Occupational Pension Schemes, Moral Hazard and International Exposure

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1 Introduction

In several countries defined benefit (DB) pension plans are insured by pension protection systems such as the Pension Benefit Guaranty Corporation (PBGC) in the United States or the Pensions-Sicherungs-Verein auf Gegenseitigkeit (PSVaG) in Germany. Since the theoretical contributions of Sharpe (1976) and Treynor (1977) this insurance has been modelled as a put option which gives rise to moral hazard incentives by DB plan sponsors. The put-option like nature of this insurance can lead to two risks. First, plan sponsors with a high default probability can increase put value by maintaining a minimum funding level. Second, the risk of the underlying assets can increase as the level of pension funding declines.

The regulatory frameworks implemented by the PBGC and the Pension Protection Fund (PPF) in the UK seek to limit moral hazard incentives by ensuring minimal funding through a system of mandatory contributions to plan assets as well as through risk-adjusted insurance premia in the case of the PPF. The PPF for instance charges a risk-based levy based on the sponsor's probability of default and underfunding risk. In contrast, regulations in Germany have failed to implement constraints on moral hazard incentives. The insurance premium levied by the PSVaG is based on the annual cost of the insurance plan and is independent of a plan sponsor's probability of default, pension asset risk as well as pension funding. The annual costs are spread across the insured plan sponsors based on the total amount of pension liabilities.[1] Contributions to plan assets are voluntary. Thus, the regulation of DB corporate pension plans and insurance premia in Germany allows full discretion in both pension funding and asset allocation. An immediate consequence of this regulation is that firms with pension plans in Germany can run fully unfunded pension plans which is a generally accepted practice. They have to be recorded for as pension provisions on balance sheets. As a consequence the funding deficit (the difference between pension benefit

[1] The PSVaG only uses a cap for the maximum individually insured pension entitlement.

obligations (PBO) and the fair value of plan assets (FVPA)) for the Dax and MDax firms has grown to a non-negligible size of EUR 125 billion in 2015 which is equivalent to 4.1% of German GDP.

We study the relationship between pension funding, investment behaviour and probability of default (as well as various control variables). We differentiate between domestic and foreign plans of German firms to account for differences in regulation. We further consider some feedback effect on domestic plans if German firms also run foreign pension plans.

We first test moral hazard incentives along pension asset risk following the research approach of Rauh (2009). The moral hazard hypothesis implies that pension plans with a lower funding level have stronger incentives to invest in risky assets (i.e. equity) and a weaker incentive to invest in safe assets (i.e. bonds, insurances to cover the pension liabilities).

Second, we introduce the effect of plan sponsors' international exposure on the risk of pension investment and funding. The process of internationalising pension plans confronts corporate governance with other-than-German pension regulations concerning funding and could lead them to treat their German obligations in the same way as foreign obligations (in particular in the Anglo-Saxon world). Reasons for this include investor and media attention, a higher degree of professionalism, rated corporate bonds debt and higher analyst coverage.[2] We hypothesize that the risk shifting incentives for German plans decline in the level of international exposure.[3] To the best of our knowledge we are the first to explore the

[2] For example, DaimlerChrysler (now Daimler) first set up a contractual trust arrangement (CTA) for its employees in Germany in 1999 to comply with international standards and to 'Conform with the practices of other Group companies in the U.S. and other countries, which use pension funds according to country-specific circumstances' (DaimlerChrysler Annual Report 1999).

[3] An obvious concern with this analysis is that the firms sponsoring foreign pension plans may differ significantly from firms sponsoring domestic plans only. To ensure that our results are not driven by unobservable factors that make sample inclusion more likely, we use Heckman's (1979) two step procedure.

differences in pension asset investment behaviour of firms that run domestic as well as foreign pension plans.

Third, we test moral hazard incentives along pension funding and hypothesize that a higher probability of default is associated with a lower funding ratio for German pension plans. Although previous studies have accepted that a firm's probability of default, profitability and pension funding are likely to be jointly determined, few have addressed this concern with the exception of Chen et al. (2013) as well as An et al. (2013).

Our results are robust to a wide range of alternative specifications and subsamples. Empirically, we find risk shifting evidence for German firms concerning both the asset allocation as well as funding. We show that the marginal effect of pension funding on asset risk is significantly lower for firms with higher international exposure. In contrast, for foreign plans the relationship between the level of pension funding and asset risk as well as the relation between the probability of default and pension funding is not significant.

The remainder of this paper proceeds as follows. In Section 2 we review the relevant literature concerning the pension put hypothesis. In Section 3 we describe the institutional background and evolution of the German occupational pension system. In Section 4 we describe data and major variables. In Section 5 we report the empirical results. In Section 6 we conclude.

2 Literature review

The literature on pension funding and asset allocation mainly relies on a risk shifting and a risk management argument. The risk shifting (moral hazard) argument builds on the option pricing theory framework. A DB plan sponsor has a put option on pension assets with a strike price equal to the pension liabilities provided by pension guarantee institutions like the PBGC in the U.S., the PPF in the U.K. or PSVaG in Germany. The value of the pension put can be maximized by maintaining just a minimum funding level and/or by increasing the risk of the

underlying assets (Sharpe (1976), Treynor (1977)). In particular firms with a higher probability of default and/or lower funding have an incentive to increase the risk of their pension plan assets. The empirical literature provides mixed evidence. Cocco and Volpin (2007) who use a cross sectional database of ninety U.K.-firms find a positive relation between firm leverage and allocation to risky assets for firms with a higher proportion of trustees being member of the firm's executive board.[4] Other studies relating to portfolio allocation decision include Hsieh *et al.* (1994) who use a cross sectional dataset for 176 U.S-firms. This study reports no significant difference in the pension asset investment strategy between overfunded and underfunded firms as well as between low default risk and high default risk firms.

Empirical evidence relating to the maximization of the put option by a minimum funding level strategy include Bodie *et al.* (1987) and Francis and Reiter (1987). Both conclude that the level of funding is positively related to the firm's long run profitability and negatively to financial risk, corroborating the corporate financial perspective. Also Coronado and Liang (2005) find that firms close to financial distress have lower funding ratios. Chen *et al.* (2013) report that for firms with low probability of default the tax benefits associated with pension contributions are maximized while for firms with high default probabilities moral hazard incentives predominate which supports the pension put hypothesis.

Another strand of the literature is based on risk management posits that firms should diversify pension assets against company risk and therefore predicts a positive relationship between funding and risk. Firms with a higher default probability should decrease portfolio risk to avoid costly financial distress. Friedman's (1983) findings support the risk management hypothesis in which firms with risky cash flows tend to invest in safer assets. Also empirical evidence from Petersen (1996) suggests that the percentage of assets invested

[4] In the UK pension plans are set up in trusts. Trustees, who are responsible for the pension plan asset allocation and management, can be employees, independent individuals or part of the firm's executive management.

in bonds is negatively related to the proportion of funded liabilities and that underfunded plans hold more bonds. An *et al.* (2013) using IRS 5500 data for 1083 sponsors for the period from 1990 to 2007 model a pension beta following Jin *et al.* (2006) as a measure for pension risk. They conclude that plan sponsors with low funding levels and high probability of default undertake low investment risk. Their findings suggest that pensions are managed in the way to offset business risk. Rauh (2009) using IRS 5500 data for 1,822 pensions plans for the years from 1990 to 2003 finds that companies invest in safer assets when the plan is less funded and when the company has a lower credit rating suggesting that firms engage in risk management rather than risk shifting. Phan and Hedge (2013) examine the effects of corporate governance on pension asset allocation using 467 US plans from 1990 to 2006. They also find evidence that higher allocation to equity is positively related to higher pension funding levels.

Amid studies focussing on plan portfolio risk and pension funding others have focussed on managerial discretion in pension actuarial assumptions. Bodie *et al.* (1987) find a negative relationship between corporate profitability and discount rates applied to pension liabilities. Feldstein and Morck (1983) conclude that underfunded firms tend to choose higher discount rates to lower perceived underfunding. Bergstresser *et al.* (2006) study the expected long-term rates of return on plan assets of firms prior to the acquisition of other firms. In particular, they find that firms increase assumed rates of return when preparing to acquire another firm in order to inflate reported corporate profits and stock prices to generate higher bargaining power in the acquisition process.

Andonov *et al.* (2017) analyse the effect of the GASB guidelines and find that firms with low levels of funding per participant take more investment risk and use higher discount rates to appear less indebted. Further, taxation can influence funding and investment behaviour of plan sponsors. Tax incentives and their implications for asset allocation decisions have been examined by Tepper (1981) and Frank (2002). In the U.S. the deductibility of contributions as well as the tax exemption on pension investment earnings can

create an incentive to overfund their pension plan and rely more heavily on highly taxable securities.[5]

Most studies on occupational pension schemes focus on the U.S. or U.K. We are not aware of any study focusing on pension asset management and moral hazard regarding German DB corporate pension plans. Salewski and Zülch (2015) provide a rare analysis of the German occupational pension landscape. They study the relationship between the discretionary discount rate for pension liabilities and the market value of equity of plan sponsors. Under IAS 19 the discount rate can be determined using market yields of high-quality, fixed interest bearing corporate bonds. Additionally, wage inflation, the duration of the liabilities and the currency of the benefits to be paid amongst others can be taken into account, which leaves a substantial discretion to firms in setting discount rates. Using a sample of 160 listed German firms from 2005 to 2011 Salewski and Zülch (2014) examine how the discretion within the determination of pension discount rates affects a firm's market value of equity. They find that the part of DBO which can be attributed to the discretionary use of discount rates is not a significant predictor of market values for German companies. They suggest that investors adjust their equity valuation to reflect the previous less complex German pension regime.

3 Occupational pension schemes in Germany

Occupational pensions have a long tradition with Krupp and Siemens being one of the first well known examples to provide such schemes in 1832 and 1871 respectively albeit only after the Second World War they gained substantial importance. Major reasons were a

[5] In Germany tax treatment of DB pension schemes is less favourable. Pension contributions are tax deductible however investment taxes are levied on distributed pension plan earnings, as well as on retained earnings from dividends, interests and real estate income. Retained earnings from asset disposals and gains from forward transactions are tax free. Further, from 2018 onwards a flat investment tax rate of 15% will be levied on dividends, rents as well as profits from real estate sales.

dysfunctional capital market, high corporate taxes and the possibility to fund pension plan internally i.e. via retained earnings (book reserves). Today the book reserve system, where pension liabilities appear on the liability side on the firm's balance sheet, is still generally accepted and of widespread use. Roughly 60% of all pension liabilities are not funded by external pension funds or earmarked assets that could be used in the case of bankruptcy to fulfil the pension commitments.[6] At the end of June 2015 47.3 percent (or 10.96 million) of the active labour force employed in the private sector were covered by the occupational pension system (BMAS (2016)).[7] In 2012 occupational pension liabilities reached EUR 444 billion (at a discount rate of 6 percent),[8] which was roughly equivalent to 12.5 percent of Germany's GDP.

A pension insurance system (Pensions-Sicherungs-Verein VVaG, PSVaG) was introduced in 1974 as a private mutual insurance association with compulsory membership for all firms with pension plans that could be affected in the case of insolvency.[9] In 2017 it insured about 94,800 plans. If pension liabilities exceed pension assets the PSVaG takes over pension commitments in case of bankruptcy.[10] Resulting costs are spread across all insured firms. Insurance premia are based on the costs of the insurance plan and are currently not adjusted to the financial health of the plan sponsor, funded or unfunded status, plan portfolio

[6] In some cases pension provisions can reach a considerable size such as for Salzgitter, a steel producer where unfunded pension liabilities made up 41% of their balance sheet in 2003 while the equity was comparatively low with 27% (measured at book values). They also can play a decisive role in the negotiation of mergers and acquisitions. General Motors paid EUR 3 billion to the acquirer PSA during the sell-off of Opel/Vauxhall to fund the German pension liabilities.

[7] Bundesministerium für Arbeit und Soziales, 2017, Verbreitung der Altersvorsorge 2015.

[8] Based on the mean discount rate of 3.52 percent as used by DAX and MDAX firms in 2012 for IFRS statements the pension benefit obligations are more likely to amount to EUR 760 billion.

[9] The Pension Benefit Guarantee Corporation in the U.S. was established in the same year. In both countries it were the failure of a car manufacturer (Studebaker and Borgward) that triggered a political process that led to the setup of pension insurance schemes. General Motors paid EUR 3 billion to the acquirer PSA during the sell-off of Opel/Vauxhall to fund the German pension liabilities.

[10] In the case of pensions provision the recovery rate given default is typically below 5%.

risk or to individual default risk.[11] The insurance association itself is supervised by the German federal financial supervisor (BaFin).

Although funding of pension liabilities is not required many firms have decided to voluntarily set aside plan assets mainly in the form of contractual trust arrangements (CTA) since the early 2000s. CTAs resemble Anglo-Saxon type pension funds and allow them to cancel out pensions liabilities from the balance sheet according to international accounting standards. The establishment of such an arrangement enables plan sponsors to irrevocably transfer assets to a trustee. Plan assets are segregated and intended solely for the purpose of pension payments.[12]

Figure 1 illustrates how the average funding ratio of German pension liabilities and equity holdings has changed over time. It shows in particular a substantial increase in funding until 2007. Since then average pension funding has stagnated or mildly deteriorated which may have been fuelled by a combination of falling stock prices and later on by a fall in interest rate that led to an increase in pension liabilities.

(Figure 1 about here)

4 Data and methodology

4.1 Data

The main data set used in this study includes financial and pension plan data for the 160 largest German firms based on market capitalization that are listed on the Dax, MDax, SDax

[11] Only insurance like pension funds are granted a 80 percent reduction of the insurance premium. But they account for less than 3 percent of all of the insured volume.

[12] This trend has lead a few firms to already have highly funded German pension plans in 2000 such as Daimler (107%) and has seen many pension plans to move from a fully unfunded to an underfunded status. However, many others did not participate in this funding wave such as ThyssenKrupp, which has pension liabilities reaching EUR 7,059 million and plan assets of EUR 197 million. Its unfunded pension liabilities make up 19.97% if the balance sheet in 2015 against 16.28% in 2000.

and TecDax during the years from 2000 to 2015. To account for survivorship bias we also include all 47 firms that dropped out leaving us with a total of 194 firms out of the indices universe.[13] The sample covers about 73% of all German occupational pension liabilities in 2012.

The data for this study consists of several matched sets. We obtained financial accounting data for the period from 2000 to 2015 from the Dafne database and market values from Datastream. The dataset on occupational pension plans was hand-collected from the notes of financial statements of each firm from 2000 to 2015. For each year this data includes actuarial parameters, sensitivity analyses as well as plan asset allocation. Statements of changes in pension benefit obligation, plan assets and the decomposition of net pension expenditure were also hand-collected. For most firms and years we can differentiate between German and foreign plans. However as this reporting is not compulsory in financial statements some data points are missing leaving us with an unbalanced panel. In some cases missing data points could be interpolated. From 2005 all companies used IFRS accounting standards, prior to this US-GAAP and HGB (German commercial code) were used in financial statements. Our data on pension plans does not include values from HGB statements.[14] Table 1 reports descriptive statistics of the pension plans and firm characteristics. Consistent with differing institutional settings the mean foreign pension plan appears to be significantly better funded that the domestic plan (0.68 vs. 0.33). In fact around 25% of German pension liabilities are unfunded.

(Table 1 about here)

[13] We excluded banks and insurances from our empirical analysis as their balance sheet structure fundamentally differs from other firms.

[14] Under HGB statements the discount rate is prescribed by the German Central Bank. Accounting standards under IFRS thus leave more flexibility in discount rate assumptions.

4.2. Methodology

To test the risk shifting hypothesis we follow Rauh (2009) and estimate following equation for German and foreign pension plans:

$$Equity_{it} = \beta_0 + \beta_1 FR_{it} + \sum_k \gamma_k Z_{kit} + \theta_t + \mu_i + u_{it} \quad (1)$$

$$Equity_{it} = \beta_0 + \beta_1 FR_{it} + \sum_k \gamma_k Z_{kit} + \theta_t + u_{it} \quad (2)$$

Following the literature (see for example Rauh (2009), Andonov et al. (2017) and Bikker et al (2012)) we measure pension portfolio risk by the percentage of assets invested in equity ($Equity_{it}$). Alternatively as risk-free investment we consider the allocation to insurances. Following Davis and de Haan (2012) we define the funding ratio (FR_{it}) as the ratio of the fair value of plan assets (FVPA) to projected benefit obligations (PBO).[15] We adjust pension benefit obligations (PBO) to their industry mean discount rate for each year. Previous work (Andonov et al. (2017)) reports that underfunded pension funds are more likely to make liberal actuarial choices to reduce perceived underfunding and to reduce pension contributions. Z_{kit} represents a vector of control variables, θ_t represents time fixed effects such as shocks to interest rates or the business cycle and μ_i represents time-invariant unobservable firm-fixed effects such as management performance.

We control for non-monotonic size effects by including the linear and logarithm of the firm's total market value of plan assets as larger pension plans tend to invest more in equity (Bikker et al. (2012). Second, we control for plan duration as optimal life-cycle saving models such as Bodie et al (1992) suggest that over a life cycle the proportion of assets invested in equity should decline.[16] We use plan duration as we do not observe the share of active

[15] This measure is equivalent to that used by Rauh (2009) and in our study more convenient to use, as most pension plans are underfunded.

[16] Bikker et al. (2012) confirm this hypothesis for Dutch pension plans.

employees or average maturity date of pension plans and expect the relation between duration of pension liabilities and the percentage of plan assets invested in equity to be positive.

Our hypotheses predict firms with lower (higher) funding ratios to invest more in risky (safe) assets. For equity holdings the predicted sign of the coefficient is negative for the funding ratio of German pension plans and positive for foreign plans. In all regressions standard errors are heteroscedasticity robust and clustered by firm.

To further analyse the influence of international exposure on the pension asset allocation of domestic plans we include $FR_{it} * int.exposure$ as interaction term between international exposure and the funding ratio. We define international exposure ($int.exposure$) as the fraction of foreign PBO to the total for firms with foreign pension plans.

As theoretical models and empirical evidence show that only the most productive firms engage in foreign activity (e.g. Melitz (2003) and Helpman et al. (2004)) it is possible that our coefficient estimate for international exposure is endogenous to unobservable factors that cause selection bias in our OLS estimates. To address this potential selection bias we employ the Heckman (1979) two step method, to check whether our conclusions regarding the effect of international exposure on pension investment risk are driven by unobservable factors that make sample inclusion more likely. First, we estimate an equation of the following form:

$$D_i = \alpha + \beta Z_i + \epsilon_i \qquad (3)$$

using a standard probit model relating the probability of sponsoring a foreign pension plan to firm characteristics. Explanatory variables of the first stage estimation include firm size, EBIT to total assets, return on assets, Tobin's Q, firm age as well as year and industry fixed effects. The probit estimates are shown in the Appendix (Table A.1).

Second, we estimate the following equations:

$$Equity_{it} = \beta_0 + \beta_1 FR_{it} + \beta_2 FR_{it} * Int.visibility + \sum_k \gamma_k Z_{kit} + \lambda_{it} + \theta_t + \mu_i + u_{it} \quad (4)$$

$$Equity_{it} = \beta_0 + \beta_1 FR_{it} + \beta_2 FR_{it} * Int.visibility + \sum_k \gamma_k Z_{kit} + \lambda_{it} + \theta_t + u_{it} \quad (5)$$

where the inverse Mills ratio λ_{it} controls for intrinsic firm differences. The set of control variables in both stages is different, which together with the differing distributional assumptions provide identification of the relationship between international exposure, pension funding and asset risk.

The second risk shifting dynamic we seek to analyse concerns the relationship between firm default risk and pension funding. To test for this we relate the German pension funding ratio and alternatively the foreign funding ratio to the DB plan sponsors' probability of default. We expect sponsors with a higher probability of default to have a lower German and a higher foreign funding ratio.

As noted earlier, pension funding and the probability of default can be endogenously determined. Omitted unobservable variables may affect pension funding and the probability of default simultaneously. Further endogeneity can arise from reverse causality. Pension plan sponsors can have a high probability of default and low profitability because of large unfunded liabilities, on the other hand firms with a high probability of default can deliberately choose to fund pension plans as little as possible. Even though in the German case high pension risk and important underfunding does not obligate firms to make mandatory contributions to plan assets and reduce capital expenditure leading to poor operating performance as shown by Rauh (2006), we address potential endogeneity in three ways. First to account for unobserved omitted variables we include sector and year fixed effects. Following Salewski and Zülch (2014) we use the sector classification from the German stock exchange (Deutsche Börse). Second, we use the lagged value of probability of default. Third, due to a high persistence in default probabilities and credit ratings we develop a 3SLS

simultaneous equation model following Chen et al. (2013) to account for the possibility of simultaneity between probability of default, firm profitability and the funding level, where the third stage specification is of the form:

$$FR_{it} = \beta_0 + \beta_1 PD_{it-1} + \beta_2 Int.visibility + \sum_k \gamma_k Z_{kit} + \theta_t + \sigma_s + u_{it} \qquad (6)$$

where PD_{it-1} represents the probability of default. We control for other variables capturing financial health of the pension plan sponsor such as EBIT to total assets as a measure of profitability and working capital to total assets as a measure of financial liquidity. Additionally we include linear and non-monotonic size effects as well as the book-to-market ratio (BtoM) to capture the effects of market optimism. For comparative purposes we further include OLS estimates in Table 10.

5. Results

Table 2 reports the empirical findings for the relation between pension funding and the asset allocations to equity (Panel A) and to insurances (Panel B) for domestic (German) pension plans only. Columns 1-2 report pooled regression results that include year fixed effects while columns 3-4 include both year and firm fixed effects. As in Rauh (2009) we estimate the relation for all firms that do not exclusively buy insurances.

(Table 2 about here)

Panel A illustrates our first main result that the pension funding ratio is (significantly) negatively correlated to the ratio of equity holdings. This result holds both at the cross section as well as at firm level and indicates that a 10-percentage point higher funding ratio is

associated with a 0.91 to 1.27 percentage point reduction in the allocation to equity, which amounts to 4.83-6.71% of a standard deviation in equity allocation. Turning to the allocation to insurances (panel B) we find a (marginally significant) yet inverse pattern with a 10-percentage point higher funding ratio being associated with a 0.86 to 2.27 percentage point increase in the allocation to insurances. Concerning the control variables we find that at firm level an increase in plan size is associated with a higher allocation to equity which is in line with both the argument and the empirical evidence put forward by Bikker et al (2012). However we find this effect to be small as at firm level a 1-billion bigger pension plan is associated with only a 0.0047 to 0.0075 percentage point higher allocation to equity. We find no evidence of plan duration having a significant effect on asset allocation.

Table 3 reports the findings for foreign pension plans of German firms. From our sample 101 firms are exposed to other than German pension liabilities.[17] The average (median) international exposure is 0.3793 (0.3442) with a standard deviation of 0.2372. As expected we do not see a negative relationship between the funding ratio and equity holdings albeit the results are not statistically significant. The magnitude of the coefficients for the funding ratios is in line with Rauh (2009).

Taken as a whole, the negative relation between the level of German funding and the allocation to risky assets as well as the different pattern for foreign plans is consistent with the hypothesis that the weak regulation in Germany gives a high leeway and leads to moral hazard.

Next, we test the effect of international exposure on moral hazard incentives for domestic plans. Table 4 reports the results for the allocation to equity. Columns 1 to 3 report cross sectional results and columns 4 to 6 fixed effects results. The interaction term is statistically significant in all estimations and implies that as international exposure increases

[17] Table A.2 reports summary statistics for firms holding foreign pension plans and for firms holding domestic plans only.

risk shifting behaviour declines. Column 1 suggests that risk shifting is present for firms with levels of international exposure below 0.58[18]. This means that only few firms, with high international exposure hold a less risky portfolio in the case of low funding, while firms with low international exposure increase portfolio risk when the level of funding declines. As most firms have lower levels of international exposure than the thresholds based on columns 1 to 6, risk shifting appears to be a predominant phenomenon among German pension plans.

(Table 4 around here)

Considering our full specifications in columns 3 and 6 we find that for a firm with median international exposure a 10-percentage point higher funding ratio is associated with a 1.4 to 1.7 percentage point lower allocation to equity.[19] This effect is non negligible in terms of size as it equates to about 7.43% to 9.03% of the standard deviation in the allocation to risky assets. For the left tail of the distribution (25th percentile) a 10-percentage point increase in funding is associated with a 3.42-3.43 percentage point lower allocation to equity. In contrast, when considering the 90th percentile risk management is visible in the sense that a 10-percentage point increase in the funding ratio leads to a 0.38 to 0.94 percentage point higher allocation to equity.

Columns 2, 3, 5 and 6 show that including additional controls has no effect on this finding. First we add *No rating* which is an indicator variable that equals to one for firms without rating as this has strong implications for both the capital structure of firms and its investment policy (Faulkender and Petersen (2005) and Sufi (2009)). Column 2 shows that the relation between the funding variable, the interaction term and the allocation to equity remains strong. At the cross section having a rating is associated with a higher allocation to

[18] The mean (median) value of international exposure is 0.38 (0.34) and the 75th percentile is 0.56.

[19] The calculation is as follows: $10 * (-0.34 + 0.59 * 0.34) = 1.4$

equity. Second, we include a firm's probability of default (*PD*) as pension funding and default probability are likely to be endogenously determined.[20] Our results indicate that at firm level (column 6) a high probability of default is associated with higher investment risk. In particular, a 10-percentage point higher default probability is associated with a 0.39 percentage point greater allocation to equity, which provides further support for our hypothesis that a higher default probability is associated with a riskier allocation of pension assets. Further, the significance of our main variables of interest are unaffected by the inclusion of *PD*.

Regarding the control variables the size effect appears non-monotonic and decreasing for values of up to EUR 7.5 billion and increasing for values above that threshold. This is in contrary to the findings from Rauh (2009), but supports Bikker et al. (2012) as we find size being positively associated with the allocation to risky assets for the largest pension plans. Further, contrary to the life cycle theory and to empirical evidence from An et al. (2013), Rauh (2009) and Bikker et al. (2012) our regressions show no significant relation between duration and pension asset allocation.

Next, we examine the relation between domestic pension funding and the allocation to insurances. For the regressions including firm fixed effects we restrict the sample to firms with positive variation in insurance holdings. Table 5 reports the regression results. As expected compared to the results focussing on pension allocation to risky assets the results show a similar but inverse pattern.

[20] We measure the probability of default following Gerke et al. (2008), who calibrated a logit model for a vast sample of German firms that sponsor occupational pension schemes. Although many studies derive the probability of distress from credit ratings (see for example Rauh (2009) and Bodie et al (1987)) we have chosen to focus on the above measure as it is continuous and also available for firms without credit ratings. As the bond market is traditionally less important than bank lending in Germany 124 firms from our sample never held a credit rating from either S&P, Moody's or Fitch.

(Table 5 about here)

We find significant results pointing to risk shifting behaviour for levels of international exposure below 0.84 (column 6), indicating that for most firms a higher funding ratio is associated with a higher allocation to low risk assets. Further, a higher probability of default is correlated with a lower allocation to insurances both at firm level and at the cross section. These results provide first evidence that risk taking in pension assets is positively related with domestic pension funding and weakly positively related with the probability of default. While moral hazard in the form of risk shifting is present for German corporate pension plans international exposure has a significant impact on risk taking.

Next, we conduct three robustness tests for the regressions. First, we consider the possibility that our results are primarily driven by small firms, which may differ significantly from the rest of the firms. To give firms with a higher number of plan participants more weight we show in Table 6 results of regressions that are weighted by the number of employees. It appears that our previous results are not disproportionately affected by small firms, as the equity specifications suggest that risk shifting dominates for levels of international exposure below 0.65 to 0.74. These results are further corroborated at firm level relating pension funding to the allocation to insurances. Here risk shifting is associated with levels of international exposure below 0.65 to 0.68.

(Table 6, 7 and 8 about here)

In Table 7 we show equally weighted regression results for the DAX 30 firms separately as they constitute the majority in terms of pension obligations (about 60 percent of all German occupational pension liabilities). Again, the regression results are similar both in terms of size as well as in terms of significance to our previous results.

Finally, as pension plan size and the level of international exposure are positively correlated we test whether the positive interaction effect between funding and international exposure is in fact due to the interaction of funding and pension plan size. We include additional interaction terms between the level of funding and pension plan size, as well as an interaction between international exposure and size (Table 8). The relation between pension funding and asset allocation as well as the marginal effect of funding as international influence increases remain robust to the inclusion of the additional interaction terms.

Thus far, we have shown that a plan sponsor's risk shifting incentive is declining in the degree of international exposure. Our results emphasize the dynamic nature of risk shifting behaviour. That is, pension plan sponsors treat pension plans differently according to the pension regulations that apply to them and may shift their asset allocation under the influence of international exposure. In particular, the risk shifting incentive dominates for German but not for foreign plans.

Next, we examine how the pension funding strategy is related to firm financial health. In Table 9 we report funding regression results for German and foreign plans separately. For brevity we report only the results for the funding equations (6). Table A.3 reports the probability of default model and the profitability models.[21]

(Table 9 and 10 about here)

Considering German pension plans we find that the coefficient estimate on PD is in the predicted direction of risk shifting. The results are significant at the 1% level and are consistent with the pension put hypothesis as well as with the empirical findings of Coronado and Liang (2005). Further, as predicted, international exposure is associated with higher

[21] The probability of default model has EBIT/TA, WC/TA, Size, log(size), and funding as control variables; the profitability model has PD, WC/TA, Size, log(size) and funding as control variables.

German funding. A 10-percentage point higher international exposure is associated with 1.67-percentage point higher German funding (in size this corresponds to 4.1% of the standard deviation) suggesting that firms whose exposure on international markets is higher tend to behave more conservative in Germany. Also the coefficients relating to earnings and firm liquidity point in the direction of moral hazard, as more profitable firms and firms with high liquidity hold better funded pension plans. Considering the control variables we find that there is a non-monotonic positive relation between plan size and funding. Further, having a rating appears to be associated with a higher German funding level. This is consistent with the political cost hypothesis put forward by Francis and Reiter (1987). We further include the book-to-market ratio as a proxy for market optimism. Our results predict a significant negative relation between book-to-market ratios and the funding ratio of German pension plans.

Overall the key result that we draw from our regression results is that moral hazard is an important determinant of domestic pension funding in the sense that firms with a higher probability of default respond by underfunding their pension plans. International exposure appears to attenuate this effect.[22]

Next in panels 3 and 4 of Table 9 we report the results for foreign funding. As predicted the probability of default has no significant effect on the level of funding for foreign plans. Concerning EBIT to total assets we find that higher profitability is associated with higher foreign funding. In contrast, in terms of liquidity our results suggest that firms with more liquidity hold pension plans with lower funding ratios. Further the relation between the two variables and funding does not appear to be robust. Including sector fixed effects in column 4 reduces the magnitude and significance of both coefficient estimates. Further, consistent with the specifications focussing on German funding we find a positive relation

[22] Hausman specification tests rejects the consistency of OLS estimates relative to 3SLS for German pension plans.

between international exposure and foreign pension funding. Comparing the results for domestic and foreign plans suggests that the effect of international exposure is stronger for foreign plans (3.51 for foreign firms and 0.17 for German firms). Overall the pattern is consistent with our hypotheses, that a plan sponsor's financial health has no robust effect on the level of funding for foreign pension plans.

6 Conclusion

In this paper we analyse the determinants of pension funding and pension asset investment behaviour for a comprehensive set of German firms. We base our approach on Germany as it has a very weak regulatory environment when it comes to the funding of occupational pension schemes. Using the sharp contrast between the Anglo-Saxon world and Germany, where non-funding is an accepted standard, we explicitly distinguish between German and foreign pension plans and consider feedback effects.

Our first main finding indicates that the risk shifting behaviour is dynamic in nature. But we further find that risk shifting depends also on the firm individual international exposure concerning pension plans. Firms with strong international exposure tend to treat domestic pension plans in the same way as foreign pension plans, i.e. they invest more in low risk assets when funding ratios decline, while firms with low international exposure however increase their investment risk. The level of foreign pension plan funding has no significant effect on pension asset risk. Our second main finding is that firms with a high default probability run lower funded German pension plans.

Both findings concerning German plans are consistent with the pension put hypothesis and provide evidence that moral hazard is at play through higher pension investment risk and through lower funding. International exposure acts as opposing force to risk shifting incentives.

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Table 1: Summary statistics of pension plan characteristics and firm financial measures.

	Mean	P25	P50	P75	SD	N
Plan characteristics (million EUR):						
PBO total	2016.17	16.47	109.04	803.60	5301	1984
PV total	1148.35	0.32	22.55	297.64	3623	1954
PBO domestic	1308.25	12.91	79.03	527.00	3534	1641
PV domestic	669.57	0.00	2.04	91.46	2249	1612
Plan characteristics (shares):						
FR (domestic)	0.3305	0.0020	0.2138	0.6274	0.3377	735
Int. Exposure	0.3793	0.1935	0.3442	0.5595	0.2372	735
Asset allocation (%):						
Equity	23.42%	2.50%	23.60%	35.00%	18.83%	1050
Bonds	35.87%	12.00%	40.00%	55.23%	24.89%	1050
Real estate	4.70%	0.00%	0.71%	5.33%	9.00%	1050
Insurances	23.26%	0.00%	0.00%	26.67%	38.80%	1050
Other	12.82%	0.68%	7.86%	16.46%	17.77%	1048
Firm characteristics:						
EBIT/TA	0.2297	0.0401	0.0726	0.1109	0.1032	2029
WC/TA	0.4531	0.2843	0.4752	0.6211	0.2268	2029
B-to-M	0.6943	0.3685	0.5637	0.8769	0.5491	1745
PD	9.10%	0.29%	2.40%	10.40%	15.96%	2028

Note: This table presents summary statistics for pension plan and firm characteristics for the full sample. Data concerning pension plans are hand-collected for the period from 2000 to 2015. Financial firm data are from Dafne database. We exclude companies from the financial sector. *FR (domestic)* represents the funding ratio of German plans; *Int. exposure* is defined as the proportion of foreign pension liabilities to the total; *EBIT / TA*, is calculated as EBIT to total assets; *WC/TA*, is defined as the working capital to total assets; *B-to-M*, represents the firm's book-to-market ration; *PD*, the firm's probability of default. *Equity*, *Bonds*, *Real Estate*, *Insurances* and *Other* are the percentage on pension assets allocated to each asset class.

Table 2: Equity allocation and domestic pension funding

	Panel A: Equity				Panel B: Insurances			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
FR (domestic)	-0.1231***	-0.1265***	-0.0920***	-0.0906**	0.0856	0.1094	0.2003*	0.2269*
	(-2.9038)	(-3.0361)	(-2.6362)	(-2.5361)	(0.7377)	(1.0368)	(1.7029)	(1.8688)
Size	-0.0050	-0.0026	0.0075**	0.0047*	0.0432***	0.0385***	-0.0186	-0.0109
	(-0.8617)	(-0.5221)	(2.4147)	(1.6708)	(4.1242)	(4.1170)	(-1.3294)	(-0.7753)
log(Size)	0.0743*	0.0515	-0.0224	0.0158	-0.4063***	-0.3625***	-0.1125	-0.1470**
	(1.7913)	(1.3650)	(-0.7134)	(0.5200)	(-5.0581)	(-4.9226)	(-1.6125)	(-2.0687)
Duration	0.0003	0.0002	0.0000	-0.0003	0.0006	0.0020	-0.0004	-0.0005
	(0.2203)	(0.1821)	(0.0463)	(-0.3043)	(0.2019)	(0.6997)	(-0.2775)	(-0.3091)
Inv. Return (t-1)		0.0239		-0.0536		-0.0859		-0.3872
		(0.3633)		(-0.9525)		(-0.6603)		(-0.7950)
Intercept	0.4371***	0.4638***	0.4016***	0.3723***	0.1430	0.0491	0.0391	0.1212
	(5.9613)	(5.5611)	(5.7453)	(5.1832)	(1.4099)	(0.3497)	(0.4982)	(1.3001)
N	873	759	856	742	873	759	373	338
R-squared	0.311	0.380	0.258	0.3188	0.363	0.376	0.2202	0.2201
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plan FE	No	No	Yes	Yes	No	No	Yes	Yes

Note: This table reports equally weighted panel least squares regression results. The dependent variable is the percentage pension allocation to equity or insurances. The sample consists of all firms for which assets are not exclusively invested in insurances. All specifications contain year fixed effects and standard errors are heteroscedasticity robust clustered at firm level. German pension funding (*FR (domestic)*) is defined as the fraction of the German fair value of plan assets (FVPA) to German projected benefit obligations (PBO). *Size* denotes pension plan size (billion EUR). *Duration* is the average duration of a pension plan's liabilities. *Inv. return* denotes the return on pension assets and is measured in the previous year. *t*-statistics are reported in parentheses. ***, **, * indicate significance levels of 1%, 5% and 10%.

Table 3: Equity allocation and foreign pension funding

	Panel A: Equity				Panel B: Insurances			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
FR (foreign)	0.0658	0.0461	0.0489	0.0150	-0.0250	-0.0169	-0.0219	0.0017
	(1.0304)	(0.7272)	(0.6139)	(0.1789)	(-0.3326)	(-0.2501)	(-0.1444)	(0.0118)
Size	0.0055	0.0062	0.0078**	0.0087***	0.0165***	0.0164***	-0.0146	-0.0119
	(0.9358)	(1.0429)	(2.3952)	(2.8164)	(3.3469)	(3.4300)	(-1.3104)	(-1.0940)
log(Size)	-0.0397	-0.0444	-0.0526*	-0.0505	-0.1616***	-0.1615***	-0.0852	-0.1076
	(-0.9336)	(-1.0197)	(-1.6499)	(-1.4513)	(-3.8157)	(-3.9525)	(-1.0053)	(-1.3490)
Duration	0.0017	0.0016	0.0001	-0.0003	-0.0008	-0.0004	0.0000	-0.0000
	(1.1232)	(1.0851)	(0.0737)	(-0.2777)	(-0.6409)	(-0.2654)	(0.0167)	(-0.0223)
Inv. Return (t-1)		-0.2037		-0.2717***		0.3042		0.2293
		(-1.5127)		(-3.4557)		(0.9815)		(0.7762)
Intercept	0.4386***	0.4167***	0.4014***	0.3567***	0.1142**	0.1925**	0.0100	0.0635
	(5.5574)	(5.4679)	(5.0376)	(4.6286)	(2.2138)	(2.4024)	(0.1474)	(0.7010)
N	623	579	623	579	627	583	312	287
R-squared	0.272	0.268	0.358	0.3693	0.204	0.211	0.229	0.2085
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plan fixed effects	No	No	Yes	Yes	No	No	Yes	Yes

Note: This table reports equally weighted panel least squares regression results. The dependent variables is the percentage pension allocation to equity or insurances. The sample consists of all firms for which assets are not exclusively invested in insurances. All specifications contain year fixed effects and standard errors are heteroscedasticity robust clustered at firm level. Foreign pension funding (*FR (foreign)*) is defined as the fraction of the foreign fair value of plan assets (FVPA) to foreign projected benefit obligations (PBO). *Size* denotes pension plan size (billion EUR). *Duration* is the average duration of a pension plan's liabilities. *Inv. return* denotes the return on pension assets and is measured in the previous year. *t*-statistics are reported in parentheses. ***, **, * indicate significance levels of 1%, 5% and 10%.

Table 4: Pension equity holdings and funding of German plans

	(1)	(2)	(3)	OLS	(4)	(5)	(6)	OLS
FR (domestic)	-0.3665***	-0.3432***	-0.3432***	-0.3015***	-0.3352***	-0.3355***	-0.3449***	-0.2768***
	(-4.0417)	(-3.8526)	(-3.8528)	(-3.1791)	(-3.0881)	(-3.1137)	(-3.2337)	(-2.7622)
FR (domestic) x int. exp.	0.6363***	0.5903***	0.5902***	0.5299**	0.5033**	0.5031**	0.5177**	0.3776*
	(3.1188)	(3.0039)	(3.0051)	(2.5955)	(2.3471)	(2.3589)	(2.4542)	(1.9773)
No rating		-0.0501**	-0.0500**	-0.0351		0.0050	0.0058	0.0143
		(-2.1779)	(-2.1893)	(-1.4663)		(0.1530)	(0.1840)	(0.4837)
PD			-0.0027	-0.0096			0.0392**	0.0152
			(-0.0895)	(-0.3339)			(2.2300)	(0.8310)
Int. exp.	-0.3276***	-0.3242***	-0.3242***	-0.2681***	-0.2502**	-0.2504**	-0.2577**	-0.1820
	(-3.2295)	(-3.3821)	(-3.3833)	(-2.6944)	(-2.1894)	(-2.1902)	(-2.2559)	(-1.6217)
Size	0.0081*	0.0105**	0.0105**	0.0069	0.0062	0.0062	0.0060	0.0071*
	(1.9369)	(2.4303)	(2.4237)	(1.3968)	(1.5706)	(1.5958)	(1.6272)	(1.9617)
Log(Size)	-0.0513	-0.0787*	-0.0789*	-0.0393	-0.0077	-0.0073	-0.0050	-0.0135
	(-1.4120)	(-1.9997)	(-1.9776)	(-0.9005)	(-0.1343)	(-0.1300)	(-0.0901)	(-0.2617)
Duration	0.0010	0.0006	0.0006	0.0017	-0.0002	-0.0001	-0.0002	-0.0000
	(0.7476)	(0.4723)	(0.4684)	(1.3356)	(-0.1284)	(-0.1126)	(-0.1192)	(-0.0195)
Lambda	-0.0694**	-0.0558**	-0.0554**		-0.0518	-0.0507	-0.0557	
	(-2.5018)	(-2.1702)	(-2.1607)		(-0.8556)	(-0.8377)	(-0.9202)	
Intercept	0.6726***	0.6996***	0.7003***	0.6423***	0.5897***	0.5874***	0.5838***	0.5297***
	(10.1395)	(10.4218)	(10.0981)	(9.5335)	(7.6656)	(7.4184)	(7.4243)	(8.7098)
Observations	484	484	484	542	484	484	484	542
R-squared	0.462	0.472	0.471	0.434	0.371	0.369	0.372	0.368
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plan FE	No	No	No	No	Yes	Yes	Yes	Yes

Note: This table reports equally weighted panel least squares regression results. The dependent variable is the percentage pension allocation to equity. The sample consists of all firms for which assets are not exclusively invested in insurances. All specifications contain year fixed effects and standard errors are heteroscedasticity robust clustered at firm level. German pension funding (*FR (domestic)*) is defined as the fraction of the German fair value of plan assets (FVPA) to German projected benefit obligations (PBO); International exposure (*Int. exp.*). is defined as the proportion of foreign PBO to the total; F*R (domestic) x int. exposure* is an interaction term between pension funding and international exposure; *Size* denotes pension plan size (billion EUR). *Duration* is the average duration of a pension plan's liabilities. Heckman's *Lambda* is estimated from the probit regressions in Table A.2; *No rating* is a dummy variable taking a value of one if a plan sponsor has a debt rating; *PD* is the plan sponsor's probability of default. *t*-statistics are reported in parentheses. ***, **, * indicate significance levels of 1%, 5% and 10%.

Table 5: Pension insurance holdings and funding of German plans

	(1)	(2)	(3)	OLS	(4)	(5)	(6)	OLS
FR (domestic)	0.5208**	0.4150*	0.4602*	0.3080	0.7261***	0.7160***	0.7694***	0.5175*
	(2.2006)	(1.8362)	(2.0464)	(1.3863)	(2.8632)	(2.9082)	(3.1327)	(1.9299)
FR (domestic) x Int. exp.	-0.4729	-0.3831	-0.4638	-0.2841	-0.8430***	-0.8446***	-0.9137***	-0.7983**
	(-1.3409)	(-1.0328)	(-1.2339)	(-0.6249)	(-2.9492)	(-2.9241)	(-3.1656)	(-2.4683)
No rating		0.0764	0.0776	-0.0022		0.0126	0.0095	0.0962
		(0.9091)	(0.9373)	(-0.0275)		(0.1952)	(0.1499)	(0.9436)
PD			-0.1077*	-0.1488**			-0.0770**	-0.0600*
			(-1.7607)	(-2.2118)			(-2.1116)	(-1.7972)
Int. exp.	-0.1634	-0.1681	-0.1452	-0.0632	0.3076	0.3051	0.3294	0.2162
	(-1.0303)	(-1.0225)	(-0.8915)	(-0.2844)	(1.1563)	(1.1615)	(1.2858)	(1.2283)
Size	-0.0000**	-0.0000**	-0.0000**	-0.0000*	-0.0000*	-0.0000*	-0.0000*	-0.0000**
	(-2.4141)	(-2.4571)	(-2.3487)	(-1.8276)	(-2.0447)	(-1.9041)	(-1.7269)	(-2.1939)
Log(Size)	-0.0453**	-0.0291	-0.0315	-0.0466**	-0.0534	-0.0513	-0.0529	0.0255
	(-2.3052)	(-1.2151)	(-1.3601)	(-2.3613)	(-0.9999)	(-0.9669)	(-0.9993)	(0.9989)
Duration	-0.0033	-0.0030	-0.0025	-0.0032*	-0.0006	-0.0005	-0.0005	-0.0008
	(-1.6245)	(-1.4063)	(-1.2144)	(-1.7447)	(-0.3433)	(-0.2815)	(-0.2633)	(-0.4485)
Lambda	0.0313	0.0651	0.0889		-0.5895**	-0.5744***	-0.5673***	
	(0.2760)	(0.6126)	(0.8313)		(-2.5662)	(-2.8877)	(-2.9975)	
Intercept	0.1907	0.0651	0.1052	0.2123*	0.3232	0.3047	0.3250	-0.1762
	(1.2552)	(0.3563)	(0.5824)	(1.6971)	(1.3451)	(1.2450)	(1.3292)	(-1.2110)
Observations	189	189	189	240	189	189	189	240
R-squared	0.336	0.348	0.357	0.291	0.354	0.351	0.358	0.236
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plan FE	No	No	No	No	Yes	Yes	Yes	Yes

Note: This table reports equally weighted panel least squares regression results. The dependent variable is the percentage pension allocation to insurances The sample consists of all firms for which assets are not exclusively invested in insurances. All specifications contain year fixed effects and standard errors are heteroscedasticity robust clustered at firm level. German pension funding (*FR (domestic)*) is defined as the fraction of the German fair value of plan assets (FVPA) to German projected benefit obligations (PBO); International exposure (*Int. vis*). is defined as the proportion of foreign PBO to the total; *FR (domestic) x int. exposure* is an interaction term between pension funding and international exposure; *Size* denotes pension plan size (billion EUR). *Duration* is the average duration of a pension plan's liabilities. Heckman's *Lambda* is estimated from the Probit regressions in Table A.2; *No rating i*s a dummy variable taking a value of one if a plan sponsor has a debt rating; *PD* is the plan sponsor's probability of default. *t*-statistics are reported in parentheses. ***, **, * indicate significance levels of 1%, 5% and 10%.

Table 6: Asset allocation and German funding

	Equity				Insurances			
	(1)	OLS	(2)	OLS	(1)	OLS	(2)	OLS
FR (domestic)	-0.3433***	-0.3167***	-0.3176***	-0.2961***	0.0821	0.0743	0.6421**	0.4114*
	(-3.1312)	(-2.9944)	(-4.0385)	(-3.4421)	(0.4588)	(0.5500)	(2.4070)	(1.8521)
FR (domestic) x Int. exp.	0.5243**	0.4849**	0.4249**	0.3976**	-0.4174	-0.4372	-0.9779**	-0.6002*
	(2.6503)	(2.6477)	(2.4867)	(2.2451)	(-1.1540)	(-1.3917)	(-2.6700)	(-1.7546)
Int. Exposure	-0.3169***	-0.2872***	-0.1626**	-0.1539**	0.0812	0.0687	0.5633*	0.1419
	(-3.2971)	(-3.0693)	(-2.2709)	(-2.4033)	(0.5151)	(0.5196)	(1.7458)	(0.5820)
PD	0.0286*	0.0234	0.0013	-0.0029	0.0063	-0.0292	-0.0086	-0.0103
	(1.7887)	(1.5807)	(0.0898)	(-0.2087)	(0.2996)	(-1.1908)	(-0.5015)	(-0.5102)
Duration	-0.0011	-0.0006	-0.0012	-0.0011	0.0005	-0.0006	-0.0014	-0.0008
	(-1.1938)	(-0.5324)	(-1.4211)	(-1.3237)	(0.4624)	(-0.5739)	(-0.8813)	(-0.7302)
No rating	-0.0580**	-0.0402	0.0027	0.0124	-0.0151	-0.0379	-0.0489	-0.0190
	(-2.2107)	(-1.4734)	(0.1098)	(0.5011)	(-0.1863)	(-0.7089)	(-0.6080)	(-0.2731)
Size	0.0112***	0.0088**	0.0028	0.0036	0.0007	0.0103	-0.0035	-0.0201**
	(3.4379)	(2.4356)	(0.7751)	(0.9670)	(0.0816)	(1.0677)	(-0.3944)	(-2.0475)
Log(Size)	-0.0801**	-0.0516	0.0451	0.0325	-0.0471	-0.1014**	-0.1666	0.0157
	(-2.1673)	(-1.5424)	(0.7493)	(0.5596)	(-1.0961)	(-2.0407)	(-1.5414)	(0.2440)
Lambda	-0.0488		0.1321*		0.0057		-0.3358*	
	(-0.7476)		(1.8332)		(0.0834)		(-1.7478)	
Intercept	0.7079***	0.6647***	0.4354***	0.4571***	0.0361	0.0688	0.0271	-0.0257
	(6.8528)	(7.1772)	(4.2871)	(5.1922)	(0.7427)	(1.1041)	(0.3910)	(-0.3837)
Observations	498	556	498	556	221	272	221	272
R-squared	0.595	0.567	0.604	0.587	0.317	0.381	0.299	0.233
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plan FE	No	No	Yes	Yes	No	No	Yes	Yes

Note: This table panel least squares regression results weighted by the number of employees. The dependent variable is the percentage pension allocation to equity or insurances. The sample consists of all firms for which assets are not exclusively invested in insurances. All specifications contain year fixed effects and standard errors are heteroscedasticity robust clustered at firm level. German pension funding (*FR (domestic)*) is defined as the fraction of the German fair value of plan assets (FVPA) to German projected benefit obligations (PBO); International exposure (*Int. vis*). is defined as the proportion of foreign PBO to the total; *FR (domestic) x int. exposure* is an interaction term between pension funding and international exposure; *Size* denotes pension plan size (billion EUR). *Duration* is the average duration of a pension plan's liabilities. Heckman's *Lambda* is estimated from the probit regressions in Table A.2; *No rating* is a dummy variable taking a value of one if a plan sponsor has a debt rating; *PD* is the plan sponsor's probability of default. *t*-statistics are reported in parentheses. ***, **, * indicate significance levels of 1%, 5% and 10%.

Table 7: Asset allocation and German funding (Dax firms)

	Equity				Insurance			
	(1)	OLS	(2)	OLS	(3)	OLS	(4)	OLS
FR (domestic)	-0.2640**	-0.2410**	-0.2779***	-0.2735**	0.2680	0.1383	0.2715	0.2229
	(-2.7444)	(-2.2937)	(-3.4669)	(-2.8055)	(0.7252)	(0.4595)	(0.8128)	(0.7932)
FR (domestic) x Int. exp.	0.4915**	0.4420**	0.3902**	0.4076**	-0.8744	-0.3658	-0.6961	-0.3780
	(2.7370)	(2.2232)	(2.1695)	(2.2242)	(-1.6697)	(-0.9259)	(-1.5458)	(-1.2350)
Int. Exposure	-0.2609**	-0.2318**	-0.1577	-0.1481	0.2280	-0.0482	-0.0179	-0.1340
	(-2.4273)	(-2.1993)	(-1.6402)	(-1.6597)	(0.5578)	(-0.1604)	(-0.0517)	(-0.4857)
PD	0.0363**	0.0359**	0.0112	0.0107	0.0065	0.0101	-0.0040	-0.0056
	(2.0933)	(2.2855)	(0.6060)	(0.6260)	(0.1846)	(0.3380)	(-0.1117)	(-0.2054)
Duration	-0.0010	-0.0008	-0.0016	-0.0014	-0.0008	-0.0010	-0.0024	-0.0023
	(-0.6855)	(-0.6165)	(-1.1644)	(-1.0443)	(-0.3869)	(-0.5375)	(-1.1553)	(-1.2082)
No rating	-0.0005	0.0169	0.0318	0.0486	-0.1466	-0.1604	-0.1566	-0.1553
	(-0.0118)	(0.4035)	(1.0969)	(1.5370)	(-1.3235)	(-1.3074)	(-1.5829)	(-1.4428)
Size	0.0066	0.0069	0.0051	0.0061*	0.0054	-0.0026	-0.0035	-0.0076
	(1.4226)	(1.4836)	(1.5272)	(1.7480)	(0.5266)	(-0.2688)	(-0.3488)	(-0.8339)
Log(Size)	-0.0514	-0.0563	0.0148	-0.0119	0.0510	0.0833	0.1289	0.1070*
	(-1.2095)	(-1.3239)	(0.2819)	(-0.2435)	(0.3892)	(1.3346)	(1.2692)	(2.1683)
Lambda	0.1398**		0.1463***		0.0643		0.1351	
	(2.3700)		(2.9535)		(0.3396)		(0.7413)	
Intercept	0.6323***	0.6370***	0.4955***	0.5311***	-0.1200	-0.0657	-0.0111	0.0597
	(7.0454)	(7.4057)	(7.8897)	(9.4429)	(-0.6114)	(-0.8950)	(-0.0941)	(0.6609)
Observations	245	256	245	256	91	101	91	101
R-squared	0.537	0.536	0.575	0.575	0.518	0.508	0.301	0.289
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plan FE	No	No	Yes	Yes	No	No	Yes	Yes

Note: This table reports equally weighted panel least squares regression results. The dependent variable is the percentage pension allocation to equity or insurances. The sample consists of all Dax firms for which assets are not exclusively invested in insurances. All specifications contain year fixed effects and standard errors are heteroscedasticity robust clustered at firm level. German pension funding (*FR (domestic)*) is defined as the fraction of the German fair value of plan assets (FVPA) to German projected benefit obligations (PBO); International exposure (*Int. vis*). is defined as the proportion of foreign PBO to the total; *FR (domestic) x int. exposure* is an interaction term between pension funding and international exposure; *Size* denotes pension plan size (billion EUR). *Duration* is the average duration of a pension plan's liabilities. Heckman's *Lambda* is estimated from the probit regressions in Table A.2; *No rating* is a dummy variable taking a value of one if a plan sponsor has a debt rating; *PD* is the plan sponsor's probability of default. *t*-statistics are reported in parentheses. ***, **, * indicate significance levels of 1%, 5% and 10%.

Table 8: Asset allocation and German funding

	Equity				Insurances			
	(1)	OLS	(2)	OLS	(3)	OLS	(4)	OLS
FR (domestic)	-0.3061***	-0.2678**	-0.3306***	-0.2719***	0.4194*	0.1934	1.0566***	0.8522***
	(-3.0932)	(-2.5847)	(-3.3417)	(-2.9533)	(1.7866)	(1.0333)	(3.7515)	(2.8286)
FR (domestic) x int. Vis	0.5178**	0.4507**	0.5005**	0.3735**	-0.5181	-0.2846	-1.3813***	-0.9546*
	(2.3778)	(2.0259)	(2.5677)	(2.1337)	(-1.3336)	(-0.6732)	(-2.8756)	(-1.8686)
Int. exp.	-0.3061***	-0.2508**	-0.2199**	-0.1561	-0.0758	0.0414	0.9346**	0.3636
	(-2.9578)	(-2.3259)	(-2.2661)	(-1.5572)	(-0.4553)	(0.1929)	(2.3718)	(0.9702)
PD	-0.0110	-0.0321	0.0359**	0.0133	-0.0572	-0.1167*	-0.0659**	-0.0516
	(-0.3457)	(-0.9270)	(2.0969)	(0.7454)	(-1.2372)	(-1.9353)	(-2.0638)	(-1.4944)
Duration	0.0005	0.0014	-0.0001	0.0000	-0.0023	-0.0031	0.0009	0.0001
	(0.3715)	(1.1157)	(-0.0569)	(0.0411)	(-1.1605)	(-1.6817)	(0.5291)	(0.0647)
No rating	-0.0582**	-0.0526*	0.0036	0.0126	0.0484	-0.0126	0.0045	0.0779
	(-2.4810)	(-1.9819)	(0.1161)	(0.4331)	(0.6696)	(-0.1601)	(0.0797)	(0.9082)
Size	0.0108	0.0049	0.0105	0.0109	0.0422	0.0384	0.0247	-0.0060
	(1.1738)	(0.5092)	(1.1696)	(1.2070)	(1.0446)	(1.0470)	(1.4170)	(-0.1981)
Log(size)	-0.0944**	-0.0378	-0.0115	-0.0177	-0.3055**	-0.3147**	-0.3844***	-0.2200
	(-2.1533)	(-0.7942)	(-0.2032)	(-0.3372)	(-2.1687)	(-2.6944)	(-3.5881)	(-1.5958)
FR (domestic) x size	0.0022	0.0024	0.0001	-0.0002	-0.0585*	-0.0335	-0.0217	-0.0252
	(0.2980)	(0.3301)	(0.0070)	(-0.0314)	(-1.8920)	(-1.1033)	(-1.2849)	(-1.0034)
Int. Vis x Size	-0.0025	-0.0012	-0.0066	-0.0055	0.0839**	0.0511	0.0048	0.0329
	(-0.3373)	(-0.1640)	(-0.9465)	(-0.7301)	(2.4162)	(1.4376)	(0.2331)	(1.0812)
Lambda	-0.1035**		-0.0551		0.0455		-0.5187***	
	(-2.6516)		(-0.9596)		(0.4744)		(-4.5621)	
Intercept	0.7142***	0.6448***	0.5629***	0.5136***	0.0412	0.0843	-0.0438	-0.1709
	(8.9875)	(8.5659)	(7.6993)	(9.1116)	(0.3721)	(0.8925)	(-0.3455)	(-0.9345)
Observations	498	556	498	556	221	272	221	272
R-squared	0.456	0.406	0.367	0.365	0.308	0.281	0.458	0.340
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plan FE	No	No	Yes	Yes	No	No	Yes	Yes

Note: This table reports equally weighted panel least squares regression results. The dependent variable is the percentage pension allocation to equity or insurances. The sample consists of all firms for which assets are not exclusively invested in insurances. All specifications contain year fixed effects and standard errors are heteroscedasticity robust clustered at firm level. German pension funding (*FR (domestic)*) is defined as the fraction of the German fair value of plan assets (FVPA) to German projected benefit obligations (PBO); International exposure (*Int. vis*) is defined as the proportion of foreign PBO to the total; *FR (domestic) x int. exposure* is an interaction term between pension funding and international exposure; *Size* denotes pension plan size (billion EUR). *Duration* is the average duration of a pension plan's liabilities. Heckman's *Lambda* is estimated from the Probit regressions in Table A.2; *No rating* is a dummy variable taking a value of one if a plan sponsor has a debt rating; *PD* is the plan sponsor's probability of default. *FR (domestic) x size* is an interaction term between *Size* and domestic funding; *Int.vis x size* is an interaction term between *size* and international exposure. *t*-statistics are reported in parentheses. ***, **, * indicate significance levels of 1%, 5% and 10%.

Table 9: Pension funding and firm financial health

	FR (domestic)		FR (foreign)	
	(1)	(2)	(3)	(4)
PD (t-1)	-0.2827***	-0.1636***	-0.0039	-0.0319
	(-4.7012)	(-3.0267)	(-0.0167)	(-0.1878)
EBIT/TA (t-1)	0.4644**	0.4362**	1.7702**	0.5440
	(2.2555)	(2.2788)	(2.2342)	(0.9038)
WC/TA (t-1)	0.2866***	0.1026	-0.8684***	0.0339
	(3.7539)	(1.2392)	(-2.9846)	(0.1292)
Size (million EUR) (t-1)	0.0003*	0.0005**	0.0005	-0.0090***
	(1.7119)	(2.5183)	(0.8748)	(-15.0967)
Log(size) (t-1)	0.0396***	0.0549***	-0.0455**	-0.0037
	(7.0508)	(10.582)	(-2.0908)	(-0.2324)
B-to-m	-0.0544**	-0.0512**	0.6091***	0.1678**
	(-1.9910)	(-1.9609)	(5.4851)	(2.0240)
No rating	-0.0784***	-0.1207***	0.2314**	0.2261***
	(-2.5900)	(-4.3150)	(1.9833)	(2.5978)
Int. Exposure	0.054	0.1668***	4.9825***	3.5111***
	(0.8788	(2.7570)	(20.9779)	(18.7649)
Intercept	0.4803***	0.4064***	-1.7813***	-0.9488***
	(5.9842)	(5.4238)	(-5.5806)	(-3.9564)
Observations	473	473	455	455
Pseudo R-sq.	0.3042	0.5403	0.556	0.808
Year FE	Yes	Yes	Yes	Yes
Sector FE	No	Yes	No	Yes
Prob > X^2	0.0074	0.097	0.3312	0.3476

Note: This table reports three stages least squares results for all firms. All specifications contain year fixed effects. The dependent variable is the German funding ratio *FR (domestic)* or the funding ratio of foreign firms (*FR (foreign)*). As independent variables we include *PD_t-1*, the plan sponsor's probability of default; *EBIT/TA_t-1*, EBIT to total assets; *WC/TA_t-1*, working capital to total assets as a measure of liquidity; *Int. exposure* defined as the proportion of foreign PBO to the total; *No rating* is a dummy variable taking a value of one if a plan sponsor has a debt rating; *Size* denotes pension plan size (million EUR). The unreported probability of default model has *EBIT/TA*, *WC/TA*, *Size*, *log(size)*, and *Funding* as control variables; the unreported profitability model has *PD*, *WC/TA*, *Size*, *log(size)*, and *funding* as control variables. *z*-statistics are reported in parentheses. ***, **, * indicate significance levels of 1%, 5%, and 10%.

Table 10: Pension plan funding and firm financial health (OLS)

	FR (domestic)		FR (foreign)	
	(1)	(2)	(3)	(4)
PD (t-1)	-0.2609**	-0.1592*	-0.0087	-0.0128
	(-2.3879)	(-1.7299)	(-0.0367)	(-0.0798)
EBIT/TA (t-1)	0.3781	0.3750	2.0570	0.5852
	(0.7509)	(0.8720)	(1.5828)	(0.7476)
WC/TA (t-1)	0.2831*	0.0917	-0.8535	0.0497
	(1.6797)	(0.5570)	(-1.2186)	(0.0866)
Size (t-1)	0.0003	0.0005*	0.0006	-0.0089***
	(1.2126)	(1.8638)	(0.8992)	(-4.4618)
Log(size) (t-1)	0.0401***	0.0549***	-0.0439	0.0000
	(3.2404)	(4.7070)	(-1.2424)	(0.0018)
B-to-m	-0.0386	-0.0394	0.5556	0.1715
	(-0.8029)	(-0.8908)	(1.3598)	(1.2638)
No rating	-0.0762	-0.1197**	0.2117	0.2238**
	(-1.0691)	(-2.1028)	(1.5334)	(2.2042)
Int. Exposure	0.0545	0.1660	4.8765***	3.4382***
	(0.4673)	(1.1891)	(4.1915)	(4.6721)
Intercept	0.4632***	0.3949***	-1.6883**	-0.9109**
	(4.7613)	(3.0664)	(-2.4206)	(-2.5772)
Observations	474	474	470	470
R-squared	0.277	0.502	0.531	0.783
Year FE	Yes	Yes	Yes	Yes
Sector FE	No	Yes	No	Yes

Note: This table reports equally weighted panel least squares regression results. The dependent variable is the domestic or foreign funding ratio. Funding (*FR*) is defined as the fraction of the fair value of plan assets (FVPA) to projected benefit obligations (PBO). All specifications contain year fixed effects and standard errors and standard errors are heteroscedasticity robust clustered at firm level. As independent variables we include *PD_t-1*, the plan sponsor's probability of default; *EBIT/TA_t-1*, EBIT to total assets; *WC/TA_t-1*, working capital to total assets as a measure of liquidity; *Int. exposure* defined as the proportion of foreign PBO to the total; *No rating*, a dummy variable taking a value of one if a plan sponsor has a debt rating; *Size* and *log(size)* ,capturing the effects of pension plan size (million EUR). *t*-statistics are reported in parentheses. ***, **, * indicate significance levels of 1%, 5%, and 10%.

Figure 1

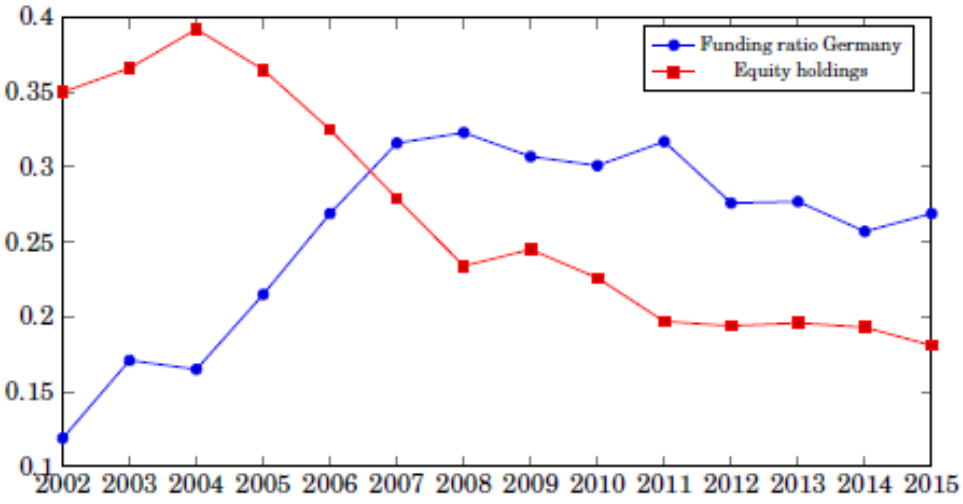

Figure 1: German funding and equity holdings

Appendix

Table A.1: Probit estimates on foreign pension plans (first-stage Heckman results)

Y=1 if the firm has a foreign pension plan	
Size	0.0001*
	(1.7246)
Log(size)	0.3517**
	(2.1950)
EBIT / TA	-1.0113
	(-1.0966)
ROA	0.5004*
	(1.8647)
TobinsQ	-0.2627
	(-1.2502)
log(1+TobinsQ)	1.7059*
	(1.7769)
Age	0.0055*
	(1.9186)
Intercept	-7.9041***
	(-5.2952)
N	1052
Pseudo-R^2	0.3938
Year FE	Yes

Note: This table reports Probit regression results, estimating the likelihood that a firm has international pension plans. The dependent variable equals one when a firm sponsors a foreign pension plan. *Size* and *Log(Size)* capture the effects of firm size (million EUR), *EBIT/TA* denotes EBIT to total assets; *ROA* denotes return on assets, *TobinsQ* denotes the market to book ratio and *Age* a firm's age. Standard errors are heteroscedasticity robust and clustered at the firm level. *z*-statistics are reported in parentheses. ***, **, * indicate significance levels of 1%, 5%, and 10%.

Table A.2: Descriptive statistics

		Mean	P25	p50	P75	SD
FR (domestic)	Foreign=0	0.21	0.00	0.00	0.35	0.33
	Foreign=1	0.31	0.00	0.17	0.61	0.34
Total assets (million EUR)	Foreign=0	2173	267	854	2428	5670
	Foreign=1	23562	1551	5138	20847	46101
Market capitalization (million EUR)	Foreign=0	1192	213	531	1413	1905
	Foreign=1	12586	999	3547	14086	19858
ROA	Foreign=0	-0.06	0.00	0.06	0.17	0.78
	Foreign=1	0.14	0.00	0.13	0.24	0.20
TobinsQ	Foreign=0	1.71	1.04	1.29	1.80	1.43
	Foreign=1	1.67	1.09	1.36	1.79	1.04

Note: This table reports the mean, median, standard deviation as well as the 25th and 75th percentile of plan sponsor characteristics. *Foreign* is equal to zero for firms with no foreign pension plan and 1 otherwise. Funding (*FR (domestic)*) is defined as the fair value of German plan assets (FVPA) scaled by German projected benefit obligations (PBO). *ROA* denotes return on assets, *TobinsQ* is defined as the market value of assets to the book value of total assets.

Table A.3: Probability of default and profitability models (3SLS)

	(1)		(2)		(3)		(4)	
	PD	EBIT / TA	PD	EBIT / TA	PD	EBIT/TA	PD	EBIT/TA
PD (t-1)		-0.0240*		-0.0249*		-0.0367**		-0.0362**
		-1.6966		-1.7614		(-2.56)		(-2.52)
EBIT/TA (t-1)	-0.2201		-0.2381		-0.4844***		-0.4761***	
	-1.4616		-1.5806		(-3.12)		(-3.07)	
WC/TA (t-1)	0.3436***	0.0142	0.3402***	0.015	0.2915***	0.0291	0.2845***	0.0308
	5.7012	0.7333	5.6444	0.7765	(4.60)	(1.45)	(4.49)	(1.53)
Size (t-1)	0.0000	-0.0001**	0.0000	-0.0001**	-0.0000	-0.0001**	-0.0000	-0.0001**
	0.1753	-2.2367	0.1442	-2.2263	(-0.33)	(-2.08)	(-0.29)	(-2.11)
Log(size) (t-1)	0.0090*	0.0019	0.0078	0.0021	-0.0012	0.0035**	-0.0017	0.0036**
	1.7417	1.1846	1.517	1.2979	(-0.23)	(2.14)	(-0.34)	(2.23)
FR domestic (t-1)	-0.2955***	0.0400***	-0.2704***	0.0361***	-0.0017	0.0025	-0.0064	0.0038
	-7.8135	3.2576	-7.1331	2.9353	(-0.21)	(0.97)	(-0.78)	(1.47)
Intercept	0.1901***	0.0622***	0.1817***	0.0638***	0.0948***	0.0751***	0.1010***	0.0732***
	5.5858	5.701	5.3374	5.8464	(2.77)	(7.07)	(2.95)	(6.89)
Observations	473	473	473	473	455	455	455	455
Pseudo R-sq.	0.1284	0.0486	0.1332	0.0503	0.0865	0.0471	0.2311	0.07622
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	No	No	Yes	Yes	No	No	Yes	Yes

Note: This table reports the first stage results of the 3SLS regressions of Table 9. The dependent variables are the probability of default (*PD*) and EBIT to total assets (*EBIT/TA*). The independent variables are last period's probability of default *PD_t-1*; *EBIT/TA_t-1*, EBIT to total assets; *WC/TA_t-1*, working capital to total assets as a measure of liquidity; *Int. exposure* defined as the proportion of foreign PBO to the total; *No rating*, a dummy variable taking a value of one if a plan sponsor has a debt rating; *Size* and *log(size)* ,capturing the effects of pension plan size. *z*-statistics are reported in parentheses. ***, **, * indicate significance levels of 1%, 5%, and 10%.