our findings about welfare gains, Table 6 shows that early resolution of uncertainty about future labor income tax rates and retirement income has a large impact on optimal consumption. Households who do not resolve this uncertainty until age A consume significantly less per year than households who resolve it early in their life cycle—at age 28. For example, in our baseline model a household that does not solve this uncertainty until age 50 consumes about 1.3% per annum less than an identical household who learns at age 28. For a household with coefficient of relative risk aversion of 7, the reduction in optimal consumption is 2.5%. Even at age 35, where the delay is only one of seven years, the reduction in consumption is 0.1% per annum in the baseline case and 0.8% per annum in the case with a coefficient of relative risk aversion of 7. In general, the fall in consumption is largest for households who are more risk averse and for households who face large possible falls in income.

8 Conclusions

If this is the first analysis of the excess burden of government indecision, it should not be the last. There are at least two extensions worth pursing. The first is including variable labor supply, including the choice of retirement dates. Doing so would likely reduce the size of the distortion we've measured since households would have more ways of responding to the added uncertainty associated with policy determination delay. The second worthwhile extension is to consider other types of policy uncertainties, including the possibilities of the government switching the tax structure from income to consumption taxation, cutting back on healthcare benefits, and printing money to pay for its bills, leading potentially to very high rates of inflation and overall financial and economic instability.

To conclude, no one likes to deliver bad news, least of all governments. The political costs of delivering bad news lead many governments to postpone making difficult decisions. Whatever politicians gain from this behavior, it fosters and exacerbates economic uncertainty. In this paper, we've begun to model and quantify the excess burden of government indecision. As we've stressed, this excess burden arises not from implementing specific policies, but from delaying their determination and announcement. We've shown that this efficiency loss can be large depending on the precise policy in question, the degree of risk aversion, and access to capital markets.

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Appendix: Welfare Metric

The welfare calculations are done in the form of standard consumption-equivalent variations: for each case (i.e. value of A) we compute the constant consumption stream that makes the investor as well-off in expected utility terms as the expected consumption stream that she/he will actually obtain. Relative utility losses are then obtained by measuring the change in this equivalent consumption stream when deviating from the optimal rule towards the rule considered.

More precisely, we first solve the optimal consumption/savings problem for an agent for a given value of A. Denoting the optimal consumption stream for this problem by $\{C_t^A\}_{t=1}^T$, we then compute the corresponding expected life-time utility:

$$V^A = E_1 \sum_{t=1}^{T} \delta^{t-1} \left(\prod_{j=0}^{t-1} p_j \right) \frac{{C_t^A}^{1-\gamma}}{1-\gamma}, \tag{22}$$

Note: This is just the value function from the maximization problem.

Then we can convert this expected discounted lifetime utility into consumption units by computing the equivalent constant consumption stream $\{\overline{C}^A\}_{t=1}^T$ that leaves the investor indifferent between this and the consumption stream $\{C_t^A\}_{t=1}^T$. This is equivalent to solving,

$$V^A = E_1 \sum_{t=1}^{T} \delta^{t-1} \left(\prod_{j=0}^{t-1} p_j \right) \frac{{\overline{C}^A}^{1-\gamma}}{1-\gamma}. \tag{23}$$

Therefore:

$$\overline{C}^A = \left[\frac{(1-\gamma)V^A}{\sum_{t=1}^{T} \delta^{t-1} \left(\prod_{j=0}^{t-1} p_j \right)} \right]^{\frac{1}{1-\gamma}}. \tag{24}$$

Taking $A = 65$ as our baseline case, the utility gain from changing A can then be obtained simply computed as the percentage loss in equivalent consumption,

$$\frac{\overline{C}^A - \overline{C}^{65}}{\overline{C}^{65}} = \frac{V^{A\,\frac{1}{1-\gamma}} - V^{65\,\frac{1}{1-\gamma}}}{V^{65\,\frac{1}{1-\gamma}}}. \tag{25}$$

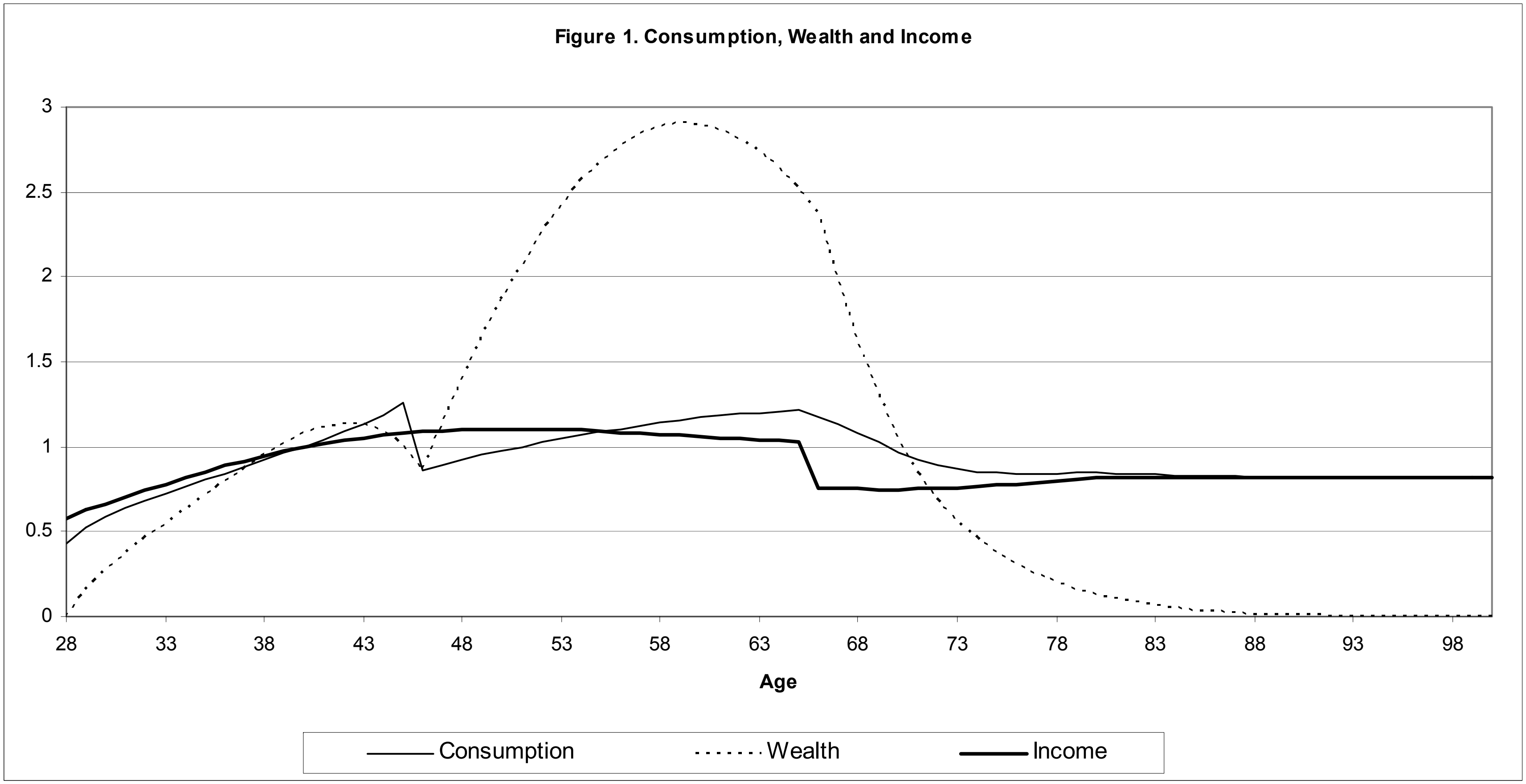

Figure 1 shows the life-cycle pattern of financial wealth, income and optimal consumption generated by the baseline model, whose parameter values are given in section 4. The units in this figure are thousands of 1992 dollars — the year to which Cocco, et. al. (2005) calibrate their income profiles. The patterns are averages based on 10,000 simulations of the baseline model.

Figure 2. Portfolio Allocation

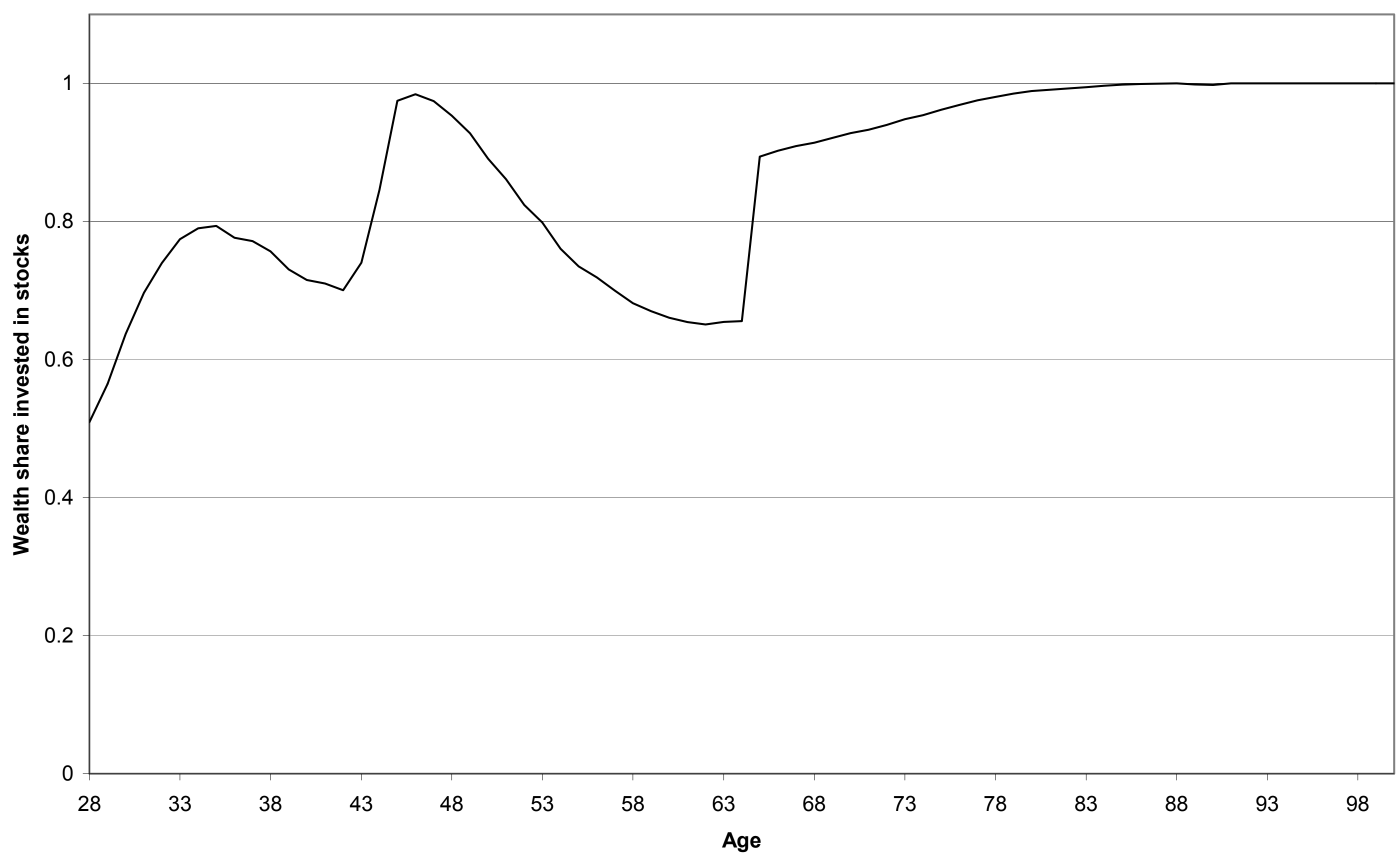

Figure 2 shows the life-cycle pattern of the percentage portfolio allocation to stocks generated by the baseline model, whose parameter values are given in section 4. The pattern is an average based on 10,000 simulations of the baseline model.

Table 1
Welfare gains from early resolution of uncertainty about future retirement benefits

	Age of resolution of uncertainty (A)					
	35	40	45	50	55	60
A. Relative risk aversion (γ)						
γ = 7	0.345%	0.327%	0.298%	0.262%	0.211%	0.131%
γ = 5 (Baseline)	0.117%	0.115%	0.111%	0.100%	0.084%	0.056%
γ = 3	0.012%	0.012%	0.012%	0.012%	0.011%	0.009%
B. Cut in replacement ratio (ξ)						
ξ = 45%	0.294%	0.290%	0.274%	0.243%	0.204%	0.153%
ξ = 40%	0.251%	0.248%	0.237%	0.213%	0.176%	0.114%
ξ = 30% (Baseline)	0.117%	0.115%	0.111%	0.100%	0.084%	0.056%
ξ = 20%	0.042%	0.042%	0.040%	0.037%	0.031%	0.021%
ξ = 15%	0.021%	0.021%	0.020%	0.019%	0.017%	0.014%
C. Volatility of shocks to permanent income (σ_u)						
σ_u = 15%	0.175%	0.169%	0.158%	0.143%	0.121%	0.080%
σ_u = 10.95% (Baseline)	0.117%	0.115%	0.111%	0.100%	0.084%	0.056%
σ_u = 7%	0.028%	0.028%	0.028%	0.027%	0.024%	0.018%
D. Assets available to household						
Only bonds (Non-equity investors)	0.141%	0.140%	0.135%	0.122%	0.101%	0.066%
Bonds and equities (Baseline)	0.117%	0.115%	0.111%	0.100%	0.084%	0.056%
E. Combined scenarios						
γ = 7, ξ = 40%, non-equity investors	0.733%	0.691%	0.624%	0.542%	0.430%	0.262%
γ = 7 and ξ = 40%	0.666%	0.630%	0.571%	0.499%	0.398%	0.244%
γ = 5, ξ = 30%, bonds and equities (Baseline)	0.117%	0.115%	0.111%	0.100%	0.084%	0.056%

Table 1 reports welfare gains for different values of A, the age at which the household learns about the retirement income it will receive at age 65, relative to the case in which the household learns at age 65. The welfare calculations are standard consumption-equivalent variations: For each case (i.e., for each value of A) we compute the constant consumption stream that makes the household as well-off in expected utility terms as under the consumption stream that it will actually obtain. Relative utility gains are measured as the change in this equivalent consumption stream relative to the case A = 65. Thus we can interpret the numbers in the table as the percentage annual consumption loss that a household is willing to accept in order to learn at age A about the replacement income ratio it will receive at age 65 when it retires. The baseline row in each table reports results for the basic experiment, whose parameter values are given in section 4. The table has five panels, each of which entails a change from the baseline model along a different dimension indicated in the heading of the panel. Panel A examines the effect of considering different coefficients of relative risk aversion. Panel B considers the effect of changing the size of the cut in the replacement ratio. Panel C considers the effect of changing the volatility of shocks to permanent income. Panel D considers the effect of allowing the investor to invest only in bonds. Finally, Panel E considers a combination of cases.

Table 2
Effect on consumption of early resolution of uncertainty about future retirement benefits

	Age of resolution of uncertainty (A)						
	35	40	45	50	55	60	65
A. Relative risk aversion (γ)							
γ = 7	0.0%	0.0%	-0.1%	-0.3%	-0.4%	-0.6%	-0.9%
γ = 5 (Baseline)	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.2%	-0.4%
γ = 3	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
B. Cut in replacement ratio (ξ)							
ξ = 45%	0.0%	0.0%	0.0%	-0.2%	-0.4%	-0.6%	-1.3%
ξ = 40%	0.0%	0.0%	0.0%	-0.1%	-0.2%	-0.4%	-0.9%
ξ = 30% (Baseline)	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.2%	-0.4%
ξ = 20%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
ξ = 15%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
C. Volatility of shocks to permanent income (σ_u)							
σ_u = 15%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.2%	-0.5%
σ_u = 10.95% (Baseline)	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.2%	-0.4%
σ_u = 7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.2%
D. Assets available to household							
Only bonds (Non-equity investors)	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.2%	-0.5%
Bonds and equities (Baseline)	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.2%	-0.4%
E. Combined scenarios							
γ = 7, ξ = 40%, non-equity investors	-0.1%	-0.2%	-0.3%	-0.5%	-0.8%	-1.2%	-2.0%
γ = 7 and ξ = 40%	-0.1%	-0.1%	-0.3%	-0.4%	-0.7%	-1.1%	-1.8%
γ = 5, ξ = 30%, bonds and equities (Baseline)	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.2%	-0.4%

Table 2 reports the percentage change in consumption for a household that does not learn about its income replacement ratio in retirement until age A, relative to a household who learns about it at the earliest possible age (i.e., age 28). The table reports percentage changes in consumption only to the first decimal digit, because digits beyond that are undistinguishable from approximation error. The table reports results for our baseline case as well as the cases we examine in Table 1.

Table 3
Welfare gains from early resolution of uncertainty about future labor income tax rates

	Age of resolution of uncertainty (A)		
	35	40	45
A. Relative risk aversion (γ)			
γ = 7	0.084%	0.067%	0.037%
γ = 5 (Baseline)	0.030%	0.028%	0.020%
γ = 3	0.003%	0.003%	0.000%
B. Change in labor income tax rate			
ξ = 45%	0.070%	0.066%	0.048%
ξ = 30% (Baseline)	0.030%	0.028%	0.020%
ξ = 15%	0.007%	0.007%	0.005%
C. Assets available to household			
Only bonds (Non-equity investors)	0.030%	0.029%	0.022%
Bonds and equities (Baseline)	0.030%	0.028%	0.020%
D. Asymmetric change in tax rate			
Asymmetric 30% change	0.037%	0.030%	0.017%
Symmetric 30% change (Baseline)	0.030%	0.028%	0.020%

Table 3 reports welfare gains for a household from learning early about the future change in the baseline labor income tax rate of 30% (during working life) and 15% (in retirement) for a household who does not learn about the change until age A, relative to a household who learns about it at the earliest possible age (i.e., age 28). The baseline row in each table reports results for the basic experiment. In this table, households know in advance the replacement ratio for their permanent labor income they get in retirement. We consider four variants of the baseline experiment, which are reported in Panels A through D. Panel A examines the effect of considering different coefficients of relative risk aversion. Panel B considers the effect of changing the size of the shock to the labor income tax rate. Panel C considers the effect of allowing the investor to invest only in bonds. Finally, Panel D considers the case in which the uncertainty about the income tax rate is asymmetric. In the asymmetric case, the tax rate can only increase (decrease) by 30% from 30 percent to 39% (19.5%) during working life (retirement) with a probability of 1/3. This case is similar in spirit to our case of a change in retirement benefits, where we have considered only cuts in retirement income.

Table 4
Effect on consumption of early resolution of uncertainty about future labor income tax rates

	Age of resolution of uncertainty (A)			
	35	40	45	50
A. Relative risk aversion (γ)				
γ = 7	0.0%	-0.1%	-0.1%	-0.3%
γ = 5 (Baseline)	0.0%	0.0%	0.0%	-0.2%
γ = 3	0.0%	0.0%	0.0%	-0.1%
B. Change in labor income tax rate				
ξ = 45%	0.0%	-0.1%	-0.1%	-0.4%
ξ = 30% (Baseline)	0.0%	0.0%	0.0%	-0.2%
ξ = 15%	0.0%	0.0%	0.0%	-0.1%
C. Assets available to household				
Only bonds (Non-equity investors)	0.0%	0.0%	0.0%	-0.1%
Bonds and equities (Baseline)	0.0%	0.0%	0.0%	-0.2%
D. Asymmetric change in tax rate				
Asymmetric 30% change	0.0%	0.0%	0.0%	-0.1%
Symmetric 30% change (Baseline)	0.0%	0.0%	0.0%	-0.2%

Table 4 reports the percentage change in optimal consumption for a household from learning early about the future change in the baseline labor income tax rate of 30% (during working life) and 15% (in retirement) for a household who does not learn about the change until age A, relative to a household who learns about it at the earliest possible age (i.e., age 28). The table reports percentage changes in consumption only to the first decimal digit, because digits beyond that are undistinguishable from approximation error. The table reports results for the same cases we examine in Table 3.

Table 5
Welfare gains from joint resolution of uncertainty about future retirement benefits and labor income tax rates

	Age of resolution of uncertainty (A)		
	35	40	45
A. Relative risk aversion (γ)			
γ = 7	0.247%	0.194%	0.107%
γ = 5 (Baseline)	0.076%	0.069%	0.047%
γ = 3	0.004%	0.004%	0.004%
B. Size of cut in retirement benefits and increase in labor income tax rate			
ξ = 45%	0.246%	0.220%	0.140%
ξ = 30% (Baseline)	0.076%	0.069%	0.047%
ξ = 15%	0.013%	0.012%	0.008%
C. Assets available to household			
Only bonds (Non-equity investors)	0.086%	0.080%	0.055%
Bonds and equities (Baseline)	0.076%	0.069%	0.047%
D. Uncorrelated uncertainty			
Uncorrelated ξ	0.038%	0.033%	0.022%
Baseline	0.076%	0.069%	0.047%

Table 5 reports the welfare gains from joint resolution of uncertainty about future tax rates and the replacement ratio of permanent income in retirement at age A relative to learning at age 50. We consider a scenario in which there is a 1/3 probability that both the baseline 30% labor income tax rate increases by 30% at age 50 and the 80% replacement ratio of permanent income in retirement declines by 30% at age 65. There is a 2/3 probability that they do not change. We assume that, in the default scenario, the household does not learn whether these changes actually occur until age 50. The baseline row in each table reports results for the basic experiment, whose parameter values are given in section 4. The table has five panels, each of which entails a change from the baseline model along a different dimension indicated in the heading of the panel. Panel A examines the effect of considering different coefficients of relative risk aversion. Panel B considers the effect of changing the size of the cut in the replacement ratio and the size of the increase in the labor income tax rate. Panel C considers the effect of allowing the investor to invest only in bonds. Finally, Panel E considers a special case where the uncertainty about future tax rates and the uncertainty about future retirement income are uncorrelated. In particular, it considers the welfare gains from early resolution of uncertainty about future labor income tax rates when the income replacement ratio is uncertain and not known until age 65.

Table 6
Effect on consumption of joint resolution of uncertainty about future retirement benefits and labor income tax rates

	Age of resolution of uncertainty (A)			
	35	40	45	50
A. Relative risk aversion (γ)				
γ = 7	-0.8%	-1.4%	-1.9%	-2.5%
γ = 5 (Baseline)	-0.1%	-0.3%	-0.5%	-1.3%
γ = 3	0.0%	0.0%	0.0%	-0.5%
B. Size of cut in retirement benefits and increase in labor income tax rate				
ξ = 45%	-0.2%	-0.6%	-1.1%	-2.5%
ξ = 30% (Baseline)	-0.1%	-0.3%	-0.5%	-1.3%
ξ = 15%	0.0%	-0.1%	-0.2%	-0.5%
C. Assets available to household				
Only bonds (Non-equity investors)	-0.1%	-0.3%	-0.5%	-1.4%
Bonds and equities (Baseline)	-0.1%	-0.3%	-0.5%	-1.3%
D. Uncorrelated uncertainty				
Uncorrelated ξ	0.0%	-0.2%	-0.4%	-1.1%
Baseline	-0.1%	-0.3%	-0.5%	-1.3%

Table 6 reports the change in optimal consumption from joint resolution of uncertainty about future tax rates and the replacement ratio of permanent income in retirement at age A relative to a household who resolves this uncertainty at age 28. The table reports percentage changes in consumption only to the first decimal digit, because digits beyond that are undistinguishable from approximation error. The table reports results for the same cases we examine in Table 5.