IAS 19 and the market valuation of UK DB pensions

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Abstract

This paper investigates how defined benefit pensions deficits/surpluses influence UK company valuation under the fair value accounting regime that became mandatory in 2006 with the introduction of IAS 19. Using a sample of FTSE firms from 2006 to 2012 we find that reported pension deficits significantly reduce the market value of a company, with the market valuation of deficits being larger than that reported by firms under IAS 19. We present evidence that this is due to the market discounting pension liabilities at a 'risk-free' rate (government bond) rather than the AA corporate bond yield allowed for under IAS 19.

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1 Introduction

A defined benefit pension (DB) requires the sponsoring company to provide its employees a pension, computed according to a contractually agreed benefit formula; this usually takes into account the employee's wage and years of service and is indexed to inflation. These obligations are then financed by a pool of pension fund assets. Despite the fact that the pension scheme's assets and liabilities are formally separated from the company, the shareholders are ultimately responsible for its solvency hence pension deficits/surpluses should affect the firm's value. The IAS 19 accounting standard introduced in the EU in 2006 aimed to make this potential liability explicit by requiring the sponsoring firm to report any pension fund deficit/surplus on its balance sheet. Thanks to the convergence of accounting standard worldwide, the rules in the United States are very close to IAS 19 as SFAS 158, issued in 2006, prescribes the recognition of the defined benefit deficit/surplus on the balance sheet. Moreover, both IAS 19 and SFAS 158 introduce fair value accounting in the world of corporate pensions. While most of the assets are traded in active markets and can be marked-to-market easily, pension liabilities are not traded and much more complicated to evaluate.

The unique features of DB pension liabilities make them problematic from an accounting perspective, as they stretch the concept of fair value to its very limit. Pension liabilities are not quoted in any market and their valuation depends on a wide range of unobservable inputs, so they fall in the lowest level of the fair value hierarchy set by the IFRC, often referred to as mark-to-model. To make things worst, pensions liabilities are by their nature long term and depend crucially on a wide range of assumptions, such as inflation, discount rate, life expectancy, salary growth, employee turnover etc.

Although UK companies have been steadily moving from defined benefit to defined contribution pensions (partly because IAS 19 makes explicit their exposure to pension risk), DB schemes still represent a substantial commitment for the biggest companies. Table 1 below presents some statistics highlighting the importance of DB pensions in the UK indicating that in 2012 DB liabilities - as measured under IAS 19 standards - at about 30% of market capitalization for both the FTSE100 and FTSE350 and that the overall DB deficit (pension assets minus liabilities) stands at over 3% of market capitalization for both indices[1]. The sheer size of these liabilities makes them important from a valuation perspective and there is evidence they have a significant impact on the free cash flow of the parent company. [2]

Table 1: DB Pension Facts

Values at the end of 2012 fiscal year using IAS 19 data, but for market capitalisation, computed at the corresponding reporting date. Data for the UK DB universe come from the Purple Book 2013. Figures are in billion pounds.

	FTSE 100	FTSE 350	UK DB universe
Firms with DB scheme	77	210	6225
of which open	4	14	841
total reported DB liabilities	526.8	599.9	1329.2
as percent of market cap	29.50%	29.95%	-
total reported deficit	57.7	65.8	210.8
as share of market cap	3.23%	3.28%	-
contributions as share of earnings	18%	18.70%	-

Another important insight from Table 1 is that despite their importance, almost all DB schemes are now closed to new members. This reflects the large scale move to Defined Contribution schemes that has occured over the last few year. This move is, arguably, at least partly due to the more transparent accounting standards for pension liabilities brought about by IAS 19.

In this paper we estimate the impact of pension deficits/surpluses on the market value of UK FTSE100 and FTSE350 companies. We employ a slight modification of the residual income model, first proposed by Feltham & Ohlson (1995), as used in the pension context by Coronado & Sharpe (2003) Coronado, Mitchell, Sharpe & Blake Nesbitt (2008) that allows to isolate the impact of pensions. As a robustness check we also use a variant of Tobin's Q model as used by Feldstein & Seligman (1981) for US pension and by Liu & Tonks (2010) for the UK. To the best of our knowledge, this is the first paper to investigate the issue of DB pension valuation under fair value accounting in either the EU or US context.

Our results for the entire sample indicate that there is a significant impact of net pension assets on the market value of firms, thus supporting the view that DB are important for valuation.

[1]under risk free discounting discussed below, liabilities stand at around 37% of market capitalization and the deficit at about 11% for the FTSE100

[2]See for instance Rauh (2006) that shows how DB pensions affect firms' investment decisions and Liu & Tonks (2013) who look at the impact of mandatory contributions to DB pension funds on investment and dividends for UK companies.

In fact we find that the market impact of deficits is larger than one (i.e. every £1 of deficit reduces market value by more than £1). We present evidence that this is consistent with market valuation being based on 'risk free' (government bond yield based) discounting of pension liabilities rather than the AA corporate bond discounting allowed for under IAS 19.

The rest of the paper is organized as follows. Section 2 offer a brief review of the empirical literature about the DB pension valuation. Section 3 gives an overview of the debate over the pricing of pension liabilities, focusing in particular on the appropriate discount rate. Section 4 describes the techniques we employ to investigate the pricing of DB schemes and how we adjust the discounting of pension liabilities. The next two sections describe the data we use and present our main results. Their robustness is discussed in section 7, which includes also a different empirical specification using Tobin's Q model and extends our results to a wider sample. The last section concludes.

2 Empirical research on the valuation of defined benefit pension schemes

The DB pension literature can be divided in two strands: the first, as in this paper, takes a market valuation approach, while the second focuses on the impact on returns. Within this literature there is also an important issue of how pension liabilities should be valued - particularly the appropriate discount rate. We discuss this part of the literature in the next subsection.

2.1 Pension Impact on Market Valuation and Returns

Most papers investigating the impact of defined benefit pension scheme on companies' valuation have focussed on the US and over the period when reporting standard were arguably more opaque. Before the introduction of FAS 158 the value of pension assets and of the projected benefit obligation (PBO) were disclosed only in the notes to the financial statements, while the number recognized on the balance sheet was just an accounting accrual representing the difference between contributions paid and costs charged to the income statement.[3]

The first set of papers taking the market valuation approach and studying US DB pensions

[3]This was also the case in the UK prior to the introduction of IAS 19.

dates back to 1980s and found that stock prices fully reflect the funding situation of the pension plan. The main examples in this literature are the works by Feldstein & Seligman (1981), Feldstein & Morck (1983) and Bulow, Morck & Summers (1987). These papers take a "transparent" view of the pension plan, meaning that pension assets and liabilities are considered as part of the sponsoring company and thus should be taken into account when valuing the firm.

Later work by Gold (2005) put forward a different theoretical position (named "opaque" view) expressing scepticism about investors' ability to pierce the accounting veil and value DB schemes correctly. The relevant accounting standard for the US at the time was FAS 87, which prescribed the disclosure of the pension related information only in the notes. The only way in which the pension plan had an effect on the sponsoring company's financial statements was through its earnings component. Coronado & Sharpe (2003) and Coronado, Mitchell, Sharpe & Blake Nesbitt (2008) tested empirically Gold's theory, finding that investors and analysts seem to fixate on the earnings impact of DB pensions and completely disregard the net position of the pension plan disclosed in the notes. Work by Hann, Heflin & Subramanayam (2007) is somewhat in between, arguing that both earnings and the pension plan net position are taken into account by market participants.

Looking at the returns approach, Franzoni & Marin (2006) find that companies with severely underfunded pension plans earn significantly lower returns, controlling for a set of other factors; they argue that pension deficits impacts companies' profitability with a lag. Their findings are reinforced by Picconi (2006) work, which shows that analysts systematically fail to take into account the effect of DB pensions in forecasting earnings. Jin, Merton & Bodie (2006) take a slightly different approach, focusing on the risk that a pension plan adds to the sponsoring company; they observe that for firms with normal leverage ratios the risk of pension liabilities is similar to that of corporate debt, whereas the portion of plan's assets invested in equities (or similar securities) has a significantly higher risk profile. Using a model much in the spirit of the CAPM they find that firms' betas reflect the additional risk generated by the DB scheme's assets and liabilities.

The literature on DB schemes for European countries is much scarcer. Fasshauer & Glaum (2012) investigate the issue in the German context, where most of the schemes are unfunded, using the Ohlson model and find support for the transparent view. Liu & Tonks (2010) use

UK data, testing both a market valuation model and the asset price approach; they find that pension deficits reduce the market value of the sponsoring firm but less than one-for-one. A similar result is found by McKillop & Pogue (2009), who also find that pension deficits have an impact on credit ratings. Cardinale (2007) focuses on the bond market and finds that pension deficits have a non-monotonic impact on credit spreads, for both the UK and the US. It should however be noted that these works on the UK use data before 2006 and the implementation of IAS 19, which significantly increased the transparency in pension accounting. The change in accounting standard could be responsible for the different results that we find in this paper.

3 Discounting of pension liabilities

Although both IAS 19 in Europe and SFAS 158 in the US prescribe that the pension liabilities should be recognized at their fair value in the sponsoring company's balance sheet, there are a number of assumptions in that process that have been criticised. Given their long duration probably the single most important of these debated assumptions is the discount rate used to estimate the present value of those liabilities.

Under both IAS 19 and SFAS 158, the pension obligation is discounted using high quality corporate bonds yields; most of the companies interpret this provision as AA rated corporate bonds of currency and duration matching those of the pension obligation.[4] There is however a long standing debate about which discount rate should be used.[5] Indeed there is some apparent contradiction within IAS 19 itself as to the nature of the discount rate. Paragraph 83 and 84 of the last version of IAS 19 read as follows:

> 83. The rate used to discount post-employment benefit obligations (both funded and unfunded) shall be determined by reference to market yields at the end of the reporting period on high quality corporate bonds. (...)
>
> 84. One actuarial assumption that has a material effect is the discount rate. The discount rate reflects the time value of money but not the actuarial or investment risk. Furthermore, the discount rate does not reflect the entity-specific credit risk

[4] the wording of the two accounting standards is slightly different, but their practical implementation has been identical in both countries.

[5] See Napier (2009) for a discussion.

> borne by the entity's creditors, nor does it reflect the risk that future experience may differ from actuarial assumptions.[6]

Paragraph 84 seems to suggest the use of a risk-free rate, contradicting the previous provision. In fact, the interpretation committee of the IFRS has been requested to clarify the passage above and the amendment for paragraphs 83-84 proposed by the IFRS' staff explicitly mentions credit risk:

> The objective of the discount rate is to reflect only the time value of money and at most very low credit risk, the currency and the estimated term of the post-employment benefit obligations. The discount rate does not reflect the actuarial or investment risk of the plan assets (as defined in paragraph 28). Furthermore, the discount rate does not reflect the entity-specific credit risk borne by the entity's creditors, and nor does it reflect the risk that future experience may differ from actuarial assumptions.[7]

Even in this formulation it remains unclear why the discount rate should reflect "at most very low credit risk" since pension liabilities are not subject to such risk from the firm's perspective. Unsurprisingly, the decision to use a discount rate that reflects some credit risk is not uncontroversial in the accounting industry. Among others, the Accounting Standard Board (ASB), the former British accounting standard setter, has recommended in a discussion paper (Pro-Active Accounting Activities in Europe (2008)) that this obligation should be discounted at a (credit) risk free rate. A similar position has been expressed also by Blake, Khorasanee, Pickels & Tyrrall (2008) in a report authored by the Pension Institute. The most striking fact is perhaps that the UK Pension Regulator and the Pension Protection Fund (PPF) use government bond yields rather than corporate bond rates as a basis for discounting the defined benefit obligation in their annual publication investigating the defined benefit universe (the Purple Book) and in calculating the levy that each sponsor has to pay to fund the PPF's guarantee.

To see why pension liabilities should be discounted using a risk free rate it is useful to split the process of their determination in two parts. The first is the proper estimation, where the

[6] IASB (2011)
[7] IFRS (2013)

schedule of future pension payments is computed using a range of actuarial assumptions that depend upon the specific situation of each DB scheme and the demographics of its participants. Once the future cash outflows of the pension fund have been estimated, they need to be discounted to compute the projected benefit obligation (PBO) that the sponsoring company has to fund and disclose in its financial statements. The discount rate used in this exercise should be determined considering the risk of these future payments from the sponsor's standpoint. The future benefit payments are however certain in this perspective, at least in regard to credit risk.[8] Hence it seems clear that the appropriate discount rate should reflect only the time value of money and no credit risk at all. As proxy for the risk free rate we use the yield curve on government bonds.

In the United States the issue of which discount rate should be used to discount pension liabilities has also received much attention recently, mostly focused on public DB schemes. These entities follow different accounting rules from corporate pension and are allowed to use the expected return on their asset holdings as discount rate, thus reporting substantially lower deficits than financial theory would imply. Novy-Marx & Rauh (2011) and Brown & Wilcox (2009) discuss the measuring of funding of state pension liabilities in this context, arguing that using risk-free rates would be more appropriate. Brown & Pennacchi (2015) also argue that the right discount rate to evaluate under- or over-funding of a scheme should not reflect credit risk, though they do note that from the perspective of an employee that has to choose between different types of pensions offered to him, a discount rate incorporating some credit risk should be used.

The last revision of IAS 19 could have incorporated these suggestions, but the IASB preferred to oblige the companies to disclose a sensitivity analysis of the pension obligation to various assumption used in its determination, including the discount rate, to provide the users of financial statements with a measure of the risk underlying the DB obligation. This change became mandatory from 2013 onwards.

Although IAS 19 correctly states that the credit risk of the sponsoring company should not be allowed for when choosing a discount rate for pension liabilities (despite, in practice, allowing for a rate with some credit risk), it is possible that the systematic volatility of those liabilities could justify discounting at a higher rate than a risk-free rate (usually interpreted as the yield

[8] The only way in which a company could reduce the burden of future pension payment is to renegotiate the contributions or benefits of the pension scheme's participant. This is effectively equivalent to a salary cut.

on government bonds in practice). Pension obligations could have embedded some systemic risk (creating a negative beta for the firm) that should be accounted for in valuation. Additionally, the true market valuation of pension liabilities could be reduced by the public insurance of pensions, giving rise to a 'pension put' option for the firm since, if it goes bankrupt, the outstanding pensions are paid (at least in part) by the Pension Protection Fund in the UK and the PBGC in the US. This put could reduce the effective value of pension liabilities to the firm. We discuss these two issues in turn.

3.1 Beta of pension liabilities

Do the pension liabilities have a degree of systemic risk that justifies discounting them at a rate incorporating some risk premium? In their model Sundaresan & Zapatero (1997) assume that wages and the stock market are perfectly correlated, and thus pension wage-related pension liabilities will also be correlated with the market. While in their model this assumption is a necessary simplification as it guarantees as closed form solution, the empirical evidence supporting it very limited. Most empirical papers (e.g. Jin, Merton & Bodie (2006) and Cooper (2009)) suggest that the beta of pension liabilities is the same as that of government bonds.

Table 2 shows estimates of the beta of pension liabilities and of government bonds (gilts) over our sample. The first line shows the relationship between the yearly returns on pension liabilities and the market index (FTSE100 or FTSE350). The point estimates are around -0.3 and statistically significant. Although this estimate does suggest that the beta of pension liabilities could be higher than that of gilts, there is a potential bias in the estimate. Since the pension liabilities reported by the firm are discounted by the AA corporate bond yield, the fact that the credit spread on these bonds is likely to be correlated with the market index may create a spurious relationship. The second line of table 2 shows the relationship between the market index and pension liabilities discounted at the risk-free discount rate (based on government bond yields, see section 4.1 for details of how this adjustment was undertaken). This estimate is very close to zero and more comparable with the beta on gilts shown in the last line of the table.

Overall, therefore it seems that over our sample the beta on pension liabilities is close to zero and similar to that on gilts. This is in line with other empirical studies and suggests that the gilt yields are an appropriate discount rate for UK pension liabilities.

Table 2: Beta of the Pension Liabilities

Method	Beta estimate	Standard Error
Beta of pension liabilities	-0.3	0.033
Beta of risk free discounted pension liabilities	-0.04	0.032
Beta of monthly returns on gilts (all in-sample observations)	-0.08	0.093

The first two lines show the beta of pension liabilities against the FTSE 100 index, using a simple CAPM regression with yearly data. The last line shows the same model using monthly returns on a coupon-stripped gilt with duration of 18 years against the FTSE 100.

3.2 Is there a pension put in the UK?

The creation of the PGBC in the United States[9] gave rise a lively academic discussion on the implication of state guarantee for defined benefit pensions, focused on evaluating the put option for the firm created by this regulation, its implication for the management of the pension liabilities and the solvency of PGBC itself. One of the first papers to discuss the issue is Sharpe & Treynor (1977) that shows qualitatively how the value of the pension put is increasing in the size of the pension plan relative to firm's assets, its underfunding and the riskiness of the assets it holds.

A more recent theoretical treatment of the subject is provided by Love, Smith & Wilcox (2011), who investigates how government insurance provides incentive for risk shifting if it is mispriced, though Rauh (2009) in his empirical investigation on US companies finds that firms with low credit rating and underfunded pension funds tend to invest in safer assets than their stronger peers.

As in the US, the defined benefit pension schemes in our sample are insured by the Pension Protection Fund, so if the sponsoring company goes bankrupt the workers do not lose their pensions entirely. As the literature discusses, this insurance may give raise to a put option for the sponsoring entity if in case of bankruptcy it can offload the pension fund's deficit on the PPF, thus leaving the other creditors of the company with a higher chance of getting at least a partial repayment. If this option exists under the UK regulation, then it should be accounted for in pricing the pension liabilities. Although the existence of a Pension Put may not alter the appropriate discount rate for pension liabilities, it may indicate that the true value of those liabilities for the firm is lower than that reported (i.e. the true value should adjust for the value

[9]The PGBC was created by the Employee Retirement Income Security Act (ERISA) in 1974.

of the put that the firm holds).

It is however quite hard to envision a pension put in the UK. If a scheme enters in the PPF, the latter has an unsecured credit towards the failed sponsoring company equal to the deficit of its pension fund calculated on a full (gilt yield discounted) buy-out basis, which is always substantially higher than the reported deficit. Additionally, although a recent judgement by the Supreme Court in the Nortel/Lehman case made clear that the PPF does not have any precedence over other unsecured creditors, schemes insured by the PPF have to pay a levy to fund the operation of the PPF itself where the levy structure is related to the riskiness of the firm. Even though McCarthy & Neuberger (2005) show that this risk-related premium is not precisely fairly priced, it does significantly reduce the market value of the pension put.

Given these circumstances and our focus on the components of FTSE 100 index, we do not have evidence that the pension put has a material impact on the market value of pension liabilities over our sample.

4 Model specification

The main model we employ to investigate empirically the valuation of DB pension scheme is a parsimonious specification of the residual income model, put forward by Feltham & Ohlson (1995). In their model, the market value of a firm's equity is expressed as the sum of the value emanating from the company's non-financial core activities plus the unrelated financial activities. We modify this model to make room for pensions as in Coronado & Sharpe (2003) and Coronado, Mitchell, Sharpe & Blake Nesbitt (2008), dividing both income statement and balance sheet variables into pension and non-pension components.

This model expresses the market value of equity (Mcap) as a function of the core book value of equity (BVc) defined as the book value of equity minus the net pension assets (NPA). Net pension assets in turn represent the economic deficit/surplus of the DB pension schemes of the company; we define them as pension assets minus pension liabilities, not taking into account any surplus restriction, minimum funding liability, corridor adjustment or deferred tax asset arising under the current accounting standard. Regarding income statement variables, we divide earnings into core earnings (Ec) defined as net earnings minus net periodic pension cost

(NPPC) and NPPC itself. The NPPC collects all the pension related entries in the income statement: service cost (benefits accrued during the accounting period), interest cost (the effect of time on the pension obligation), expected return on plan's assets and temporary events such as curtailment and settlements.[10] Coronado & Sharpe (2003) and Coronado, Mitchell, Sharpe & Blake Nesbitt (2008) use a slightly different definition of NPPC, where service cost is considered as a core expense rather that a pension item. We prefer to aggregate all the pension variables, but changing this definition has no major effect on the results. Hence we bring to the data the following model, where all variables are standardized by total company assets to make the series stationary and reduce heteroskedasticity:

$$Mcap_{it} = \alpha + \beta_1 BVc_{it} + \beta_2 NPA_{it} + \beta_3 Ec_{it} + \beta_4 NPPC_{it} + \epsilon_{it} \tag{1}$$

where we also include company or year and sector dummies.[11]

As contributions to the pension fund are tax deductible in the UK, in our base specification we also present results for an adjusted NPA that adds back the associated deferred tax asset/liability. We compute this as NPA times the marginal tax rate that the companies in our sample face every year.[12] We use this tax adjusted NPA in most specifications.

4.1 Estimating risk free pension liabilities

As discussed in section 3 an important question mark over pension liabilities as they are reported in company accounts is the discount rate used to create their present value. In this section we describe how we adjust that valuation such that liabilities are discounted at the 'risk-free' rate - the yield on UK gilts.

Although not required to do so over our sample, most of the companies in the FTSE 100 disclose a sensitivity analysis to help users of financial statements understand the impact of the assumptions used in calculating the pension obligation. The IASB has since made this disclosure mandatory from 2013 with the latest revision of IAS 19. However for our sample almost none of

[10]Excluding these exceptional events altogether does not alter our results.

[11]We used the Global Industry Classification Standard (GICS) and take the broadest sectoral definition, using 10 different sectors in total.

[12]UK Corporation tax has been changing during the period that we take as our sample, starting at 30% and being lowered first to 28% in 2009, then to 26% in 2011 and finally to 24% in 2012.

the firms in the FTSE 350 not in the FTSE 100 report this information. It is for this reason we conduct most of our analysis on the FTSE 100, though we report some more limited results for the FTSE 350 in section 7.

We use the interest rate sensitivity analysis to compute the duration of the defined benefit obligation; this in turn allows us to find the corresponding gilt rate appropriate for that liability and allows us to calculate the value of pension liabilities under 'risk free' discounting; we label the resulting estimate risk free pension liabilities and obtain the associated risk free NPA by subtracting it from the reported pension assets (as these are already marked-to-market, no adjustment is necessary)[13]. The formula used in both passages above is just the standard duration approximation:

$$\frac{\Delta P}{P} = -\frac{\Delta i}{1+i} D \tag{2}$$

The duration of the pension obligation averages about 18 years, with a median very close to it but with wide variation over a span of more than 15 years; half of the companies are within the 15 to 20 year range. Duration is missing for slightly more than a third of our main sample as some companies do not disclose any sensitivity analysis. In the main estimation we fixed the duration of these missing values at the mean of the rest of the sample, but the alternative approach of dropping these observations delivers similar results (albeit with larger standard errors). If a company disclosed the discount rate sensitivity only for a couple of the years in our sample then we the calculate the missing figures from the closest year for which a value is available. The yields on UK gilts come from the Bank of England historical yield curve data; in adjusting the pension liabilities, we retrieved the yields at the balance sheet closing date.

Changing the discount rate of the pension liability to the gilt rate increases the size of the pension commitment considerably. On average the increase amounts to more than 20 per cent of the reported liability. Under risk-free discounting, only five companies have posted a surplus in at least one year and none has had a consistent surplus throughout our sample period. The median company has deficit totalling more than 5 per cent of assets.

[13]We did not adjust NPA to account for the deferred tax credit/debit that they generate in this section. We choose not to present the results with both adjustments as they are nearly identical to the ones in this section.

5 Dataset construction and summary statistics

Our main dataset includes all the FTSE 100 constituents with at a defined benefit pension scheme. [14] It spans from 2006, the first year when IAS 19 became mandatory, until 2012. To deal with the wide variation in balance sheet closing dates, we defined time in our sample as fiscal year, i. e. all the companies closing their accounts from May 2008 to April 2009 are considered in year 2008.

All the pension related variables have been hand-collected from the notes to the financial statements. The rest of the companies account data have been retrieved from Bloomberg, using the balance sheet closing date as reference; for companies that do not use pound sterling as reporting currency, the data have been converted in pounds using the closing exchange rate at the balance sheet date. The market capitalisation of each company has been retrieved at the reporting date instead of the balance sheet date, focusing on when the financial statements became publicly available.

This leaves us with 83 companies that have a DB scheme for at least one of the years in our main sample of FTSE 100;[15] we drop two of them (Burberry and Lonmin) because their DBs were demerged or wound up in 2008. We also drop Fresnillo and Vedanta Resources because they do not have any DB scheme in Europe or the United States, but only very small arrangements in developing countries.[16] These exclusions do not affect our results in any material way. Given that for some companies we don't have the full seven years of data, our main dataset includes 543 observations.

Table 3 below summarizes the variables used in the estimation for the main sample of FTSE 100 firms, already standardized by assets. The main variable of interest for this study, net pension assets, averages at about - 2.7 per cent of assets, but the distribution is considerably skewed to the right so the median company has a deficit of only 0.8 per cent. Tax adjusted NPA displays similar feature as NPA, but by construction has smaller mean and dispersion.

[14]recall that we use the FTSE 100 for the main part of the paper because the pension reporting - particularly of interest rate sensitivity is superior to that of the FTSE 250. We present results for the FTSE 350 in section **??**

[15]During this period there was a major merger between British Airways and Iberia. For the sake of dataset construction, we consider the resulting company (International Airlines Group) as a new firm that take the place of BA.

[16]In 2012 their combined pension liabilities were under 100m £, less than 0.2 per cent of the whole liabilities of FTSE 100 constituents.

Also the distribution of pension liabilities is skewed to the right, with some supersized pension funds pushing the mean up to 29 per cent. For the median company pension liabilities represent about 17 per cent of assets, but in some cases the pension fund is actually bigger than the company itself. Obviously using a risk free rate to discount pension liabilities increases their size considerably.

Non pension earnings average 6 per cent of assets, while the direct impact of DB schemes on the sponsoring firms' income statement is very modest as testified by NPPC. Moreover, nearly 15 per cent of our sample's companies are actually booking negative pension expenses, with the DB scheme contributing to firm profitability despite being in deficit in some cases. We should however note that a great deal of these profits comes from settlements and curtailments related to the restructuring of the pension fund.

Table 3: Descriptive Statistics

variable	N	mean	standard dev	1st quartile	median	3rd quartile
Market Capitalisation	543	0.9192	0.7333	0.4106	0.7406	1.3289
Core Book Value	543	0.3416	0.1859	0.1930	0.3590	0.4939
NPA - Tax Adjusted	543	-0.0195	0.0370	-0.0275	-0.0065	-0.0006
Net Pension Assets	543	-0.0270	0.0510	-0.0383	-0.0090	-0.0009
Pension Liabilities	543	-0.2873	0.4094	-0.3444	-0.1773	-0.0307
NPA - Gilt Discount	543	-0.0931	0.1294	-0.1103	-0.0565	-0.0090
PL - Gilt Discount	543	-0.3536	0.4955	-0.4404	-0.2167	-0.0390
Core Earnings	543	0.0607	0.0788	0.0188	0.0601	0.0933
NPPC	543	-0.0026	0.0053	-0.0043	-0.0016	-0.0002

Notes: All variables are divided by total company assets on the balance sheet date, except market capitalization which was retrieved at the reporting date.

6 Estimation and results

Column (1) and (2) of table 4 reports the parameter estimates for equation (1) with tax adjusted net pension assets, while column (3) and (4) use the unadjusted value for NPA. Odd columns report the estimates obtained with sector and year dummies, while in even columns we use fixed effects at the firm level.

The specifications as in table (1) seem to support the transparent view: the coefficient on

NPA is statistically significant, while the estimated coefficient on pension expenses is quite noisy. In some specifications the coefficient on pension earnings is significant but negative. This is due to the service cost anomaly, a fact well documented in the literature:[17] service cost expenses are a proxy for human capital formation and hence contribute positively to the value of the company. If we follow of Coronado & Sharpe (2003) and Coronado, Mitchell, Sharpe & Blake Nesbitt (2008) in considering service cost in core earnings, the coefficient on pension earnings becomes indistinguishable from zero. As expected, the coefficients on core book value and earnings are generally significant. They are in the same ballpark as the estimates for the US in Hann, Heflin & Subramanayam (2007), albeit a bit smaller and sensitive to the level at which we impose fixed effects. At first blush, the coefficient on tax adjusted NPA in column (1) is quite puzzling as it is consistently bigger than one. The same holds for NPA in column (3): since we did not make any allowance for deferred taxes, according to the transparent view this coefficient should be around 0.75. The parameter estimate in columns (1) and (3) would imply that the market gives a disproportionate weight to pension deficit/surplus, with £1 of gross pension deficit reducing the market value of the company by about £1.5.

These results are however less evident in the specifications where we include fixed effects at the company level. Column (2) and (4) still support strongly the transparent view of DB pension funds, but the overvaluation of net pension assets is much less evident. We explain this difference by maintaining that the discount rate effect is mitigated by the firm level fixed effects. The difference between the risk-free NPA and the reported value depends on the absolute size of pension liabilities and their duration: as these two are specific to every company, in these specifications their effect is likely to be captured at least partially by the company dummies.

In all the specification in table 4 we decided to cluster the standard errors at the sector level since this is the least restrictive assumption about the correlation of the errors themselves. However, this is problematic with our data. Clustered standard errors are unbiased when the number of clusters approaches infinity and in our setup we have only ten sectors. Moreover each sector has a different size in terms of number of observations, further compounding the problem of over-rejection of the null hypothesis. Of the various bootstrap based improvements proposed by the literature we choose to use the wild cluster bootstrap of t-statistics as in Cameron, Gelbach

[17] See for example Hann, Heflin & Subramanayam (2007).

& Miller (2008) since this method corrects for both the small number of clusters and the unequal cluster size.[18] Moreover, we slightly modify to original procedure by using the weight structure proposed by Webb (2013) and later endorsed in Colin Cameron & Miller (2015) when the number of clusters is smaller than 15. MacKinnon & Webb (2015) discuss in detail the properties of this technique, showing how it approaches the true rejection rates even with imbalanced cluster size. [19]

To summarize briefly this technique, the goal of the bootstrapping is to generate an empirical distribution of t-statistics. These are obtained by running the base regression having imposed the null hypothesis, storing the residuals and the predicted value. For each cluster, the predicted value is then added to the residual multiplied by a random weight chosen from an appropriate distribution to generate a new set of dependant variables (all the observations in the same cluster get the same weight). These are then used as dependent variables in the model to obtain an empirical distribution of the t-statistic. Finally, the original t-stat is compared to this empirical distribution to calculate a bootstrap p-value used for inference. For a complete discussion of the steps followed in the bootstrap procedure we refer to the papers quoted above, but we provide a description of the steps we followed in section 9. We run 1000 replications for each of the specification in table 4. The resulting p-values for Tax Adjusted NPA are 0.20 for using sector and year fixed effects and 0.04 with firm level fixed effects. The p-values for the NPA specification are very similar, namely 0.22 using sector and year dummies and 0.03 using firm level fixed effects.

Using the adjusted liability series described above we can now test to see if the larger than expected estimates of the market impact of reported pensions deficits is due to the market valuing liabilities using risk-free rates rather than AA corporate bonds yields. First, we re-estimate (1) using gilt discounted liabilities. As column (1) in table 5 shows on this basis the coefficient on net pension assets is now within the predicted range and column (2) shows that this result is robust to firm fixed effects. As in the previous estimation, we use cluster the standard errors at the sector level and use the wild cluster bootstrap of t-statistics as in Cameron, Gelbach & Miller (2008) to obtain reliable inference. As it is the case in the table, Risk free NPA is more

[18]Clearly another possible solution is to make more restricting assumption about the correlation of the errors. Allowing them to be correlated only at firm level or using robust standard errors improves the precision of the results in table 4 without changing the interpretation of the results.

[19]Using Rademacher weights as in the original Cameron Gelbach and Miller paper would not impair our results, but the use of 6 weights as in Webb (2013) improves the distribution of our bootstrapped t-statics.

Table 4: Residual income model

Table presents our estimation results using the main FTSE 100 sample, stretching from 2006 to 2012. The independent variable is market capitalisation at the reporting date. Core book value is book value minus net pension assets, core earnings are net income minus net periodic pension cost (NPPC), the measure of pension-related earnings in income. Net pension assets are the difference between pension assets and liabilities for each firm, the tax adjustment is due to the tax credit associated with pension contributions in the UK. All the variables are standardized by total company assets. We use the broadest GISC sector classification, with 10 sectors in total.

	(1)	(2)	(3)	(4)
Core Book Value	0.48	1.485***	0.48	1.482***
	(0.439)	(0.408)	(0.440)	(0.406)
Tax Adjusted NPA	2.142*	1.227**		
	(1.058)	(0.398)		
NPA			1.547*	0.903**
			(0.779)	(0.287)
Core Earnings	3.713*	1.525**	3.714*	1.527**
	(1.748)	(0.558)	(1.748)	(0.559)
NPPC	6.007	-5.321*	5.955	-5.42**
	(3.533)	(2.359)	(3.553)	(2.341)
Fixed Effects	Sector, Year	Company	Sector, Year	Company
N	543	543	543	543
R^2	0.578	-	0.578	-

precisely estimated also with this bootstrap based technique. The resulting p-values are 0.045 with sector and year fixed effects and 0.003 using fixed effects at the firm level.

Of course, these estimates do not necessarily indicate that it is the change in discounting that explains the higher than expected estimates that we first observed, so in column (3) we separate the NPA and the additional component due to the gilt adjustment, creating a variable named Adjustment (Adj) defined as Risk free NPA - NPA which amounts to testing the following:

$$Mcap_{it} = \alpha + \beta_1 BVc_{it} + \beta_2 NPAt_{it} + \beta_3 Adj_{it} + \beta_4 Ec_{it} + \beta_5 NPPC_{it} + \epsilon_{it} \tag{3}$$

.

Even though the coefficient on tax adjusted NPA is just short of significance at the conventional levels, the one on the adjustment is strong and very close to what we found for the risk-free net pension assets. Finally in column (4) we test directly the prediction that companies with long duration liabilities should see a larger coefficient on their reported liabilities. We define a new variable called Ddif, equal to the duration of each company's pension liabilities minus the average duration across the sample, and interact it with tax adjusted NPA.[20] As column (4) shows, the interaction term is significant indicating that firms with longer duration liabilities have a larger coefficient on reported pension deficits.

Overall, our results suggest that risk-free discounting is the most plausible explanation for the higher than expected impact of pension deficits on market valuation, not least since the effect seems larger for firms with longer duration liabilities.

6.1 Model selection tests

Testing econometrically whether the model with risk-free NPA is preferable to the model using the accounting NPA is tricky in our framework as the two models are non-nested. One possible solution is to use Vuong (1989) test statistic, as Hann, Lu & Subramanyam (2007) do in this literature. To run the test, we assume that the errors in our regression are normally distributed rather than allowing for a richer correlation structure as we do in the main estimation. While this assumption is admittedly restrictive, it has the benefit of simplifying the calculation of the

[20] Using unadjusted NPA or pension liabilities yields the same result.

Table 5: Risk-free pension liabilities

Table presents our estimation results using net pension assets discounted at a risk free rate (UK gilt yields). The independent variable is market capitalisation at the reporting date. Core book value is book value minus net pension assets, core earnings are net income minus net periodic pension cost (NPPC), the measure of pension-related earnings in income. Adjustment is defined as risk-free NPA - NPA. Duration dif is the duration of pension liabilities minus its average across the sample. All the variables but duration dif are standardized by total company assets. We use the broadest GISC sector classification, with 10 sectors in total. A Vuong (1989) test confirms that the model with risk-free NPA is better specified than its counterparts with tax-free NPA or unadjusted NPA at the 5% confidence level.

Variable	(1)	(2)	(3)	(4)	(5)
Core Book Value	0.449	1.519***	0.442***	0.494***	0.441***
	(0.444)	(0.447)	(0.149)	(0.147)	(0.149)
Risk-free NPA	0.960***	1.084***			1.048***
	(0.238)	(0.201)			(0.295)
Core Earnings	3.804*	1.458**	3.812***	3.658***	3.814***
	(1.763)	(0.539)	(0.801)	(0.797)	(0.800)
NPPC	2.123	-3.838	2.317	5.389	2.243
	(3.099)	(2.615)	(6.280)	(5.993)	(6.293)
Tax Adjusted NPA			1.045	2.607***	-0.400
			(0.659)	(0.777)	(0.852)
Adjustment			1.045***		
			(0.294)		
Duration dif				0.021***	
				(0.008)	
Duration dif x Tax NPA				0.449**	
				(0.212)	
Fixed Effects	Sector, Year	Company	Sector, Year	Sector, Year	Sector, Year
Standard Errors	Cluster	Cluster	Robust	Robust	Robust
N	543	543	543	543	
R^2	0.587	-	0.587	0.592	

likelihood functions that are Vuong's test argument.[21] This test does indeed confirm that the risk-free model is better specified, preferring it to the specification with NPA or tax-adjusted NPA at the 5% confidence level using both company and sector and years fixed effects. Another alternative to compare the two models is to use Aikake's information criterion, which also indicates that the risk-free model is better specified.

An, admittedly rough, alternative to the test presented above is to nest the two models by force, running a regression with both risk-free NPA and regular NPA as independent variables. We do in column 5 of table 5, where risk-free NPA completely dominates its tax-adjusted counterpart: the coefficient and standard errors on risk-free NPA are almost unchanged from what we present in columns 1 and 2 of table 5.[22]

7 Extensions

This section presents a set of extensions to our basic results that aim to confirm the validity of our results. First, we extend our sample to the full FTSE350, though the lack of liability duration data for the smaller firms means we cannot recalculate pension liabilities using a risk-free rate. Second we use Tobin's Q model rather than the residual income model as the basis of our estimation.

7.1 FTSE 350 firms

In the extended sample of FTSE 350 constituents we have 215 firms with a defined benefit pension scheme for at least one year in our sample. The disclosure of firms in the FTSE 250 is not as comprehensive as that of the constituents of the FTSE 100, so for those firms we could not work out the duration of the pension obligation and hence the discount rate adjustment. We drop all the observations that have a negative book value of equity together with two firms that experienced exceptional circumstances during the years that we consider in our sample, namely Howden Joinery and ITV. This leaves us with 1408 firm-year observations. As table 6 shows, the two samples are remarkably similar for the variables that we consider, even if the pension

[21] In this setup the test is equivalent to a comparison of R^2, but it nevertheless useful as it gives a confidence range for this comparison.

[22] Using unadjusted NPA yields the same result.

commitments of companies in companies in the FTSE 250 are only a fraction of those of their bigger peers[23].

Table 6: Descriptive Statistics - FTSE 350 Firms

variable	N	mean	standard dev	1st quartile	median	3rd quartile
Market Capitalisation	1408	0.96624	0.85402	0.43764	0.74809	1.2553
Core Book Value	1408	0.38811	0.19034	0.26208	0.38931	0.52006
Net Pension Assets	1408	-0.02778	0.05088	-0.04246	-0.01235	-0.00098
Pension Liabilities	1408	-0.28252	0.347	-0.38959	-0.17291	-0.03954
Core Earnings	1408	0.06222	0.07962	0.0256	0.05649	0.09258
NPPC	1408	-0.002	0.00678	-0.00362	-0.00124	-0.00006

We test equation (1) with and without the usual deferred tax adjustment in this extended sample, the results are reported in table 7. As in table 4 odd columns have sector and year fixed effect while even columns have firm dummies. The effect of book value and earnings on companies' valuation appears to be stronger in this sample, at least when using sector and year fixed effects, while net pension assets are still overvalued but slightly less than in our main sample of FTSE 100 constituents. Here the service cost anomaly is less pronounced than in FTSE 100 sample, pension earnings are still negative but the result is not statistically significant. As in the previous estimation we use clustered standard error at the sector level and use the wild cluster bootstrap as in Cameron, Gelbach & Miller (2008) to correct for over-rejection of the null hypothesis. The bootstrap based p-values are 0.045 for the tax adjusted NPA with sector and year fixed effects, 0.06 using company fixed effects. The p-values for the unadjusted NPA are almost identical, 0.043 using sector and year fixed effects and 0.06 using the company ones.

7.2 Tobin's Q

The second model we employ to test the valuation of defined benefit pension schemes is derived from Tobin (1969), much in the spirit of Feldstein & Seligman (1981) and Liu & Tonks (2010). We defined Q as in the latter, namely as market value of equity plus book value of long term debt over total firm assets. Under strict assumptions, the value of Q should be equal to one in equilibrium; however the situation in the real world could be much different. To take this into

[23]See section 1, in particular table 1.

Table 7: FTSE 350 sample

Table presents our estimation results using the extended FTSE 350 sample, stretching from 2006 to 2012. The independent variable is market capitalisation at the reporting date. Core book value is book value minus net pension assets, core earnings are net income minus net periodic pension cost (NPPC), the measure of pension-related earnings in income. Net pension assets are the difference between pension assets and liabilities for each firm, the tax adjustment is due to the tax credit associated with pension contributions in the UK. All the variables are standardized by total company assets. We use the broadest GISC sector classification, with 10 sectors in total.

Variable	(1)	(2)	(3)	(4)
Core Book Value	1.021**	1.537***	1.021**	1.546***
	(0.439)	(0.154)	(0.439)	(0.153)
Tax Adjusted NPA	1.625**	1.159**		
	(0.611)	(0.48)		
Net Pension Assets			1.192**	0.93**
			(0.44)	(0.299)
Core Earnings	4.57***	1.396***	4.57***	1.39***
	(1.194)	(0.333)	(1.194)	(0.331)
NPPC	-4.015	-3.859	-4.068	-3.987
	(2.893)	(2.162)	(2.901)	(2.106)
Fixed Effects	Sector, Year	Company	Sector, Year	Company
N	1408	1408	1408	1408
R^2	0.471	-	0.471	-

account, we include a set of control variables that may have an effect on Q, following again Liu & Tonks (2010).

Total earnings (Etot) are defined as net earnings plus interest expenses on debt[24]. To control for the growth trajectory of the firm, we include 5y earnings growth, defined as the average of the last five years earnings minus the average of the five previous years; we also define its three years equivalent to limit the loss of observations caused by the data requirement of this variable. We also include net debt, defined as cash holdings minus total debt; hence a positive value indicates that the firms is a net creditor. All these variables are standardized by total company assets. The last control variable we add is the firm CAPM beta, computed using one year of weekly returns against the FTSE 100 index.

We test this model using both the tax and the gilt adjusted value for net pension assets, bringing to the data the following equation:

$$Q_{it} = \alpha + \beta_1 Etot_{it} + \beta_2 5yGrowth_{it} + \beta_3 NPAt_{it} + \beta_4 Debt_{it} + \beta_5 Beta_{it} + \epsilon_{it} \tag{4}$$

where we also include year and sector dummies. In the estimation we progressively drop the control variables to ensure that they are not driving the results.

Total earnings average about 50 per cent above net earnings. The growth trajectory of earnings is positive for most companies, both if measured over a five or three year period. The values for Tobin's Q are very plausible, with an average about 1.1 and median very close to 1; for most of the financial companies in our dataset (mainly the high street banks) the value for Q is sensibly lower. Excluding them from the sample as in Liu & Tonks (2010) does not materially change our results. Net debt averages at about 18 per cent of total assets but with considerable variation, with most firms being net debtors as expected. The beta against the FTSE 100 is very close to one on average.

The estimation results are presented in table 8. We start with (4) in the first column, then substitute the 5 years growth terms with its 3 years counterpart in column 2. Column 3 drops the earnings growth term entirely, while column 4 drops the net debt term as well. Columns 5 to 8 repeat the same exercise using risk free NPA instead of the tax adjusted values. We choose

[24]Using net earnings instead of this variable does not alter our results

Table 8: Tobin's Q Model

Table presents our estimation results for the Tobin's Q model. Q is defined as market value of equity plus long term debt over total assets. Total earnings are net earnings plus interest expenses, net debt is cash minus total debt. The CAPM beta is computed against the FTSE 100. NPA is pension assets minus pension liabilities, for its risk free version we discounted liabilities using gilt rates. All specification include sector and year fixed effects. We cluster the errors at the sector level. The Vuong (1989) test confirms that the models with risk-free NPA are better specified than their counterparts with tax-free NPA or unadjusted NPA at the 5% confidence level.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Total Earings	3.16*	4.114**	4.211**	2.445	3.103*	4.134**	4.237**	2.461
	(1.526)	(1.566)	(1.532)	(1.748)	(1.748)	(1.56)	(1.535)	(1.757)
Beta	-0.123*	-0.103	-0.09*	-0.138***	-0.130**	-0.105	-0.093*	-0.137***
	(0.057)	(0.064)	(0.042)	(0.032)	(0.054)	(0.068)	(0.043)	(0.032)
Net Debt	-0.986***	-0.761**	-0.814**		-0.942***	-0.680**	-0.739**	
	(0.274)	(0.294)	(0.259)		(0.267)	(0.267)	(0.247)	
Tax adjusted NPA	1.868	1.963**	1.920**	2.657**				
	(1.075)	(0.847)	(0.771)	(1.112)				
Gil discounted NPA					0.995**	0.896***	0.874***	1.080***
					(0.394)	(0.186)	(0.176)	(0.273)
5y Earnings Growth	2.633***				2.978***			
	(0.758)				(0.720)			
3y Earnings Growth		-0.084				-0.088		
		(0.433)				(0.490)		
N	421	461	491	525	421	461	491	525
R^2	0.544	0.542	0.558	0.518	0.56	0.553	0.568	0.529

not to report the estimation with unadjusted NPA as they are not materially different from the results in table 8.

The results in table 8 broadly confirm the findings we highlighted in the previous sections: the coefficients on tax adjusted net pension assets are significant and consistently above one. On the other hand, adjusting their value using a discount rate that does not allow for credit risk yields estimates very close to unity.

Also in these estimation we used clustering at the sector level despite the econometrics problems that it entails. Using the wild t-statistics bootstrap, the p-values on tax adjusted NPA are 0.267, 0.126, 0.93 and 0.92 for the first four columns in table 8. As usual Risk-free NPA is more precisely estimates, with value of 0.14, 0.01, and 0.03 for the last two specifications. As one would expected, using robust standard errors or clustering at the company level yield more precise estimates without changing the inference.

As with the Ohlson model, we compared the models with risk-free NPA in table 8 with their counterparts that use tax-adjusted NPA as measure of pension deficit. Vuong's test statistics indicates that each risk-free NPA model is always preferred to its counterpart at least with a 5% confidence level. Also Aikake information criterion gives the same result.

8 Conclusion

Comparing our results with the previous literature investigating the issue of pricing of DB in the United Kingdom and elsewhere, it seems that the increased disclosure brought by IAS 19 has improved the way in which investors evaluate DB pensions. However the European accounting standard falls short on the discount rate, where both financial theory and market valuation suggest the use of a risk-free rate rather than corporate bond yields. Given these results, it seems that not only should IAS 19 itself move to government bond yield based discounting of pension liabilities, but other moves to reveal even more actuarial information, such as life expectancy assumptions, could help the market arrive at an even more accurate valuation of pensions.

9 Appendix

The procedure for using the cluster wild bootstrap of Cameron, Gelbach & Miller (2008) to perform the test on β_2 in equation (1) is as follows:

1. Estimate equation (1) by OLS.

2. Calculate $\hat{t}_2$, the t-statistic for $\beta_2 = 0$, using cluster robust standard errors.

3. Estimateby OLS the restricted regression

$$Mcap_{ig} = \alpha + \beta_1 BVc_{ig} + \beta_3 Ec_{ig} + \beta_4 NPPC_{ig} + \epsilon_{ig} \tag{5}$$

   where the subscript g indicates the cluster, imposing the null hypothesis that $\beta_2 = 0$.

4. Store the restricted residual $\tilde{\epsilon}_{ig}$ and the restricted estimate $\tilde{\beta}_{H_0}$.

5. For each of B bootstrap replications, generate a new set of bootstrap dependent variables $y^{\star}_{ig}$ using the data generating process

$$y^{\star}_{ig} = \tilde{\beta}_{H_0} + \tilde{\epsilon}_{ig} v^{\star}_g \tag{6}$$

   ,

   where $v^{\star}_g$ is a random variable that takes values $-\sqrt{\frac{3}{2}}$, -1, $-\sqrt{\frac{1}{2}}$, $\sqrt{\frac{1}{2}}$, 1, $\sqrt{\frac{3}{2}}$ with equal probability. [25]

6. For each bootstrap replication, indexed by j, estimate regression (1) using $y^{\star}_{ig}$ as the regressand and calculate $\hat{t}^{\star}_{2j}$, the bootstrap t-statistic for $\beta_2 = 0$ using clustered standard errors.

7. Calculate the bootstrap p-value as

$$\hat{p}^{\star}_s = \frac{1}{B} \sum_{i=1}^{B} I(|\hat{t}^{\star}_{2j}| > |\hat{t}_2|) \tag{7}$$

[25] This is the weight distribution proposed by Webb (2013). The original Cameron, Gelbach & Miller (2008) uses Rademacher weights.

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