



ECONOMICS AND FINANCE OF PENSIONS

Lecture 10

CORPORATE FINANCE AND DB PENSIONS

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This lecture

- In this lecture we are going to examine occupational pension funds in a corporate finance perspective
 - Occupational pension funds are pension funds which are created by an employer as part of a job contract
 - We will show how pension funds fit into the balance sheet of companies, and use options theory and corporate finance theory to tease out implications for pension funds
 - We will also very briefly examine empirical evidence on some of these theories in the context of pensions but mostly will leave that for later in the course



A stylised view of an employer

- We can represent an employer using a balance sheet
 - Firm has assets, A, liabilities, L and owners equity, E
 - The accounting identity states that $L + E = A$
 - Anything which changes the left hand side of the identity must therefore change the right hand side, which is the basis of double entry accounting

Assets		Liabilities	
Firm assets	A	Firm liabilities	L
		Owner's equity	E



A stylised view of a pension plan

- The employer creates a pension plan, which promises certain benefits, B , and it funds the pension plan with assets I
- The pension fund has its own balance sheet, and may have a surplus or deficit, which is defined as $S = I - B$, so then $I = S + B$ (which has obvious similarities with the accounting equation)

Assets		Liabilities	
Pension assets	I	Pension liabilities	B
		Surplus / deficit	S



Two views of pensions

- One view puts the pension fund balance sheet separately from the employer's balance sheet; another view places the pension fund squarely on the balance sheet of the employer
- The importance of this depends on how the pension liabilities themselves depend on the value of the firm's assets and the pension assets
- For instance, if $B = I$ by definition, then it makes no difference whether you look at the balance sheets together or separately
 - What type of pension is this?



Pension augmented balance sheet

- The pension augmented balance sheet of the firm includes both the pension fund and the firm's assets on the balance sheet, on the grounds that the firm is usually responsible for meeting the liabilities that cannot be met by the assets in the pension fund
 - Hence, the owner's interest will change by S

Assets		Liabilities	
Firm assets	A	Firm liabilities	L
Pension fund assets	I	Pension fund liabilities	B
		Owners equity	E+S



Different pension schemes

- Previous slide begs the question – does the owner's interest actually change by S if the pension is underfunded or significantly overfunded?
 - What do you think?
 - How can we find out?
- We can include all pension schemes in this framework by writing out the benefits as a function of the assets in the pension scheme and the firm.



Defined contribution pension schemes

- In a defined contribution pension scheme, firms and individuals contribute to a fund, and the liabilities of the fund are always and everywhere equal to the assets
- Individuals get what they contribute to the fund, plus accumulated asset returns
- Hence, $B = I$ always and everywhere and the owner's interest in the augmented balance sheet is exactly the same as the owner's interest in the unaugmented balance sheet



Defined benefit pension schemes

- Here, the employer promises pensions equal to an amount B , and makes contributions to the pension fund which meet some (or all) of the liability
 - However, the liability remains regardless of the amount of assets in the fund
- Hence, B can be greater (or less than) I and the pension fund affects the augmented balance sheet of the company
- If the fund is in surplus, in other words if $B < I$, then the assets revert to the employer



Complications

- However, there are some complications:
 - Surplus may be trapped in the fund, and be used to improve benefits rather than revert to the employer (also called irrecoverable surplus)
 - The employer may not have sufficient funds to meet the liabilities to pensioners, and may default
 - There is sometimes a pension insurer which pays some or all of the pension liabilities if the employer defaults
 - Assets usually build up in the fund free of tax, or at a reduced rate of tax, implying that by funding the pension, the employer can reduce its tax bill



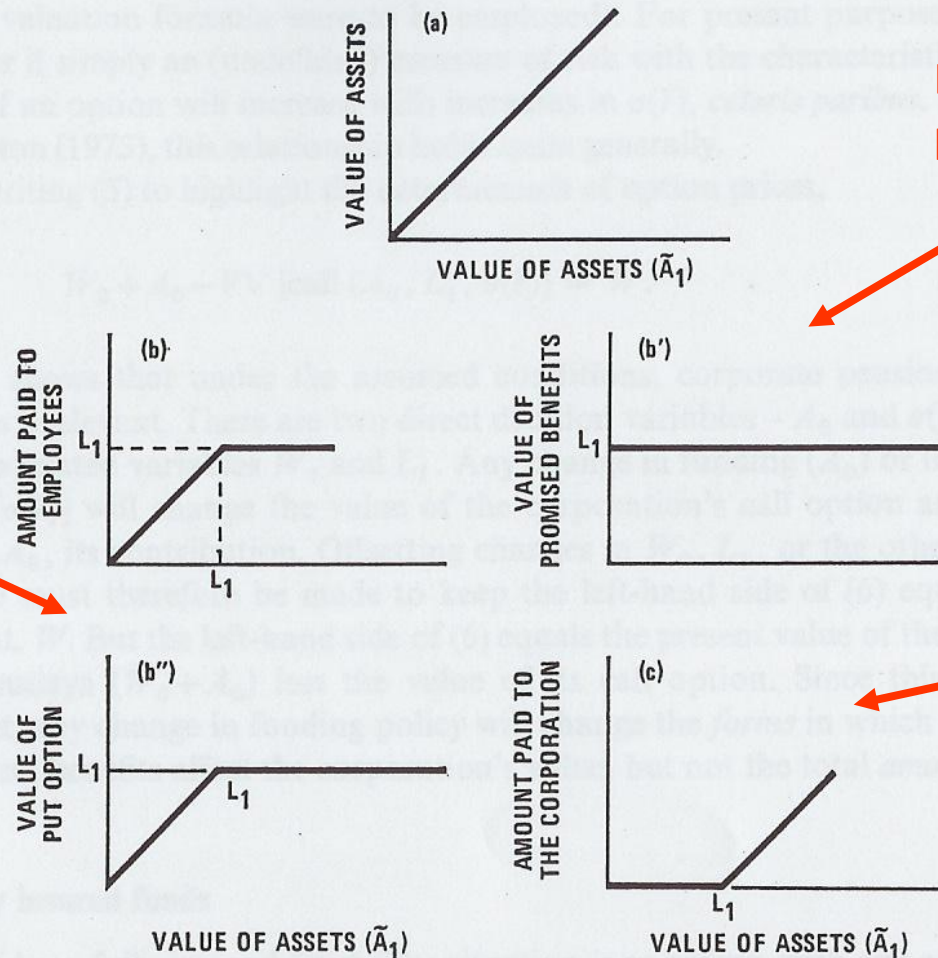
Sharpe (1976)

- We were introduced to this paper in the pensions economics class
- No distinction is made between firm assets and pension assets; we will loosen this assumption later
- He examined the case of a corporation which had promised a pension to employees of amount L_1 to be paid at the end of the year.
- Employer funds the pension with assets, market value A_{MV} .
- If at the end of the year, MV of assets $< L_1$, employer defaults, employees get assets
- Assume that all participants have equal access to capital markets, equal information, rational

Options analysis of pension funding

If firm defaults, employees lose out: a put option

Level of promised pensions



Firm has a call option on the assets

Fig. 1. Values of claims versus the value of fund assets.

Source: Sharpe (1976)

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Options analysis of pension fund

- Employee's portion of value is made up of the promised pension benefits less the put option

$$EE_{\text{total}} = PV[L_1] - PV[\text{Put}]$$

- The shareholder's portion of value is just the call option:

$$ER_{\text{total}} = PV[\text{Call}]$$

- The total corporation's value is

$$C_{\text{total}} = EE_{\text{total}} + ER_{\text{total}} = PV[\text{Call}] - PV[\text{Put}] + PV[L_1] = A_{\text{MV}}$$

- Rearranging gives:

$$PV[\text{Put}] - PV[\text{Call}] = A_{\text{MV}} - PV[L_1]$$



Rational employees

- Imagine that employees receive a cash wage, W_0
- Then their total compensation is given by W , say, and must equal

$$W = PV[L_1] + W_0 - PV[\text{Put}]$$

- Remember that:

$$PV[\text{Call}] - PV[\text{Put}] + PV[L_1] = A_{MV}$$

So:

$$PV[\text{Call}] - \underbrace{PV[\text{Put}] + PV[L_1] + W_0}_{\text{Employee's interest = } W} = \underbrace{A_{MV} + W_0}_{\text{Total amount of cash at firm's disposal before employees are paid}}$$

Shareholder's interest

Employee's interest = W

Total amount of cash at
firm's disposal before
employees are paid



Sharpe's pension invariance result

- The implication is that corporate pension funding and investment policy does not affect firm value in any way
- This is not true if:
 - There is a tax exemption for investments in the pension plan (which there is)
 - If there is a pension insurer (which there is)
 - Or if employees are not rational (which they probably are not)
 - There are no transactions costs (which there are)
 - Are these assumptions (at least 1, 3 and 4) familiar to you in another context (corporate finance?)



Sharpe's result and MM

- Sharpe's result is effectively a restatement of the Miller-Modigliani theorem and the fact that unfunded pension liabilities are (in his model) equivalent to bonds on the balance sheet of the firm
 - Whether the firm funds itself by issuing debt to its employees or to a third party makes no difference to its value, provided that employees value debt at the same value as outsiders (which they will do if both them and outsiders are rational)
 - Whether the firm finances itself using debt or equity makes no difference to its value



Sharpe's model and pension insurance

- We can introduce a pension insurer, which promises to pay pensions if the employer defaults
- In the framework of Sharpe, we can see that unless the pension insurer charges the value of the insurance to the employer (which is the value of the pension put option), then the employer and employees will be able to extract value from the pension insurer by maximising the difference between the value of the insurance and the value of the premium



Pensions and firm finance

- The pension fund, in Sharpe's model, is really a source of finance for the company
 - In other words, the decision about how much to fund the pension fund is exactly equivalent to a decision about determining the capital structure of the company
 - Do you think it is cheap or expensive to borrow from employees rather than to borrow from markets?
 - Why?



Loosening the assumptions: taxation

- In practice, the pension fund can invest assets free of tax, while the corporation must pay taxes on earnings
- Therefore, the company has an incentive to fully fund the pension plan to maximise the value of the tax shield
- The Inland Revenue becomes a party to the pensions contract, and the more funded the pension plan is, the greater the value of the transfer
- The next few slides are based on the work of Black (1980) and Tepper (1981), work by Exley, Mehta and Smith (1997) is based on their papers

Tax advantage of funding pensions

- The tax advantage arises because the firm is able to borrow at the post-tax rate, but invest at the pre-tax rate in the pension plan
- In this example, we assume that the firm invests in bonds in the pension fund; we will examine the corporate finance consequences of equity investment in the pension plan later

PAYG scheme

RECURRING

Pay pensions

-P

Tax benefit on pensions

+ τ P

TOTAL RECURRING

-(1- τ)P

Funded scheme

ONE-OFF

Borrow P/r

+P/r

Place P/r in pension plan

-P/r

Tax benefit on transfer

+ τ P/r

TOTAL ONE-OFF

+ τ P/r

RECURRING

Interest payment on debt

-rP/r = P

Tax relief on interest payment on debt

+ τ P

TOTAL RECURRING

+(1- τ)P



Funding the pension: bonds vs equities

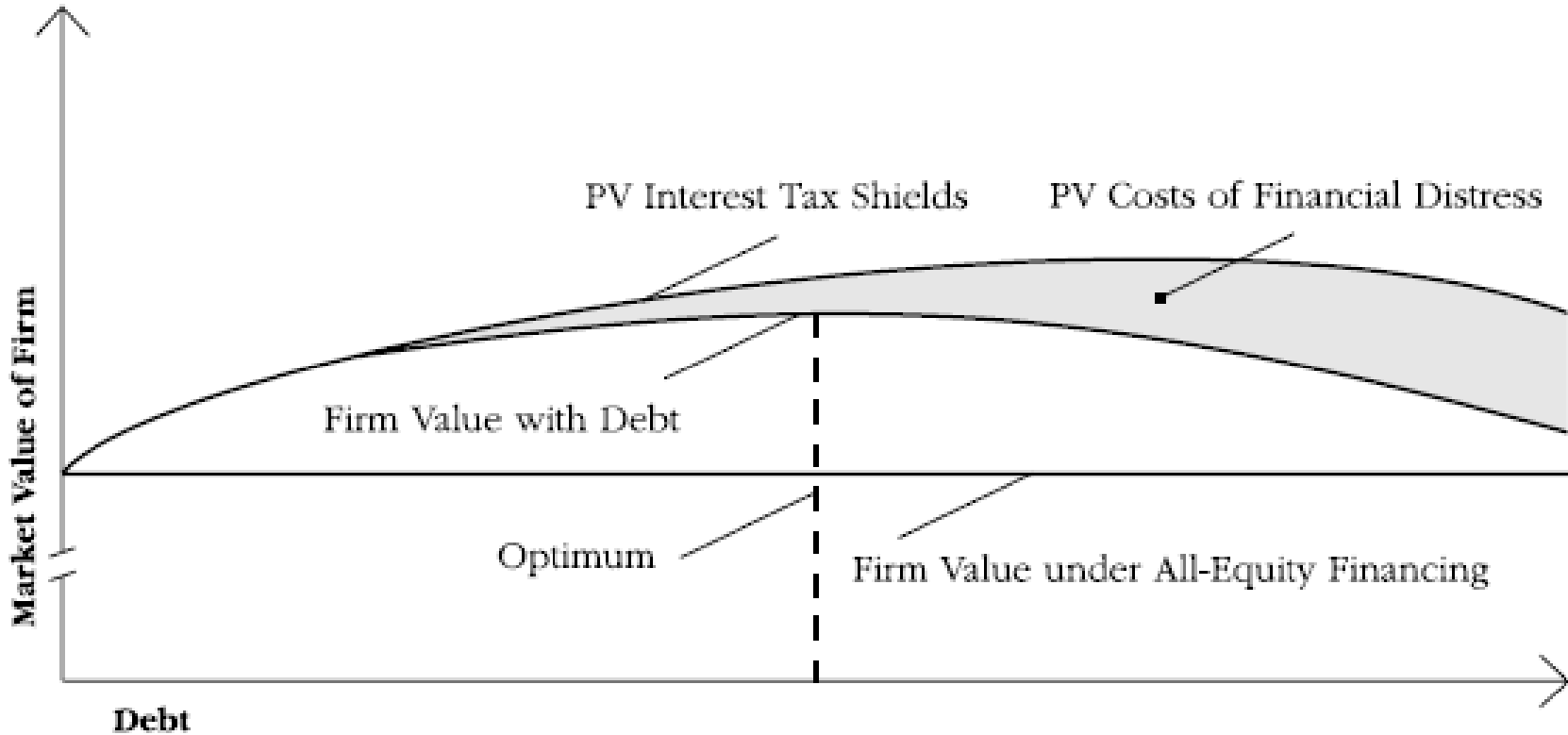
- In our example, the company issues debt to fund the pension plan
 - Of course, it could also issue equities
 - But dividend payments are not tax deductible (they are profits, not expenses that can be used to generate profits), so the firm gets no tax advantage to funding the pension plan with equity instead of debt
 - Also, there are personal taxes, and interest income is taxed in the hands of the recipient, while dividends attract a lower rate of tax
 - Thus, the important variable is actually the difference between the corporate and personal rates of tax



Review of corporate finance

- The optimal funding level of the pension is therefore partly a question about optimal capital structure
- There are competing models looking at optimal capital structure
- Miller-Modigliani (1958) said that, in the absence of taxes, transactions costs and other imperfections, there was no optimal capital structure
 - MM: A firm's value is independent of how it is financed
- A practical way of viewing Miller-Modigliani is that if there *is* an optimal capital structure, then it must be the result of some identifiable imperfection, e.g. taxes

Static trade-off theory



- Optimal leverage structure is a trade-off between the costs of financial distress and the value of the interest tax shield



Static trade-off theory

- This doesn't really apply to pension funds for two reasons
 - If a company underfunds a pension plan and uses the money to finance its operations, there is no (first order) tax benefit because it is just trading off tax benefits now versus tax benefits in the future
 - Pension funds never force companies into default, so they don't add to corporate default costs, either
- So we can't use the static trade-off theory to try and understand the incentives companies face in determining an optimal funding ratio for their pensions



Static trade-off theory

- Event studies find that virtually all leverage-increasing transactions increase firm value
- Within an industry, there is a strong negative correlation between leverage and profitability: the most profitable firms in an industry borrow the least
 - This is exactly the opposite prediction to the static trade-off theory



Pecking order theory

- Myers and Majluf (1984) developed a “pecking-order” theory of corporate finance
- They suggest that information asymmetries between managers and capital markets result in high transactions costs associated with firms raising external finance, as well as a sticky dividend policy (so profitable firms retain finance internally)
- This means that there is a pecking order of desirable sources of finance. Firms start at the top of the pecking order and then move their way down as each tier is exhausted
 - Safe securities first (e.g. debt)
 - Risky securities follow (e.g. convertible debt, equities)
 - Where do you think pension funds fit in the preference ordering?

Investing the pension: bonds or equities

- Let's look again at the augmented balance sheet of the corporation

Assets		Liabilities	
Firm assets	A	Firm liabilities	L
Pension fund assets	I	Pension fund liabilities	B
		Owners equity	E+S

Investing in bond-like assets in the pension fund means that the firm takes advantage of the tax benefit of the pension plan but does not expose itself to additional leverage

Bond-like liabilities on a firm's balance sheet



Investing the pension: bonds or equities

- In fact, we can view equity investment in the pension plan as bond investment plus a bond-equity swap where the pension fund / firm borrows money using the appropriate bonds and uses the proceeds to invest in equity, as shown in the next slide
- The implication is that equity investment in a firm's pension plan is exactly the same as extra leverage for the firm, where the leverage is used to invest in a broad equity index rather than in the firm's own productive projects
- Does not attract the same tax benefits as regular firm leverage, because it is achieved inside the pension plan



Book reserving

- In some countries (most notably, Germany), companies hold pension assets and liabilities directly on their balance sheets
- This is called “book reserving”
- For this system to be effective, it needs to be introduced with a pension insurer to protect employees from too much employer default risk
 - and this pension insurance needs to be correctly priced!!

Pension equity investment = extra leverage

Assets		Liabilities	
Firm assets	A	Firm liabilities	L
Pension fund assets (equities)	E	Pension fund liabilities	B
		Owners equity	E+S

.... is the same as.....

Assets		Liabilities	
Firm assets	A	Firm liabilities	L
Pension fund assets (bonds)	I	Pension fund liabilities	B
Bond-equity swap	E-I	Owners equity	E+S

.... which is the same as.....

Assets		Liabilities	
Firm assets	A	Firm liabilities	L+I
Equities	E	Pension fund liabilities	B
Pension fund assets	I	Owners equity	E+S



One other point....

- There is another point about investment in equities inside the pension plan and that is related to taxation
 - Bonds are more heavily taxed than equities in the hands of individuals
 - Therefore, it makes sense for pension funds to hold bonds (because all other holders of bonds will be taxed, driving down the price) and for individuals to hold equities privately
 - This is an example of look-through valuation & clientele effects



Black (1980) & Tepper (1981)

- For these two reasons, both Black and Tepper argue that pension funds maximise corporate value when they are fully funded and invested in bonds
- Black tempered his conclusions later when it came to acknowledging that some pensions – those of active members – are linked to wage increases, although this was before the introduction of indexed-linked bonds in the US



In aggregate.....

- if ALL pension funds were to invest in corporate bonds, firms would have to issue more debt and use the proceeds to buy back equity, so the average leverage in the economy would have to increase substantially
 - This would mean that, on average, corporate debt would become riskier, but pensions would still be, on average, safer than they would be if all were invested in equities because, overall, the order of priority has changed (but the assets backing the pensions have not)



Final complications

- There are two more complications to consider
 - The effect of pension insurance, which means that a third party covers the liabilities to employees if the company defaults (and raises the possibility that employees and the employer may collude to extract the most value out of the insurance)
 - The fact that surplus which arises in the pension fund may be used to improve benefits rather than be recovered by the employer, which reduces the advantages of fully funding the pension plan
- These complications can be managed using an options-based approach



Three views of a pension fund

- A stand-alone fund with its assets and liabilities
 - Nice because then we can use ALMs / Markowitz etc, BUT
 - Ignores sponsor covenant
- Part of the balance sheet of the employer
 - Nice because pension is then collateralised debt,
BUT
 - Ignores distribution of surplus and pension insurance issues
- A portfolio of options on the assets of the employer and a fund of assets



An options approach

- To value pensions as collateralised debt we need options theory
 - Present the payoffs to different parties to the transaction as a function of the surplus of the fund and the financial status of the employer
 - Let's treat the pension fund as though it is a one-period model (easily generalised)
- If the pension fund is in surplus, then the surplus is shared between members (in the form of benefit improvements) and the employer (in the form of a reversion)
- If the pension fund is in deficit, if the employer is able to, the employer makes up the difference
- If the employer defaults, then some of the deficits is made up by the pension insurer and some benefits go unpaid



Underlying assets

- If we assume that the pension liabilities and the firm's debt are fixed, this is an options valuation problem with two underlying assets: the assets of the company on its own balance sheet and the assets in the pension plan
- We can write the payoffs to each party to the pension transaction in terms of each of these two values
 - We need to consider the employees, the shareholders, the bondholders and the pension insurer
 - Here, we ignore the tax authority but could include this too, in principle
 - We will also treat the pension fund as a one-period problem, in practice it is a many-period problem



Notation

- Let's write all these payoffs as a function of the value of assets at time 1, using the following notation:

- Firm's assets at time $t = A_t^F$
- Firm's liabilities at time $t = L_t^F$
- Pension fund assets at time $t = A_t^P$
- Pension fund liabilities at time $t = L_t^P$

Pension fund members

- If the pension plan is over-funded, they get their promised benefits plus a portion, α , of the surplus
- If the pension plan is under-funded, their benefit is topped up first by the corporation, and then by the pension insurer, which we assume covers a proportion β of their benefit

$$\begin{aligned}
 & \max[\min(A_1^P, L_1^P) \\
 & \quad + \max(\alpha(A_1^P - L_1^P), 0) \\
 & \quad + \min(\max(L_1^P - A_1^P, 0), \max(A_1^F - L_1^F, 0)), \\
 & \quad \beta L_1^P]
 \end{aligned}$$

Get all pension assets up to level of liabilities (red arrow pointing to $\min(A_1^P, L_1^P)$)
 Get a proportion of the pension surplus, if any (green arrow pointing to $\max(\alpha(A_1^P - L_1^P), 0)$)
 The employer pays up to the level of the liabilities, if it can (blue arrow pointing to $\min(\max(L_1^P - A_1^P, 0), \max(A_1^F - L_1^F, 0))$)
 Finally, the pension insurer covers any shortfall (purple arrow pointing to βL_1^P)



Shareholders

- The shareholders receive a portion $(1-\alpha)$ of the pension fund surplus, if any
- They must make up all the deficit that they are able to from the firm's assets, but get the remainder
- They get the residual claim of the firm's assets

Get the residual claim on the assets of the firm after paying off the bond-holders

Get a proportion of the pension surplus, if there is any

$$\max(A_1^F + \max((1-\alpha)(A_1^P - L_1^P), 0) - L_1^F, 0) - \min(\max(L_1^P - A_1^P, 0), \max(A_1^F - L_1^F, 0))$$

Pay as much of the pension deficit as they are able



Bondholders

- We assume that bondholders get the first portion of the firm's assets, but have no recourse to the pension fund assets, unless the fund is in surplus and the employer doesn't have enough money from other sources to meet their claim

$$\min(A_1^F + \max((1 - \alpha)(A_1^P - L_1^P), 0), L_1^F)$$

Firm's assets

Pension fund surplus

Claims limited to the face value of the debt



Pension insurer

- Must pay any portion of the pension liability that the assets of the fund don't cover and that the employer is unable to make

Portion of liabilities made up from assets and transfer from employers

$$\min[0, \min(A_1^P, L_1^P) + \min(\max(L_1^P - A_1^P, 0), \max(A_1^F - L_1^F, 0)) - \beta L_1^P]$$

Pension liabilities promised by insurer



Total payoffs

- If we add up the payoffs to bondholders and shareholders, we get:

$$A_1^F + \max((1 - \alpha)(A_1^P - L_1^P), 0) \\ - \min(\max(L_1^P - A_1^P, 0), \max(A_1^F - L_1^F, 0))$$

- If we add what pension fund members receive, before transfers from the pension insurance agency we get:

$$\min(A_1^P, L_1^P) \\ + \max(\alpha(A_1^P - L_1^P), 0) \\ + \min(\max(L_1^P - A_1^P, 0), \max(A_1^F - L_1^F, 0))$$



Total payoffs

- If we add the shareholders, plus the bondholders, plus the members, before the pension insurance transfer, we get:

$$\begin{aligned} & A_1^F + \max((1 - \alpha)(A_1^P - L_1^P), 0) \\ & \quad - \min(\max(L_1^P - A_1^P, 0), \max(A_1^F - L_1^F, 0)) \\ & + \min(A_1^P, L_1^P) \\ & \quad + \max(\alpha(A_1^P - L_1^P), 0) \\ & \quad + \min(\max(L_1^P - A_1^P, 0), \max(A_1^F - L_1^F, 0)) \\ & = A_1^F + A_1^P \end{aligned}$$



Now we need to *value* these transfers

- So what is the value at time 0 of the following cash flow at time 1:

$$\begin{aligned} & P_0 \{ \min(A_1^P, L_1^P) \} \\ &= P_0 \{ \min(A_1^P - L_1^P, 0) + L_1^P \} \\ &= P_0 \{ \min(A_1^P - L_1^P, 0) \} + P_0 \{ L_1^P \} \end{aligned}$$

- We can, using a standard finance approach, say that the value at time 0, of a set of cash flows at time 1 is the value of a portfolio of assets at time 0 which, possibly after following a dynamic trading strategy, is sufficient to meet the cash flows at time 1 (OPTIONS PRICING)



Valuing these cash flows

- So now we can write out the value of our transfers as the value of a set of options, where the value is slightly complicated because it is a set of options with two underlyings – the firm assets and the assets held by the pension fund
- Let's not go any further than remembering our fundamental pricing formula as, and note that we need to take the expectation over the two random variables driving the cash flows in this case:

$$P_0\{X\} = E_0^Q[B_1^{-1}X]$$



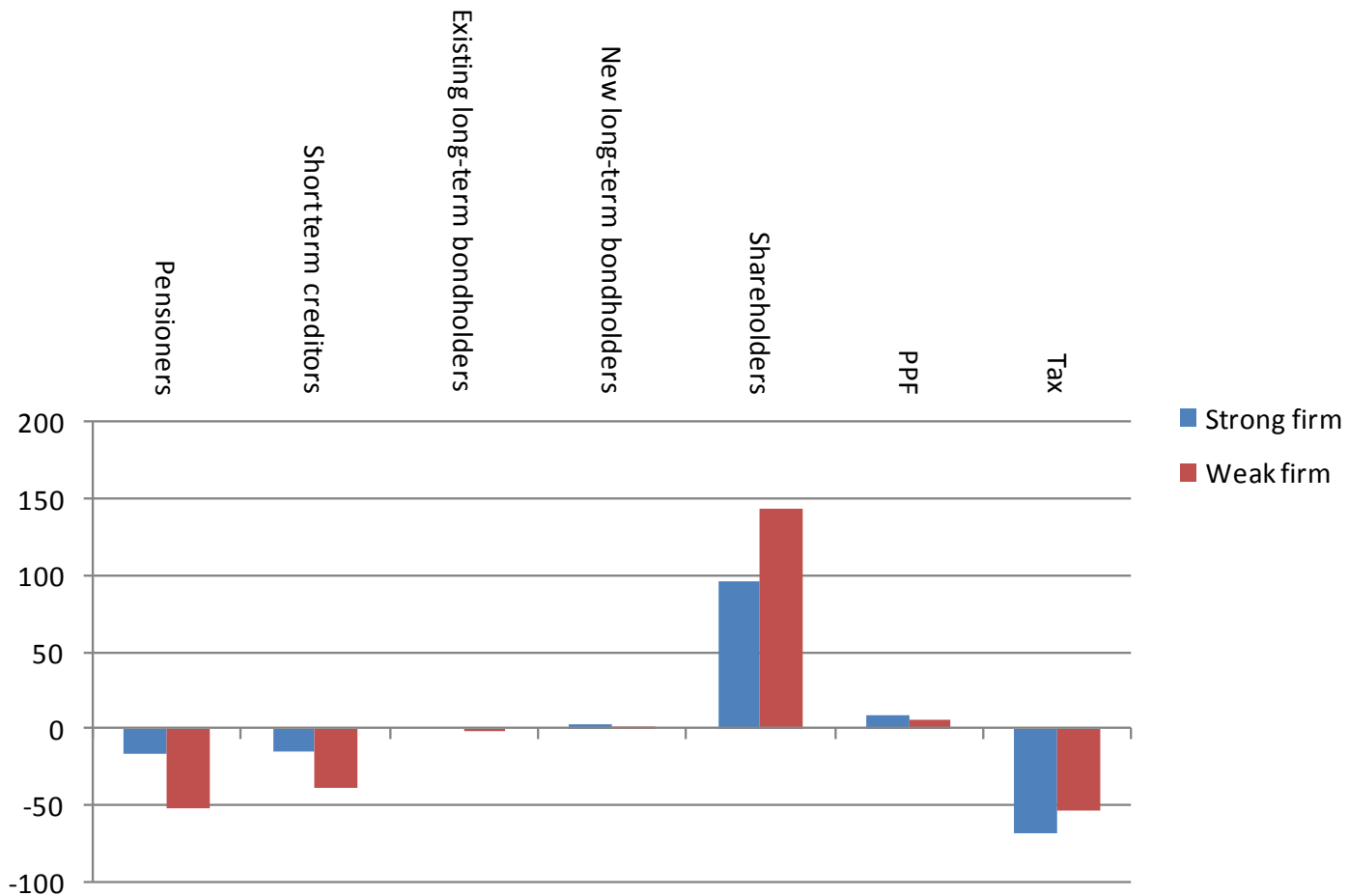
Using these values....

- We can chart the transfers of value that occur between parties to pensions as a result of decisions made by different parties
 - E.g. decision to fund the pension or not
 - E.g. how the pension is invested (risky or not)
 - E.g. how leveraged the company is (or not)

More complex (dynamic) models permit the following division

		STRONG SPONSOR		WEAK SPONSOR	
		HIGH	LOW	HIGH	LOW
Firm assets	Pension assets	1,909	954	1,909	954
	Firm assets	10,000	10,960	5,000	5,960
	TOTAL	11,909	11,914	6,909	6,914
Firm liabilities	Pensioners	2,373	2,356	2,334	2,282
	Short term creditors	1,563	1,548	1,487	1,448
	Existing long-term bondholders	690	690	689	688
	New long-term bondholders	64	66	4	5
	Shareholders	6,835	6,931	2,077	2,220
	PPF	18	26	14	20
	Tax	366	298	304	251
	TOTAL	11,909	11,914	6,909	6,914
Change in interest caused by change in pension funding	Pensioners		-17		-52
	Short term creditors		-15		-39
	Existing long-term bondholders		0		-1
	New long-term bondholders		2		1
	Shareholders		96		143
	PPF		8		6
	Tax		-68		-53

Changes in value associated with decrease in pension funding





Empirical relationships

- The theoretical relationships we examined in this lecture can be tested by looking at empirical data
- In particular, what is the effect on a corporation's share price and bond price (credit rating) of
 - The funding level in the pension plan
 - The investment mix of the pension plan
- How much do corporations and employees collude to maximise the value of the transfer from the pension insurer?



Future empirical work

- This empirical work is very important, and fits well elsewhere in the course, so it's best covered there
 - In the lecture on funding DB pension we will look at the empirical work that assesses the impact of pension over/under funding on firm value
 - Feldstein & Seligman (1981)
 - Bodie (1985)
 - Bulow (1985)
 - Mittelstaedt & Warshawsky (1993)
 - Coronado & Sharpe (2003)
 - Picconi (2004)



Empirical literature

- In the lecture on plan funding, we will examine the effect of pension over or underfunding and investment on credit spreads
 - Carroll and Niehaus (1998)
 - Cardinale (2007)
- In the lecture on pension insurance we will examine the extent to which firms abuse the pension insurer
 - Rauh (2006)



Review

- We looked at a way of presenting both DC and DB pensions in the context of corporate finance, although the issues are mainly applicable to DB pensions
- We examined two views of pensions: separate from the corporation or part of the corporation
- We examined Sharpe's pension invariance result and related it to the Miller-Modigliani theorem
- We examined other theories of corporate finance and showed how pensions fitted into these
- We showed how pensions could increase firm leverage
- We presented an options-based analysis of payoffs in pensions
- We briefly reviewed empirical evidence we will examine later