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Pension fund governance

The intergenerational conflict over risk and contributions

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Abstract

Many pension funds have a mismatch between assets and liabilities, taking more risks than securing liabilities implies. This puts .xed claims of retirees at risk. For the cases with and without macro-risk, this paper analyses the implications of this asset-liability mismatch for welfare, contribution policy and pension fund governance. The first result is that borrowing against human capital can be optimal if young workers are borrowing constrained. However, then contributions need be raised in case of underfunding. This implies that the ex ante risk level cannot be separated from the contribution policy ex post. An optimal governance structure addresses this; otherwise a risk immunization policy -with the pension fund taking less risk- is second-best.

In the presence of macro-risk it is not optimal to avoid losses for retirees. Optimal intergenerational risk sharing then implies retirees bear risks. The price and allocation of risk are determined endogenously with the result that losses are shared by higher contributions and lower pensions. This case applies in particular to large and nation-wide funds in a closed economies where the working participants coincide with tax-payers who underwrite "riskfree" government bonds.

Keywords: pension fund governance; leverage; macro risk.

JEL classification: D74; G11; G23; G32.

Nederlandse samenvatting (Dutch summary)

Veel pensioenfondsen nemen meer risico dan nodig is om aan de verplichtingen te voldoen. Dit betekent dat deelnemers met een gemaximaliseerde aanspraak op het fonds -slapers en gepensioneerden- een verhoogde kans lopen om bij onderdekking gekort te worden op die aanspraak. Omgekeerd hebben werkende deelnemers en mogelijk de sponsor het voordeel dat zij de opbrengsten van het risicovolle beleid ontvangen in de vorm van premiekorting maar de verliezen deels kunnen afwentelen. Zo een zogenaamde "asset-liability mismatch" kan optimaal zijn, maar is dat onder een belangrijke voorwaarde. Bij onderdekking dienen de premies verhoogd te worden; premiebeleid en risicobeleid hangen op deze wijze nauw samen. Feitelijk lenen jongere van oudere deelnemers met menselijk kapitaal als onderpand. Indien dit niet mogelijk is omdat premies niet kunnen stijgen, dan is een alternatieve, sub-optimale oplossing om het risico te beperken.

Deze resultaten gelden zowel in een situatie waarin het pensioenfonds klein is en geen invloed heeft op kapitaalmarkten als in de situatie waarin een groot pensioenfonds de prijzen beïnvloedt en er risico.s zijn op macroniveau die het fonds niet kan vermijden. Dit laatste geval onderscheidt zich wel in een ander opzicht. Het is dan niet optimaal dat gepensioneerden geen (macro)risico lopen; dat betekent namelijk dat actieve deelnemers inefficient veel risico lopen. Het is dan optimaal dat het risico gedeeld wordt door een combinatie van hogere premies en lagere uitkeringen in geval van onderdekking.

1. Introduction

Pension funds take risks. This may put .xed claims on the fund, typically held by retirees and deferred participants, at risk. The other way round, the claims of participants who are quasi-shareholders of the fund -generally the workers- increase in value. The latter can recoup gains in the form of lower pension contributions which is indeed the argument given by pension funds themselves to take risk. The pension fund effectively leverages investments of active participants. Retirees instead desire an investment strategy geared towards safeguarding liabilities by investing in .xed-security assets like bonds. The risky investments of pension funds thus lead to a conflict of interest between retirees and workers, or more general between participants with .xed claims and participants who are quasi-shareholders.

This description of a¤airs is however incomplete from a macro perspective. Aggregate risks cannot be avoided and at a macro-level there is no such thing as a safe asset. When one party -the retirees- is fully sheltered from losses, it is ultimately another party -the workers- who takes on the risk. So when a pension fund buys "safe" bonds, it are the taxpayers -thus the workers- who underwrite the bonds and thereby take on macro-economic risks. The allocation of all macro-risks with one group -the workers- is inefficient. And the larger the group that is sheltered from macro-risks becomes, the larger the problem becomes; this is precisely the consequence of aging. This may lead to a conflict of interest between a group that is sheltered from all losses -the retirees- and a group that consequently bears all risks, the workers.

This study analyses the conflict between young and old participants over the risk level in these two settings. First, it considers the situation where a pension fund does not have any effect on capital markets. The capital market is exogenous to the fund that can thus buy safe assets and/or invest in risky assets as much as it wants without influencing prices.

The model formalizes that leverage can be welfare enhancing, as pension funds claim. The reason is that young workers are borrowing constrained. They want to invest borrowed money on the stock market. Pension funds can alleviate this constraint by facilitating that workers borrow from retirees. When this is done, young participants use human capital as collateral. Following Bodie et al. [1992], abundant human capital is the reason why young participants want to leverage up stock investment in the first place. They can hedge their equity risk with their human capital. When capital market returns are depressed, contributions need be raised to secure claims of lenders. The borrowing facility thus comes with the caveat that the risk level ex ante cannot be separated from the contribution policy ex post. Good pension fund governance takes this into account and considers both simultaneously.

This paper considers several ways to do so. Handing over control rights over the contribution level to retirees secures claims. This could be done by explicit board representation of retirees. This may however lead to another problem if the lending group (ab)uses this position to increase contributions beyond what is needed to repay. In that case control should not to be handed over totally and contributions need to be determined jointly. When retirees are not involved in determining contributions, another solution could be considered. Then the risk level could be scaled back to avoid losses for retirees. This risk immunization policy is sub optimal compared to joint control over contributions, but secures the claims of the lenders.

The second perspective is that of a large or national pension fund that cannot buy safe assets without influencing prices. Prices are endogenous, as taxpayers are increasingly unwilling to underwrite the bonds. As the tax-payers largely coincide with the working participants of the fund, the pension fund as a whole bears aggregate and unavoidable risks. In this case, it is not optimal to allocate all risks with one group, the workers. Instead it is best to share risks. Optimal risk sharing leads to a swap of risks between younger and older participants. The first then disproportionally benefit from a soaring economy whereas the latter suffer less from an economic downturn without being fully insured against it. Optimal risk sharing may still imply that the young borrow against human capital and similar problems as in the first case arise.

An important implication is that retirees share in losses, although to a lesser extent than working generations. These results are derived under the assumption that all participants are fully aware of all risks. This in turn implies that pension funds communicate clearly about the risks participants face. Arguably this has seldom been the case.

Leverage is focal in understanding current losses of pension funds and the resulting conflicts between in particular younger and older participants. The OECD estimated that pension funds lost 3540 billion worldwide in 2008. The losses were concentrated with pension funds with high risk-exposure. On the other hand, pension funds that invested in "safe" government bonds are ultimately insured by the tax payer, that is the working generations.

This study relates to several streams of literature. First, there is an increasing literature on pension fund governance, see for example Besley and Prat [2003], van Ewijk [2009] and Lavigne and Nze-Obame [2010]. This literature focuses primarily on conflicts between participants and the sponsoring company; here the focus is on conflicting interests between participants instead. This applies to Collective Defined Contribution funds in which the sponsoring company pays contributions but does bear risk in case of underfunding. Second, the literature on optimal savings-consumption decisions over the life-cycle is important here, see

Bovenberg et al. [2006] for an overview. This literature abstracts however from problems arising from collateralisation of human capital. This paper addresses optimal consumption-savings decisions when collateral is not credible, making governance and regulation important.

Pension fund governance also resembles the conflict between shareholders and debt holders, which involves the third relevant literature, see Jensen and Meckling [1976] and Sharpe [1976]. Shareholders reap the upside of large risks but can partly shift losses to bondholders in case of insolvency. The solution is that shareholders hand over control over insolvent company to creditors. This could be achieved by board representation of retirees.

The remainder of this paper is organized as follows. Section two discusses the case without aggregate risk and also provides a numerical example. The third section considers the inclusion of macro-risk in the model and the last section concludes.

2. No Aggregate risk

The model considers a pension fund with mandatory participation. The pension fund consists of two groups that differ in one respect and one respect only, the size of human capital relative to financial capital. The group with human capital is interpreted as workers. The group without human capital is interpreted as a group of retirees. This interpretation is not necessary but follows natural, as workers have more human capital than retirees.

The two groups may differ in size. The number of workers equals N_y and the number of retirees equals N_o. Both N_y and N_o. are strictly positive and the relative size of the working group is given by $n \equiv \frac{N_y}{N_o}$.

Human capital of workers equals $H > 0$ and it is risk free; their financial capital is equal to F_y. The retirees have no human capital and financial capital equals $F_o > 0$. The two groups thus have their own separate assets. The pension fund invests the assets on behalf of the participants without guaranteeing a minimal result. The pension arrangement is thereby Collective Defined Contribution where the sponsoring company bears no risk and all risks are borne by the collective of participants.

Individuals of both groups have a logarithmic utility function. Utility of workers and retirees is denoted by $u_y(c_y) = \ln(c_y)$ and $u_o(c_o) = \ln(c_o)$ respectively; c_i stands for consumption and equals human capital plus financial capital.

2.1. The capital market

The capital market consists of two assets. The first asset is a risk-free bond with a return r. The second asset represents risky stock investment and is Bernouilli distributed. With a probability p the stock has a high return equal to $\overline{r}$ and with complementary probability $1-p$ the return is $\underline{r}$. Stock return is the sole risk factor in this economy. The following relation holds: $\overline{r} > r > \underline{r} > 0$. Unless stated otherwise the expected return of the stock exceeds the risk free return: $p\overline{r} + (1-p)\underline{r} > r$.

2.2. Workers borrowing constrained: leverage welfare enhancing

This section considers a situation where participants can borrow from each other; this is only relevant when one group prefers to borrow and the other group prefers to lend.

The possibility that workers borrow outside the pension fund on financial markets is ruled out. They are thus borrowing constrained. First, it is difficult to borrow against (future) human capital. Second, most young people are not active on capital markets and it would come with high .xed costs to do so. Third, insurance companies are notoriously cost-inefficient which generally offsets all investment gains; see Bikker and de Dreu [2009]. In choosing the optimal asset allocation, the workers face the following maximization problem where represents stock investment:

$$\max_{\alpha} \qquad p\ln[F_y(\alpha\overline{r}+(1-\alpha)r)+H]+(1-p)\ln[F_y(\alpha\underline{r}+(1-\alpha)r)+H]$$

The subscripts *y* and *o* indicate younger workers and retirees respectively. The first order condition reads:

$$\frac{p(\overline{r}-r)}{F_y(\alpha\overline{r}+(1-\alpha)r)+H}+\frac{(1-p)(\underline{r}-r)}{F_y(\alpha\underline{r}+(1-\alpha)r)+H}=0$$

The optimal solution equals: $\alpha_y^*=\frac{(H+F_yr)[p(\overline{r}-r)+(1-p)(\underline{r}-r)]}{F_y(r-\underline{r})(\overline{r}-r)}\equiv\frac{(H+F_yr)\overline{\mu}}{F_y(r-\underline{r})(\overline{r}-r)}.$

The equity premium is denoted by $\overline{\mu}\equiv p\overline{r}+(1-p)\underline{r}-r$. Since the equity premium is strictly positive the stock allocation is strictly positive. The stock allocation can exceed one. In that case workers want to leverage their stock investment by investing borrowed money in the stock market.

Comparative statics indicate that the optimal equity allocation increases when human capital holdings increase and decreases if financial capital increases.[1] The intuition is that workers have implicit bond exposure with their human capital, as both human capital and bonds are risk free. This in turn renders a higher stock fraction of financial capital optimal.

The retirees essentially face the same maximization problem, though their human capital equals zero. Their optimal equity exposure therefore becomes:

$$\alpha_o^*=\frac{r\overline{\mu}}{(r-\underline{r})(\overline{r}-r)}$$

The following relation between optimal stock allocation of the two groups holds:

$$\alpha_y^*=\alpha_o^*+\frac{H\overline{\mu}}{F_y(r-\underline{r})(\overline{r}-r)}$$

1 The comparative statics are: $\frac{d\alpha_y^*}{dH}=\frac{\overline{\mu}}{F_y(r-\underline{r})(\overline{r}-r)}>0$

$$\frac{d\alpha_y^*}{dF_y}=\frac{\overline{\mu}}{(r-\underline{r})(\overline{r}-r)}\frac{-H}{F_y^2}<0$$

This indicates that α_o^* is always smaller than α_y^*, irrespective the values of financial capital of the two groups. So $\alpha_y^* > \alpha_o^* \; \forall \; H > 0$. The intuition is that the workers already (implicitly) hold a risk free asset with their wage, thereby increasing optimal equity exposure of their financial capital.

Three possible configurations for the optimal asset allocation of old and young result. First, when $\alpha_y^* \leqq 1$ the workers can implement their preferred stock allocation; they don't need to borrow. The same holds for the retirees as $\alpha_o^* < \alpha_y^*$.

Second, when $\alpha_y^* > \alpha_o^* > 1$ both groups want to borrow to invest. The possibility to borrow outside the pension fund is ruled out and therefore neither of the two groups can implement its optimal investment. Instead both groups invest all assets in equity and $\alpha_y = \alpha_o = 1$.

The third case is $\alpha_y^* > 1 > \alpha_o^*$. In this case retirees can implement their preferred stock allocation but the workers cannot. For that they need to borrow. The remainder of this section focuses on this case which is the most relevant as it captures the conflict of interest that is currently present in many a pension fund.

Then the pension fund may be able to implement the optimal allocation for both groups. After all, the fund consists of a group -the workers- that wants to borrow and a group -the retirees- that wants to lend. The retirees are in principle indifferent whether they lend on an anonymous capital market or to the young. There is thus a gain from trade which the pension fund can exploit. The fund can do so in the following way.

The workers borrow $(\alpha_y^* - 1)F_y$ from the old, repaying $r(\alpha_y^* - 1)F_y$. This is equivalent for the retirees and strictly improves welfare for the young vis-à-vis the situation where their stock allocation is restricted to $\alpha_y = 1$. Alternatively but not assumed here the working participants could pay a (very) small premium above the risk free rate to persuade the retirees.

For the optimal equity exposure to be feasible, one further condition needs to hold:

$$F_o(1 - \alpha_o^*) \geqq n(\alpha_y^* - 1)F_y$$

This condition states that the maximum amount the retirees are willing to lend is equal to or larger than the amount the workers want to borrow. Unless stated otherwise, this is assumed, considering that the old generally have (much) more financial capital than young workers.

When the optimal equity exposure is implemented, the overall stock exposure of the fund equals:

$$\frac{n\alpha_y^* F_y + \alpha_o^* F_o}{nF_y + F_o} = \alpha_o^* + \frac{nF_y(\alpha_y^* - \alpha_o^*)}{nF_y + F_o}$$

Note that a decrease of n -which can be interpreted as aging- leads to a lower risk level. This is indeed in line with empirical .ndings. Bikker et al. [2009] document that Dutch pension funds with older participants decrease their risk level. An increase in the average participants´ age of one year is associated with a decrease of half a percentage point of the stock exposure. Other studies find this as well, see Alestalo and Puttonen [2006] and Gerber and Weber [2007] for analyses of Finnish and Swiss pension funds respectively.

2.3. The consequences for contribution policy

With inter group lending, the workers borrow $(\alpha_y^* - 1)$ from the old. When capital returns are high, the workers repay out of their financial capital. When market returns are depressed, they need to repay (partly) with the human capital that served as collateral. In the context of pension funds, this implies higher pension contributions. Leverage thus results in a direct link between the risk level ex ante and the contribution policy ex post.

Human capital serves as collateral when the following condition holds:

$$F_y \alpha_y^* \underline{r} < r(\alpha_y^* - 1)F_y \Longrightarrow \alpha_y^* \underline{r} < r(\alpha_y^* - 1) \Longrightarrow \frac{\alpha_y^*}{\alpha_y^* - 1} < \frac{r}{\underline{r}}$$

Paying back becomes more problematic if the risk free rate increases relative to there turn in the low-state. The condition compares low return on workers´ financial capital together with the borrowed amount with the gross risk free return on the borrowed amount. If the first is smaller than the latter, human capital is needed to repay.

This could be hindered by pre-negotiated legal limits to contributions or by unwillingness of workers to pay higher contributions. The first best allocation is then unfeasible. In the most extreme case, the workers do not use human capital. In that case the retirees receive $\underline{r}\alpha_y^* F_y$ instead of $r(\alpha_y^* - 1)F_y$. Consumption of retirees then equals:

$$(\alpha_o^* F_o + \alpha_y^* F_y)\underline{r} + r[(1 - \alpha_o^*)F_o - (\alpha_y^* - 1)F_y].$$

If workers do not use human capital to pay off their debt, they essentially have a form of limited liability, similar to shareholders. Once all their financial capital is lost when capital market is depressed, they do not face further losses irrespective of the size of the borrowed amount. Workers are quasi-shareholders who can reap all benefits but do not bear all losses. Retirees are quasi-bondholders with a .xed claim and downside risk.

This changes the decision problem of active participants as expected utility now becomes:

$$p \ln[F_y(\alpha \overline{r} + (1 - \alpha)r) + H] + (1 - p)\ln[H + \max(0, \alpha \underline{r} F_y + (1 - \alpha)rF_y)]$$

Once $\alpha\underline{r} + (1-\alpha)r = 0 \iff \alpha = \frac{r}{r-\underline{r}}$ this pay-out function is strictly increasing in. From then on the workers will thus want to increase stock exposure as much as possible, the maximum borrowed amount equalling $(1-\alpha_o^*)F_o$. This leads to a direct conflict with retired participants, as for them unsecured lending comes down to expropriation. This again shows that investment decisions cannot be separated from the contribution policy.

2.4. Solutions for the hold-up problem

2.4.1. Pension fund governance

The problem of borrowing against human capital resembles a hold-up problem. Workers want to leverage up stock investments, simultaneously promising to increase contributions in case of low stock return. However, when low returns materialize they have an incentive to break their promise. This commitment problem could be solved by voluntarily relinquishing their own power to resist higher contributions. In that case control over contributions is given to the retirees.

The following game formalizes this notion:

Step 1. The workers decide whether to hand over control to determine contributions.

2. The retirees decide how much to lend to working participants, in particular whether to accept human capital as collateral.

3. Move by nature: stock returns are either high or low.

4a. If returns are high, the workers pay back fully.

4b. If returns are low, whoever is in control decides how much of human capital is used when necessary.

There are two cases to consider. First consider the case where retirees, when in control, exactly match contributions to what they are entitled to. When workers do not hand over control, retirees will not accept human capital as collateral; workers have an incentive to "default" on their "debt" in the case of low stock return. When the young do hand over control in step 1 and retirees accept human capital in step 2, an e¢fficient equilibrium results. Then the retirees lend the optimal amount while being repaid fully. Given the strategy of the other group no group can do better.

There are two other possible equilibria. Retirees restricting borrowing and the young not handing over control also constitutes a Nash equilibrium. And retirees restricting borrowing while the young do hand over control likewise constitutes a Nash equilibrium.

The latter is an equilibrium because retirees do not profit from borrowing whatsoever. This would not be the case if the young (could) share their welfare gain by giving retirees a small but positive amount after they have accepted human capital as collateral.

Even then, there is no unique equilibrium as a strategy of the old to restrict borrowing and the strategy of the young to limit human capital transfers remains a Nash equilibrium also in that case. This underlines the importance to coordinate in the pension fund board on a Pareto efficient equilibrium.

A second case arises when retirees (ab)use their control to transfer more than necessary, redistributing from workers to retirees via higher contributions. The commitment problem is then replaced by a dictatorship game where retirees are the ´dictator´ dictating their desired contribution level, which is as high as possible.

There is then a trade-off when handing over control over contribution policy. Too much control for retirees leads to excessive contributions whereas too much control for young leads to high leverage and unsecured lending. This suggests that in the presence of high leverage control over contributions has to be shared between workers and retirees. This could again be achieved by board representation of retirees.

2.4.2. Risk immunization policy

A second solution to address too much leverage is limiting it. Borrowing of the young is restricted to the maximum that workers can repay with all their financial capital and the borrowed money as collateral. This amount results from the following equation:

$$Br = (B + F_y)\underline{r} \Longrightarrow B(r - \underline{r}) = F_y\underline{r} \Longrightarrow B = \frac{F_y\underline{r}}{r-\underline{r}}$$

This is the maximum total amount that can be borrowed without human capital as collateral. The expression for B shows that the larger the financial capital of the workers the more they can borrow, while a higher risk free rate or lower $\underline{r}$ decreases the maximum that can be borrowed.[2]

2 The comparative statics are:

$$\frac{dB}{dr} = -\frac{F_y\underline{r}}{(r-\underline{r})^2} < 0$$
$$\frac{dB}{d\underline{r}} = \frac{F_y r}{(r-\underline{r})^2} > 0$$

When the young borrow B, their restricted equity fraction, denoted α_r , becomes:

$$\alpha_r = \frac{B+F_y}{F_y} = 1 + \frac{\underline{r}}{r-\underline{r}} = \frac{r}{r-\underline{r}}$$

This is equal to the earlier found expression for which young start to borrow against human capital. When $\alpha_r < \alpha_y^*$, the workers can only invest α_r instead of α_y^* When $\alpha_r \geqq \alpha_y^*$ the optimal stock exposure can still be implemented and the workers choose the optimal exposure, α_y^*. When leverage is limited the final stock exposure thus equals $\min(\alpha_r, \alpha_y^*)$. Again a feasibility condition is that the old are able to lend:

$$n(\alpha_r - 1)F_y \leqq (1 - \alpha_o^*)F_o$$

When $\alpha_r < \alpha_y^*$, which is the more interesting case from this papers´ perspective, the overall stock exposure of the pension funds equals:

$$\frac{\alpha_r F_y + \alpha_o^* F_o}{nF_y + F_o} = \alpha_o^* + \frac{n(\alpha_r F_y - \alpha_o^* F_y)}{nF_y + F_o}.$$

This again implies that the overall risk is decreased when there are relatively more retirees.

2.4.3. Numerical example

This section provides a numerical example illustrating the model. The parameter values are given in the table below. The values are not calibrated and are used for illustrative purposes only. The first graph depicts the optimal equity allocation for both groups as a function of the constant relative risk aversion. To construct this graph a more general version of the model, including a CRRA-utility function, is considered3.If the constant relative risk aversion equals 1 the utility function reduces to logarithmic utility. Using the earlier derived expressions in this case, $\alpha_y^* = 5$, $\alpha_0^* = 0.5$, and $\alpha_r = 2$. As $(\alpha_y^* - 1)F_y = 40$ is smaller than $(1 - \alpha_o^*)F_o = 50$ all borrowing transactions are feasible in this example.

The graph shows that the conflict diminishes when risk aversion increases; if the young do not want to borrow, there is no conflict anymore. Both groups can implement their optimal equity exposure.

3 With $u(c) = \frac{c^{1-\gamma}}{1-\gamma}$ it can be shown that:

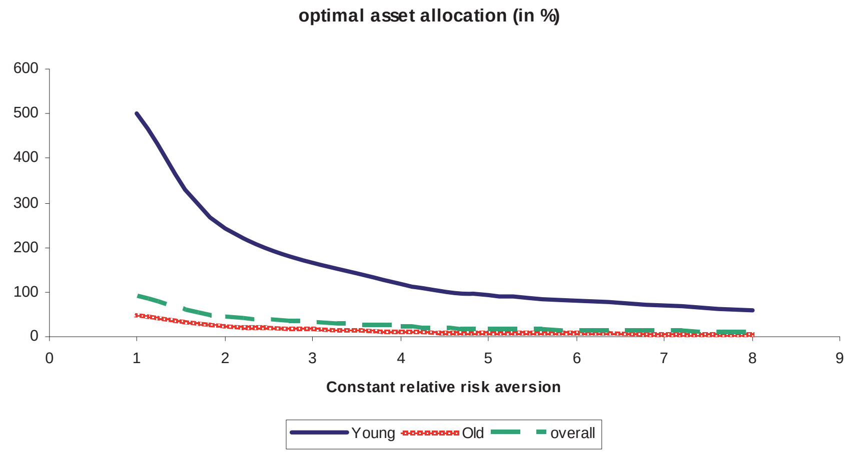
$$\alpha_y^* = \frac{(H + F_y r^f)[Q_2 - Q_1]}{F_y[Q_2(r^f - r^L) + Q_1(r^H - r^f)]}$$

where $Q_1 = p^{-\frac{1}{\gamma}}(r^H - r^f)^{-\frac{1}{\gamma}}$ and $Q_2 = (1-p)^{-\frac{1}{\gamma}}(r^f - r^L)^{-\frac{1}{\gamma}}$

This expression reduces to the logarithmic case if $\gamma = 1$

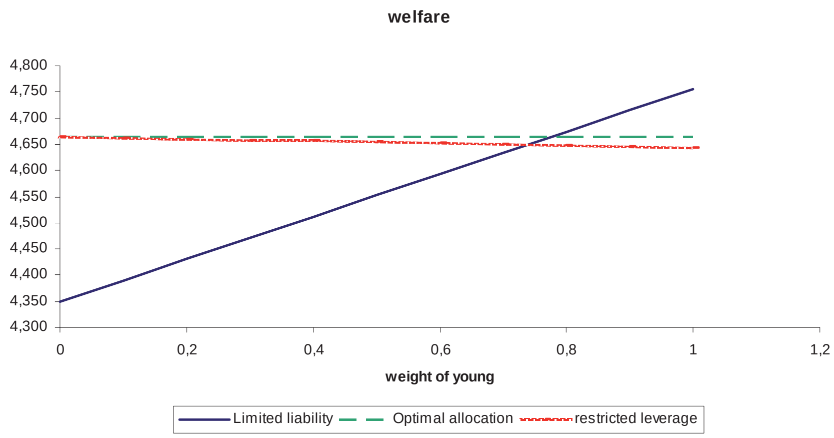
parameters	value
p	0:5
r	1
r	0:5
r	2
n	1
H	90
Fy	10
Fo	100

Graph 1



The second graph shows the weighted sum of utility of the working and retired participants in three different cases. The first case is the equity fraction that would result when human capital can serve as collateral, as described in section 2.2. The second case corresponds to restricted borrowing, as described in section 2.4.2. The third case results when the equity exposure of section 2.2. is chosen ex ante but contributions are not used to repay the old ex post; the young thus have a form of limited liability, as described in section 2.3.

Graph 2

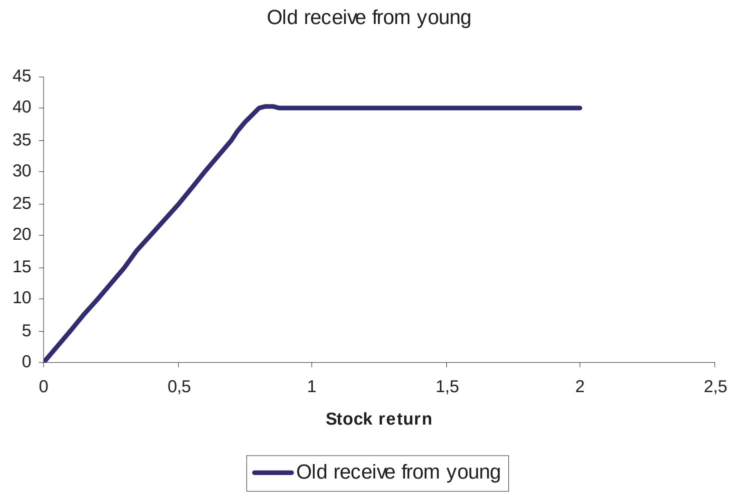


For di¤erent values of $\lambda \in [0, 1]$ the expression $\lambda u_y + (1-\lambda)u_o$ is given where u_y and u_o denote the utility of working and retired generation respectively in each scenario. Values of $\lambda = 0$ and $\lambda = 1$ indicate that only utility of the young and the old respectively are considered. High leverage with limited liability is optimal for the young, but not for the old. The case with (credible) lending against human capital Pareto dominates the case when only financial assets can be used as collateral.

The third graph shows pay-outs for the retired as a function of the actual stock return when workers have limited liability. As the stock is Bernouilli distributed only two values can in fact be realized and one outcome is realized. The optimal stock allocation is a function of these values which are 2 and 0.5 in the example.

The graph depicts the pay-outs for the resulting optimal stock allocation when the stock return takes on other values than 0.5 and 2. This disregards that in that case the optimal stock allocation itself would change.

Graph 3



3. Model with aggregate risk and optimal risk sharing

Thus far there was no macro-risk and the capital market was exogenous. In particular, the risk free asset was in limitless supply and with a constant price. This case is relevant for a small pension fund or a nation-wide pension fund in a small open economy. For large pension funds or closed economies the assumption of a risk free asset is counterfactual. There exists considerable macro-risk and it has to be borne by some party. If one group owns "safe" assets, this means that some other party bears the risks. For a small pension fund this is not an important consideration. It can buy bonds without influencing its prices and with neglectable effects for tax-payers, who coincide with the participants.

For a large pension fund this is not the case. Safeguarding one group -the retirees- means increasing risks for another group, the workers. Generally the resulting absence of risk sharing will not be optimal. This inefficiency becomes more problematic when the risk bearing group decreases in size relative to the first group and aging has exactly this effect. The following model considers the optimal risk sharing between older and younger participants in the presence of (unavoidable) aggregate risks. The pension fund as a whole faces macro-risk that it cannot avoid; the risks can only be allocated within the fund.

The result is again that borrowing against human capital can be optimal. This may therefore lead to the same type of problems as before. An important difference is that it is not optimal to shelter retirees from all risks. When the economy tumbles it is optimal ex ante that they also shoulder part of the losses.

3.1. The model

The young again receive a .xed risk free wage per worker, denoted H. The .xed capital stock is denoted K and it is owned by the young and the old. The young have a claim equal to $K_y = (1-\gamma)K$ and the old have a claim equal to $K_o = \gamma K$. There are N_y workers and N_o retirees. The relative size of the younger cohort is again defined as $n \equiv \frac{N_y}{N_o}$. An individual worker thus receives $F_y \equiv \frac{(1-\gamma)K}{N_y}$ while an individual retiree receives $F_o \equiv \frac{\gamma K}{N_o}$. Total capital stock is Bernouilli distributed:

$$K = \overline{K} \text{ w.p. } p$$

$$K = \underline{K} \text{ w.p. } 1-p$$

The following relation holds: $\overline{K} > \underline{K} \geqq 0$.

Now define $\overline{F}_y \equiv \frac{(1-\gamma)\overline{K}}{N_y}$ and $\underline{F}_y \equiv \frac{(1-\gamma)\underline{K}}{N_y}$. Further define $\overline{F}_o \equiv \frac{\gamma\overline{K}}{N_o}$ and $\underline{F}_o \equiv \frac{\gamma\underline{K}}{N_o}$.

As the young hold a risk free quasi-asset with their human capital, they prefer to take on more risk than the elderly, exactly as in the previous section. Both generations can thereby gain from risk sharing. Optimally, the young profit disproportionally when the economy booms while the retirees are hurt relatively less when the economy tanks. The young and retirees can swap risks by trading between them the following asset, denoted Z. This asset pays out $\widehat{r}$ in case $K = \overline{K}$ and pays out -1 in case $K = \underline{K}$. Demand by young and old for this asset depends on $\widehat{r}$, which follows from market clearing.

Demand by the young in turn results endogenously from maximizing utility:

$$\max_Z \qquad p\ln[H + \overline{F}_y + \widehat{r}Z] + (1-p)\ln[H + \underline{F}_y - Z]$$

The first order condition is:

$$\frac{p\widehat{r}}{H+\overline{F}_y+\widehat{r}Z} = \frac{1-p}{H+\underline{F}_y-Z}$$

The optimal value of Z is:

$$Z_y^* = \frac{[H+\underline{F}_y]p\widehat{r}-(1-p)[H+\overline{F}_y]}{\widehat{r}}$$

Demand of the old likewise follows from optimising their utility:

$$\max_Z \qquad p\ln[\overline{F}_o + \widehat{r}Z] + (1-p)\ln[\underline{F}_o - Z]$$

For the elderly the optimal amount of Z is:

$$Z_o^* = \frac{\underline{F}_o p\widehat{r}-(1-p)\overline{F}_o}{\widehat{r}}$$

The market only clears when one group -the workers- is in demand for the asset Z, while the other group -retirees- is willing to supply the asset. The market for the asset Z clears if the price, implied by $\widehat{r}$, is such that demand by the young equals supply by the old. This market clearing return in the up-state, $\widehat{r}$, then follows from the condition $nZ_y^* = -Z_o^*$.

The market-clearing return resulting from this condition is:

$$\widehat{r}^* = \frac{(1-p)[n(\overline{F}_y+H)+\overline{F}_o]}{p[n(\underline{F}_y+H)+\underline{F}_o]}$$

If the young buy the asset, they pay Z per person to the old in case $K = \underline{K}$, whereas the elderly pay $\widehat{r}^*Z$ when the economy booms. Ex ante these transactions are strictly welfare improving vis-à-vis the situation without transactions. When $H = 0$, no transactions take place because both groups have exactly the same risk preferences. There is thus no $\widehat{r}^*$ for which there is simultaneously positive supply and positive demand; either both groups have positive or both have negative demand for the asset.[4]

4 When $H = 0$, $\widehat{r}^* = \frac{(1-p)[n\overline{F}_y+\overline{F}_o]}{p[n\underline{F}_y+\underline{F}_o]} = \frac{(1-p)\overline{K}}{p\underline{K}}$

For this value of $\widehat{r}^*$ demand and supply equals zero, that is: $Z_y^* = Z_o^* = 0$.

The transactions can however lead to the same problems as before if the young cannot pay Z out of their financial capital when called for. This is the case when $Z > F_y$. As an example, if $\gamma = 0 \implies F_y = 0$ and the condition would follow for any positive amount of Z. In this case, there is again a hold-up problem and the same two solutions -limiting risk or a change in the governance structure- can be considered.

The inclusion of aggregate risk indicates that from a macro-perspective buying a "safe" asset implies that another group faces more risks. This is generally not optimal and the corollary is that it is (ex ante) optimal that retirees share in the losses. This is in particular relevant for large pension funds which influence capital markets and aggregate risk allocation with their financial transaction. The model assumes that participants are fully aware and consent with the risks they bear. This awareness is not always present with retirees nor is this awareness promoted by all pension funds.

4. Conclusion

This paper focuses on the conflict between young and retired generations that results from a risky investment policy. This conflict can be witnessed in many pension funds nowadays. The central observation here is that risk-seeking pension funds may put claims of retirees at risk. This can be optimal when workers are borrowing contrained. However, then contributions need be raised when the risks turn bad. Workers however have an incentive to "default" ex post on their implicit obligation that results from ex ante optimal borrowing. The young then essentially face a hold-up problem. Optimal pension fund governance considers the risk level and contributions jointly.

This may be interpreted as a special application of Teulings and de Vries [2006] who argue that pension funds should exhibit cohort-specific investment. This study adds to their argument that borrowing between cohorts should be possible only when there is a securitized claim in the form of a credible contribution policy. Otherwise a risk immunization policy where risks are limited to secure assets of retirees is second-best.

The results apply irrespective of the presence of aggregate risks at the pension fund level. However, factoring in unavoidable macro-risks does change results in an important respect. It is then optimal that retirees face risk ex ante and thus may have to take losses ex post. Optimal risk sharing entails that the working generations bear more but not all risks. When the economy tanks, losses are optimally shared by simultaneously increasing contributions and lowering pensions. In a meaningful discussion contribution policy, risk level and liabilities are considered jointly.

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