Other people’s money: essays on capital market frictions

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Chapter 3

Collective Pension Funds[1]

Credit Constraints and a Conflict over Risk and Contributions

Abstract. This chapter explores one rationale for pension funds. If individuals face credit constraints, i.e., if markets are incomplete, then a pension fund is able to improve on welfare by implementing participants' preferred investment strategy. A pension fund can do this if (i) participation is mandatory and (ii) it has access to a tax on human wealth. We show that implementation of the optimal allocation can be achieved through a defined-contribution (DC) pension scheme. We argue that, after a low stock return, such schemes can run into the same type of problems as underfunded defined-benefit (DB) schemes.

[1]This chapter is based on joint work with David Hollanders. For helpful comments, we thank Lans Bovenberg, Enrico Perotti, Bas Jacobs, and various seminar audiences.

3.1 Introduction

A pension is a payment stream that people receive upon retirement, i.e., when they leave the labor force. Rather than leaving it to individuals to save for their retirement, most advanced economies have pension systems in which individuals are required to participate. Common to such systems is that people contribute in their active working years, which entitles them to a pension benefit upon retirement.[2] But there is considerable variation between countries in how the pension system operates, how it is financed, and how pension benefits are determined.[3]

For example, some countries, like Germany, operate pay-as-you-go (PAYG) pension systems, where the active working population pays for the current retirees. Other countries, like the Netherlands, operate additional prefunded schemes, in which people *save* through pension contributions and receive a pension benefit that is set according to the pension contract. Again, pension contracts differ between countries. Roughly, one can distinguish between *defined-contribution* (DC) type contracts, where the pension benefit depends explicitly on investment returns (e.g. the famous 401(k) plans in the U.S.), and *defined-benefit* (DB) type contracts, where the pension is set according to a formula that may depend on average pay, years of employment, age at retirement, and other factors (e.g. the second pillar in the Netherlands).

Prefunded DB pension schemes—as found in the U.S., the Netherlands, and elsewhere—run into trouble when they are *underfunded*, i.e., when pension liabilities, which are fixed, exceed pension assets, which may fluctuate; the difference is called the *pension shortfall*. Pension shortfalls are an inherent risk—and recurring feature—of funded DB pension schemes.[4] When there is a pension shortfall,

[2] This seems an obvious requirement, but note that the first generation in a pay-as-you-go (PAYG) pension system receives a pension without having paid contributions.

[3] World Bank (1994) gives a useful categorization of pension systems into three pillars: a *state pension*, aimed at poverty reduction, and financed through taxes; an *occupational pension*, aimed to maintain the standard of living, and prefunded; and a *private pension*, allowing for individual supplements, also prefunded.

[4] For example, General Motor's defined-benefit pension plans reported a shortfall of $35 billion in 2011; this exceeded GM's market value.

there are two ways to restore the pension system's solvency: pension entitlements can be cut; or, contributions can be raised.[5] While cutting entitlements hurts older generations the most—as they have accumulated most entitlements—raising contributions hurts younger generations more and shields retirees from losses. Clearly, ex-post, generations do not agree over who should pay for the shortfall; this must be agreed upon, ex ante, in the pension contract.[6] By default, and per definition, DB schemes put the risk of a pension shortfall on the working generation, implying that contributions must be raised in case of a shortfall. In practice, this may turn out to be infeasible for political or regulatory reasons: employers and workers may effectively resist an increase in contributions—which is a tax an labor—especially during a recession; if regulations require a quick return to solvency, as they often do, then pension funds may have no option than to cut entitlements.

To illustrate these issues, consider the Dutch case. After the 2008 credit crisis, more than half of the pension funds in the Netherlands were designated 'underfunded,' by the Dutch Central Bank. The decline in pension wealth led to controversy over who should pay to restore the solvency of the pension system—Dutch regulations required a return to solvency within 5 years. Van Ewijk (2009) calculates that the proposed policy mix of entitlement cuts and raised contributions hurts older generations the most.

In recognition of the intrinsic tensions in DB pension systems with mismatch risk, DB pension schemes are being replaced with DC pension schemes, cf. Goudzwaard et al. (2009). In this chapter, my aim is to explore one rationale for a DC pension scheme that has, so far, received little attention in the literature.[7] The rationale we explore is that pension funds exist to lift credit constraints and implement the optimal optimal life-cycle investment strategy of participating gener-

[5] By cutting entitlements, pension funds decrease their liabilities; by raising contributions—while keeping entitlements fixed—pension funds increase their assets.

[6] As van Ewijk (2009) argues, the controversy over who should pay cannot be resolved *ex post*; it requires a model of optimal *ex ante* risk sharing.

[7] The notable exception is Bovenberg et al. (2007) ; Teulings and de Vries (2006) mention but do not pursue this rationale for pension funds.

ations.

An important finding of the literature on modern life-cycle investment theory is that, over their life-cycle, individuals should hold a constant fraction of their total wealth in risky assets, with the remainder invested in a risk-free asset, cf. Bodie, Merton, and Samuelson (1992). The upshot is that individuals' optimal investment strategy depends on their age: the young—who have human capital as well as financial capital—should invest their financial capital in a riskier manner than retirees—who have only financial capital. With their human capital, the young are naturally hedged against stock market risk.[8] Typically, these models require the young to take a leveraged position in the stock market, i.e., to borrow and invest the proceeds in the stock market.[9] If the young face credit constraints, this strategy is infeasible.

It is plausible that the young face credit constraints in private markets, as they do not have any collateral to offer to lenders.[10] If the young are credit constrained, then pension funds have a role to play: pension funds can implement the young's preferred investment strategy by extending them credit; thus, effectively alleviating the young's credit constraints.[11] There are two reasons why pension funds are better placed than private sector lenders to extend credit to the young: (i) participation is mandatory, reducing the adverse selection problem; and (ii) pension funds have access to a tax on human wealth, which allows them to enforce repayment. In effect, the pension fund helps to secure the human capital of participants as collateral, cf. Bovenberg et al. (2007).

[8]This finding relies on the assumption that human capital is risk-free. If capital returns and wages are cointegrated, as Benzoni, Collin-Dufresne, and Goldstein (2007) propose, then the young already hold a risky asset through their human capital.

[9]For example, Teulings and de Vries (2006) show that, at the beginning of one's career, a generation should borrow five times its yearly wage to invest in equity—similar results can be found in Bodie, Merton, and Samuelson (1992).

[10]The young wish to borrow against their human capital to invest in financial capital, but as Constantinides, Donaldson, and Mehra (2002) note: 'human capital alone does not collateralize major loans for reasons of moral hazard and adverse selection.'

[11]Bovenberg et al. (2007) provide a review of different rationales for pension funds; the review discusses alleviation of borrowing constraints as one possible rationale.

Implementation of optimal investment strategies can be achieved by a DC pension scheme, where participants pay a fixed amount of contributions (e.g. yearly), and pension funds invest these contributions on behalf of participants. To implement the optimal strategy of its youngest participants, the pension fund needs to borrow on their behalf. A pension fund with only young participants would, thus, have to take a leveraged position in the stock market, i.e., take a short position in the risk-free asset. By contrast, pension funds with young and older participants would still take a net long position in the risk-free asset, as older generations prefer strategies that are less risky.[12] Implementation of the optimal investment strategy can then be interpreted as the young borrowing from other participants at the risk-free rate, pledging their human capital as collateral.

To demonstrate how pension funds can improve welfare, we present a simple and stylized model with three overlapping generations of risk-averse individuals: the young, the middle-aged, and the old. The capital market is equally stylized, it consists of a risk-free bond and a risky stock; the equity premium is positive. To focus on the optimal investment decision, we fix the amount of savings in each period, i.e., we abstract from the labor supply and optimal savings decision, as in Gollier (2008). Savings then take the form of a per-period endowment, and the problem is simply to determine the optimal investment strategy of the young and middle-aged. The old consume their pension benefit, which is endogenous and depends on past stock returns. After deriving the complete markets benchmark, we introduce credit constraints, a form of market incompleteness. Market incompleteness, in turn, is the main rationale for pension funds.[13]

[12]One interpretation is the following: the pension fund operates an internal capital market where the young issue risk-free debt to the old and use the proceeds to invest in equity.

[13]Market incompleteness due to credit constraints is a key assumption of our analysis; without credit constraints, there is no rationale to have a pension fund in our model. Credit constraints are also assumed in related work by Beetsma and Bovenberg (2006) and Gollier (2008).

3.2 Model

The economy is populated by three overlapping generations, each of unit mass, called the *young* (y), the *middle-aged* (m), and the *old* (o). In their active working years, generations contribute to a pension fund: the young and middle-aged pay a fixed contribution, s, to a pension fund in each period. In retirement, generations consume a pension benefit: the old obtain a pension benefit, b, from the pension fund. The welfare of a generation is measured by its utility in retirement, and we assume that generations have a CRRA utility function,

$$u(b) = \frac{b^{1-\phi}}{1-\phi}$$

where $\phi > 0$ is the coefficient of relative risk aversion.[14] After retirement, generations leave the model.

There is a simple capital market consisting of two financial assets: a risk-free asset, called *bond*, and a risky asset, called *stock*. The gross return of the bond is fixed over time and normalized to 1. The excess stock return is stochastic and serially uncorrelated over time. We denote the excess stock return in period t by $\tilde{r}_t$—the mnemonic is that random variables are denoted with a tilde, realized values without. For simplicity, we assume the excess return follows a Bernoulli distribution: with probability p, the excess return takes the value $r^h > 0$; with probability $1-p$, it takes the value $r^l < 0$. The equity premium is positive,

$$\mu := pr^h + (1-p)r^l > 0 \tag{3.2.1}$$

Within each period, the timing within each period is as follows: (i) individuals enter the period with their *financial reserve*, i.e., financial assets carried from the last period; (ii) an investment decision is made; (iii) the young and middle-aged

[14] As usual the utility function is given by $u(b) = \ln(b)$ for $\phi = 1$. Following Gollier (2008), we focus exclusively on individuals' optimal investment decision, and we abstract from their labor supply and savings decision. Hence contributions, s, are exogenously fixed, and individuals maximize their expected retirement benefit, b, which is endogenously determined.

pay their contributions, and the pension fund pays benefits to the old; (iv) returns materialize.

3.2.1 Complete Markets

As a benchmark, we examine each generation's optimal investment strategy if financial markets are complete in the sense that there are no credit constraints.[15] At the beginning of each period, the young and middle-aged decide how much to invest in the stock, and how much to invest in the risk-free bond. The old have no more decision to make, they simply consume their accumulated retirement wealth. Let α_t^i denote the monetary investment in the stock by generation $i = y, m$ in period t.

We define a generation's *retirement wealth* at the beginning of period t as the sum of (i) its *financial reserve*, i.e., the balance of its financial assets, which we denote by w_t^i; and (ii) its *human capital reserve*, i.e., the residual net present value of future contributions to the pension fund, which we denote by h_t^i for $i = y, m, o$. The old generation's retirement wealth consists only of their financial reserve, w^o; they have exhausted their human capital reserve. By contrast, the young generation's retirement wealth consists only of their human capital reserve, h^y; they have no financial reserve. The retirement wealth of the middle aged generation consists of both a financial reserve and a human capital reserve, $w^m + h^m$.

The dynamic investment problem can now be written as:

$$\max_{\alpha_t^y, \alpha_{t+1}^m} Eu(\tilde{b})$$

[15] Financial markets are still incomplete in the sense that non-overlapping generations cannot share risks with each other, cf. Diamond (1977), Gordon and Varian (1988), and Ball and Mankiw (2007).

such that

$$
\begin{aligned}
w_t^y &= 0 \\
w_{t+1}^m &= \alpha_t^y(1+\tilde{r}_t)+(y-\alpha_t^y) \\
w_{t+2}^o &= \alpha_{t+1}^m(1+\tilde{r}_{t+1})+(w_{t+1}^m+y-\alpha_{t+1}^m) \\
\tilde{b} &= w_{t+2}^o
\end{aligned}
$$

The solution to the investment problem is given by the following proposition.

Proposition 3.2.1. *The optimal dynamic investment strategy of each generation is to invest a constant fraction of retirement wealth in the risky asset, or* $\alpha_t^i = a^*\left(w_t^i + h_t^i\right)$ *for* $i = y, m$ *; where the optimal fraction is given by*

$$
a^* = \frac{\left(\frac{-r^l(1-p)}{r^h p}\right)^{\frac{1}{\phi}} - 1}{r^l - r^h\left(\frac{-r^l(1-p)}{r^h p}\right)^{\frac{1}{\phi}}}
$$

The corresponding expected lifetime utility for a young individual is

$$
\begin{aligned}
U^{cm} &= Eu(\tilde{b}) \\
&= \delta^2 u(h_1) \\
&= \delta^2 u(2s)
\end{aligned}
$$

with

$$
\delta := E\left(1+a^*\tilde{r}\right)^{1-\phi} \tag{3.2.2}
$$

Proof. See the Appendix. □

The proposition gives the optimal investment decision for the young, the middle-aged, and the old; the proposition shows that, over their life-cycle, individuals optimally hold a constant fraction of their retirement wealth in the risky asset. This result is well-known from the literature on optimal life-cycle investment, cf.

Merton (1969), Samuelson (1969), and Bodie, Merton, and Samuelson (1992). Simple comparative statics show that optimal investment in the risky asset, a^*, is increasing in the equity premium, μ, and decreasing in the coefficient of relative risk aversion, ϕ.

Note that δ can be interpreted as the gross per-period *utility return* of investing optimally in one period. A young individual's retirement wealth consists entirely of his human capital reserve, $h_1 = 2s$. In utility terms, each period of optimal investment yields a gross return of δ; hence $U^{cm} = \delta^2 u(2s)$. Using a first-order approximation we note that

$$\delta \approx 1 + (1-\phi)a^*\mu$$

In financial terms, the corresponding *certainty equivalent rate of return*, r^{ceq}, is then given by

$$u\left(h_1\left(1+r^{ceq}\right)^2\right) = \delta^2 u\left(h_1\right)$$

or

$$r^{ceq} = \delta^{\frac{1}{1-\phi}} - 1 \tag{3.2.3}$$

which is increasing in the equity premium, μ, and in the optimal risky asset exposure, a^*. The certainty equivalent excess return, r^{ceq}, is the riskless return that would leave the young as well off as optimally investing their retirement wealth.

To conclude the description of complete markets, note that implementation of the optimal investment strategy requires individuals to actively manage their portfolios: as individuals grow older, their financial portfolio optimally shows a decrease in risk. The young hold the riskiest portfolio; to obtain their optimal risk exposure, the young have to take a leveraged position in the risky asset, i.e., they have to borrow at the risk-free rate and invest the proceeds in the risky asset. In practice, this strategy is infeasible if the young are credit constrained.

3.2.2 Credit Constraints

In the following, we examine each generation's optimal investment policy if financial markets are incomplete in the sense that there are credit constraints. Specifically, we assume that individuals cannot use future contributions as collateral;[16] individuals then face a per-period budget constraint that equals their financial reserve, $\alpha_t^i \leq w_t^i$.

Compared to the complete market benchmark, these additional constraints lead to a welfare loss. The young, in particular, are affected: they cannot invest in the risky asset until the next period, as w^y. The middle-aged may also run into credit constraints, depending on the parameters of the model. We obtain a lower bound for the welfare loss by assuming that only the young are credit constrained,

Proposition 3.2.2. *With credit constraints, the maximum expected lifetime utility for a young individual is*

$$\begin{aligned} U^{cc} &= Eu(\tilde{b}) \\ &= Eu\left(2s\left(1+a^{*}\tilde{r}_{t+1}\right)\right) \\ &= \delta u(2s) \end{aligned}$$

and the minimum welfare loss due to credit constraints is

$$\left(\delta^2-\delta\right)u(2s)$$

Proof. See the Appendix. □

The proposition is intuitive. The minimum welfare loss arises if individuals face credit constraints when they are young, but invest optimally when they are middle-aged. The welfare loss equals the opportunity cost of not being able to invest in the risky asset while young. In utility terms, this opportunity cost is

[16] Without collateral, the market for stock-investment credit breaks down due to adverse selection and moral hazard problems, cf. Bovenberg et al. (2007) and Constantinides et al. (2002).

the utility gross return δ; in financial terms, the opportunity cost is the certainty equivalent excess return, r^{ceq}, given by (3.2.3).

When markets are incomplete, there is a role for pension funds: they can extend credit to the young and implement the young's preferred investment strategy for them. This is the rationale for pension funds that we examine. There are two reasons why pension funds are better placed than the private sector to extend credit to the young: (i) compulsory participation alleviates adverse selection problems; and (ii) pension funds have access to a tax on human wealth.[17]

To implement the optimal allocation of participants, pension funds can operate *extended generational accounts,* a form of generational accounting where each generation pays contributions into their account; and gets the balance of its account upon retirement. The difference with strict generational accounts, as in Teulings and de Vries (2006), is that the pension fund borrows on behalf of the young. Note that, with extended generational accounts, the pension fund consists simply of the merged, accounts of the participating generations; its investment strategy is a weighted average of the strategies of the participating generations.

Consider the pension fund at time t. From proposition 3.2.1, the young want to invest an amount

$$\begin{aligned} \alpha_t^y &= a^* \left(w_t^y + h_t^y \right) \\ &= a^* 2s \end{aligned}$$

in the risky asset. Likewise, the middle-aged want to invest an amount

$$\begin{aligned} \alpha_t^m &= a^* \left(w_t^m + h_t^m \right) \\ &= a^* 2y \left(1 + a^* r_{t-1} \right) \end{aligned}$$

which depends on the stock return in period $t-1$. It follows that the pension fund

[17] Bovenberg at al. (2007) note: 'compulsory participation in collective pension schemes can alleviate adverse selection and moral hazard when young workers borrow against their human capital to invest in equity.'

invests a total amount of $\alpha_t^y + \alpha_t^m = a^* 2y(2 + a^* r_{t-1})$ in stock on behalf of the young and the middle-aged. Whether the pension funds' stock investment exceeds its financial reserve depends (i) on past stock returns, and (ii) the parameters of the problem. It is possible, in other words, that the pension fund as a whole has to take a leveraged position in the stock market. The investment strategy of the pension fund is a weighted average of the preferred strategies of the young and the old.

The scheme we described above is similar to *generational accounting*, where each generation pays contributions into their own account; the account's investments are separately administered; and generations get the balance of their account when they retire. A pension fund then simply consists of the merged, ring-fenced, savings accounts of its participants. But generational accounting in the strict sense, as proposed in Teulings and de Vries (2006), does not allow the young to borrow against their future contributions, i.e., they are still credit constrained.[18]

We have argued that pension funds, operating within a mandatory DC pension scheme, can improve on a laissez-faire market allocation by allowing the young to implement their optimal investment strategy, i.e., by alleviating their credit constraints. The lower bound welfare gain of introducing a pension fund is given by proposition 3.2.2. As long as the pension fund does not need to borrow in financial markets, the optimal allocation can be interpreted as the young borrowing from older participants at the risk-free rate, pledging their human capital as collateral. The pension fund acts to secure the young's human capital as collateral to facilitate trades in its internal capital market. We note that the ability of pension funds to increase welfare hinges crucially on the assumption that pension funds can collateralize the human capital of participants. This assumption may be problematic, as we discuss in the concluding section.

[18]Such a pension fund would not improve on welfare in our stylized model. It is motivated by hyperbolic discounting and sharing of longevity risks in Teulings and de Vries (2006).

3.3 Conclusion

We summarize our argument as follows. If the young face credit constraints, i.e., if markets are incomplete, then a pension fund is able to improve on welfare by implementing the young's preferred investment strategy. A pension fund can do this because (i) participation is mandatory and (ii) because it has access to a tax on human wealth. In effect, the pension fund is able to collateralize the human capital of its participants; in particular, the pension fund is able to collateralize the human capital of the young. Introducing a pension fund, thus, increases welfare compared to a situation in which everyone invests for himself.

The welfare increase by the pension fund relies crucially on the credibility of young's future contribution policy. In practice, it may be difficult to raise contributions after a low stock market outcome—and in particular in a recession. Clearly, the young do not want to raise contributions ex post, and it may be politically unpalatable to do so in times of recession.[19] If ex-post, after a low stock market outcome, the pension fund cannot collect contributions, then the result is a distributional conflict, similar to those witnessed in underfunded DB pension schemes. It follows that the DC pension scheme we describe may run into the same problems as a DB pension scheme with mismatch risk, and that the ex-ante optimal risk level at the pension fund cannot be separated from the ex post contribution policy.

Indeed, one interpretation of the distributional conflict in the Netherlands is that the pension funds—which, de facto, run a combination of DB and DC pension contracts—took too much risk on behalf of the young, assuming that contributions could be raised in case of a pension shortfall. When this proved infeasible, the old realized that they had implicitly lent their capital to the young and wished to see a return. The young on the other hand, do not wish contributions to be raised. This *ex post* distributional conflict leads to an *ex ante* governance conflict at the

[19]The young workers face a commitment problem: ex ante they want to pledge human capital as collateral, but ex post they have no incentive to raise pension contributions.

pension fund.[20] The old wish to limit risk taking such that they are repaid in every contingency. Alternatively, the old may agree to letting the young take a high risk if pension contributions can indeed be raised ex post.

Several important caveats apply. First of all, we've abstracted from the labor-supply and from the savings-consumption decision of individuals to focus on the optimal investment decision. This is, of course, restrictive. For example, credit constrained individuals would save more to compensate for the lack in risk taking opportunities; thus the pension fund becomes less important.

In this chapter I focus exclusively on the preferred risk exposure of participants as a determinant of the investment strategy of a pension fund. Bikker, Broeders, Hollanders, and Ponds (2009) provide evidence that indeed age composition is an important determinant of a pension fund's asset allocation. But there may be others. For example, we have abstracted from agency problems that may be present at the pension fund. Reward systems may favor risky investment, as portfolio managers gain from profits but are sheltered from losses.

Regarding the conceptual framework, our simple, stylized, model allows us to explore one rationale for pension funds. We show that a pension fund may be able to improve the welfare of credit constrained participants by letting them borrow within the pension fund. Our analysis could be extended to have an additional rationale for pension funds: to smooth risks between non-overlapping generations, as in Gollier (2008). In theory, this is an important benefit that pension funds can achieve. In practice, however, regulations—like the Dutch requirement to restore solvency within 5 years—inhibit such risk sharing. Furthermore, from a theory point of view, it is an open question how optimal risk sharing between non-overlapping generations is best achieved: through government policy (debt and tax) or through funded pension schemes. Beetsma and Bovenberg (2006) present a stylized model in which optimal risk-sharing is achieved through both.

[20]This governance conflict resembles the conflict between debt- and equity holders in a firm that is close to financial distress Tirole and Dwatripont (1994). The young are, like equity holders, protected by limited liability, while the old have a claim on the pension fund that is debt-like.

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