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ABSTRACT

The asset allocation is a crucial decision for pension funds, and this paper analyses the economic factors which determine this choice. The analysis proceeds on the basis that, in the absence of taxation, risk sharing and default insurance, the asset allocation between equities and bonds is indeterminate and governed by the risk-return preferences of the trustees and the employer. If the employing company and its shareholders are subject to taxation, there is a tax advantage in a largely bond allocation. Risk sharing between the employer and the employees often means that one group favours a high equity allocation, while the other favours a low equity allocation. Underpriced default insurance creates an incentive for a high equity allocation. When taxation, risk sharing and underpriced default insurance are all present it is concluded that the appropriate asset allocation varies with the circumstances of the scheme; but that a high equity allocation is probably inappropriate for many private sector pension schemes.

Key words: pension fund, asset allocation, tax arbitrage, risk sharing, default insurance, embedded options

The main determinant of the investment performance of a pension fund is the asset allocation, rather than the stock selection (Blake, Lehmann and Timmermann, 1999; Brinson, Hood and Beebower, 1986; Brinson, Singer and Beebower, 1991; and Ibbotson and Kaplan, 2000). This paper concentrates on the equity-bond decision, but the arguments can be generalised to include other asset classes. There is a considerable amount of evidence that in competitive capital markets additional risk is compensated by additional expected returns (e.g. the equity risk premium) Dimson, Marsh and Staunton, 2002; Cornell, 1999; and Siegel, 2002. There is also evidence that time diversification[1] is not present for equities (Sutcliffe, 2004). Therefore, in both the long and the short run, there is a linear trade-off between risk and return, as in the Capital Asset Pricing Model (Sharpe, 1964), and equities are not relatively more attractive for long term investors. There is empirical evidence that equities are not a good hedge for pension scheme liabilities, and so there is no particular hedging advantage in equities over other forms of investment (Sutcliffe, 2004). In these circumstances (and in the absence of taxation, risk sharing and default insurance), the asset allocation decision depends on the risk-return preferences of the trustees, in consultation with the employer. A high equity proportion leads to a high risk, high expected return outcome; while a low equity proportion gives a low risk, low expected return outcome.

This paper relies on higher expected returns from equities being offset by the higher risks, equity having no special hedging merits, and the absence of a reduction in equity risk for long run investors. It proceeds on the premise that, in the absence of taxation, risk sharing and default insurance, the asset allocation is indeterminate. Section 1 considers the effects of introducing taxation on the asset allocation, section 2 analyses the consequences of recognising that risks are shared between the employer and the employees, while section 3 examines the consequences of introducing default insurance. Section 4 presents the implications for the asset allocation of various combinations of taxation, risk sharing and default insurance. Finally, section 5 has the

[1] Time diversification occurs when over and under performance tends to cancel out in the long run.

conclusions.

1. Taxation Arbitrage

The taxation effect only applies to companies which pay tax on their profits, and does not apply when the employer is not subject to corporate taxation, e.g. local authorities, universities, public utilities (for example, coal, electricity, post, gas, transport, airways, civil aviation), churches, charities, state-owned broadcasters, etc. Therefore, tax arbitrage is not relevant to many large pension schemes.

Assuming that the earnings of the pension fund are tax exempt, while contributions to the fund by the employer are tax deductible, and there are no transactions costs; there are two situations in which there is a tax arbitrage gain from switching the investment of a pension fund from equities to bonds. The first situation was analysed by Tepper (1981) (see also Bader, 2003, and Frank, 2002); while the second was analysed by Black (1980) (see also Black & Dewhurst, 1981, Ralfe, Speed and Palin, 2003, Surz, 1981, Frank, 2002, Tepper and Affleck, 1974, and Alexander, 2002).

Both models assume that the pension scheme will not default, the employer owns any surplus on the scheme, and that the pension scheme is viewed as an integral part of the employer. The Black model assumes that the capital market equates the *gross* risk-adjusted returns on bonds and equity; i.e. the world assumed by Modigliani and Miller (1958), where the tax deductibility of interest payments creates an incentive for companies to use primarily debt finance. The Tepper model follows Miller (1977) and assumes that it is *net* risk-adjusted returns for bonds and equities which are equal, and so there is no benefit from companies using debt finance. If the marginal investor is tax exempt, for both the Modigliani and Miller and Miller worlds, there is no benefit to using debt finance (Frank, 2002).

Tepper. In this case the pension scheme switches from equities to debt, effectively lowering the gearing of the employer (which is integrated with the pension scheme). At the same time the shareholders in the employer borrow money and invest the proceeds in equities with the same expected returns and systematic risk as shares in the employer. Provided the rate of personal taxation on income from equities (t_s) is higher than the rate of personal taxation on income from bonds (t_b), there is a tax benefit to the shareholders from this strategy[2]. The two steps of the Tepper strategy will now be described in more detail.

A. The pension fund is fully invested in equities, which it sells; investing the proceeds in bonds. Let the value of the pension fund be F, the expected gross return on equities be $E[R_e]$ and the expected gross return on bonds be $E[R_b]$. The resulting reduction in the expected revenue of the fund is $F(E[R_b]-E[R_e])$. A change of £1 in the revenue of the fund is equivalent to a change of only $(1-t_c)$£1 in the earnings of the employer because the employer must pay tax at the rate of t_c on earnings[3]. Therefore the switch from equities to bonds by the pension fund is equivalent to a reduction in the earnings of the employer of $F(E[R_b]-E[R_e])(1-t_c)$. Such a decrease in net profits by the employer is passed on to the shareholders, who pay tax at the rate t_s, so that the net loss to the shareholders is $F(E[R_b]-E[R_e])(1-t_c)(1-t_s)$[4].

B. At the same time as the fund switches from equities to bonds, the shareholders borrow $F(1-t_c)$ at the expected rate $E[R_b]$ and invest the proceeds in equities with an expected return and systematic risk which is the same as that of shares in the employer. Assuming that the interest payments by the shareholder are tax deductible, the change in the net revenue of the shareholders is $F(1-t_c)\{E[R_e](1-t_s)-E[R_b](1-t_b)\}$.

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[2] The values of t_s and t_b will differ between individuals, and the appropriate rates are those for the marginal investor.

[3] This assumes that the employer has taxable earnings in excess of their pension contributions.

[4] This switch from equities to bonds effectively lowers the gearing of the employer. However in the world of Miller this has no effect on the employer's net cost of capital.

The total net change in the revenues of shareholders from steps A and B is $F(E[R_b]-E[R_e])\times (1-t_c)(1-t_s)+F(1-t_c)\{E[R_e](1-t_s)-E[R_b](1-t_b)\} = F(1-t_c)E[R_b](t_b-t_s)$. Provided that $t_b > t_s$, the shareholders gain this amount each year in perpetuity. The present value to the shareholders of the profit stream from this tax arbitrage (discounting at the after-tax bond rate $(1-t_c)E[R_b]$ because this gain is riskless) is $F(t_b-t_s)$.

Black. As for Tepper, the pension scheme switches from equities to bonds, effectively lowering the gearing of the employer (which is assumed to be integrated with the pension scheme). In the world of Modigliani and Miller, as the level of debt is increased, the employer gains. The employer can either benefit from a lower cost of capital, or restore their initial level of gearing and enjoy a tax gain because interest payments are tax deductible, while payments to shareholders are not. These two steps will now be explained.

A. The pension fund is fully invested in equities, which it sells; investing the proceeds in bonds. As for Tepper, the net cost to the employer of this switch is $F(E[R_b]-E[R_e])(1-t_c)$.

B. The employer issues debt to raise the sum $F(1-t_c)$, and the interest on this debt has a gross cost to the firm of $F(1-t_c)E[R_b]$ per year, where the firm's bonds are assumed to pay the same rate of interest as the bonds held by the pension fund[5]. The money raised from issuing this debt is used to buy back an equivalent value of the employer's shares, leading to a reduction in the gross cost of equity capital to the employer of $F(1-t_c)E[R_e]$ per year[6]. Hence the reduction in the gross cost

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[5] Even if the employer pays a higher rate on the debt it issues (Y) than the fund receives on the bonds in which it invests (R), the strategy is still worthwhile provided $R < Y/(1-t_c)$, Alexander (2002).

[6] This assumes that the employer has sufficient equity capital available to be repurchased. If the employer purchases shares in other companies with the same expected return and systematic risk as its own equity, any taxes on these returns reduce the tax arbitrage gain. It also assumes that there are no transactions costs from issuing the bonds, the purchasers of the bonds require no risk premium for the possibility that the pension fund may switch back to investing in equities, and no risk premium for their inability to claim the assets

of capital to the employer is $F(1-t_c)(E[R_e]-E[R_b])$ per year.

Using the assumptions of Modigliani and Miler, the reduction in the gross cost of capital to the employer equals the increased cost of funding the pension scheme caused by its switch from equities to bonds. However, there is a tax gain to the employer, because the interest paid by the company on its new debt is tax deductible, while payments to shareholders are not. The overall net gain to the employer from this strategy is $F(1-t_c)\{E[R_e]-E[R_b](1-t_c)\}+F\{E[R_b]-E[R_e]\}(1-t_c) = F(1-t_c)E[R_b])t_c$ per year. The present value of this perpetuity (discounted at the after-tax riskless rate) is Ft_c.

This analysis shows that for both the Tepper and Black models the larger is the value of the pension fund *(F),* the greater is the tax arbitrage gain[7]. This implies that schemes adopting either the Tepper or Black strategies should also seek to fund their schemes up to the maximum level permitted by the tax authorities[8] [9] [10].

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of the pension scheme if the employer goes bankrupt, Scholes, Wolfson, Erickson, Maydew and Shevlin (2001).

[7] However, substantially over-funding the scheme brings the risks of hitting the Inland Revenue upper limit on the funding ratio (see section 2), and pressure to grant substantial benefit improvements out of the large surplus.

[8] Thomas (1988) finds empirical evidence for the USA that, if the employer's marginal tax rate or expected future taxable income change over time, this leads to a change in the level of contributions and the funding ratio in order to maximise the tax benefits.

[9] In the USA when the upper funding ratio is hit, further contributions to the fund are restricted; but there is no requirement to reduce the surplus, as in the UK. Ippolito (1990) shows that this situation provides an incentive for funds to invest in equities in order to generate an even larger surplus, before the fund is switched to bonds.

[10] The desire by companies to hold financial slack may also lead to over-funding, Myers and Majluf (1984). Datta, Iskander-Datta and Zychowicz (1996) found US evidence supporting the hypothesis that the financial slack motive for over-funding is strengthened when the managers of the employer do not own shares in the company.

The Tepper and Black models deal with different worlds. The Tepper strategy (which applies in the Modigliani and Miller world) produces a gain with a present value of $F(t_b - t_s)$, while the Black strategy (which applies in the Miller world) gives a gain of Ft_c[11]. If the corporate tax rate is 30%, the present value of the tax arbitrage gain from the Black strategy will be substantial at 30% of the value of the fund. Therefore, tax arbitrage can provide a powerful reason for company pension schemes to switch the fund to bonds. This is illustrated by the example of Boots. As well as switching the pension fund into 100% bonds, Boots bought back £300 million of its own shares using available cash. This is the tax arbitrage strategy of Black, except that the share buy-back should have been almost four times larger[12]. The estimated present value of the tax gain to Boots from this capital restructuring is £100 million (Ralfe, Speed and Palin, 2003).

Tax arbitrage generates a gain for the firm's shareholders, while the pension scheme is now less likely to default as it is 100% bonds. Therefore, such a switch should benefit both the employer and the employees, and there should not be any conflict between these groups in making the asset allocation decision. The tax arbitrage case for an all-bond portfolio assumes that the risk-minimising portfolio is all bonds, although this may not be the case. The all-bond portfolio may be inefficient, and a small proportion of equities may be beneficial by reducing risk and increasing expected return. In these circumstances pension funds face a trade-off between risk minimization and the tax arbitrage profits from holding 100% bonds[13] [14]. This could lead to a

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[11] An empirical study of US pension schemes by Frank (2002) found support for the Black model, which is consistent with Graham (2000) who presents evidence for the USA in support of the Modigliani and Miller world, and therefore the Black model.

[12] The size of the Boots share buy-back was set on advice from the credit rating agencies.

[13] Making this risk return trade-off requires the scheme to estimate the segment of their asset-liability efficient frontier that is dominated by the risk-minimising portfolio.

[14] UK pension schemes in aggregate have high equity allocations, and those with corporate employers have not pursued a tax-arbitrage strategy. For the Black model this may be for the reasons mentioned above by Scholes, Wolfson, Erickson, Maydew & Shevlin (2001), or because the employer has insufficient taxable profits to offset the bond interest payments,

small difference of opinion between the employer and the employees, but this may be resolved by the employer offering a share of the tax arbitrage gain to the employees to compensate for the increase in risk.

2. Risk Sharing

The risks and rewards from investing the pension fund do not concern solely the employer, but are shared with the employees and pensioners. If the employer goes into liquidation, there may be insufficient assets to meet the scheme's liabilities, with the loss falling on the employees and pensioners. Conversely, if the scheme has a substantial surplus, this may well be shared between the employer, employees and pensioners via reduced contributions and increased benefits. In these ways the employees and pensioners are exposed to the risks of the scheme[15].

The sharing of deficits and surpluses between the employer and the employees has been analysed using option theory by Sharpe (1976). After explaining the Sharpe model, it will be extended by relaxing a number of the underlying assumptions. In constructing his simple model Sharpe assumes that the employer benefits from the full amount of any surplus, but is not liable for any

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or because the employer has insufficient share capital to buy-back. For both the Black and Tepper models the employer must have sufficient profits to offset their contributions to the fund; while if the risk-minimising portfolio includes an equity component, this may result in a pension fund that is not 100% bonds. The Tepper argument for all bonds may not apply because t_b is not greater than t_s, which has been argued to be the case for the USA by Chen and Reichenstein (1992). Erickson, Goolsbee and Maydew (2003), who studied a different form of tax arbitrage in the USA, found that the level of arbitrage activity could have been about twenty times larger, and conclude that the lack of tax arbitrage is a puzzle. A similar puzzle exists for Black and Tepper tax arbitrage.

[15] In reality, there are additional features of the problem which mean that the employees may bear a substantial share of the cost of a deficit, without the scheme being wound up. A deficit can lead to the scheme being closed to new members or to additional contributions. Benefits, other than those already accrued, can be reduced, the retirement age can be increased, the accrual rate reduced and the employee contribution rate increased. In addition, wages may be frozen, or increased at a lower rate for those in the pension scheme (as did the Financial Services Authority in April 2003).

deficiency[16]. He also assumes there is no taxation and no default insurance or compensation[17]. The pension scheme liabilities are valued at L, while the assets are valued at A, and so the value of any scheme surplus or deficit is $(A-L)$. Sharpe argues that, in effect, the employer has a long position in a call option on the assets of the fund, with a strike price of L (i.e. the right to buy the assets in the fund on payment of L). This call option is valued at C. The employees have the right to receive their contractual pensions benefits (i.e. L), and have effectively sold a put option on the assets of the fund with a strike price of L (i.e. they must supply the assets in the fund for L, on request). This put option is valued at P. The European style put-call parity means that $A = C-P+L$[18].

By working for the employer, employees receive their pension entitlement (L) and their wages, which have a present value of W. The employees have also accepted the obligation to bear any scheme deficits, and this is valued by the put premium (P). Sharpe argues that in a competitive labour market the sum of these three amounts will be a constant (K)[19], and so $L-P+W = K$[20]. Therefore, since $A = C-P+L$; it follows that $K = W+A-C$. This means that the fixed cost of remuneration (K, or salary plus pension costs) equals the wage cost (W), plus the assets in the fund (A), less the value of the call option on any surplus in the fund (C). Black and Scholes

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16 These assumptions will be relaxed below.

17 It is also implicitly assumed that there are no pension scheme termination costs, e.g. lawyers fees, poor labour relations, etc. Their presence makes a high equity allocation less attractive.

18 Note that for European style options on non-dividend paying assets, unless $A = L(1+r)$, where r is the riskless rate of interest between now and expiry, C does not equal P.

19 If the employer is a public sector organization, it may be constrained by its government funding, and seek to fix the total cost of employment.

20 The empirical evidence on the existence of a trade-off between pension benefits and salaries is mixed. Gunderson, Hyatt and Pesando (1992) review this evidence, and find five papers which support a trade-off, three papers with some evidence for a trade-off, two papers that fail to find a trade-off, and three papers that find a positive relationship between pensions and salaries.

(1973) have shown that the value of a European style call or put option depends on six variables - the price of the underlying asset (*A*), the strike price of the option (*L*), the riskless interest rate (r), dividends (which are zero in this case), the time to expiry of the option (*t*) and the volatility of returns on the underlying asset (σ). Sharpe then argues that, although a high equity allocation increases the riskiness of returns on the pension fund (i.e. σ) thereby increasing *C* and *P*; this will be offset by a corresponding increase in either wages (*W*), or assets in the fund (*A*). Therefore, a high equity allocation has no effect on the total cost of employee remuneration to the employer. In Sharpe's view pension "funding policy is irrelevant"[21] [22] [23] [24].

Sharpe's simple model will be elaborated in three different ways. First, if total employee remuneration is not fixed, the asset allocation is no longer irrelevant. Assuming that there is no wages or funding level offset, a high equity allocation increases the volatility of the underlying asset, and this increases the value of the put and call options. Given the assumptions of Sharpe about how deficits and surpluses are shared, investment risk for the employer is a bet with the characteristics of "heads I win, tails you lose". Therefore a high equity allocation makes the

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[21] It also follows from the theory of option pricing that by reducing the funding ratio, the value of the put option is increased, while the value of the call option is reduced.

[22] The funding ratio is also indeterminate as an increase in *L* will be offset by an increase in *P* and a reduction in *C*.

[23] In this case, the asset allocation is the chosen point on the efficient frontier. If a number of asset classes is under consideration (e.g. bonds, index-linked gilts, property, UK equities, overseas equities, etc) an asset-liability study is needed to determine the efficient frontier.

[24] Sharpe's model deals only with active members who can renegotiate their wages as the scheme's asset allocation is altered. Deferred members and pensioners have no such sanction against an employer whose pension fund adopts a high equity allocation. However, pensioners come before active members in the priority order for compensation on a winding up, and so the greater is the liability to pensioners, the greater is the increase in risk borne by active members when the fund has a high equity allocation. Therefore, although the problem is more complicated than presented by Sharpe, even for mature schemes, the Sharpe model may be a reasonable approximation.

employees worse off, and the employer better off[25].

Second, if total remuneration is not fixed and the employer bears a proportion of deficits (d), while the employees receive a share ($1-s$) of any surplus; the situation becomes more complex[26] [27] [28]. If there is no offsetting, then employees' total remuneration rises to $K = L-P(1-d)+C((1-s)+W$, while the cost to the employer increases to $K = W+A-Cs+Pd$. Whether a high equity allocation in this situation is beneficial to the employees or the employer depends on the way in which K changes as the volatility of returns on the fund (σ) changes. This depends on the sign of $\partial K/\partial\sigma = \partial(L+W)/\partial\sigma+(1-s)(\partial C/\partial\sigma)-(1-d)(\partial P/\partial\sigma)$, where $\partial C/\partial\sigma$ and $\partial P/\partial\sigma$ are, by definition, the values of vega (ν) for the call and put options, respectively.

Using the Black-Scholes model, vega is a positive number which is the same for both put and call options, and is given by $\nu = A\sqrt{t}.exp(-D^2/2)/(2\pi)^{0.5}$ where $D = [ln(A/L) +(r+0.5\sigma^2)t]/\sigma\sqrt{t}$. Since the values of r, t, A, L and σ are the same for both the call and put options, and total remuneration is fully responsive, i.e. $\partial(L+W)/\partial\sigma = 0$, then $\partial K/\partial\sigma = \nu(d-s)$. Provided that $d > s$, a high equity allocation increases σ, which increases K, making the employees better off and the employer worse off. When $s > d$ a high equity allocation leads to a reduction in K, and so the employer

25 This outcome is mentioned by Sherris (1992).

26 The variables d and s are in the zero-one range, and are assumed for the moment to be known for certain.

27 It will be assumed for simplicity that the same values of s and d apply to both active members and pensioners. However, given the priority order on a winding-up in the Pensions Act 1995 (and the recently proposed government amendments), active members bear much more of the default risk than do current pensioners. Therefore, pensioners have a greater appetite for a high equity allocation than active members. Benefit increases may be directed at active members, current pensioners, deferred pensioners, or all three groups.

28 Until 2003, when a scheme was wound-up the employer only needed to ensure the funding level was up to the MFR, and this may correspond to a funding ratio of only about 70%. In consequence, the employees and pensioners could suffer the first 30% of any under-funding. From 11th June 2003 the UK government required employers to fully fund schemes on a winding-up, Department for Work and Pensions (2003). This increased d.

gains, and the employees lose. For example, if the employing company is close to financial distress, with a net asset value near zero, it may be in the interests of the shareholders of this company to have a high equity allocation. If equities do well the net asset value of the company increases because the value of the pension fund has increased. If equities do badly, the funding ratio of the scheme deteriorates, leading to an increase in the contribution rate and the likely liquidation of the employer. In this case all the outstanding obligations of the employer fall on the creditors of the company, including the obligations to the pension scheme, Alexander (2002).

Therefore, when total remuneration is not fixed, surpluses and deficits are shared between the employer and the employers on a simple proportionate basis, the Black-Scholes option pricing model applies, and there are no tax arbitrage effects: (a) the interests of the employer and the employees concerning a high equity allocation are directly opposed[29], and (b) whether it is the employer or the employees who favour a high equity allocation depends on the relative magnitudes of *d* and *s*[30].

Over the past two decades, many pension schemes have granted substantial benefit improvements, but no data is available on the cost of these improvements, as a proportion of the

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[29] Conflict between the employer and the employees over the investment policy of the fund is only important if neither party can make this decision acting alone. The requirement by the Pensions Act 1995 for member nominated trustees from 1997 may have increased the influence of employees on the asset allocation decision. However, whether or not one group controls this decision depends on the rules of each scheme, and some schemes allow the employer to set the contribution rate. Useem and Hess (2001) analysed the asset allocation decisions of 253 of the largest US public pension schemes in 1992. They found that the equity proportion was negatively related to investment restrictions, and positively related to the existence of independent performance evaluation and the number of trustees. However, the proportion of trustees elected by the members had no significant effect on the equity proportions.

[30] Ippolito (1985) shows that, if the labour force is unionised and the company has a substantial investment in specialised capital equipment, the union may seek to increase wages by threatening to strike. The employer can counter this threat by deliberately under-funding the pension scheme. The employees now bear some of the risks of a strike which may lead to the closure of the company and default on the pension scheme.

surplus. However, there is information on the way in which surpluses are shared when schemes breach the Revenue limit. Schemes whose funding ratio breaches the upper limit of 105% set by the Inland Revenue for the retention of their tax exempt status, must reduce their surplus. For a 14 year period (1987 to 2001) the proportion of such required reductions in surplus received by members was 34.4%, i.e. $s = 0.656$[31]. For well-funded schemes with a large and successful employer who is committed to the scheme, the value of d will be close to unity. Therefore, it is probable that $d > s$, and a high equity allocation favours the employees at the expense of the employer[32]. However, if the employees receive a very small share of any surpluses, or the employer may well default, then it is likely that $s > d$ and the employees will be opposed to a high equity allocation, while the employer will support a high equity allocation.

A further complication of the second variant of the Sharpe model arises if there is a partial offset, i.e. total remuneration responds to a change in the values of C and P, but by less than the full amount because of a partial offset against wages or the funding level. In which case $\partial(L+W)/\partial\sigma \neq 0$. In consequence, assuming that the degree of partial offset is the same for both surpluses and deficits, the gains and losses are reduced in size by the partial offset, but the result that the employees favour a high equity allocation when $d > s$ (and vice versa) is unaffected.

In the final variation of the Sharpe model it is again assumed that total remuneration (K) is fixed, while deficits and surpluses are shared in some way, and any gains or losses to the employees and employer from a high equity allocation are offset by changes in wages or the level of funding. In such circumstances the asset allocation again becomes irrelevant.

The various situations analysed above are summarised in table 1. In each case a high equity

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[31] Inland Revenue web site.

[32] The value of d may also be close to unity if there is some actual or implicit guarantee (e.g. the government) in the event of a deficit on winding up. This situation will be considered in section 3 on default insurance.

allocation is a zero sum game. A likely situation is a strong probability that the employer will not wind up the scheme in a deficit situation (so that *d* is close to unity), surpluses are shared (possibly s = ⅔) and total remuneration (K) is variable. In these circumstance $d > s$, and the employees favour a high equity allocation, while the employer favours bonds. This is because a high equity allocation now offers the employees a "heads I win, tails you lose" bet. If equities perform well, the employees receive substantial benefit improvements, while if equities perform badly, the costs are very largely met by the employer. However, because they bear most of the risk of deficits, but receive only a proportion of the surpluses, employers favour the risk-minimising portfolio. When total remuneration is fixed, the asset allocation is unaffected by the values of *d* and *s*. If total remuneration can vary, the funding decision only requires the estimation of the relative size of two parameters, *d* and *s*. It does not require the valuation of the implicit put and call options, the degree of partial offset, or the value of vega.

	The Sharpe Model and its Three Variants				
	1	**2**	**0.125**	**3B**[33]	**4**[34]
K	Fixed	Variable	Variable	Variable	Fixed
d and s	d=0, s=1	d=0, s=1	d > s	s > d	1≥d≥0,1≥s≥0
Employer	Irrelevant	High Equity	Low Equity	High Equity	Irrelevant
Employees	Irrelevant	Low Equity	High Equity	Low Equity	Irrelevant

Table 1: Summary of the Various Combinations of Total Remuneration and Risk Sharing

Two generalizations of the various Sharpe models will now be considered. The first involves the implicit assumption concerning diversifiable risk. A high equity allocation increases the volatility of the assets, and this increased risk is shared in different ways between the employees and the employer. It has been assumed so far that these changes in risk are reflected in the value of the put and call options, and no further consideration need be given to this risk. For a corporate employer this may be a reasonable assumption as the company's shareholders are assumed to have well diversified portfolios, and the increase in the systematic risk of their personal portfolios

[33] The second situation, with $d = 0$ and $s = 1$, is a special case of $s > d$, where K is variable.

[34] The simple Sharpe model ($d = 0$ and $s = 1$) is a special case of *d* and *s* in the zero-one range, where K is fixed.

due to one company having a high equity allocation for its pension fund is small[35]. Where the employer is not a company, it is likely that the increased exposure to systematic risk will again be small. However, for employees the situation is probably different. The risk of the pension scheme defaulting is strongly positively correlated with the risk of the employees losing their job with the employer, Alexander (2002), Ralfe, Speed and Palin (2003)[36]. Therefore, so far as the portfolio of each employee is concerned, there is minimal diversification for the risk of highly negative outcomes for both pensions and employment. For most people, their pension and employment are major components of their wealth, and it may be unwise to create a situation in which the value of both of these important assets drops sharply when their employer fails.

Employees may require additional total remuneration of ψ as compensation for each increase of unity in risk (σ) (in the form of higher wages, a higher share of surpluses, a lower share of the deficits, etc). In this case the situation is no longer zero-sum, and some of the results in table 1 are altered. The first and last cases in table 1 now require the employer to increase total remuneration as equity risk is increased, which implies that the employer now favours the risk-minimising portfolio, as this has the lowest cost. For case 2 in table 1 some of the gains to the employer from a high equity allocation are now shared with the employees via ψ, but the strategies for the employer and employees are unchanged. In the third case in table 1 the employees favour a high equity allocation if $\nu(d-s)+\psi > 0$, while the employer favours a high equity allocation if $\nu(d-s)+\psi < 0$. Making these judgements requires a knowledge of both vega and ψ, in addition to d and s. The revised results when non-diversifiable risk is recognised are set out in table 2.

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35 If there was a mass switch by all UK companies to a high equity allocation, then the exposure of every company to the stock market would be increased, and the resulting increase in systematic risk would be more substantial.

36 Note that this problem applies to both corporate and non-corporate employers.

		The Sharpe Model and its Three Variants				
		1	**2**	**0.125**	**3B**	**4**
K		Fixed	Variable	Variable	Variable	Fixed
d and s		d=0, s=1	d=0, s=1	$\nu(d-s)+\psi > 0$	$\nu(d-s)+\psi < 0$	$1 \geq d \geq 0,\ 1 \geq s \geq 0$
Non-diversifiable risk (ψ)	Employer	Low Equity	High Equity	Low Equity	High Equity	Low Equity
	Employees	Irrelevant	Low Equity	High Equity	Low Equity	Irrelevant
d and s risk (σ_K) and ψ	Employer	Low Equity	?	Low Equity	?	Low Equity
	Employees	Irrelevant	Low Equity	?	Low Equity	Irrelevant

Table 2: Summary of the Various Combinations of Total Remuneration and Risk Sharing When there is Non-Diversifiable Risk and *d* and *s* are Risky

The second generalization of the Sharpe model concerns the way in which deficits and surpluses are shared between the employer and the employees. This has previously been assumed to be clearly specified in advance, i.e. *d* and *s* are certain. However, in reality this is seldom the case. For example, when the scheme shows a big surplus, the employer may just reduce the employer's contribution rate, with no benefit improvements for the employees. Therefore, the employer and employees have entered into a risky contract where the division of the payoffs between them (*d* and *s*) has not been clearly defined in advance, i.e. they have entered into an incomplete contract. This makes it more difficult to assess the costs and benefits from a high equity allocation because an additional layer of risk is present[37]. This risk leads to a strengthening of the argument against a high equity allocation.

If the values of *d* and *s* are risky, the employer and employees will form their own expectations of the distributions of *s* and *d*[38]. The single decision variable, total remuneration (*K*), is replaced by four variables:- expected total remuneration *E[K]* and its risk σ_K for both the employer and the employees. When *K* is variable, its risk increases as the fund moves into equities. The four cases in table 2 will be re-considered under the assumption that both the employer and the

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[37] If the total value of wages and pensions benefits is fixed, this incomplete contracts risk only involves the form of remuneration, not its magnitude.

[38] Since the actual values of *d* and *s* may be substantially under the control of the employer, it is likely that the standard deviations of these distributions are smaller for the employer than for the employees.

employees are risk averse. In cases 1 and 4 it is assumed that $\sigma_K = 0$, and so there is no change in the previous conclusions. For case 3B (which subsumes case 2), a high equity allocation lowers $E[K]$ and increases σ_K, and for both these reasons, is opposed by the employees. For the employer, there is a trade-off between the increase in $E[K]$ and the increase in σ_K, and they may or may not support a high equity allocation. For case 3A, a high equity allocation leads to an increase in $E[K]$ as well as an increase in σ_K, and so is opposed by the employer. The employees now have a trade-off between the increase in $E[K]$ and the increase in σ_K, and they may support or oppose a high equity allocation. The conclusions when d and s are risky and there is non-diversifiable risk ($\psi > 0$) are summarised in table 2. Since σ_K increases as the fund switches more money into equities, the asset allocation may be a mixture of equities and bonds at the point where the additional benefits to the employer or employees from greater equity investment equal the additional costs from the increased risk.

In the absence of underpriced default insurance and corporation tax, there appear to be two situations in which a pension fund will adopt a high equity allocation. First, if total remuneration is variable, $v(d-s)+\psi > 0$, and the employees determine the investment policy and have a low level of risk aversion. Second, if total remuneration is variable, $v(d-s)+\psi < 0$, and the employer determines the investment policy and has a low level of risk aversion.

Overall, the conclusions are that, if total remuneration (K) is fixed, the employer prefers the risk-minimising portfolio, while the employees are indifferent to the asset allocation. If K is variable, the choice of asset allocation is a zero-sum game[39] between the employer and employees, with one favouring the risk-minimising portfolio while the other party may or may not support a high equity allocation, depending on the values of d, s, ψ, ν and their degree of risk aversion[40].

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[39] Apart from the effects of an increase in σ_K as the fund switches into equities.

[40] The implication of conflict over the asset allocation for the schemes of non-corporate employers with variable remuneration is not borne out in practice. Bunt, Winterbotham and Williams (1998) report that the trustees of UK schemes nearly always

3. Default Insurance

In the USA the Employee Retirement Income Security Act (ERISA) of 1974 created the Pension Benefit Guarantee Corporation (PBGC). The PBGC provides insurance against default by US pension schemes. The UK has never had any default insurance scheme (although the Pension Compensation Scheme was set up by the Pensions Act, 1995, to deal with cases of fraud), and so this factor cannot have affected the high equity allocation in the UK. However, in June 2003 the UK government announced the establishment of a Pension Protection Fund, which may be modelled on the PBGC. Therefore, the effects of default insurance may soon be important to UK pension schemes.

Sharpe (1976) suggests that the PBGC can be viewed as providing the employer with a put option. If the insurance premium to the PBGC is paid by the employer and equals the value of the put option, the cost of default in Sharpe's original model has been transferred from the employees to the employer[41]. Since no other aspect of Sharpe's simple model has changed, the introduction of correctly priced full default insurance should have no overall effect; other than to make the employees better off and the employer worse off, and so the asset allocation remains irrelevant, as does the funding ratio[42]. However, in two respects, the PBGC has operated in a different manner to that assumed by Sharpe. The PBGC insures only part of any default, and the premiums were simply a flat fee per member until 1987, when fees were varied with the degree of under-funding. However, PBGC fees do not reflect the solvency of the employer or the asset allocation of the fund. Partial default insurance just means that some of the risk of default

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make decisions on a consensual basis, and voting is rare. Pratten and Satchell (1998) found a similar situation for investment decisions. Since trustees are required to act in the best interests of the beneficiaries of the trust, it is possible that employer trustees promote the interests of the employees, and so there is no conflict over the asset allocation policy.

41 If both the employer and the employees are exposed to default risk; while only one party pays the insurance premium, the party that pays the premium will lose out from the introduction of correctly priced default insurance.

42 However, the introduction of default insurance removes the efficacy of an under-funded pension scheme in deterring strikes for higher wages, Ippolito (1985).

continues to be borne by the employees, and is of no great significance. The failure to correctly price the default insurance to accurately reflect the increase in risk as the scheme switches to risky investments, means that the employer and employees have an incentive to either adopt a high equity allocation or, if it were possible, leave the default insurance scheme to avoid cross-subsidizing other schemes that are highly risky[43]. Therefore, underpriced default insurance has created an incentive for a high equity allocation in the USA since 1974. Whether the introduction of default insurance in the UK has a similar outcome depends on the way the insurance is priced.

4. Combining Taxation Arbitrage, Risk Sharing and Default Insurance

Tax arbitrage provides a strong case for company schemes adopting an all-bond portfolio and funding the scheme up to the Revenue limit. Risk sharing means that usually one group (employer or employees) will support a high equity allocation, while the other group will oppose this asset allocation. Finally, underpriced default insurance provides an incentive for a high equity allocation and reduce the funding ratio to the minimum permitted. This section considers the likely outcome when schemes are exposed to various combinations of these conflicting factors.

4a. Taxation Arbitrage and Default Insurance. Bicksler and Chen (1985) considered the combined effects of the tax arbitrage and default insurance factors. These two factors imply that the investment strategy of the fund is a corner solution: either all bonds or all equities[44]. A similar conclusion was reached by Harrison and Sharpe (1983) and Marcus (1987). However, the actual

[43] The lower is the funding ratio, the more likely is the scheme to benefit from the default insurance, giving an incentive to reduce the funding ratio to the minimum permitted level.

[44] Bulow (1981) mentions that the tax benefits might be achieved by fully funding the scheme using an all-bond portfolio. The default insurance benefits are then obtained by adding a derivative overlay (e.g. index options, index futures or index swaps) which increases the exposure of the fund to the stock market to the selected level. However, this strategy is not attractive because it leaves the employer (which is assumed to be integrated with the pension scheme) with a high level of risk.

behaviour of pension funds in the US which have underpriced default insurance lies somewhere between these two extremes[45]. Bicksler and Chen (1985) explain the presence of such interior solutions by the introduction of market imperfections. Although the scheme is insured, the employer may experience pension termination costs (e.g. large legal expenses, poor labour relations, problems obtaining tax exempt status for a subsequent pension scheme, etc). These costs make default costly to the employer (and probably also the employees). If there are progressive corporate tax rates, then as the pension fund switches more and more money into equities and issues corporate bonds (following the Black, 1980, strategy), the tax gain to the employer gets smaller and smaller because the company's marginal tax rate gets lower and lower. There is also the problem that in some years the company may not have any taxable income against which to offset the interest it pays on the bonds it has issued. While such tax credits may be carried forwards or backwards, this may result in a reduction in the present value of the tax deduction. Therefore, the marginal benefits from tax arbitrage decrease as the fund switches most of its money into bonds. Provided the tax and default insurance effects are of broadly similar size, Bicksler and Chen (1985) argue that these market imperfections are responsible for the mixtures of bonds and equities that prevail in practice. Another reason for deviating from the all-bond portfolio is that the risk-minimising portfolio contains a small proportion of equities, and an all-bond portfolio is inefficient.

4b. Taxation Arbitrage and Risk Sharing. In the UK there is no default insurance, and the only interaction that currently matters is between tax arbitrage and risk sharing. The four possibilities are summarised in table 3. If the employer does not pay corporation tax, tax arbitrage is irrelevant, and the asset allocation is determined by risk sharing. If total remuneration is fixed the employer will oppose a high equity allocation because it introduces *d* and *s* risk, while the

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[45] For example, Bodie, Light, Mørck & Taggart (1985, 1987) studied data on 939 US pension funds for 1980. They found that the asset allocation followed a bimodal distribution, as predicted; and that one mode was 100% in bonds. However, the other mode was only 55% in equities. Papke (1992) analysed 1987 data on the asset allocation of more than 24,000 US defined benefit single employer pension schemes. He found considerable variety in their asset allocations, and little evidence of all-bond or all-equity allocations.

all-bond portfolio is excluded because it is inefficient. If total remuneration is variable, then the asset allocation is a zero-sum game (ignoring the effects of σ_K) between the employer and the employees. The outcome will probably not be 100% bonds, because this portfolio is inefficient; and will not be 100% equities, as this portfolio has the highest probability of incurring pension termination costs. An all-equity portfolio may also be ruled out by the increasing level of total remuneration risk (σ_K) outweighing the benefits from an increasing or decreasing level of $E[K]$.

K	Non-company	Company
Fixed	There is no tax benefit from bonds, and the employer opposes a high equity allocation because of the *d* and *s* risk which a high equity allocation introduces. The all-bond portfolio is ruled out because it is inefficient.	Very largely bonds, but with some equity for risk-minimising reasons.
Variable	There is no tax benefit from bonds, and it is a zero-sum game between the employer and the employees (apart from σ_K). Equity investment, beyond that for risk-minimising reasons, depends on circumstances, including d, s, ψ, v and risk aversion.	Very largely bonds because the tax arbitrage profits to the employer can be used to offset the attractions of equities to themselves, or the employees.

Table 3: Total Remuneration, Corporate Status and Investment Policy

If the employer pays corporation tax and can obtain a substantial tax arbitrage profit from an all-bond portfolio, some of this arbitrage profit can be used to either (a) compensate the employees for accepting an all-bond portfolio, or (b) change the balance of advantage to the employer away from a preference for a high equity allocation to an all-bond portfolio. Again, because the all-bond portfolio is probably not efficient, there may be a small percentage of equities in the chosen portfolio. Thus, in a situation where the tax arbitrage and risk sharing factors both operate, the asset allocation is likely to be predominantly bonds, but not 100% bonds.

The funding ratio is one of the variables in the risk sharing model, with a lower funding ratio increasing the risks of a deficit. Therefore, when there is just risk sharing, the funding ratio is part of the bargain between the employer and the employees. But for corporate employers, and in the absence of underpriced default insurance, the benefits from tax arbitrage indicate moving to the maximum allowable funding ratio.

4c. Risk Sharing and Default Insurance. Underpriced default insurance creates an incentive for a high equity allocation, subject to pension termination costs. In the basic Sharpe model the costs of default to the employees are greatly reduced by default insurance (correctly priced or otherwise), and the value of the put option tends to zero. This affects the condition that $L-P+W = K$, which is also affected by the inclusion of the costs of deposit insurance (D); assumed to be paid by the employees since they receive the benefits. If the default insurance is correctly priced, the value of the reduction in P equals D, and the net effect on the employees is zero, as it is on the employers. However, if the default insurance is underpriced, the employees gain, leading to a decrease in W. According to the basic Sharpe model, the asset allocation remains indeterminate. If total remuneration is not fixed and deficits are shared, the gain from underpriced default insurance (whether paid by the employer or the employees) is shared between them. However, provided d is unchanged, the conflict between the employer and employees over the asset allocation is unchanged. Since the gains from underpriced default insurance rise with a higher equity allocation, there is tendency for those who benefit from these gains to increase the extent to which they favour equities. This increases the likelihood of a high equity allocation.

4d Taxation Arbitrage, Risk Sharing and Default Insurance. When all three factors are present, it has been argued above that the dominant effects are tax arbitrage and default insurance, and so the analysis in section 4a is appropriate. Risk sharing adds the possibility that the main beneficiary from tax arbitrage gains (the employer) or underpriced default insurance (the employees) can compensate the other group to accept their preferred asset allocation; so removing any conflict over the asset allocation.

5. Conclusions

In the absence of taxation, risk sharing and default insurance the asset allocation of pension funds is set using the risk and return preferences of the employer and employees, and these may vary from scheme to scheme. When present, these three factors can have a powerful influence on the optimal asset allocation. The interaction of tax arbitrage and risk sharing is shown to lead to four main possibilities, and while a wide range of asset allocations is possible; the risk-minimising portfolio of largely bonds appears to be the most likely decision for the majority of pension schemes in the private sector. If underpriced default insurance is added, the pull towards an all-bond allocation is reduced.

Since most UK pension funds have a substantial equity allocation, these conclusions are in sharp contrast to actual asset allocation decisions. One response to this puzzle is that pension funds make optimal decisions, and the model needs to be modified so that it can explain this behaviour. Another response is to argue that many pension funds make sub-optimal asset allocation decisions. The absence to date of powerful rational arguments supporting the widespread pursuit of high equity proportions leaves the sub-optimal decision making explanation. However, further research is needed on the asset allocation puzzle and why many pension funds make what appear to be sub-optimal asset allocation decisions.

If the sub-optimal decision making view is accepted, the implication is that many pension funds should hold substantially lower proportions of their assets in equities. In these circumstances, funds should adopt the risk-minimising portfolio; with an asset-liability study to discover this risk-minimising portfolio. The scheme can then determine the extent to which it wishes to increase the bond proportion to achieve tax arbitrage profits (if available), or increase the equity proportion to increase the fund's risks and expected returns and the gains from underpriced default insurance. If total remuneration is variable, and the employer is not a corporation, it is more likely there will be conflicting views from the employer and the employees over the appropriate asset allocation.

Some implications from the analysis in this paper are that (a) company pension schemes should have a lower proportion of their funds invested in equities than the schemes of non-corporate employers, (b) there should be little conflict over the asset allocation decision in company pension schemes, with more conflict in non-company pension schemes, and (c) company pension schemes should have higher funding ratios than non-corporate schemes.

If most funds switch a substantial portion of their assets from equities to bonds, this may have macro-economic effects. While there do not appear to be any insurmountable macro-economic problems (e.g. Exley, 2003), further research is needed on this question. Additional research is also needed on various other issues - (a) the composition of the typical risk-minimising (or liability-matching) portfolio, (b) the values of d, s, ψ and v for non-corporate schemes, where these values may be substantially different from those for company schemes, (c) the procedures used by trustees for setting d and s, (d) estimates of ψ, v, d and s, (e) whether there is conflict over the asset allocation between the employer and the employees in non-corporate schemes, (f) whether one group is dominant in determining the asset allocation, and (g) whether any persons, apart from trustees, play a decisive role in setting the asset allocation (e.g. investment consultants and fund managers).

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