Essays in Pension Finance

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Abstract

This work analyses how investors and market participants perceive corporate defined benefit pensions.

The first chapter compares how pension obligations impact the market value of US corporations under two accounting regimes. I find that market participants take into account the net position of the pension fund only if it is recognized on the sponsor's balance sheet. Before 2006 investors seem to focus on the accrual recognized on the balance sheet rather than the net funding position of the scheme disclosed in the notes to the financial statements, thus mispricing the pension deficit/surplus when valuing the sponsor.

The second chapter focuses on UK defined benefit pensions and in particular on how future liabilities are discounted. I find that equity market valuation of DB pensions is consistent with discounting that allows for no credit risk. This is the appropriate approach but differs from that used in published accounts for which IAS 19 (and SFAS 158, its US equivalent) allows for discounting with a corporate bond yield. The difference is significant, as credit risk free discounting would decrease the reported value of FTSE 100 firms by about 7%.

The third chapter investigates the ability of analysts to incorporate the income effect of defined benefit pensions on their earnings estimates. The earning component of defined benefit pensions can be reliably estimated using a set of assumption chosen by the sponsoring company and disclosed in its annual report. I find that

analysts persistently fail to use this information in their forecasts. I also exploit the different reporting periods of the companies in my sample together with a change in pension accounting rules to show that analysts at first fail to incorporate the effects of the accounting revision in their forecasts, but they do so for companies adopting it later.

Dedication

A mio padre

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Contents

List of Figures

List of Tables

Chapter 1

Introduction: accounting for defined benefit pensions

This introductory chapter aims at clarifying the regulatory background of my thesis. The unifying theme of the next three chapters is that they all investigate issues revolving around market participants' perceptions of defined benefit pensions and how these perceptions changes as the regulatory system does.

Defined benefit (DB) pensions are by nature complex and long term arrangements. Despite the move towards contributory pensions, DB pensions still represent a significant commitment for most of the companies listed in either the US or the UK. I believe that the complexity of the institutional background and the sheer size of the liabilities involved provide an ideal setting to test a number of research questions concerning how market participants perceive and value these commitments under different accounting regimes. Accounting for defined benefit pensions has been evolving in the past 20 years, with a focus on increasing transparency and making these liabilities more explicit. This period has also been marked by a change of focus in accounting, from historical cost to fair value accounting. This move clearly had repercussions on how DB pensions are accounted

for and presented to users of financial statements.

This introduction explains accounting for DB pensions in both the US and UK, highlighting the regulatory changes that are the background of my research questions in the following chapters. The next section explains the basics of accrual accounting for DB pensions, that have been largely left untouched by the changes in regulations and are common in both the US and the UK. Section 1.2 analyzes in detail accounting for DB pensions under US GAAP, focusing on its evolution over time. Section 1.3 discusses the same matter under the International Accounting Standards, the relevant framework for companies listed in the United Kingdom. The last section concludes.

1.1 Accounting for DB pensions

This section lays out the basic of accounting for DB pensions, common to both US GAAP and IAS. These two regimes have a shared focus on accrual accounting, so that costs and revenues are recorded in the period when they occur, irrespective of cash movements. Thanks to the convergence of accounting standards worldwide, the two legislations share many features but have also important differences. This section focuses on their shared provisions, while the next two highlight the specificity of each standard. DB pensions have income statement, comprehensive income, balance sheet and cash flow effects, which I will analyze in turn.

1.1.1 Income statement

A company sponsoring a defined benefit pension scheme has to record the benefits earned by its employees in each accounting period. The corresponding entry is service cost, representing the discounted value of the future benefits earned by employees during the year. This entry is always a cost for a company with an active

DB scheme, but is zero for sponsors that have closed their schemes to new members and future accruals (so that benefits are frozen). Companies which have closed their DB scheme to future accruals generally offer different retirement benefits to their current employees (typically defined contribution pension schemes). Service cost is often booked under employee compensation in the income statement.

The other recurring entries in the income statement for a company sponsoring a DB scheme are interest cost and expected return on assets. Interest cost represents the effect of the passage of time on pension liabilities: since the value of the latter is discounted, as time goes by liabilities increase mechanically as they are one year closer to their due date. Hence interest cost is calculated as pension liabilities times their discount rate. In both the UK and the US DB pensions are funded, meaning that there is a pool of assets to cover for pension liabilities. These assets are invested and companies book a revenue item equal to their expected return (not their actual return). Under both US GAAP and IAS 19 sponsors enjoyed considerable freedom in setting their expected return on assets, but with the latest revision of IAS 19 this is set to be equal to the discount rate on pension liabilities.[1] The financial component of DB pension cost is generally booked under financial expenses in the income statement. This is the also the most predictable component of pension cost, it can be readily estimated using the values for pension assets/liabilities and the financial assumptions disclosed by each company. In the fourth chapter I ask whether financial analysts incorporate in their estimates the predictable effect that this component of DB costs has on earnings.

Other DB pension related income statement entries follow exceptional events. Curtailments arise when benefits are cut, either because the benefit formula changes for all employees or because some of them will enjoy a different treatment in the

[1] More details on the difference between IAS 19 and IAS 19 revised are presented in section 1.3

future (for instance following the sale of a business unit). Settlements are transactions that eliminate all further obligations for all or part of the benefits under the plan. The simplest case of settlement is when employees decide to renounce their entitlement for an annuity, opting instead for a lump-sum payment. More complex settlements arise when the sponsor sells part of its plan to an insurer, which in turn guarantees annuities to participants. Plans amendments and curtailments often give rise also to past service costs. The latter follows changes to the plan's formula that require adjustments to the service cost that was booked in the past.

All the DB pension related income statements entries are grouped together into net periodic pension cost (NPPC), an entry that summarizes the profit and loss impact of DB pensions.[2]

1.1.2 Actuarial gains and losses

Not all the changes in value of DB pensions go through the income statement. Remeasurement effects due to changes in assumptions in the formula to compute pension liabilities are generally orders of magnitude bigger than the NPPC described above. These remeasurement effects are mainly due to changes in actuarial assumptions, so they are labelled actuarial gains and losses. Since companies are allowed to book an expected return on assets in their income statement, also the difference between the real return achieved on pension assets and this hypothetic measure falls under actuarial G&L.

Actuarial gains and losses hit shareholders' equity bypassing the income statement, so they are booked only in other comprehensive income (OCI). Before the introduction of SFAS No. 158 and IAS 19 revised, companies had the option to

[2]Under both SFAS No. 87 and the original IAS 19 companies had the possibility of smoothing actuarial gains and losses using the corridor approach. If this was the case, actuarial gains and losses above a certain threshold were recycled in the income statement. I describe the corridor in more detail below.

avoid OCI recognition and could disclose these items only in the notes, as long as the cumulative total of gains and losses did not exceed 10% of the biggest between liabilities and assets. This is know as the "corridor" approach: its rationale is that actuarial gains and losses should compensate over time. If this was not the case and actuarial gains or losses were above the corridor threshold, the exceeding part had to amortized in the income statement (thus adding another component to NPPC).

1.1.3 Pension assets and liabilities

The gross values of DB pensions' assets and liabilities are not recognized on the balance sheet of the sponsor but rather disclosed in the notes. The biggest change brought forward in 2006 by the introduction of IAS 19 in Europe and SFAS No. 158 in the US is that their sum (net pension assets or NPA, the surplus/deficit of pension funds) has to be recognized, while the gross amount of assets and liabilities is still disclosed only in the notes. I investigate if the movement from disclosure to recognition of NPA changed investors' valuation of DB sponsors in the first chapter, using US data.

Both pension assets and liabilities are marked to market. This is easier for pension assets, as most of them are actively traded securities. Valuing pension liabilities is much more complicated, as they are not traded and their valuation depends on a host of assumptions made by the sponsoring companies. Since these liabilities are by nature very long term and they have to be discounted, the discount rate plays a crucial role in their valuation. In the third chapter I exploit the unique features of UK data to investigate if the AA corporate bond rate that the accounting standards prescribe is indeed the appropriate discount rate for this exercise.

Liabilities are generally measured using the projected benefit obligation or PBO. This measure takes into account also the benefits that have been earned but have not vested yet and future salary increases in case of final salary DB schemes. Companies are allowed to weight benefits earned but non vested according to their experience, hence taking into account employees' turnover. So the PBO measures pension liabilities on a going concern basis.

1.1.4 Cash contributions to DB schemes

In both the US and the UK DB schemes are funded, so that companies have to contribute cash to the schemes, building a pool of assets meant to cover the future pension liabilities. Contributions are not part of the income statement, but rather get recorded in the cash flow statement. In both the US and the UK pension contributions are tax deductable.

The level of contributions is agreed with the fund's trustees to guarantee future solvency. A rough rule of thumb is to set contributions equal to service cost, hence at the level of (discounted) benefits earned by employees during the period. However there are significant deviations to this heuristic: often when schemes are in surplus companies contribute less, sometimes none at all (this is called a contribution holiday). When schemes are in deficit contributions rise, most of the times following a multi year plan agreed among the company, the trustees and the regulator to address the deficit.

National laws regulate the cases of most severe underfunding, setting rules to defend the employees' right to a pension in the future. The relevant regulations are the Pension Act for the UK and the Employment Retirement Income Security Act (ERISA) in the US.

1.2 DB pension accounting under US GAAP

This section focuses on the evolution of US GAAP regulating financial reporting for DB pensions in the last 30 years, highlighting the differences with the basics of accrual accounting discussed above.

From 1987 until 2006 the relevant standard was SFAS No. 87 *Employers' accounting for pensions* (FASB (1985)), which mandated the reporting on the balance sheet of a net prepaid pension asset or accrued pension liability that represented only a part of the sponsor's pension assets and liabilities. In particular, the funding status recognized on the balance sheet was the result of netting several off-balance-sheet items: pension assets, pension liabilities (measured as projected benefit obligation or PBO), prior service cost, actuarial gains and losses, the difference between expected and realized return on plans' assets and net transition assets or liabilities. The rationale behind these adjustments is to have a smoothed measure for pension surplus/deficit, eliminating the effects of fluctuations in the value of assets and liabilities. The resulting asset or liability recognized on the balance sheet was essentially the cumulative difference between pension expenses recognized by the company in its income statement and cash contribution to the pension fund, with a net asset arising if contributions were above pension expenses or a liability in the reverse case. The accrual computed under SFAS No. 87 could be significantly different from the underlying surplus/deficit of the pension fund, as figure 2.1 in chapter 2 shows. Companies were also required to recognize a minimum liability if the value of pension assets was smaller than the accumulated benefit obligation (ABO), a measure of pension liabilities that does not include benefits that have not yet vested and future salary increases. In other words, the ABO is the amount of pension liabilities if the plan was to be terminated

immediately.

SFAS No. 87 also allowed companies to use a smoothed measure for pension assets rather than their value at the balance sheet date when estimating expected return on pension assets. This measure was called market related value and gave significant leeway to management in its determination, with the limit of using no more than 5 years in the smoothing process. This changed with the introduction of SFAS No. 132 that dictated the use of market value of assets in determining their expected return. Actuarial gains and losses were accounted for using the corridor approach described above.

The disclosure requirements for DB schemes were significantly expanded by the introduction of SFAS No. 132 in 1998 (and by its revised version issued in 2003), but neither standard changed the measurement or recognition requirements of SFAS No. 87. Both these requirements changed with the introduction of SFAS No. 158 in December 2006. The most important requirements of SFAS No. 158 are that companies have to fully recognize the funding status of their pension schemes on the balance sheet and recognize in other comprehensive income (OCI) the financial effects of certain plan events when they occur.[3] Thus the balance sheet recognition of previously disclosed items requires an OCI offset. Under SFAS No. 158 the corridor approach is no longer allowed, so companies have to recognize immediately actuarial gains and losses in OCI.

The introduction of SFAS No. 158 typically increased the reported DB pension liabilities, as under the previous standard companies were allowed to recognize an asset even if their schemes were in deficit. The FASB's objective in introducing this new reporting standard was to increase the transparency and usefulness of

[3]These include actuarial gain and losses, prior service cost, the difference between expected and realized return on plan's assets and transition asset or liability. Under the previous regime these items were deferred and gradually amortized in net income when they were above a certain threshold, using the corridor approach.

reported pension information. The next chapter focuses on the difference between disclosure and recognition of net pension assets, asking if this change in accounting rules changed the valuation of DB schemes that investors attach to the sponsoring companies.

1.3 International Accounting Standards

Since 2006 the relevant accounting standard for companies listed in the UK is IAS 19, which was later revised, with the new version mandatory since 2013. To avoid confusion, I refer to the original version as IAS 19 and to the revised version as IAS 19R. Before 2006 UK companies accounted for DB pensions under Financial Reporting Standard 17, which did not require balance sheet recognition for net pension assets.

The main change with IAS 19 is the obligation to recognize the net position of the pension funds (NPA) on the balance sheet. Companies could choose how to account for actuarial gains and losses between three options: the corridor approach, immediate OCI recognition and immediate profit and loss recognition. The last proved very unpopular, with none of the constituents of FTSE 350 following it. Most of the companies opted for OCI, but a minority decided to follow the corridor approach.

Despite the minor difference in wording between IAS 19 and SFAS No. 158, the discount rate provision of both standards has been interpreted in the same way, so that companies under both standards use AA rated corporate bond yields. This provision has proven controversial, as I argue in section 3.3. Standard setters considered changing it during the consultation period that preceded the introduction of IAS 19R, but opted for no modification. Instead, they increased the disclosure requirements, adding the duration of pension liabilities. However most

of the biggest UK companies were already disclosing it in the sensitivity analysis of pension assumptions in the notes to the financial statements. The third chapter uses these data to ask if market participants take the sponsors' assumptions at face value when valuing DB pensions.

The main change introduced by IAS 19R is to eliminate the difference in accounting for actuarial gains and losses, prescribing that all companies should recognize them in OCI in the period when they occur. Another important difference between IAS 19 and IAS 19R is that under the latter companies have to use the discount rate as their expected rate of return on pension assets. Hence with IAS 19R the financial component of NPPC is equal to net pension assets times the discount rate on pension liabilities, irrespective of the pension assets allocation of each sponsor. In the fourth chapter I investigate also if this change improved analysts' ability to forecast the financial component of NPPC.

1.4 Conclusion

This introductory chapter explained the intricacy of pension accounting that is the background to my research hypotheses in the following chapters. The second chapters looks at the difference between disclosure and recognition, asking if equity markets value DB sponsors differently in the two regimes. The change from SFAS No. 87 to SFAS No. 158 is an ideal setting for this research question as it does not modify the type of information that market participants receive, just the delivery method.

The third chapter uses the sensitivity analysis that companies disclose under IAS 19 to estimate a discounted value of pension liabilities using a credit risk-free rate and uses this measure to test if market participants believe the companies' assumptions in their valuation exercises.

The fourth chapter tests if analysts use the assumptions that the companies disclose in the note to the financial statements in their earnings estimates. As the financial component of NPPC is predictable under both IAS 19 and its revised version, I ask if analysts incorporate this element in their forecasts under each standard.

Chapter 2

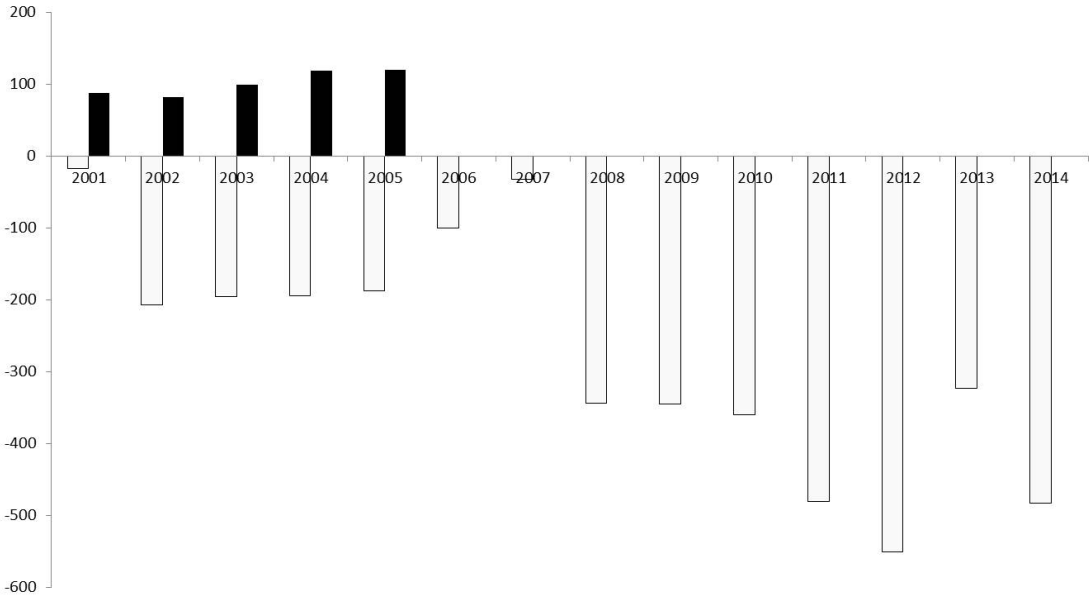
Disclosure versus recognition: the value relevance of pensions

2.1 Introduction

In 2006 the accounting regime for US defined benefit (DB) pensions changed dramatically, for the first time sponsoring companies had to recognize on the balance sheet the funded status of their pension funds. Before this information was only disclosed in the notes to the financial statements, with an accrual on the balance sheet that bore little relation to the true surplus/deficit it was meant to summarize:[1] as figure 1 shows, the average company was recognizing an asset on its balance sheet despite having a pension deficit. In this paper I investigate whether the move from disclosure to recognition changed investors' perception of DB pensions, confronting the value relevance of pensions under the two accounting regimes and identifying the effect of the introduction of Statement of Financial Accounting Standards (SFAS) No. 158 in 2006.

[1] I describe in more detail accounting for DB pension under both SFAS No. 87 and 158 in section 2.2.

Figure 2.1: Pension funding under SFAS No. 87 and 158



Notes: The chart shows the average reported pension asset/liability under SFAS No. 87 (black columns) and the average funding status of DB schemes disclosed in the notes to the financial statements before SFAS No. 158 and recognized on the balance sheet afterwards (shaded columns), in million US Dollars.

A vast body of research has investigated whether disclosure in the footnotes is a substitute for recognition in the financial statements. The efficient market hypothesis in semi-strong form implies that there should be no difference, as long as the information is publicly available. However, standard setters tend to view disclosure and recognition as different: for instance, the Financial Accounting Standards Board (FASB) affirms that "footnote disclosure is not an adequate substitute for recognition" (FASB (2006), paragraph 116). Recent research in accounting tends to agree, finding that disclosure and recognition are different in terms of value relevance (e.g., Ahmed et al. (2006), Davis-Friday et al. (1999) and Michels (2017)), with market participants placing more weight on recognized information. My work contributes to this debate by studying the valuation implications of disclosure versus recognition for pension surpluses/deficits. The introduction of SFAS No. 158 provides a good framework for testing this hypothesis, as it did not change how the

funding status of a pension plan is calculated. Hence in this setting disclosure and recognition can be compared for exactly the same item. Moreover, SFAS No. 158 became mandatory for all the companies at the same time, limiting the selection problem that often comes with the possibility of early adoption.

My study also contributes to the extensive literature that has looked at the implications of DB pensions, especially the strand that focuses on valuation, such as Coronado and Sharpe (2003), Hann et al. (2007a) and Coronado et al. (2008). The introduction of SFAS No. 158 itself has also been studied extensively, with a number of papers asking a research question similar to what I am addressing, like Beaudoin et al. (2011), Mitra and Hossain (2009) and Yu (2012). My work contributes to this debate by using a larger sample and a different econometric technique that allows me to identify more precisely the effect of the accounting change in 2006. Most of those papers focus only on 2005 and 2006, a choice that is problematic given that the wording and introduction date of SFAS No. 158 were already publicly know at the end of 2005 when companies published their balance sheets.[2] To circumvent this problem I use data from 2001 to 2014. Yu (2012) uses data from 1999 but stops in 2007, thus failing to take into account the increase in pension deficits due to the financial crisis and the subsequent fall in interest rates from 2008 onwards (figure 1 shows the worsening of the funded status of DB pensions from 2008 onwards). I discuss the differences between these works and mine in section 2.3.

Overall, my results suggest that investors treat disclosed and recognized information differently, focusing on the number recognized on the balance sheet and thus mispricing DB pensions' surpluses/deficits before the introduction of SFAS No. 158. Using a sample of 2590 firm (21063 observations) I document that the

[2]I discuss these paper in more detail in section 2.3, while section 2.6.1 elaborates on the problems of using only 2005 and 2006.

funded status of DB pensions is value relevant only after 2006, while before only the balance sheet accrual recognized under SFAS No. 87 accounting is value relevant. Then I focus on the introduction of SFAS No. 158 and try to pin down its effect using a panel of 773 DB sponsors and 956 control firms over the 10 years surrounding the accounting reform. My results suggest that the new accounting standard is indeed responsible for the change in investors' perception of DB pensions' surpluses/deficits.

The rest of the paper is organised as follows. Section 2.2 describes pension accounting under SFAS no. 87 and SFAS No. 158. Section 2.3 places my work in the wider context of the literature on DB pensions and disclosure versus recognition, and discusses the links between my contribution and the papers that have looked at the same issue. Section 2.4 presents the data and the empirical strategy I use to address my research question, while section 2.6 discusses my results. The last section concludes. Further robustness tests are provided in the appendices.

2.2 Pension accounting under SFAS No. 87 and 158

Accounting for DB pensions has evolved continuously in the past 20 years. From 1987 until 2006 the relevant standard was SFAS No. 87 *Employers' accounting for pensions* (FASB (1985)), which mandated the reporting on the balance sheet of a net prepaid pension asset or accrued pension liability that represented only a part of the sponsor's pension assets and liabilities. In particular, the funding status recognized on the balance sheet was the result of netting several off-balance-sheet items: pension assets, pension liabilities (measured as projected benefit obligation or PBO), prior service cost, actuarial gains and losses, the difference between

expected and realized return on plans' assets and net transition assets or liabilities. The rationale behind these adjustments is to have a smoothed measure for pension surplus/deficit, eliminating the effects of fluctuations in the value of assets and liabilities. The resulting asset or liability recognized on the balance sheet was essentially the cumulative difference between pension expenses recognized by the company in its income statement and cash contribution to the pension fund, with a net asset arising if contributions were above pension expenses or a liability in the reverse case. The accrual computed under SFAS No. 87 could be significantly different from the underlying surplus/deficit of the pension fund, as figure 2.1 above shows.

The disclosure requirements for DB schemes were significantly expanded by the introduction of SFAS No. 132 in 1998 (and by its revised version issued in 2003), but neither standard changed the measurement or recognition requirements of SFAS No. 87. Both of these requirements changed with the introduction of SFAS No. 158 in December 2006. The most important requirements of SFAS No. 158 are that companies have to fully recognize the funding status of their pension schemes on the balance sheet and recognize in other comprehensive income (OCI) the financial effects of certain plan events when they occur.[3] Thus the balance sheet recognition of previously disclosed items requires an OCI offset.

The introduction of SFAS No. 158 typically increased the reported DB pension liabilities, as under the previous standard companies were allowed to recognize an asset even if their schemes were in deficit. The FASB's objective in introducing this new reporting standard was to increase the transparency and usefulness of reported pension information. In the rest of the paper I investigate if this is the

[3]These include actuarial gain and losses, prior service cost, the difference between expected and realized return on plan's assets and transition asset or liability. Under the previous regime these items were deferred and gradually amortized in net income when they were above a certain threshold.

case for equity investors.

2.3 Literature review

My work contributes to two large strands of literature, one focusing on the value relevance of disclosed versus recognized accounting information and the other regarding the valuation of DB pensions. Whether disclosure and recognition are good substitutes has been a central question in accounting research, with recent empirical evidence suggesting that investors underweight disclosed information. Ahmed et al. (2006) finds that recognized derivative positions are value relevant while the disclosed ones are not, while Davis-Friday et al. (1999) find modest evidence that market participants place more weight on recognized rather than disclosed information in the context of post-retirement benefits other than pensions. Schipper (2007) discusses disclosure from various standpoints, arguing that it is perceived differently from recognition. The literature has put forward various explanations for this, with a stream of literature suggesting that recognized information is more reliable like Davis-Friday et al. (2004) and Frederickson et al. (2006). Another set of papers argues that the difference is due to information processing, either because users of financial statements lack the competence to understand disclosure (Dearman and Shields (2005)) or because of cognitive biases (Hobson and Kachelmeier (2005) and Koonce et al. (2005)). Barth et al. (2003) provides a theoretical treatment of disclosure versus recognition. In this paper I don't address the question of what motivates the different reaction to disclosed and recognized information, I focus on establishing the difference between the two in a setting that minimizes the many research design problems typical to this type of study and discussed in Bernard and Schipper (1994).

DB pensions have a great influence in many aspects of corporate life and have

been studied extensively. Here I focus only on the stream of literature that discusses the valuation implications of this type of pension, the closest studies to my work. For a recent comprehensive review of the literature on DB pensions I refer to Coco (2014). The empirical evidence on the value relevance of DB pensions is mixed. An earlier set of papers found that stock prices fully reflect the funding status of DB schemes, like Feldstein and Seligman (1981), Feldstein and Morck (1983) and Bulow et al. (1987). Coronado and Sharpe (2003) and Coronado et al. (2008) find that instead investors focus on the the earnings impact of pensions while disregarding their funding status. Hann et al. (2007a) finds that both income statement and balance sheet variables are value relevant. Using an asset pricing approach Franzoni and Marin (2006) finds that companies with severely underfunded DB pensions earn significantly lower returns. Their findings are reinforced by Picconi (2006), who shows that analysts systematically fail to take DB pensions into account when forecasting earnings.

A set of recent papers investigates the effects of the introduction of SFAS No. 158, asking a research question very close to mine. Mitra and Hossain (2009) find a negative relation between stock returns and the pension transition adjustment in 2006, the adoption year of SFAS No. 158, a relationship driven by large S&P 500 firms. Beaudoin et al. (2011) use a slightly different sample and compare the value relevance of the funded status of DB schemes in 2005 (disclosure year) and 2006 (recognition year), finding that investor price this information correctly in both accounting regimes. However, I believe that using only 2005 and 2006 to investigate the value relevance of disclosed and recognized pension surpluses/deficits might lead to spurious conclusions, as the FASB made clear in November 2005 that it was going to overhaul pension accounting by requiring the recognition of the funded status on balance sheet (FASB (2005)). This might have prompted some investors to anticipate the accounting reform and change their perception

of disclosed information for fiscal year 2005. To mitigate this problem I exclude the year 2005 from my regression aimed at establishing a causal link between the introduction of SFAS No. 158 and the change in value relevance of pension surpluses/deficits. Later work by Yu (2012) uses a larger sample, stretching from 1999 to 2007. He finds that the disclosed information about DB schemes is value relevant and that this effect is stronger for firms with a high level of institutional ownership and analyst following. He also finds that disclosure improves the value relevance of pension funding for firms with a low level of institutional ownership and analyst following. One potential problem with this sample is that during the period analysed by Yu (2012) pension funds were significantly better funded than in the following decade.

My work differs from these three paper in that it uses a significantly larger sample of firms and years, and a different econometric technique that allows me to pin down more effectively the introduction of SFAS No. 158. Another difference is that I cluster standard errors by company in all my specifications, while none of these papers quoted above controls for correlation in standard errors. As Petersen (2009) points out, failing to cluster the standard errors in a panel setting leads to inflated t statistics that may jeopardize the inference. To facilitate the comparison with the previous literature, I provide results using the same model as Beaudoin et al. (2011) and Yu (2012) in appendix 2.10.

2.4 Research methodology and hypothesis development

Barth et al. (2001) suggests that levels models are better specified to address the question of what is reflected in firms' value, while changes models are appropriate

to investigate timeliness of the accounting amounts. Given my research question of how a pension surplus/deficit influences the valuation of the sponsoring company, a levels model appears the most appropriate. In doing so I follow the extensive literature that has addressed this issue before (for instance Coronado and Sharpe (2003), Coronado et al. (2008), Hann et al. (2007a), Hann et al. (2007b), Yu (2012)). Hence the main model I employ to investigate empirically the valuation of DB pension scheme is a parsimonious specification of the residual income model, put forward by Feltham and 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. I modify this model to make room for pensions as in the previous literature, dividing both income statement and balance sheet variables into pension and non-pension components. The next subsection describes the model I use to analyse value relevance of DB pensions, highlighting the hypothesis that I test and the expected coefficients. The following subsection presents the slight modifications I make to both my model and hypothesis to focus on the effect of the introduction of SFAS No. 158.

2.4.1 Value relevance of DB pensions

My first research question investigates the value relevance of DB pensions under two different accounting regimes, disclosure (under SFAS No. 87) and recognition (under SFAS No. 158). As the same information about the funded status of pension funds is publicly available under both regimes, market participants should value it in the same way. Formally, I test the following hypothesis:

> H1: Is the funded status of defined benefit pension plans equally value relevant under SFAS No.87 (disclosure) and SFAS No. 158 (recognition)?

Consistent with prior research, the model I use to investigate the value relevance of pension deficits/surpluses in cross-section is the following, where all variables are standardized by total company assets to make the series stationary and reduce heteroskedasticity:[4]

$$Mcap_{i,t} = \alpha + \beta_1 BVc_{i,t} + \beta_2 NPA_{i,t} + \beta_3 Ec_{i,t} + \beta_4 NPPC_{i,t} + \sum_{s=1}^{S} \gamma_s S_s + \sum_{t=1}^{T} \gamma_t Y_t + \epsilon_{i,t} \tag{2.1}$$

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 accounting pension deficit/surplus recognized on the balance sheet. Net pension assets (NPA) represent the funded status of the DB pension schemes of the company; I define it as pension assets minus pension liabilities (the projected benefit obligation or PBO), not taking into account any post-retirement benefit other than pensions. Although entering pension assets and liabilities separately into the model rather than the net position might be useful for my analysis, the high correlation between the two items means it is not practical to do so. Regarding income statement variables, I divide earnings into core earnings (Ec) defined as net income before extraordinary items minus net periodic pension cost (NPPC) and NPPC itself. 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, temporary events such as curtailment and settlements and the recycling into income of the unrecognized

[4]All the variables that I use in the main paper are standardized by total company assets as in Coronado et al. (2008) and Beaudoin et al. (2011). I believe this to be the most stable and economically better specified standardisation, however as a robustness test I provide my most important results standardising the variables by the total number of shares outstanding in appendix 2.9. Using total sales as denominator yields very similar estimates (results not reported).

pension deficit if this is bigger than a certain threshold.[5] As NPPC is a pre-tax measure, I multiply it by 0.65 to compare it with earnings (assuming a tex rate of 35%). S and Y are industry (we use the first four digit of GISC, with 24 industry groups in total) and years dummies, respectively.

I expect the coefficients on book value to be positive and close to 1. NPA is positive when pension funds are in surplus and negative when they have a deficit, so its coefficient should be positive if DB pensions are at least partially value relevant. As contributions to the pension fund are tax deductible in the US, full value relevance implies that the coefficient on NPA should be bracketed between 1 and (1 - t), where t is the marginal tax rate that the average company faces. Earnings are clearly positively associated with market value, so I expect a positive coefficient. I expect its magnitude to depend on the level of fixed effects imposed in the regression. NPPC takes a negative value when the company reports a pension cost in its income statement and a positive one when DB pensions contribute positively to the firm's profitability. As it is an income statement item, I expect NPPC to have the same coefficient as earnings if it is value relevant.

For the part of my sample where SFAS No. 87 is the relevant standard, I also test whether investors apply different weights to the accrual recognized on the balance sheet to summarize the funding of the company's DB schemes and the amount disclosed in the notes. To do so I create two new variables: ON bs, equal to the accrual recognized under SFAS No. 87 and OFF bs, equal to the difference between NPA and ON bs. In doing so, I follow part of the literature that splits the pension obligations in the same way, like Yu (2012) and Beaudoin et al. (2011).

[5]This is under SFAS No. 87. With the introduction of SFAS No. 158 and the recognition of NPA on the balance sheet, this component is lost. It is however substituted by a gradual amortisation in income of the transition liability that has to be immediately recognized in OCI upon the implementation of SFAS No. 158. See section 2.2 for a description of the changes caused by the introduction of SFAS No. 158.

So I bring to the data the following specification:

$$Mcap_{i,t} = \alpha + \beta_1 BVc_{i,t} + \beta_2 ONbs_{i,t} + \beta_3 OFFbs_{i,t} + \beta_4 Ec_{i,t} + \beta_5 NPPC_{i,t} + \sum_{s=1}^{S} \gamma_s S_s + \sum_{t=1}^{T} \gamma_t Y_t + \epsilon_{i,t} \quad (2.2)$$

The variables ONbs and OFFbs sum up exactly to NPA, so this specification is equivalent to equation 2.1. Hence if DB pensions are value relevant both the coefficients on ONbs and OFFbs should be between 1 and (1 - t). On the other hand, if market participants focus on information recognized on the balance sheet and disregard disclosure in the notes, only ONbs should be value relevant.

I also test both of the models by year, thus running a battery of regressions of both equations 2.1 and 2.2,[6] dropping the year dummies. Further robustness tests are in the appendices.

2.4.2 The introduction of SFAS No. 158

To identify the changes caused by the introduction of SFAS No. 158 and hence the recognition of NPA on the balance sheet, I use a balanced panel of companies (with and without DB schemes) that reported under both accounting regimes. The goal is to pin down the effects of the introduction of SFAS No. 158 on the value relevance of pensions. Formally, I test the following hypothesis:

> H2: The introduction of SFAS No. 158 increased the value relevance of the funded status of defined benefit pensions

To test this hypothesis, I first run equations 2.1 and 2.2 using company rather than sector dummies. Then I focus on the reform itself and test whether it changed

[6] The results for equation 2.1 are not reported for brevity as they are nearly identical to those of equation 2.2, but are available from the author on request.

the perception of pension deficits/surplues, running an estimation in the spirit of difference-in-differences using the following equation:

$$Mcap_{i,t} = \alpha + \beta_1 BVc_{i,t} + \beta_2 NPA_{i,t} + \beta_3 NPA_{i,t} * FAS158 + \beta_4 FAS158 + \beta_5 DB + \beta_6 FAS158 * DB + \beta_7 Ec_{i,t} + \beta_8 NPPC_{i,t} + \sum_{i=1}^{I} \gamma_i I_i + \sum_{t=1}^{T} \gamma_t Y_t + \epsilon_{i,t} \quad (2.3)$$

Where FAS 158 is a dummy that takes the value of 1 if SFAS No. 158 is the relevant accounting standard and 0 otherwise, and DB is a dummy that takes the value 1 if the company sponsors a DB scheme. The variable of interest is the interaction between NPA and FAS 158, which captures the incremental effect on the sponsor of the recognition of NPA on the balance sheet. If the introduction of SFAS No. 158 increased the value relevance of NPA, this interaction term should be positive and significant. If on the other hand the move from disclosure to recognition did not change investors' perception of DB pensions, the coefficient on the interaction term should be zero. The coefficient on the DB dummy indicates difference in valuation between firms that sponsor a DB pension and those who do not. A positive value implies that DB sponsors enjoy a premium valuation, all else equal. Similarly, the interaction between the DB and FAS 158 dummies identifies if there has been a change to the relative valuation of DB sponsors after the introduction of SFAS No. 158: a positive (negative) value implies an increase (decrease) in the valuation of DB sponsors against firms that do not have a DB pension.

2.5 Samples selection and description

The main sample to investigate the value relevance of pension deficits/surpluses consists of all the firm-year observations from 2001 to 2014 available in the Compustat Pension database. I then merge it with the Compustat Fundamentals Quarterly database to obtain the information for the accounting variables and the share price. I delete all entries that don't have a DB scheme (companies that either have missing data for both pension assets and liabilities, or whose PBO is zero) and all observation with missing values to calculate independent variables. Further, I delete all the companies with negative book value of equity. These firms are likely to be in, or close to, financial distress and the literature has shown that they should be valued separately (see for instance Jan and Ou (2011)). In my robustness analysis I find that they have a disproportionate effect on the results and, given the public insurance on DB pensions provided by the Pension Benefit Guarantee Corporation, there are good reasons to believe that the valuation of DB pensions is different for sponsors close to financial distress. As table 4.1 shows, excluding firms with negative book value reduces the observations in my main sample by about 5%.

Table 2.2 presents the descriptive statistics for the main sample. As seen in figure 2.1, the accrual on the balance sheet representing the funding of DB pensions under SFAS No. 87 underestimates the underfunding of pension schemes in my sample. On average it is very close to zero when divided by assets, but a significant number of companies recognize a surplus despite a pension scheme in deficit.

I use this sample to investigate the value relevance of DB pensions' deficit/surplus. In order to focus on the effect of the introduction of SFAS No. 158, I build a panel of companies that have the full data in the years around the accounting reform. I

Table 2.1: Samples description

Main sample	Observations	Firms
Compustat Pension 2001-2014	36129	4589
- without a DB scheme	-8323	
- missing variables	-5722	
- negative book value	-1021	
Final: main sample	21063	2590
Panel sample	**Observations (with DB)**	**Firms (with DB)**
Compustat Fundamentals 2001-2010	92929 (20370)	15111 (3063)
- missing at least one year	-42136 (-5585)	
- missing variables	-17754 (-5695)	
- negative book value	-7679 (-920)	
- assets smaller than 100M	-8070 (-440)	
Final: panel sample	17290 (7730)	1729 (773)

decide to stop my sample in 2010 to limit the loss of observations, as this leaves us with five years of data under both accounting regimes. I include also companies that do not sponsor a DB scheme as control group. For the panel sample, I keep the same requirements as the main sample and further I eliminate all companies that have total assets smaller than 100 million US dollars. Excluding these small companies serves primarily to ensure that the control group of companies with no DB scheme is not too different from the companies sponsoring a DB. In fact this exclusion reduces significantly the number of firms in the control group, while it eliminates only 44 firms that sponsor a DB pension. Including these 44 firms in my analysis does not alter the estimates (results not reported).

Table 2.3 collects the descriptive statistics for the panel sample. The companies that sponsor a DB pension have very similar characteristics across the two samples, while companies without a DB scheme are on average smaller, less profitable, better capitalized and have a higher market value when standardised by assets. The sector composition of the two groups of companies that make up my panel sample is however quite different. Companies with a DB scheme tend to dominate

Table 2.2: Main sample descriptive statistics

variable	N	mean	st dev	1st quartile	median	3rd quartile
Market capitalisation	21063	0.9013	1.1160	0.2670	0.6365	1.1604
Core book value	21063	0.3756	0.3328	0.1850	0.3693	0.5268
Core earnings	21063	0.0359	0.2063	0.0081	0.0317	0.0680
Net pension assets	21063	-0.0271	0.2567	-0.0353	-0.0112	-0.0020
ON bs	7629	-0.0008	0.4216	-0.0064	0.0002	0.0087
OFF bs	7629	-0.0288	0.0497	-0.0379	-0.0101	-0.0019
NPPC	21063	-0.0024	0.0113	-0.0032	-0.0011	-0.0002

Notes: All variables are standardised by total company assets and were collected on the balance sheet closing date, except market capitalization which was retrieved one quarter after the end of the fiscal year.

Table 2.3: Panel sample descriptive statistics

DB firms	N	mean	st dev	1st quartile	median	3rd quartile
Market capitalisation	7730	0.8576	0.8036	0.2891	0.6468	1.1393
Core book value	7730	0.3582	0.2019	0.1827	0.3567	0.5011
Core earnings	7730	0.0396	0.0676	0.0110	0.0346	0.0684
Net pensions assets	7730	-0.0230	0.0436	-0.0352	-0.0126	-0.0019
ON bs	3865	0.0085	0.0356	-0.0041	0.0013	0.0139
OFF bs	3865	-0.0309	0.0471	-0.0421	-0.0147	-0.0032
NPPC	7730	-0.0023	0.0042	-0.0035	-0.0014	-0.0003
Control firms						
Market capitalisation	9560	1.1301	1.2977	0.2123	0.7599	1.4991
Book value	9560	0.4255	0.2681	0.1350	0.4302	0.6429
Earnings	9560	0.0230	0.1338	0.0054	0.0228	0.0684

Notes: All variables are standardised by total company assets and were collected on the balance sheet closing date, except market capitalization which was retrieved one quarter after the end of the fiscal year.

traditional sectors such as energy, materials and utilities, while the majority of firms in the IT and consumer discretionary sector do not sponsor a DB pension.

To address this potential concern, I use the panel sample to match the companies that sponsor a DB with a peer that does not. I mechanically pair DB companies with a peer in the same industry group (4 digit GICS code), matching them by size (total assets) and breaking the ties using market capitalisation. I impose the constraint that no firm in the matched pair should be bigger than twice their counterpart in 2005, the last year prior to the introduction of SFAS No. 158. This leaves us with 302 matched pairs, for a total of 604 companies. I use these matched companies as an additional robustness test for equation 2.3. While the matching requirements significantly shrink the sample, they help ensure that the control group is indeed comparable to DB sponsors in terms of size and sector composition. Table 2.4 shows that the components of the matched sample are indeed comparable: DB sponsors and control firms have very similar descriptive statistics, differing significantly only in the dependent variable (market capitalisation).

Table 2.4: Matched sample descriptive statistics

Table presents descriptive statistics for the matched sample. It shows the mean of each variable that I use to estimate the impact of FAS 158, analyzing DB sponsors and control firms separately. Stars indicate significance at conventional levels of a t test for difference in mean.

	DB sponsors	control group	difference	t statistic
Book value	1710.52	1670.06	40.46	0.25
Core book value	1701.52	1670.06	31.46	0.19
Earnings	201.72	209.92	-8.20	-0.31
Core earnings	209.39	209.92	-0.53	-0.02
Total assets	9155.34	7510.86	1644.48	0.85
Market capitalisation	4036.46	5042.08	-1005.62**	2.39

2.6 Results

This section presents my results on the value relevance of the net pension obligation using the main sample, while the next subsection focuses on the impact of SFAS No. 158. In my specifications I divide the sample using the introduction of SFAS No. 158 as cut off date (15th December 2006) rather than identifying the effect of the introduction of the new standards with a dummy and interactions as in Yu (2012) or Beaudoin et al. (2011). However in my case both methods yield the same results and I provide estimates using a dummy and interactions to identify the accounting reform in appendix 2.10.

Column 1 and 2 of table 2.5 reports the parameter estimates for the basic Ohlson model before and after the introduction of SFAS No. 158, using only book value and earnings as independent variables, with sector and years fixed effects. Estimates for the models corresponds quite closely to those found in the literature (see for example Hann et al. (2007a) and Dechow et al. (1999)) and my modification of the model to make room for pensions does not alter the estimated coefficient on either book value or earnings. Column 3 and 4 show estimation results for equations 2.2 and 2.1 respectively. Net pension assets are not value relevant in this part of the sample. Investors seem to focus on the accrual recognized on the balance sheet under SFAS No. 87 accounting rather than the funding of the pension scheme disclosed in the notes, arguably the most important piece of information to determine future cash flows to the pension fund and hence firm value. Column 5 indicates that this changed after the introduction of SFAS No. 158, in this part of the sample NPA is strongly significant. Its point estimate of about 2 is above what the theory would imply, perhaps indicating that companies underestimate the pension liability in their accounts.[7] In column 5 I also find that NPPC is

[7] Various articles have suggested that companies under report their pension obligations,

Table 2.5: Value relevance of pensions under SFAS 87 and SFAS 158

Table presents my estimation results using the main sample. The independent variable is market capitalisation one quarter after the fiscal year end. Core book value is book value minus the pension deficit/surplus recognized on the balance sheet, core earnings are net income minus net periodic pension cost (NPPC, tax adjusted). Net pension assets are the difference between pension assets and liabilities for each firm. ON bs is the amount recognized on the balance sheet under SFAS 87, OFF bs is NPA - ON bs . All the variables are standardized by total company assets. All specifications include year and 4 digit industry code dummies, standard errors are clustered at the company level. To mute outliers I exclude the top and bottom 1% of all variables.

Variable	(1)	(2)	(3)	(4)	(5)
Book value	1.055***	0.922***			
	(0.083)	(0.069)			
Earnings	4.926***	5.153***			
	(0.279)	(0.226)			
Core book value			1.087***	0.949***	0.909***
			(0.083)	(0.081)	(0.069)
Net pension assets				0.385	2.144***
				(0.441)	(0.309)
ON bs			1.968***		
			(0.494)		
OFF bs			-0.452		
			(0.433)		
Core earnings			4.871***	5.005***	5.106***
			(0.275)	(0.279)	(0.222)
NPPC			-3.376	-6.193	-14.65***
			(4.495)	(4.665)	(3.557)
Accounting regime	SFAS 87	SFAS 158	SFAS 87	SFAS 87	SFAS 158
N	7165	12169	7165	7165	12169
R^2	0.551	0.541	0.555	0.547	0.545

value relevant, but with the wrong sign: the result implies that pension costs are positively related to the market value of sponsors. This is due to the service cost anomaly, first documented in Barth et al. (1992) and later confirmed by most of the literature on DB pensions. I discuss this issue in appendix 2.8.

The results in table 2.6 confirm and reinforce the insight from table 2.5. In table 2.6 I run a battery of yearly regressions of equations 2.1 (when SFAS No. 158 is the relevant standard) and 2.2 (in the period when companies report under SFAS No. 87). Estimating equation 2.1 before 2006 indicates that NPA is never significant in this period (results not reported for brevity), while the results for equation 2.2 suggest again that investors focus on the amount recognized on the balance sheet disregarding the disclosure in the notes, with DB pensions contributing positively to firm value even when they are in deficit. From 2006 onwards, NPA is always significant (except for 2014) and with a coefficient above 1, confirming my interpretation of the results in table 2.5.

I take these results to imply that the accounting reform introducing SFAS No. 158 and the recognition of pensions deficit/surplus on the balance sheet changed investors' perception of DB pensions. In the next subsection I turn to my panel sample to provide additional evidence to support this claim.

2.6.1 Effects of the introduction of SFAS No. 158

Using a panel of companies allows us to use firm fixed effects rather than performing a cross sectional analysis like in the previous section. Table 2.7 shows the same estimation as table 2.5, using firm and year fixed effects in the panel sample,

mainly through the choice of discount rates that are too high. See for instance Kisser et al. (2017) who discusses discount rate and mortality assumptions, and Fried and Davis-Friday (2013) that find evidence that companies deflate their liabilities after the introduction of SFAS No. 158 by manipulating the discount rate. There is a long standing debate about which discount rate is most appropriate for pension liabilities, see Brown and Pennacchi (2016) for a recent discussion of the subject.

Table 2.6: Yearly regressions

Table presents my estimation for a battery of yearly regression from my main sample, using standard errors clustered at the industry level. The independent variable is market capitalisation one quarter after the fiscal year end. Core book value is book value minus the pension deficit/surplus recognized on the balance sheet, core earnings are net income minus net periodic pension cost (NPPC, tax adjusted). Net pension assets are the difference between pension assets and liabilities for each firm. ON bs is the amount recognized on the balance sheet under SFAS 87, OFF bs is NPA - ON bs . All the variables are standardized by total company assets. All specifications include 4 digit industry code dummies. To mute outliers I exclude the top and bottom 1% of all variables.

	BVc	NPA	Onbs	OFFbs	Ec	NPPC	N	R^2
2001	0.937***		0.905	-0.493	5.14***	7.004	1323	0.549
	(0.187)		(1.241)	(1.028)	(0.508)	(8.589)		
2002	1.013***		1.143*	-1.391**	3.947***	4.558	1376	0.514
	(0.137)		(0.655)	(0.606)	(0.438)	(5.959)		
2003	1.116***		2.601**	-0.043	4.967***	-13.34	1405	0.575
	(0.135)		(1.157)	(0.881)	(0.611)	(11.017)		
2004	1.176***		1.91**	-0.478	4.929***	-6.442	1420	0.568
	(0.157)		(0.732)	(0.715)	(0.734)	(9.141)		
2005	1.191***		2.234**	-0.001	5.516***	-0.267	1438	0.58
	(0.219)		(0.977)	(0.946)	(0.72)	(8.234)		
2006	0.954***	1.905**			6.663***	-10.415**	1474	0.612
	(0.181)	(0.855)			(0.685)	(4.653)		
2007	0.98***	3.518**			5.8***	-27.908***	1456	0.578
	(0.168)	(1.287)			(0.43)	(9.641)		
2008	0.768***	1.048***			2.963***	-8.536	1336	0.51
	(0.116)	(0.364)			(0.273)	(5.669)		
2009	1.025***	1.943***			4.216***	-9.701	1391	0.507
	(0.114)	(0.615)			(0.543)	(6.841)		
2010	0.906***	2.886***			5.914***	-16.358**	1378	0.565
	(0.117)	(0.547)			(0.554)	(5.954)		
2011	0.738***	1.63***			5.828***	-16.209***	1376	0.549
	(0.123)	(0.512)			(0.51)	(4.741)		
2012	0.912***	2.06***			4.804***	-16.834**	1349	0.518
	(0.174)	(0.479)			(0.541)	(7.236)		
2013	0.934***	3.739***			5.872***	-15.851***	1315	0.589
	(0.123)	(0.527)			(0.63)	(4.149)		
2014	0.623***	0.762			6.66***	3.177	1297	0.587
	(0.154)	(0.528)			(0.624)	(7.687)		

Table 2.7: Value relevance panel sample

Table presents my estimation results using the panel sample, using standard errors clustered at the company level. The independent variable is market capitalisation one quarter after the fiscal year end. Core book value is book value minus the pension deficit/surplus recognized on the balance sheet, core earnings are net income minus net periodic pension cost (NPPC, tax adjusted). Net pension assets are the difference between pension assets and liabilities for each firm. ON bs is the amount recognized on the balance sheet under SFAS 87, OFF bs is NPA - ON bs . All the variables are standardized by total company assets. All specifications include year and firm dummies. To mute outliers I exclude the top and bottom 1% of all variables.

Variable	(1)	(2)	(3)	(4)	(5)
Book value	1.083***	1.057***			
	(0.143)	(0.11)			
Earnings	2.574***	0.999***			
	(0.238)	(0.132)			
Core book value			1.088***	1.082***	1.035***
			(0.145)	(0.145)	(0.112)
Net pension assets				-0.48	1.581***
				(0.607)	(0.393)
ON bs			0.094		
			(1.025)		
OFF bs			-0.725		
			(-0.639)		
Core earnings			2.579***	2.588***	1.012***
			(0.239)	(0.239)	(0.132)
NPPC			3.497	2.218	-14.354***
			(5.52)	(5.643)	(5.982)
Accounting regime	SFAS 87	SFAS 158	SFAS 87	SFAS 87	SFAS 158
N	8171	7703	8171	8171	7703

including all the companies.[8] The small difference in the number of observation between the pre and post SFAS No. 158 specification is due to firms closing their accounts before the calendar year end, so that some companies still report under SFAS No. 87 in 2006 (my cut off date is the introduction of the standard, so the 15th of December 2006). The estimates confirm that after the introduction of SFAS No. 158 net pension assets are priced in the market value of the scheme's sponsor and show that this results is robust to using firm level fixed effects. Comparing the results with table 2.5, the coefficient on core earnings is significantly lower, especially after 2006. This is due to controlling for firm fixed effects, in fact the earnings' coefficients are in the same range as those estimate by Yu (2012), one of the few papers that uses the same battery of controls. Again, comparing columns 4 and 5 with columns 1 and 2 I find that my modification of the Ohlson model to make room for pensions does not unduly influence the coefficients on book value and earnings.

The main difference with table 2.5 is in column 3. In this sample, market participants seem to disregard pensions completely before the introduction of SFAS No. 158, while in cross section I found that the accrual recognized on the balance sheet under SFAS No. 87 was value relevant. A possible explanation for this difference lies in the smoothing nature of such an accrual: ON bs does not vary much over time compared with net pensions assets, as it was designed to do. Using firm fixed effect is equivalent to subtracting each variable its mean (by company), leaving very little variation in this variable and constraining its significance.

A battery of yearly regressions in the panel sample[9] confirms the results in the previous tables, but with one important caveat. In the year 2005 net pension assets are value relevant and precisely estimated, almost as if SFAS No. 158 was

[8] Using only companies that sponsor a DB scheme does not alter the results.
[9] Results not reported for brevity.

Table 2.8: The effect of the introduction of SFAS No. 158

Table presents my estimation results for equation 2.3. The first 3 columns use the panel sample, the last three use 302 pairs of companies (with and without DB pensions) matched by sector and assets. The independent variable is market capitalisation one quarter after the fiscal year end. Core book value is book value minus the pension deficit/surplus recognized on the balance sheet, core earnings are net income minus net periodic pension cost (NPPC, tax adjusted). Net pension assets are the difference between pension assets and liabilities for each firm. All the variables are standardized by total company assets, standard errors are clustered at the company level. To mute outliers I exclude the top and bottom 1% of all variables.

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Core book value	1.499***	1.346***	1.344***	1.646***	1.411***	1.412***
	(0.080)	(0.094)	(0.094)	(0.155)	(0.153)	(0.150)
NPA	0.481	1.930***	-0.166	0.826	2.280**	0.191
	(0.663)	(0.469)	(0.471)	(1.277)	(1.026)	(1.002)
NPA*FAS 158	2.881***	1.464***	1.724***	3.783***	2.053**	2.409**
	(0.622)	(0.501)	(0.499)	(1.158)	(0.977)	(0.964)
Core earnings	4.852***	2.434***	2.217***	4.559***	2.225***	1.991***
	(0.246)	(0.155)	(0.156)	(0.477)	(0.241)	(0.243)
NPPC	-17.647***	-22.135***	-3.771	1.028	-31.917***	-15.472
	(6.730)	(4.251)	(4.163)	(12.841)	(9.572)	(9.463)
FAS 158	0.006	0.042*	-0.065**	-0.058	0.080*	-0.045
	(0.044)	(0.024)	(0.031)	(0.077)	(0.041)	(0.049)
DB	-0.132***			-0.142**		
	(0.027)			(0.045)		
DB*FAS 158	0.102***	0.121***	0.131***	0.127***	0.133***	0.135***
	(0.025)	(0.023)	(0.023)	(0.043)	(0.039)	(0.040)
Fixed effects	Sector, year	Firm, time trends	Firm, year	Sector, year	Firm, time trends	Firm, year
N	14265	14265	14265	4979	4979	4979
R^2	0.572	-	-	0.574	-	-

already mandatory.[10] I believe this to be due to market participants anticipating the effect of the accounting reform, as the Financial Accounting Standards Board made clear in November 2005 that it was going to overhaul pension accounting by requiring the recognition on the balance sheet of the difference between pension assets and the projected benefit obligation.[11] In light of this, I prefer to exclude the year 2005 from the following estimation intended to identify the effect of the accounting reform.[12]

Next I turn my attention to the accounting reform and try to pin down the introduction of SFAS No. 158. Table 2.8 presents various estimates of equation 2.3, where I identify the accounting reform using the interaction between the FAS 158 dummy and NPA, much in the spirit of a difference in difference estimation. Columns 1 to 3 of table 2.8 report estimates using the full panel sample, while columns 4 to 6 use 302 matched pairs of companies with and without a DB pension. Column 1 and 4 report estimates using sector and year fixed effects, column 2 and 5 use firm fixed effects and control for time using time trends polynomia (linear, quadratic and cubic)[13] and finally column 3 and 6 use firm and years fixed effects.

The main variable of interest in table 2.8 is the interaction between NPA and the FAS 158 dummy, which is always zero before the introduction of the new standard and then switches to NPA for companies that sponsor a DB scheme while remaining at zero for the other firms. Using the full panel sample (columns 1 to 3) the estimated coefficients are in line with what I observed in the previous tables

[10] The effect of the year 2005 might be responsible for the difference between my results and those of Beaudoin et al. (2011). They find that the introduction of SFAS No. 158 did not improve the value relevance of DB pensions as these were already priced before the accounting reform, but get to this conclusion using data from a panel of companies in years 2005 and 2006.

[11] See section 2.2 for a discussion of the introduction of SFAS No. 158.

[12] This exclusion does not have a strong impact on the estimates, but using also the data for 2005 yields weaker results.

[13] I use this specification to control for time effects without resorting to a full battery of years dummies. The polynomia capture time effects without absorbing as much variation as time dummies.

for NPA after 2006, with the magnitude of the effect on firm value depending on the controls. If instead I use a subset of companies matched by sector and size (columns 4 to 6) the coefficients estimates on my variable of interest is stronger and significant in all three different specifications. On the other hand NPA seems to be value relevant only when interacted (but for the specifications that do not include yearly controls), reinforcing the previous finding that investors did not value pension deficits/surpluses when they were disclosed in the notes to the financial statements. Columns 1 and 4 indicate that DB sponsors are on average less valuable than firms that do not have such pensions (the DB dummy is negative and significant), but this negative premium is almost completely absent after the introduction of IAS No. 158. The coefficient estimates for the other variables in table 2.8 are very similar to what I found before, moreover there is no meaningful difference in the estimates between the regressions that use the full panel sample and those that focus on a subset of matched companies.

These result strengthen the result that SFAS No. 158 did indeed change investors' perception of DB pensions, with making the recognised pension surplus/deficit value relevant and thus confirming H2.

2.7 Conclusion

This paper investigates whether there is a difference in the value relevance of disclosed versus recognized pension liabilities. I find that before the introduction of SFAS No. 158 investors focused on the accrual recognized on the balance sheet, disregarding the net position of the pension funds disclosed in the notes. As this accrual computed under SFAS No. 87 bears little relationship with the funded status of DB schemes, markets participants were not valuing DB plans' sponsors correctly, often underestimating the impact of pension commitments. Investors'

perceptions changed with the disclosure regime brought by SFAS No. 158 in 2006. DB pension surpluses/deficits are value relevant when reported on the balance sheet. Further analysis in the years around the accounting reform suggests that the introduction of SFAS No. 158 is indeed responsible for the increased value relevance of pension commitments.

My analysis suggest that the FASB achieved its objective of increasing the transparency of pension reporting and that this improved investors' valuation of DB schemes sponsors. My results also confirms and strengthens the findings of earlier empirical studies that highlighted the incremental value relevance of recognized versus disclosed information, using a setting where there is no issue of selection bias and where exactly the same information is disclosed or recognized.

2.8 Appendix A1: service cost anomaly

According to the service cost anomaly, first documented in Barth et al. (1992), the negative sign on pensions expenses is due to service cost being a proxy for human capital formation in the company and hence contributing positevely to firm value. In table 2.9 I investigate if this is anomaly is driving the negative sign that I find for NPPC after the introduction of SFAS No. 158. Column 1 of table 2.9 is just a repetition of column 5 in table 2.5 to facilitate the comparison. Column 2 separates the elements of NPPC and shows clearly the service cost anomaly in my data: service cost is positively related to firm value despite being a cost.[14] Hann et al. (2007a) includes research and development expenses and the number of employees as controls for human capital and shows that the anomaly disappears. I replicate their analysis in column 3, but in my sample the inclusion of these two controls does not have any effect on the estimates for the components of NPPC. [15] An alternative strategy, used by Coronado and Sharpe (2003) and Coronado et al. (2008) is to consider service cost as a core rather than a pension expense, thus using a measure of NPPC that includes only accruals. I replicate their method is column 4, where service cost is included in core earnings rather than in NPPC. In this case, the coefficient on pension expenses loses its value relevance, while the earnings coefficient is little changed.[16]

[14] The small differences in sample size for the regressions in table 2.9 are due to some components of NPPC having missing data in Compustat. Recoding this missing values to zero to use the original sample does not change the parameters' estimates.

[15] Following the literature, I recoded R&D to zero for all the companies that have a missing value in Compustat to avoid losing observations. Excluding companies with missing values significantly shrinks the sample without correcting the service cost anomaly.

[16] If I use Coronado and Sharpe (2003) treatment of service cost in the period before 2006, I find their very same results: before the introduction of SFAS No. 158 the net value of the pension assets disclosed in the notes is not value relevant, while the stream of pension related earnings is.

Table 2.9: Service cost anomaly

Table presents my estimation results to investigate the service cost anomaly. The independent variable is market capitalisation one quarter after the fiscal year end. Core book value is book value minus the pension deficit/surplus recognized on the balance sheet, core earnings are net income minus net periodic pension cost (NPPC, tax adjusted). In the last column NPPC does not include service cost and the core earnings variable is adjusted accordingly. Net pension assets are the difference between pension assets and liabilities for each firm. All the variables but for employees are standardized by total assets. All specifications include year and 4 digit industry code dummies, standard errors are clustered at the company level.To mute outliers I exclude the top and bottom 1% of all variables.

Variable	(1)	(2)	(3)	(4)
Core book value	0.909***	0.913***	0.842***	0.904***
	(0.069)	(0.07)	(0.068)	(0.07)
Core earnings	5.106***	5.058***	5.175***	5.198***
	(0.222)	(0.225)	(0.214)	(0.23)
Net pension assets	2.144***	2***	2.129***	1.295***
	(0.309)	(0.331)	(0.317)	(0.29)
NPPC	-14.65***			0.632
	(3.557)			3.767
Service cost		27.139***	23.556***	
		(7.164)	(7.01)	
Interest cost		-4.473*	-4.386*	
		(2.393)	(2.301)	
Other NPPC		14.684***	14.991***	
		(3.902)	(3.779)	
R&D			4.143***	
			(0.476)	
Employee			-0.609**	
			(0.294)	
N	12169	11884	11884	11895
R^2	0.545	0.548	0.566	0.542

2.9 Appendix B1: results by shares

This appendix presents my main results standardising all variables by the number of shares outstanding one quarter after the fiscal year end rather than total assets as in the main paper. I believe that the asset specification is better defined, suffers less from problems of collinearity and its coefficients have a more straightforward economic interpretation. However various works in this literature used a standardisation by shares,[17] so I include these results as robustness for my main estimation. Standardising the variables by sales as in Hann et al. (2007b) or Yu (2012) yields very similar results.

Table 2.10 presents the same specifications as table 2.5, standardising the variables by shares. In terms of signs and significance, the results are similar to those in table 2.5, even if the point estimates of coefficients are slightly different. The minor difference in the number of observations in the regressions in table 2.5 and 2.10 is due to the exclusion of outliers. A slightly puzzling difference is the negative coefficient on the variable OFF bs in column 3. I believe that this is due to the high correlation of variables describing pension schemes when these are standardised by shares: ON bs and OFF bs have a correlation of nearly 0.93 before the introduction of SFAS No. 158, while NPA and OFF bs are perfectly collinear.[18]

Table 2.11 presents the same estimations as table 2.7, again standardising all variables by the number of shares outstanding one quarter after the fiscal year end rather than total assets. Here almost all the coefficients are statistically undistinguishable from the one in table 2.7, confirming my inference in the main paper.

[17] For example Hann et al. (2007a) and Coronado and Sharpe (2003).

[18] I believe that these correlations are yet another reason to prefer the standardisation by assets that I use in the main paper.

Table 2.10: Value relevance of pensions under SFAS 87 and SFAS 158 (by share)

Table presents my estimation results using the main sample. The independent variable is market capitalisation one quarter after the fiscal year end. Core book value is book value minus the pension deficit/surplus recognized on the balance sheet, core earnings are net income minus net periodic pension cost (NPPC, tax adjusted). Net pension assets are the difference between pension assets and liabilities for each firm. ON bs is the amount recognized on the balance sheet under SFAS 87, OFF bs is NPA - ON bs . All the variables are standardized by the number of shares outstanding one quarter after the fiscal year end. All specifications include year and 4 digit industry code dummies, standard errors clustered at the company level. To mute outliers I exclude the top and bottom 1% of all variables.

Variable	(1)	(2)	(3)	(4)	(5)
Book value	0.766***	0.698***			
	(0.04)	(0.034)			
Earnings	4.586***	4.835***			
	(0.233)	(0.187)			
Core book value			0.714***	0.69***	0.662***
			(0.042)	(0.041)	(0.035)
Net pension assets				-0.274	0.713***
				(0.274)	(0.242)
ON bs			1.147***		
			(0.337)		
OFF bs			-0.708***		
			(0.274)		
Core earnings			4.55***	4.704***	4.757***
			(0.232)	(0.233)	(0.185)
NPPC			1.546	-1.512	-8.846***
			(2.433)	(2.576)	(2.632)
Accounting regime	SFAS 87	SFAS 158	SFAS 87	SFAS 87	SFAS 158
N	7311	12367	7311	7311	12367
R^2	0.586	0.59	0.594	0.581	0.595

Table 2.11: Value relevance panel sample (by share)

Table presents my estimation results using the panel sample. The independent variable is market capitalisation one quarter after the fiscal year end. Core book value is book value minus the pension deficit/surplus recognized on the balance sheet, core earnings are net income minus net periodic pension cost (NPPC, tax adjusted). Net pension assets are the difference between pension assets and liabilities for each firm. ON bs is the amount recognized on the balance sheet under SFAS 87, OFF bs is NPA - ON bs . All the variables are standardized by the number of shares outstanding one quarter after the fiscal year end. All specifications include year and company fixed effects, standard errors clustered at the company level. To mute outliers I exclude the top and bottom 1% of all variables.

Variable	(1)	(2)	(3)	(4)	(5)
Book value	1.093***	0.903***			
	(0.06)	(0.053)			
Earnings	2.222***	1.29***			
	(0.162)	(0.12)			
Core book value			1.086***	1.08***	0.877***
			(0.062)	(0.061)	(0.054)
Net pension assets				0.424	1.727***
				(0.316)	(0.26)
ON bs			1.146**		
			(0.458)		
OFF bs			0.104		
			(0.328)		
Core earnings			2.219***	2.247***	1.308***
			(0.163)	(0.162)	(0.12)
NPPC			-0.967	-2.441	-10.9***
			(3.005)	(3.032)	(3.317)
Accounting regime	SFAS 87	SFAS 158	SFAS 87	SFAS 87	SFAS 158
N	8387	7739	8387	8387	7739

2.10 Appendix C1: reconciliation with previous literature

Since Yu (2012) and Beaudoin et al. (2011) have looked at the same research question as this paper but with a different methodology, this section shows that my results are robust to their estimation strategy. Both papers use a dummy for SFAS No. 158 and its interaction with the other regressors to identify the effect on the introduction of that accounting standard. I believe that the use of a control sample as in section 2.6.1 is more appropriate to identify such effect, however for completeness I report also estimates obtained with their technique. It involves bringing to the data modifications of the following equation:

$$\begin{aligned} Mcap_{i,t} = \alpha + \beta_1 BVc_{i,t} + \beta_2 NPA_{i,t} + \beta_3 Ec_{i,t} + \beta_4 NPPC_{i,t} + \beta_5 FAS158 \\ + \beta_6 BVc_{i,t} * FAS158 + \beta_7 NPA_{i,t} * FAS158 + \beta_8 Ec_{i,t} * FAS158 \\ + \beta_9 NPPC_{i,t} * FAS158 + \sum_{i=1}^{I} \gamma_i I_i + \sum_{t=1}^{T} \gamma_t Y_t + \epsilon_{i,t} \end{aligned} \tag{2.4}$$

Where I standardise all variables by total company assets as in the main paper. I also test a slight modification of equation 2.4, substituting NPA with its on and off balance sheet components when SFAS No. 87 is the relevant standard, much like in equation 2.2. The first two columns of table 2.12 report estimates using my main sample and sector and year fixed effects, while column 3 and 4 use the panel sample (I excluded all companies without a DB scheme as it does not make much sense to include them using this estimation strategy) with firm and year fixed effects. I report only the coefficient estimates for the interactions of interest for brevity (also, using only interactions on the pension variables rather than the

full model does not unduly influence my results). The different specification in table 2.12 all have the same interpretation, the interaction between FAS 158 and NPA is always positive and significant as expected, confirming my claim that DB pensions are value relevant when their net position is recognized on the balance sheet. In columns 1 and 3, NPA is not significant when not interacted, indicating that market participants tend to disregard the pension deficit/surplus when this is disclosed in the notes. Column 2 and 4 support my claim that investor focused on the pension accrual recognized on the balance sheet when valuing a DB sponsor prior to 2006, without considering the additional disclosure in the notes to the financial statements.

Table 2.12: Alternative models

Table presents my estimation for various modification of equation 2.4, using the main sample in columns 1 and 2 and the panel sample in columns 3 and 4. The independent variable is market capitalisation one quarter after the fiscal year end. Core book value is book value minus the pension deficit/surplus recognized on the balance sheet, core earnings are net income minus net periodic pension cost (NPPC, tax adjusted). Net pension assets are the difference between pension assets and liabilities for each firm. ON bs is the amount recognized on the balance sheet under SFAS 87, OFF bs is NPA - ON bs. All the variables are standardized by total assets, standard errors are clustered at the firm level. To mute outliers I exclude the top and bottom 1% of all variables.

Variable	(1)	(2)	(3)	(4)
Core book value	1.013***	1.099***	1.178***	1.228***
	(0.073)	(0.073)	(0.135)	(0.136)
NPA	0.538		0.433	
	(0.437)		(0.471)	
ON bs		2.05***		1.22**
		(0.49)		(0.549)
OFF bs		-0.069		0.069
		(0.427)		(0.509)
Core earnings	4.949***	4.837***	3.39***	3.309***
	(0.278)	(0.274)	(0.379)	(0.373)
NPPC	-5.171	-2.454	-4.182	-3.108
	(4.671)	(4.506)	(5.175)	(5.266)
NPA*FAS 158	1.473***	1.966***	1.254**	1.621***
	(0.458)	(0.308)	(0.593)	(0.414)
NPPC*FAS 158	-10.277**	-13.376***	-10.037*	-12.471**
	(4.976)	(4.915)	(5.872)	(6.158)
FAS158	0.022	0.054	0.127***	0.136***
	(0.046)	(0.045)	(0.041)	(0.041)
Fixed effects	Sector, year	Sector, year	Firm, year	Firm, year
N	19334	19334	7039	7039
R^2	0.542	0.544	-	-

Chapter 3

Discounting and the market valuation of defined benefit pensions

3.1 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 aims 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 standards 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.

Whilst pension assets are fairly easy to value, 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, DB schemes still represent a substantial commitment for most companies. Table 3.1 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 - were about 30% of market capitalization for both the FTSE 100 and FTSE 350 and that the overall DB deficit (pension assets minus liabilities) stood 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 growing evidence they have a significant impact on the free cash flow of the parent company and its investment decisions.[2]

Another important insight from table 3.1 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 occurred over the last few

[1] Under risk free discounting discussed below, liabilities stand at around 37% of market capitalization and the deficit at about 11% for the FTSE 100.

[2] See for instance Rauh (2006) that shows how DB pensions affect firms' investment in fixed assets and Liu and Tonks (2013) who look at the impact of mandatory contributions to DB pension funds on investment and dividends for UK companies. Alderson and Betker (2009) shows that after the burst of the dotcom bubble firms with underfunded pension scheme redirected investment towards activities that produce higher cash flow, while Duygun et al. (2017) find that DB coverage influences the propensity of making major investments and the type of such investments.

Table 3.1: DB Pension Facts

	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%	-

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.

years.

In this paper I estimate the impact of pension deficits/surpluses on the market value of FTSE 100 and FTSE 350 companies. I employ a slight modification of the residual income model, first proposed by Feltham and Ohlson (1995), as used in the pension context by Coronado and Sharpe (2003) and Coronado et al. (2008) that allows to isolate the impact of pensions. As a robustness check I also use a variant of Tobin's Q model as used by Feldstein and Seligman (1981) for US pension and by Liu and Tonks (2010) for the UK. To the best of my 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. However, my focus is on one key aspect of pension valuation, the discount rate used to value future of pension liabilities. Using data available in the notes of most company accounts I create an alternative value of liabilities based on 'risk-free' (government bond yield) discounting and compare the market impact of pension deficits/surpluses based on that measure as compared with the published measure.

I find that only in the case of risk-free discounting are my estimates consistent with the prediction that a £1 increase in the tax-adjusted deficit has a £1 impact

on the value of the sponsoring company. It is also the case that model estimates based on risk-free discounting are statistically superior and that, as expected, the difference between the market valuation and reported value of pensions is largest for firms with longer duration pension liabilities.

The rest of the paper is organized as follows. Section 3.2 offer a brief review of the empirical literature about the DB pension valuation. Section 3.3 gives an overview of the debate over the pricing of pension liabilities, focusing in particular on the appropriate discount rate. Section 3.4 describes the techniques I employ to investigate the pricing of DB schemes and how I adjust the discounting of pension liabilities. The next two sections describe the data I use and present my main results. Their robustness is discussed in section 3.7, which includes also a different empirical specification using Tobin's Q model and extends my results to a wider sample. The last section concludes.

3.2 Empirical Research on the Valuation of Defined Benefit Pension Schemes

The literature on DB pension valuation 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. I discuss this part of the literature in the next section. A full review of the vast and rich literature about corporate DB scheme is outside of the scope of this paper, in the next sections I refer to the papers that are most relevant to my work. For a thorough discussion of the academic work on DB pension I refer to Coco (2014).

3.2.1 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 SFAS No. 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 to study US DB pensions dates back to 1980s and found that stock prices fully reflected the funding situation of the pension plan. The main examples in this literature are the works by Feldstein and Seligman (1981), Feldstein and Morck (1983) and Bulow et al. (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 the "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 SFAS No. 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 and Sharpe (2003) and Coronado et al. (2008) tested empirically Gold's theory, finding that investors and analysts seem to fixate on the earnings impact of DB pensions and disregard the net position of the pension plans disclosed in the notes. Work by Hann et al. (2007a) is somewhat

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

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 and 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 et al. (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. Choy et al. (2014) find evidence that firms are comfortable taking more risks after freezing their defined benefit pension plans, increasing research and development expenses and leverage.

The literature on DB schemes for European countries is much scarcer. Fasshauer and 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 and 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 and 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 I find in this paper, but I don't address this question directly as my sample starts in 2006.

3.3 Discounting of Pension Liabilities

Although both IAS 19 in Europe and SFAS No. 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. This debate is summarised in Brown and Pennacchi (2016) who demonstrate that, whilst it is appropriate for the future pension recipient to include some measure of default risk when valuing their future pension benefits, from the sponsoring firm's point of view the pension liability has no default risk and so should be valued without allowing for credit risk (in practice government bond yields). In other words, Brown and Pennacchi (2016) argue that the appropriate discount rate for pension liabilities depends on the objective of the valuation exercise. The risk-free rate should always be used to measure the funding of a pension scheme, while a discount rate reflecting the risk of the sponsoring company is appropriate when measuring the market value of the company's pension promises. Novy-Marx (2015) stresses a similar point, arguing that the valuation of pension liabilities depends on both the concept of liability being used and from whose point of view the liabilities are valued.

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 estimation, where the 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 from this perspective, at least in regard to credit risk.[4] Hence it seems clear that the appropriate discount rate from the sponsoring firm's perspective should not reflect any credit risk.

In the US context (where the focus has been more on the valuation of public DB schemes) a number of papers, most notably Novy-Marx and Rauh (2011) and Brown and Wilcox (2009), discuss the correct discount rate for pension liabilities, and argue that a credit risk free-rate is appropriate. Fabozzi (2015) focuses on the investment policy and liability valuation concept of the Pension Benefit Guaranty Corporation, maintaining that a correct valuation of liability is key to design an optimal investment strategy and arguing the this valuation should be done using risk-free rates for both public and private pension plan sponsors. Kisser et al. (2017) find evidence that US corporate DB scheme manipulate reported pension liabilities, underestimating them by approximately 10 per cent on average, mainly using discount rates that are higher than appropriate. Also Comprix and Muller (2011) find that companies are opportunistic in choosing the discount rate and other assumptions, providing evidence that firms use them to exaggerate pension commitments before freezing benefits.

Despite the academic consensus that the discount rate should not allow for credit risk, both IAS 19 and SFAS No. 158 allow discounting using corporate

[4]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.

bond yields that are significantly above those of government bonds due, largely, to perceived credit risk. Under both standards, 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 their pension obligation.[5] There is however a long standing debate about which discount rate should be used.[6] 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 borne by the entity's creditors, nor does it reflect the risk that future experience may differ from actuarial assumptions.[7]

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

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

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

[7]IASB (2011)

> 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.[8]

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 et al. (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 defined benefit obligations in their annual publication investigating the DB universe (the Purple Book) and in calculating the levy that each sponsor has to pay to fund the PPF's guarantee. 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

[8] IFRS (2013)

onwards.

Of course, although it is hard to justify allowing for credit risk when estimating the present value of pension liabilities, it is possible that other considerations mean that the effective discount rate need not be the yield on government bonds. The literature (e.g.Brown and Wilcox, 2009) highlight two important differences between government bonds and pension liabilities that may make bond yields inappropriate for discounting DB liabilities. First, government bonds are significantly more liquid than pension liabilities as although the latter can be traded it is a complex process unlike government bonds that are easily traded in an active secondary market. This liquidity premium would tend to mean that the yield on government bonds is too low a rate for discounting pension liabilities. Second, since pension liabilities tend to be at least partially indexed to inflation, they have a lower inflation risk premium than nominal government bonds (see Breedon and Chadha, 2003 and Buraschi and Jiltsov, 2005 for evidence on the inflation risk premium in nominal bonds). Thus the yield on nominal government bonds may be too high a rate for discounting pension liabilities (sadly I have too little information on indexing to estimate the present value of real liabilities using inflation indexed bond yields). Since there is no consensus on the scale of either of these effects (and they work in opposite directions), I follow the approach of previous papers and take government bond yields as the best measure available.[9]

A recent working paper by Anantharaman and Henderson (2016) tackles empirically the issue of discount rate for pension liabilities, confronting AA corporate bond rate, risk-free rate and the expected return on plan's assets. They find that discounting at the expected return on pension assets provides the best fit in explaining both equity values and credit ratings (for financially healthy firms). The different result I find in this paper could be due to difference in samples, as Anan-

[9]I discuss other factors that may influence this calculation in the appendix.

tharaman and Henderson (2016) focus on US firms and start their analysis in 1995. Another explanation could be in the different method they use to estimate the sensitivity of the pension obligation to changes in the discount rate. They rely on actuarial gains and losses for this estimation, discarding more than 60% of data in the process, while I rely on the sensitivity analysis disclosed by firms as described in section 3.4.1.

3.4 Model Specification and hypothesis development

The main model I employ to investigate empirically the valuation of DB pension scheme is a parsimonious specification of the residual income model, put forward by Feltham and 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. I modify this model to make room for pensions as in Coronado and Sharpe (2003) and Coronado et al. (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; I 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. As noted earlier, although entering pension assets and liabilities separately into the model rather than the net position might be useful for my analysis, the high correlation between the two items means

it is not practical to do so.

Regarding income statement variables, I 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 and Sharpe (2003) and Coronado et al. (2008) use a slightly different definition of NPPC, where service cost is considered as a core expense rather that a pension item. I prefer to aggregate all the pension variables, but changing this definition has no major effect on the results. Hence I bring to the data the following models, where all variables are standardized by total company assets to make the series stationary and reduce heteroskedasticity:

$$Mcap_{i,t} = \alpha + \sum_{s=1}^{10} \gamma_s S_s + \beta_1 BVc_{i,t} + \beta_2 NPA_{i,t} + \beta_3 Ec_{i,t} + \beta_4 NPPC_{i,t} + \epsilon_{i,t} \quad (3.1)$$

$$Mcap_{i,t} = \alpha + \sum_{i=1}^{75} \gamma_i I_i + \beta_1 BVc_{i,t} + \beta_2 NPA_{i,t} + \beta_3 Ec_{i,t} + \beta_4 NPPC_{i,t} + \epsilon_{i,t} \quad (3.2)$$

where the only difference between the two specification is given by the fixed effects, which I include at either the sector of company level.[11]

As contributions to the pension fund are tax deductible in the UK, my estimates are based on a tax adjusted NPA that adds back the associated deferred tax asset/liability. I compute this as NPA times the corporation tax rate that the

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

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

companies in my sample face every year.[12] Although I do not directly observe the marginal tax rate paid by companies, the fact that the average tax rate paid by my sample of companies is about 24% it seems reasonable to assume that my firms face a marginal tax rate equal to or very close to the corporation tax rate. As Shivdasani and Stefanescu (2010) provide evidence that firms incorporate the tax implication of DB pensions in their capital structure decisions, so disregarding the tax credit associated with pension contributions could limit the validity of my results. However, as a robustness check the appendix includes estimates based on unadjusted NPA.

I use the models above to test two separate hipotheses. The first concerns the value relevance of DB pensions:

H1: The net position of DB pension funds is value relevant

If H1 holds, I expect the coefficient on NPA to be positive and significant. Considering that I adjust NPA for the associated tax credit, theory suggests that its coefficient should be equal to 1-t, where t is the marginal tax rate that companies face (so in my case it should be around 0.75). A higher (lower) coefficient would indicate that investors overreact (undereact) to DB pensions' deficits/surpluses. On the other hand, a coefficient of zero on NPA would indicate that H1 does not hold.

The second hypothesis concerns the estimation of the present value of pension liabilities. As discussed in section 3.3, financial theory suggests that pension liabilities should be discounted using a discount rate that reflects just the time value of money and does not allow for any credit risk. This is in contrast with the provisions of IAS 19 that mandate companies to use high quality corporate bond yields for such discounting. Formally I test the following hypothesis:

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

H2: Do investors use risk-free discounting rather than AA corporate bond rates when discounting pension liabilities?

Sice using risk-free discounting pension deficits are substantially bigger than the reported amounts, I expect the coefficient on NPA to be higher than 0.75 in equation (3.1) and (3.2) if H2 holds. Conversely, the coefficient on risk-free NPA in the same equations should be around 1 if H2 holds. In equation (3.4) I explicitly include the adjustment due to risk-free discounting alongside NPA in my model, so if H2 holds the coefficients on these two variables should both be around 1. The next section illustrates how I adjust pension liabilities using risk-free discounting.

3.4.1 Estimating risk-free pension liabilities

As discussed in section 3.3 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 I describe how I 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 my 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. However for my sample almost none of the firms in the FTSE 350, other than those in the FTSE 100, report this information. It is for this reason I conduct most of my analysis on the FTSE 100, though I report some more limited results for the FTSE 350 in section 3.7.

I use the interest rate sensitivity analysis to compute the duration of the defined benefit obligation; this in turn allows me to find the corresponding gilt rate appropriate for that liability and allows me to calculate the value of pension liabilities under 'risk free' discounting; I label the resulting estimate risk-free pension liabil-

ities 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:

$$\frac{\Delta P}{P} = -\frac{\Delta i}{1+i} D \tag{3.3}$$

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. Most of the companies do not disclose consistently the sensitivity analysis of the pension obligation to changes in interest rates. To solve this problem, I impute the duration of missing years to be equal to the closest available one. About a third of companies in my main sample do not report any sensitivity so for these firms I need to use values reported in years outside my sample (this disclosure became mandatory in 2013). However, pension liabilities are of very long term nature and since almost all schemes are closed to new members I can make a relatively accurate estimate of duration for all other years based on standard assumptions. The alternative approach of dropping these observations delivers similar results (albeit with larger standard errors).[14]

The yields on UK gilts come from the Bank of England historical yield curve data; in adjusting the pension liabilities, I 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

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

[14] These results are available in the appendix.

and none has had a consistent surplus throughout my sample period. The median company has deficit totalling more than 5 per cent of assets.

3.5 Dataset Construction and Summary Statistics

My main dataset includes all the FTSE 100 constituents with a defined benefit pension scheme.[15] It spans from 2006, the first year when IAS 19 became mandatory, until 2012, when the revised version of IAS 19 became mandatory. I decided not to include the data from 2013 onwards as this revision could significantly influence my results and so I preferred to have a homogeneous sample.

To deal with the wide variation in balance sheet closing dates, I defined time in my 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 me with 83 companies that have a DB scheme for at least one of the years in my main sample of FTSE 100;[16] I drop two of them (Burberry and Lonmin) because their DBs were demerged or wound up in 2008. I also drop Fresnillo and

[15] Recall that I 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. I present results for the FTSE 350 in section 3.7.

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

Vedanta Resources because they do not have any DB scheme in Europe or the United States, but only very small arrangements in developing countries.[17] I also drop four companies that do not disclose any duration or sensitivity analysis in any of their accounts (including them with duration fixed at the sample mean or median does not influence the results). These exclusions do not affect my results in any material way.

Given that for some companies I don't have the full seven years of data, my main dataset includes 511 observations. Table 3.2 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 - 2.8 per cent of assets, but the distribution is considerably skewed to the right so the median company has a deficit of only 1.1 per cent. Also the distribution of pension liabilities is skewed to the right, with some supersized pension funds pushing the mean up to 30 per cent. For the median company pension liabilities represent about 19 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 6.5 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 my sample's companies are actually booking negative pension expenses, with the DB scheme contributing to firm profitability despite being in deficit in some cases. I should however note that a great deal of these profits comes from settlements and curtailments related to the restructuring of the pension fund.

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

Table 3.2: Descriptive Statistics

variable	N	mean	standard dev	1st quartile	median	3rd quartile
Market Capitalisation	511	0.9416	0.7420	0.4223	0.7560	1.3519
Core Book Value	511	0.3355	0.1821	0.1918	0.3535	0.4859
Net Pension Assets	511	-0.0207	0.0378	-0.0288	-0.0077	-0.0009
Pension Liabilities	511	-0.3048	0.4159	-0.3606	-0.1939	-0.0400
Risk-free NPA	511	-0.0986	0.1311	-0.1124	-0.0626	-0.0127
Risk-free PL	511	-0.3750	0.5028	-0.4689	-0.2432	-0.0496
Core Earnings	511	0.0644	0.0722	0.0213	0.0615	0.0958
NPPC	511	-0.0028	0.0054	-0.0045	-0.0018	-0.0003

All variables are standardised by total company assets and were collected on the balance sheet closing date, except market capitalization which was retrieved at the reporting date.

3.6 Estimation and Results

Columns 1 and 2 of table 3.3 reports the parameter estimates for the basic Ohlson model, using only book value and earnings as independent variables, with sector and company fixed effects. Estimates for the model with sector fixed effects corresponds quite closely to those found in the US literature (see for example Hann et al., 2007a and Dechow et al., 1999) even though the book value coefficient is not significant in my case (though it is when I include FTSE 250 companies as in table 3.6). The use of company fixed effects is less common on the literature since the firm level dummies often pick up some of the impact of book value and earnings making the coefficients on those variables more difficult to interpret, despite this the coefficients on this model are both significant. Interestingly, the coefficient estimates that I get with company fixed effects are much closer to the Ohlson's model implied values that Dechow et al. (1999) find assuming a 12% cost of capital and using the realized persistence of abnormal earnings, suggesting that company fixed effects absorb some of this persistence. Column 3 and 4 show my results for Equation (3.1) and (3.2) with net pension assets. A comparison of column 1 with 3 and 2 with 4 shows that my modification of the Ohlson model to make room for

pensions does not have a big impact on the estimated coefficients on book value and earnings. Although NPA is only marginally significant in the sector dummy case, both specifications seem to give some support to the transparent view that net pension assets influence market valuation. The estimated coefficient on pension expenses is quite noisy. Indeed, 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:[18] effectively service cost expenses are a proxy for human capital formation and hence can contribute positively to the value of the company.

Although it is positive and significant as the transparent view of pension accounting would predict, the coefficient on NPA in column 3 is puzzling as it is consistently larger than one implying that the market gives a disproportionate weight to pension deficits, with £1 of net pension deficit reducing the market value of the company by about £2. Although this result is not present in the specifications where I include fixed effects at the company level (Column 4) this is unsurprising since the discount rate effect I discuss below is mitigated by the firm level fixed effects. In effect, since the difference between Risk-free NPA and the reported value depends on the absolute size of pension liabilities and their duration and these two variables are specific to every company and move slowly through time, in these specifications their effect is likely to be captured at least partially by the company dummies.

In all the specifications in table 3.3 I 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 my data. Clustered standard errors are unbiased when the number of clusters approaches infinity and in my setup I have only ten sectors. Moreover each sector has a different size in terms

[18] See for example Hann et al., 2007a.

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 I choose to use the wild cluster bootstrap of t-statistics as in Cameron et al. (2008) since this method corrects for both the small number of clusters and the unequal cluster size.[19] Significance levels based on the wild bootstrap are presented in the appendix along with further details of the procedure. Overall, the bootstrap results are similar to those presented in table 3.3.

3.6.1 Risk-free pension liabilities: results

I now compare the estimates of the impact of pension deficits using my alternative measure 'risk-free' measure described in section 3.4.1. First, I re-estimate Equation (3.1) using gilt discounted liabilities. As column 1 in table 3.4 shows on this basis the coefficient on net pension assets is now more precisely estimated and within the predicted range and column 2 shows that this result is robust to firm fixed effects as in Equation (3.2). As in the previous estimation, I cluster the standard errors at the sector level and use the wild cluster bootstrap of t-statistics to obtain reliable inference (see appendix for details of the bootstrap results which are similar to table 3.4.1). Of course, these estimates do not necessarily indicate that it is the change in discounting that explains the higher than expected estimates that I first observed, so in column 3 I separate the NPA and the additional component due to the gilt adjustment, creating a variable named Adjustment (Adj) defined as

[19] 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 3.3 without changing the interpretation of the results. I provide estimates using clustering at the firm level for most of my specifications in the appendix.

Table 3.3: Residual income model

	(1)	(2)	(3)	(4)
Book Value	0.526	1.490***		
	(0.427)	(0.321)		
Earnings	5.043**	2.019***		
	(1.633)	(0.525)		
Core Book Value			0.480	1.591***
			(0.413)	(0.420)
NPA			1.964*	1.115***
			(0.978)	(0.326)
Core Earnings			5.018**	2.113***
			(1.642)	(0.558)
NPPC			2.302	-5.689*
			(3.739)	(2.603)
Fixed Effects	Sector	Company	Sector	Company
N	511	511	511	511
R^2	0.575	-	0.578	-

Table presents 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. All the variables are standardized by total company assets. When imposing fixed effect at the sector level, I use the broadest GISC sector classification with 10 sectors in total. The standard errors are clustered at the sector level.

Risk-free NPA - NPA which amounts to testing the following:

$$Mcap_{i,t} = \alpha + \sum_{i=1}^{75} \gamma_i I_i + \beta_1 BVc_{i,t} + \beta_2 NPAt_{i,t} + \beta_3 Adj_{i,t} + \beta_4 Ec_{i,t} + \beta_5 NPPC_{i,t} + \epsilon_{i,t} \tag{3.4}$$

.

Both the coefficients on NPA and on the adjustment are significant and very close to what I found for the risk-free net pension assets. Finally in column 4 I test directly the prediction that companies with long duration liabilities should see a larger coefficient on their reported liabilities. I 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 pension liabilities.[20] This amounts to testing:

$$Mcap_{i,t} = \alpha + \sum_{s=1}^{10} \gamma_s S_s + \beta_1 BVc_{i,t} + \beta_2 PL_{i,t} + \beta_3 Ddif_{i,t} + \beta_4 PLxDdif_{i,t} + \beta_5 Ec_{i,t} + \beta_6 NPPC_{i,t} + \epsilon_{i,t} \tag{3.5}$$

which I do in column 4. The interaction sign is significant and has the predicted sign, indicating that firms with longer duration liabilities have a larger coefficient on reported pension deficits. In this specification I only use fixed effects at the sector level as this is a test of the cross-section properties of pension liabilities.

Overall, my results suggest that risk-free discounting is the most plausible explanation for the higher than expected impact of pension deficits on market valua-

[20] Using NPA or the accounting deficit for the interaction yield results with the same interpretation.

Table 3.4: Risk-free pension liabilities

Variable	(1)	(2)	(3)	(4)	(5)
Core Book Value	0.442	1.627***	1.623***	0.428	1.624***
	(0.409)	(0.457)	(0.382)	(0.236)	(0.380)
Risk-free NPA	1.038***	1.010***			1.020***
	(0.230)	(0.177)			(0.375)
Core Earnings	5.078**	2.028***	2.034***	5.175***	2.029***
	(1.638)	(0.544)	(0.741)	(1.190)	(0.732)
NPPC	-1.994	-4.338	-4.254	-1.601	-4.292
	(3.516)	(2.851)	(6.700)	(7.612)	(6.705)
NPA			1.336**		-0.043
			(0.660)		(0.732)
Risk-free Adjustement			0.963**		
			(0.368)		
Pension Liabilities				0.392**	
				0.15203	
Duration Difference				0.029**	
				(0.014)	
Ddiff*Pension Liabilities				0.058**	
				(0.029)	
Fixed Effects	Sector	Company	Company	Sector	Company
N	511	511	511	511	511
R^2	0.592	-	-	0.594	-

Table presents 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 minus reported NPA. Duration difference is the duration of pension liabilities minus its average across the sample. All the variables but duration difference are standardized by total company assets. Fixed effect at the sector level are based on the broadest GISC sector classification with 10 sectors in total. The standard errors are clustered at the sector level.

tion, not least since the effect seems larger for firms with longer duration liabilities.

3.6.2 Model selection tests

Testing econometrically whether the model with Risk-free NPA is preferable to the model using the accounting NPA is problematic in my framework as the two models are non-nested. I use two approaches to test which model is preferred.

First, I use the Vuong (1989) test statistic, as Hann et al. (2007b) do in this literature. Vuong (1989) is a likelihood based test statistic that allows to compare the explanatory power of non-nested econometric models. It does indeed confirm that the risk-free model is better specified, preferring it to the specification with reported NPA at the 5% confidence level using sector fixed effects, while the test statistic is just shy of significance at the conventional level using company fixed effects. Second, I effectively force the two models to be nested by running a regression with both Risk-free NPA and NPA as independent variables. I do this in column 5 of table 3.4, where Risk-free NPA completely dominates its reported counterpart: the coefficient and standard errors on Risk-free NPA are almost unchanged from what I present in columns 1 and 2 of table 3.4 whilst NPA is insignificant and has a coefficient very close to zero.

Therefore for both approaches it seems that pension deficit based on risk-free discounting dominated the reported deficit in terms of financial market impact.

3.7 Extensions

This section presents a set of extensions to my basic results that aim to confirm the validity of my results. First, I extend my sample to the full FTSE 350, though the lack of liability duration data for the smaller firms means I cannot recalculate pension liabilities using a risk-free rate. Second I use Tobin's Q model rather than

the residual income model as the basis of my estimation. Further extensions are presented in the appendices.

3.7.1 FTSE 350 firms

In the extended sample of FTSE 350 constituents I have 215 firms with a defined benefit pension scheme for at least one year in my 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 I could not work out the duration of the pension obligation and hence the discount rate adjustment. I drop all the observations that have a negative book value of equity together with two firms that experienced exceptional circumstances during the years that I consider in my sample, namely Howden Joinery and ITV. This leaves me with 1408 firm-year observations.

As table 3.5 shows, the FTSE 250 sample is remarkably similar to the FTSE 100 for the variables that I consider, even if the pension commitments of companies in companies in the FTSE 250 are only a fraction of those of their bigger peers.[21]

Table 3.5: Descriptive Statistics for FTSE 350

variable	N	mean	standard dev	1st quartile	median	3rd quartile
Market Capitalisation	1408	0.9695	0.8556	0.4376	0.7487	1.2665
Core Book Value	1408	0.3881	0.1904	0.2621	0.3893	0.5205
Net Pension Assets	1408	-0.0201	0.0369	-0.0305	-0.0900	-0.0007
Pension Liabilities	1408	-0.2826	0.3470	-0.3896	-0.1729	-0.0399
Core Earnings	1408	0.0624	0.0796	0.0259	0.0570	0.0928
NPPC	1408	-0.0020	0.0068	-0.0036	-0.0013	-0.0001

All variables are standardised by total company assets and were collected on the balance sheet closing date, except market capitalization which was retrieved at the reporting date.

My estimates for the enlarged sample of FTSE 350 companies are reported in table 3.6, which has the same structure as table 3.3. The first two columns report estimates for the Ohlson model with just book value and earnings as independent

[21] See section 3.1, in particular table 3.1.

variables using respectively sector and company fixed effects, their coefficient are remarkably similar to the estimates for core book value and earnings in the following two columns. Columns 3 and 4 report estimates for Equation (3.1) and (3.2). Net pension assets are still overvalued but slightly less than in my 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 I use clustered standard error at the sector level and wild cluster bootstrap results are reported in the appendix.

3.7.2 Tobin'S Q

The second model I employ to test the valuation of defined benefit pension schemes is derived from Tobin (1969), much in the spirit of Feldstein and Seligman (1981) and Liu and Tonks (2010). I 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 different. To take this into account, I include a set of control variables that may have an effect on Q, following again Liu and Tonks (2010).

I define Total earnings (Etot) as net earnings plus interest expenses on debt.[22] To control for the growth trajectory of the firm, I include 5y earnings growth, defined as the average of the last five years earnings minus the average of the five previous years; I also define its three years equivalent to limit the loss of observations caused by the data requirement of this variable. I also include net debt, defined as cash holdings minus total debt; hence a positive value indicates that the firm is a net creditor. All these variables are standardized by total company

[22] Using net earnings instead of this variable does not alter my results.

Table 3.6: FTSE 350 companies

	(1)	(2)	(3)	(4)
Book Value	1.027**	1.461***		
	(0.396)	(0.124)		
Earnings	4.698***	1.339***		
	(1.146)	(0.308)		
Core Book Value			1.067**	1.535***
			(0.433)	(0.154)
NPA			1.467**	1.157**
			(0.546)	(0.481)
Core Earnings			4.752***	1.395***
			(1.159)	(0.332)
NPPC			-4.965	-3.856
			(2.994)	(2.163)
Fixed Effects	Sector	Company	Sector	Company
N	1408	1408	1408	1408
R^2	0.447	-	0.453	-

Estimation results using the enlarged FTSE 350 sample, 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. All the variables are standardized by total company assets. When imposing fixed effect at the sector level, I use the broadest GISC sector classification with 10 sectors in total. The standard errors are clustered at the sector level.

Table 3.7: Tobin's Q Model

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Total Earnings	4.439**	5.408***	5.328***	3.191	4.292**	5.353***	5.309***	3.180
	(1.597)	(1.401)	(1.328)	(1.818)	(1.630)	(1.417)	(1.319)	(1.815)
Beta	-0.102*	-0.101	-0.081*	-0.117***	-0.109*	-0.102	-0.083*	-0.117***
	(0.053)	(0.055)	(0.037)	(0.029)	(0.051)	(0.058)	(0.037)	(0.026)
Net Debt	-0.656**	-0.483	-0.560		-0.606**	-0.396	-0.468	
	(0.305)	(0.370)	(0.334)		(0.262)	(0.321)	(0.286)	
NPA	1.349	1.507	1.442	2.228**				
	(0.882)	(0.833)	(0.806)	(0.953)				
Risk-free NPA					0.972**	0.933***	0.913***	1.085***
					(0.358)	(0.193)	(0.190)	(0.247)
5y Earnings Growth	1.606				2.028*			
	(0.979)				(0.983)			
3y Earnings Growth		-0.411				-0.351		
		(0.479)				(0.585)		
N	395	433	463	497	395	433	463	497
R^2	0.526	0.534	0.551	0.510	0.546	0.550	0.566	0.526

Table presents my 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. Its risk-free version is obtained discounting liabilities using gilt rates. All specification include sector and year fixed effects. I cluster the errors at the sector level.

assets. The last control variable I add is the firm CAPM beta, computed using one year of weekly returns against the FTSE 100 index. I test this model using both the reported and gilt adjusted value for net pension assets, bringing to the data the following equations:

$$Q_{i,t} = \alpha + \sum_{s=1}^{10} \gamma_s S_s + \beta_1 Etot_{i,t} + \beta_2 5yGrowth_{i,t} + \beta_3 NPAt_{i,t} + \beta_4 Debt_{i,t} + \beta_5 Beta_{i,t} + \epsilon_{i,t} \tag{3.6}$$

In the estimation I 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 my dataset (mainly the high street banks) the value for Q is understandably lower. Excluding them from the sample as in Liu and Tonks (2010) does not materially change my 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 3.7. I start with Equation (3.6) 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 reported values. The results in table 3.7 broadly confirm the findings I highlighted in the previous sections: the coefficients on net pension assets are consistently above one, even though their significance depends on the specification and the sample. On the other hand, adjusting their value using a discount rate that does not allow for credit risk yields estimates very close to

unity and significantly lower standard errors, irrespective of the different samples and controls. Also in these estimation I used clustering at the sector level and present wild bootstrap results in the appendix.

As with the Ohlson model, I compared the models with Risk-free NPA in table 3.7 with their counterparts that use reported 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 1% confidence level. Also enforced nesting confirms that Risk-free NPA is preferred.

3.8 Conclusion

Comparing my results with the previous literature investigating the issue of pricing of defined benefit pension schemes in the United Kingdom and elsewhere, it seems that the increased disclosure brought by IAS 19 has improved the way in which investors evaluate these schemes. However the European (and equivalent US) accounting standard falls short on the discount rate, where both financial theory and market valuation suggest the use of a credit risk-free rate rather than corporate bond yields. As I have argued, this is more than a technical issue as such a move would reduce the reported market capitalization of FTSE firms by about 7%.

My results suggest that even though such a change would increase reported pension liabilities dramatically, the market impact would be muted since market participants already incorporate lower discount rates into their valuations. Given these results, it seems logical that IAS 19 itself should move to government bond yield based discounting of pension liabilities. Even though such a change would have limited market impact it could improve the regulation, monitoring and reporting of pension liabilities. Also, since my results suggest that market participants carefully judge pension liabilities when valuing firms they imply that 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.

3.9 Appendix A2: Beta of Pension Liabilities and Pension Put

In the main paper I argue that pension liabilities should be discounted at a risk-free rate. There are two issue that can potentially undermine my claim: pension liabilities could have a degree of systemic risk that justifies a higher discount rate and the existence of public insurance for DB schemes of bankrupt sponsors could create an option to offload the pension deficit on the Pension Protection Fund. I address them in turn.

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 and 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 a closed form solution, the empirical evidence supporting it is very limited. Most empirical papers (e.g. Jin et al., 2006 and Cooper, 2009) suggest that the beta of pension liabilities is in fact the same as that of government bonds. Table 3.8 shows estimates of the beta of pension liabilities and of government bonds (gilts) over my sample. The first line shows the relationship between the yearly returns on pension liabilities and the market index (FTSE 100 or FTSE 350). 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 3.8 shows

the relationship between the market index and pension liabilities discounted at the risk-free discount rate (based on government bond yields, see section 3.4.1 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 my 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 3.8: 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	-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, using all in-sample observations.

The creation of the Pension Benefit Guaranty Corporation (PBGC) in the United States[23] 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 PBGC itself. One of the first papers to discuss the issue is Sharpe and 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 et al. (2011), who investigates how government insurance provides incentive for risk shifting if it is mispriced, though

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

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. Bartram (2018) provides more evidence that companies integrate DB schemes in their overall financial management, but his findings are mostly supportive of risk management, with limited evidence of risk shifting during major economic downturns.

As in the US, the defined benefit pension schemes in my 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 rise 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 of the put that the firm holds). However, it is however quite hard to envision a significant 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. 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 and Neuberger (2005) show that this risk-related premium is not precisely fairly priced, it does significantly reduce the

market value of the pension put since the risk-related levy firms pay to the PPF offset the value of the put they hold. Given these circumstances and my focus on the components of FTSE 100 index, I do have little evidence that the pension put has a material impact on the market value of pension liabilities over my sample.

3.10 Appendix B2: Robustness

This section presents estimations that test the robustness of my results. First I discuss the wild bootstrap of the t-statistic as in Cameron et al. (2008), then I present results clustering the standard errors at the firm level as Petersen (2009) suggests for panel data with a short time dimension. After I show that using the balance sheet figure for NPA rather than the tax-adjusted measure that I use in the main paper does not change my results. Lastly, I limit my analysis to the companies that disclose the sensitivity analysis of the pension obligation in the notes to their financial statements.

3.10.1 Bootstrap t-statistic

Clustering at the sector level allows me to assume the richest correlation structure for standard errors, but it is problematic in my data due to the small number of clusters and their unequal size. The wild bootstrap of the t-statistics solves both problem, so I employ this technique to correct my standard errors. Moreover, I use the weight structure proposed by Webb (2013) and later endorsed in Cameron and Miller (2015) when the number of clusters is smaller than 15. Mackinnon and Webb (2017) discuss in detail the properties of this technique, showing how it approaches the true rejection rates even with unbalanced cluster size. The procedure for using the cluster wild bootstrap of Cameron et al. (2008) to perform the test on β_2 in Equation (3.1) is as follows:

1. Estimate Equation (3.1) by OLS.

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

3. Estimate by OLS the restricted regression

$$Mcap_{ig} = \alpha + \beta_1 BVc_{ig} + \beta_3 Ec_{ig} + \beta_4 NPPC_{ig} + \epsilon_{ig} \tag{3.7}$$

   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

$$y^{\star}_{ig} = \tilde{\beta}_{H_0} + \tilde{\epsilon}_{ig} v^{\star}_{g} \tag{3.8}$$

   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. [24]

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

$$\hat{p}^{\star}_{s} = \frac{1}{B} \sum_{i=1}^{B} I(|\hat{t}^{\star}_{2j}| > |\hat{t}_2|) \tag{3.9}$$

[24] This is the weight distribution proposed by Webb (2013). The original Cameron et al. (2008) uses Rademacher weights.

I run 1000 replication for each of my estimation. The resulting p-values for NPA in table 3.3 are 0.20 using sector fixed effects (column 3) and 0.02 using company fixed effects (column 4). As usual the specifications with Risk-free NPA have stronger significance, with bootstrap p-values of 0.03 in column 1 of table 3.4 and 0.002 using company fixed effects (column 2 of table 3.4). The bootstrap increases the standard errors also using the enlarged sample of FTSE 350 constituents, with p-values for NPA of 0.058 for the specification in column 3 of table 3.6 and 0.085 for the one in column 4 of the same table. Regarding my estimation of Tobin's Q model, NPA is not significant at the conventional levels in any of the specifications in table 3.7, while the empirical p-values for Risk-free NPA in table 3.7 are 0.11 in column 5, 0.025 in column 6, 0.029 in column 7 and 0.025 in column 8.

3.10.2 Clustering standard errors at the company level

Allowing the regression residuals to be correlated at the firm rather than the sector level entails a more restrictive assumption, but Petersen (2009) shows that the resulting standard errors are a good approximation in panel datasets with a short time dimension like the one I am using. Table 3.9 shows how my main estimation using clustering at the company level. While there are some minor difference in the significance of regressors from the tables in the main paper, the results have the same interpretation.

3.10.3 Companies with missing sensitivity analysis

As discussed in section 3.4.1, about one third of the companies in my sample lack the sensitivity analysis that I need to compute the duration of the pension obligation and the corresponding Risk-free NPA. While in my main estimation I use the financial statements from 2013 to estimate the duration of the pension obliga-

Table 3.9: Clustering by company

	(1)	(2)	(3)	(4)	(5)	(6)
Book Value	0.526**	1.490***				
	(0.239)	(0.391)				
Earnings	5.043***	2.019***				
	(1.233)	(0.733)				
Core Book Value			0.480**	1.591***	0.442*	1.627***
			(0.244)	(0.395)	(0.243)	(0.379)
NPA			1.964*	1.115		
			(1.130)	(0.744)		
Risk-free NPA					1.038***	1.010***
					(0.381)	(0.327)
Core Earnings			5.018***	2.113***	5.078***	2.028***
			(1.197)	(0.737)	(1.187)	(0.735)
NPPC			2.302	-5.689	-1.994	-4.339
			(8.437)	(6.504)	(7.724)	(6.381)
Fixed Effects	Sector	Company	Sector	Company	Sector	Company
N	511	511	511	511	511	511
R^2	0.575	-	0.578	-	0.592	-

Table presents my estimation results using the main FTSE 100 sample, using standard errors clustered at the company level. 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. The calculations behind Risk-free NPA are described in section 4.1 of the main paper. All the variables are standardized by total company assets. When imposing fixed effect at the sector level, I use the broadest GISC sector classification with 10 sectors in total.

tion of these companies, this section reports my main estimates using a restricted sample that drops all the companies that did not publish any sensitivity analysis during the years covered by my sample. Doing so increases the standard errors in nearly all the estimates, but does not impair the significance of my variables of interest.

Table 3.10: Restricted sample with sensitivity analysis

	(1)	(2)	(3)	(4)	(5)	(6)
Book Value	0.013	1.903***				
	(0.536)	(0.438)				
Earnings	4.745**	1.270*				
	(1.711)	(0.630)				
Core Book Value			-0.065	2.183***	-0.018	2.220***
			(0.497)	(0.488)	(0.477)	(0.458)
Tax-adjusted NPA			0.860	1.301**		
			(0.802)	(0.505)		
Risk-free NPA					0.892***	1.249***
					(0.158)	(0.214)
Core Earnings			4.593**	1.359*	4.586**	1.203
			(1.794)	(0.717)	(1.749)	(0.679)
NPPC			7.467	-1.955	2.872	-0.034
			(5.169)	(2.216)	(3.306)	(2.130)
Fixed Effects	Sector	Company	Sector	Company	Sector	Company
N	358	358	358	358	358	358
R^2	0.595	-	0.599	-	0.614	-

Table presents my estimation results using the main FTSE 100 sample excluding all the companies that do not report any sensitivity analysis in their notes to the financial statements. 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. When imposing fixed effect at the sector level, I use the broadest GISC sector classification with 10 sectors in total. The standard errors are clustered at the sector level.

3.11 Appendix C2: Accounting NPA

As section 3.4 discusses, my main estimates are based on tax-adjusted NPA. In this section I show that the estimation results for unadjusted NPA are very similar to what I present in the main paper, for both the FTSE 100 and the FTSE 350 samples. Clearly the accounting deficit is larger without taking the associated tax credit into account, averaging at 2.86 per cent of assets for the FTSE 100 sample and at 2.78 per cent of assets for the enlarged sample of FTSE 350 constituents. Table 3.11 presents the estimation results for the Ohlson model using the unadjusted figures. As expected, the coefficients on unadjusted NPA are slightly smaller without taking the tax credit into account, leaving my interpretation unaffected.

Table 3.11: Unadjusted NPA

	(1)	(2)	(3)	(4)
Core Book Value	0.479	1.588***	1.067**	1.544***
	(0.413)	(0.418)	(0.433)	(0.153)
NPA	1.428*	0.820***	1.090**	0.982**
	(0.720)	(0.235)	(0.393)	(0.299)
Core Earnings	5.014**	2.11***	4.752***	1.389***
	(1.642)	(0.558)	(1.158)	(0.330)
NPPC	2.200	-5.779*	-5.051	-3.984*
	(3.746)	(2.591)	(3.001)	(2.107)
Fixed Effects	Sector	Company	Sector	Company
N	511	511	1408	1408
R^2	0.578	-	0.453	-

Table presents my estimation results using unadjusted NPA for both my samples, the first two columns report estimates for the FTSE 100 while the last two report results for the FTSE 350. 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. All the variables are standardized by total company assets. When imposing fixed effect at the sector level, I use the broadest GISC sector classification with 10 sectors in total. The standard errors are clustered at the sector level.

Chapter 4

The importance of reading the small print: analysts' estimates and pension accounting

4.1 Introduction

This paper investigates whether analysts incorporate all the pension information available to them under IAS 19 when forecasting earnings. My goal is twofold: first to ascertain if analysts use complex information that is repeatedly disclosed by the companies they follow and second if they anticipate the mechanical earning effects of an accounting revision. Analysts are important and sophisticated users of financial statements, so answering these questions would help evaluate the recent changes in accounting for defined benefit pensions. Moreover, it would give insights in how analysts use financial statements and accounting information that is repeatedly made available to them, as well as in how they process the implications of changes in accounting regulation.

Accounting for defined benefit (henceforth DB) pensions underwent a series of

changes in the past fifteen years, with the goals of making it more transparent and useful for users of financial statements IASB (2011). The International Accounting Standard Board (IASB) introduced IAS 19 in 2006, revolutionising DB pension accounting by introducing fair value. Despite this change, pension accounting remains a technically complex area, with most of the relevant information disclosed in the notes rather than on the balance sheet or income statement.

In this paper I focus on sell-side analysts because they are a sophisticated class of users of financial statements and perform an important role in disseminating information in the market, aiding the process of price discovery. DB pension accounting provides an ideal setting to test the forecasting ability of analysts for a two reasons. It is complex, but the financial component of future pension earnings can be reliably estimated using information that companies disclose in their annual report. Moreover, the changes introduced by the revised IAS 19 during my sample modify the formula to estimate future pension income, but were announced nearly two years before they became mandatory and so although their impact on each company's earnings can be mechanically estimated it would require careful attention by analysts.

I find that analysts repeatedly failed to incorporate changes in pension income in their earnings forecasts, despite the fact that such changes can be reliably estimated using information publicly available at least 8 month before the earnings are realised. This result is in line with a large body of literature that investigates the formation of analysts' forecasts and shows that they regularly fail to incorporate the relationship between accounting information and earnings (see for example Bradshaw et al. (2001) and Chang et al. (2016)). We also show that analysts do not anticipate the effects of changes in regulation that have a mechanical impact on the earnings they are estimating, improving their forecasts only after being surprised. Again, this result fits in the wider literature showing how analysts fail to

grasp the effects of accounting changes in their forecasts, even when these changes can be estimated precisely in advance, as shown for example in Plumlee (2003) and Chen and Schoderbek (2000). My work also contributes to the strand of literature that investigates how analysts deal with complex information, reinforcing the finding that they generally struggle in such settings, as shown by Frankel et al. (2006), Gu and Wang (2005), Duru and Reeb (2002) and many others.

The rest of the paper is organised as follows. The next section provides a detailed background of my work, then in section 4.3 I discuss the relevant literature and develop my hypotheses. Section 4.4 describes the empirical strategy and the data that I use, then my empirical results are presented in section 4.5. The last section concludes.

4.2 Institutional background

The relevant accounting standard for UK companies during the period I examine is IAS 19, effective from 2006, and its revised version (henceforth IAS 19R) effective from 2013. This section explains how the income component of a DB pension scheme is calculated according to both versions of IAS 19.

The effect of a DB benefit pension scheme on the earnings of its sponsoring company is not directly linked to cash contributions to the pension fund, but is rather an accounting accrual called net periodic pension cost (henceforth NPPC). Conceptually, it can be separated into two distinct parts, an operative component and a financial one, and often companies choose to split the reporting of DB income/cost this way in their financial statements. The operative part is service cost, an expense representing the pension benefits earned by employees during the accounting period. The financial component encompasses interest cost on pension liabilities (representing the impact of the passage of time on the discounted

value of future pension commitments) and the expected return on pension assets. Companies have to use the rate on comparable high quality corporate bonds to discount their pension obligation and thus determine interest cost,[1] while before the introduction of IAS 19R they were free to choose the expected rate of return (henceforth ERR) on pension assets.

Hence both the discount rate on pension liabilities and the ERR on pension assets are specific to every company: the former is determined by the currency and duration of pension obligations, while the latter depends on pension asset allocation. In practice companies enjoyed considerable freedom in deciding the ERR and prior academic work showed that DB sponsors used this freedom to set assumption strategically.[2] A further components of pension cost are exceptional items such as settlement and curtailments, where changes to the retirement benefits offered to workers generate a one-off earning accrual.

In June 2011 the International Accounting Standards Board (IASB) revised IAS 19, with the revision coming into effect for accounting periods starting on or after the first of January 2013 (early adoption was permitted). The main change concerns the ERR on pension assets: IAS 19R mandates that companies use the discount rate on the pension obligation to calculate expected return on pension assets. This change removes some discretion in the calculation of the financial component of NPPC, effectively making it equal to the surplus or deficit of the pension fund times the discount rate, irrespective of the specific pension assets allocation of each company. For most of the companies in my sample this entails an increase in reported pension costs with respect to prior reporting requirements.

[1] This choice is contentious, with many papers arguing that this is not the appropriate rate to discount pension liabilities. See Brown and Pennacchi (2016) for a recent discussion.

[2] See for instance work by Bergstresser et al. (2006) and An et al. (2014). These works use US data, where the institutional setting is different. However, the American accounting standards for defined benefit pensions is actually identical to the original IAS 19 in the determination of net periodic pension cost.

The financial component of pension earnings can be estimated in advance using the sponsoring company's disclosure in the notes to the financial statements, under both version of IAS 19. Section 4.4 describes the detail of such estimation and figure 4.1 summarizes the timeline, showing that all the data for this calculation are available to market participants at least 8 months before the realisation of the earnings being predicted. The next section develops the hypotheses that I test in section 4.5 and puts them in the context of the wider literature.

4.3 Literature review and hypotheses development

Both analysts' forecasts and pension accounting are topics that have been investigated extensively in the economics and finance literature, a full review is outside the scope of this work. This section relates my work to the broader literature, focusing on the papers that are closest to the problems I investigate.

Prior academic literature shows that analysts struggle to fully reflect the implications of complex accounting disclosure in their earnings estimates. For instance, Chang et al. (2016) find that analysts routinely misjudge the earnings implication of firms' derivatives positions, with the result driven by the complexity of the reporting requirements rather than the actual sophistication of the firms' derivatives positions. Bradshaw et al. (2001) show that analysts (and auditors) fail to predict the future earnings implications of accounting accruals, while Frankel et al. (2006) argue that analysts' reports are less informative when processing information is costly because of complexity. Chen et al. (2015) find that analysts' estimates are less precise and more disperse for companies that report goodwill impairments relative to a matched sample of companies that do not. Perhaps the closest work is Picconi (2006), who looks at changes in pension plans parameters and finds that analysts fail to anticipate the earnings implications of such changes.

The fact that analysts' accuracy in forecasting earnings decreases as the complexity of the task increases is well documented in the literature, covering more settings than the intricacy of financial reporting. For instance, Duru and Reeb (2002) find that earnings forecasts are less accurate for American companies with bigger overseas operations, Gu and Wang (2005) find that forecasts are more dispersed for firms with higher intangible assets intensity, Haw et al. (1994) show that accuracy decreases significantly after a merger (to recover later on) and Lehavy et al. (2011) argue that readability of companies' disclosure is linked to forecast accuracy and dispersion.

DB pension accounting is quite elaborated and represent an ideal setting to test how analysts cope with complex information, since in this context the small print can be exploited to predict accurately a component of income. I use this background to test the following hypothesis:

> H1: mechanically estimated changes in pension cost are predictive of analyst forecast errors

My work also relates to a set of papers that investigate how analysts react to changes in accounting for the companies they follow.[3] Chen and Schoderbek (2000) use the 1993 tax increase and find that analysts failed to incorporate the resulting deferred tax adjustments in their earnings forecasts. Using a different set of tax changes, Plumlee (2003) shows how analysts revise their forecasts to take into account the less complex changes but not the more complicated ones, suggesting

[3]In the discussion of the literature on analysts' reaction to accounting changes I am deliberately avoiding a review of the enormous literature analyzing the effects of the introduction of IFRS around the world. The reason is twofold. First, the task is outside the scope of the present work. Second, I believe that such a revolution in accounting practice is not comparable with the small and incremental change that I am analyzing. A worldwide overhaul in accounting is likely to have captured the full attention of market participants, regulators and users of financial statements at large. Hence I think there are good reasons to believe that my setting is different from the background of research investigating the introduction of IFRS.

that they struggle in assimilating complex information. In the UK context, Acker et al. (2002) argue that the introduction of FRS3 improved forecasts' accuracy (as it was expected given that this accounting change increased the information content of financial reporting), but not in the first year of its introduction as analysts struggled to cope with the new disclosure.

As discussed above, the introduction of IAS 19R changed the formula to determine the financial component of NPPC, reducing the sponsors' discretion and making the mechanical estimation of pension cost easier. I use the introduction of IAS 19R in 2013 to test the following two hypotheses:

> H2: mechanically estimated changes in pension cost are still predictive of analyst forecast errors even under the simpler IAS 19R
>
> H3: analysts' do not anticipate the effect on earnings of the introduction of IAS 19R, but their estimates improve thereafter

H2 tests if the simpler calculation required to estimate changes in pension cost under IAS 19R improve analysts' perception of this element of EPS. H3 focuses on the first year in which IAS 19R was introduced. As table 4.2 below shows, the change from IAS 19 to its revised version increases significantly the difference between simple and informed estimates for pension costs. Hence analysts have a stronger incentive to take this reform into account when estimating EPS. Moreover the accounting reform was announced two years prior and the publicity around this event could have pointed the attention of analysts to its effect. These two factors suggest that it is worth looking at the year in which IAS 19R was introduced separately from the rest of the sample where companies account under this standard.

My work also relates to the vast literature examining the effect of DB pensions on firm value. Most of those works focus on the surplus/deficit of the pension fund

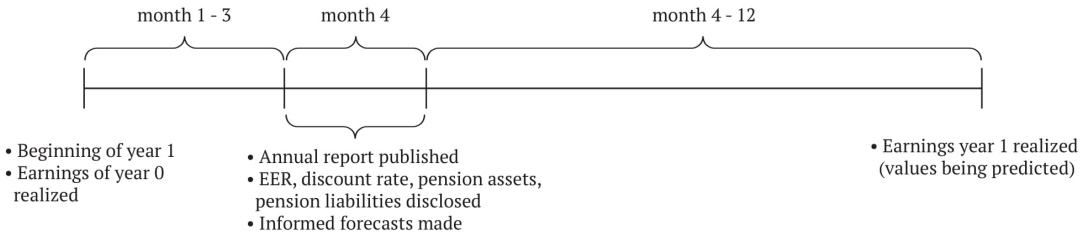
(Hann et al. (2007a), Coronado and Sharpe (2003) and Coronado et al. (2008) among many others), as this impacts future cash flows of the sponsoring firm through contributions to the fund. While the results of these works do not always coincide, overall they show that investors tend to focus more on information that is recognised on the financial statements rather than what is disclosed in the notes, even if the latter is arguably more important in estimating future cash flows and hence firm value. My results on analysts point in the same direction, suggesting that also they seem to disregard disclosure in the notes and instead focus on information recognised on the financial statements.

4.4 Methodology and data

This paper focuses on the financial component of NPPC as it can be estimated fairly precisely using information disclosed in the sponsors' annual report, unlike service cost and exceptional items. Moreover, since DB schemes in the UK are largely a legacy issue, with the vast majority of the schemes closed to new members and most closed to future accruals, the financial component makes up the majority of NPPC. This section illustrates how I compute the informed forecasts for interest cost and expected return on pension assets using the companies' disclosure, while the next subsection specifies how I test for the incorporation of this information in the published forecasts.

Figure 4.1 describes the timeline for my estimation. I define it in terms of fiscal year, so that every company closes its balance sheet in month 12 irrespective of the different choices of reporting year. I make the conservative assumption that the annual report is published within 4 months from the end of the fiscal year, such that market participants have access to the financial statements and the notes during month 4. At this stage it is possible to use that disclosure to develop

Figure 4.1: Timeline for estimating informed earnings forecasts



informed expectations about the future evolution of the financial components of NPPC. Hence my regression analysis in section 4.5 spans from month 4 to month 12, when the earnings are realized.

According to the timeline in figure 4.1 I can estimate interest cost in year 1 using public information disclosed in the companies' annual report for year 0 in the following way:

$$Informed\,Interest\,Cost_1 = Discount\,Rate_0 * Pension\,Liability_0 \tag{4.1}$$

and for expected return on pension assets under IAS 19:

$$Informed\,Expected\,Return_1 = ERR_0 * Pension\,Assets_0 \tag{4.2}$$

where I obtain ERR_0 using the following approximation for companies reporting under the original version of IAS 19:

$$ERR_0 = Expected\,Return_0/(Pension\,Assets_0 + Pension\,Assets_{-1})/2 \tag{4.3}$$

which assumes a linear increase or decrease of assets in year 0. After the

introduction of IAS 19R in 2013 the ERR on pension assets in equation 2 is equal to the discount rate in equation 1. I prefer to approximate the expected return this way rather than use the companies' disclosure because it is quite patchy, with a only small minority of companies reporting their ERR in the notes. Most companies disclose their assumed rate of return for each individual asset class in their pension assets instead, making the computation of each company's average ERR time consuming and uncertain.

Combining the results of equations (1) and (2) gives the informed forecast for the financial component of pension cost, net interest cost:

$$Informed\,Net\,Interest\,Cost_1 = Inf\,Expected\,Return_1 - Inf\,Interest\,Cost_1 \tag{4.4}$$

For the base forecast I hypothesise that analyst do not respond to changes in the information disclosed in the notes to the financial statements but rely only on income statement data, thus assuming that net interest cost is not going to change from last year:

$$Base\,Net\,Interest\,Cost_1 = Net\,Interest\,Cost_0 \tag{4.5}$$

The difference between the informed and the base forecast for net interest cost gives my variable of interest for the regression analysis in section 4.5:

$$\Delta PensionCost_1 = Informed\,Net\,Interest\,Cost_1 - Base\,Net\,Interest\,Cost_1 \tag{4.6}$$

This variable allows me to test the hypotheses specified in section 4.3, i. e.

if analysts use the pension information disclosed in the annual reports to better forecast the sponsors' earnings or if they assume the pension component of income to be unchanged from last year.

4.4.1 Model

To investigate whether analysis incorporate changes in the parameters determining net interest cost in their earnings forecast I follow the methodology proposed by Rajgopal et al. (2003) and later used by Picconi (2006), which I modify slightly to suit my purposes. I define monthly forecast error (FE) on year 1 earnings as realized EPS minus the consensus forecast at the end of each month and I regress it on ΔPensionCost and a battery of control variables based on year 0 values:

$$\begin{aligned} FE_{i,t+1,m} = \alpha + \beta_1 \Delta PensionCost_{i,t+1} + \beta_2 EPS_{i,t} + \beta_3 FE_{i,t} + \beta_4 Book/Market_{i,t} \\ + \beta_5 Size_{i,t} + \beta_6 Beta_{i,t} + \beta_7 EPS/Price_{i,t} + \beta_8 Age_{i,t} + \beta_9 Net\,Operating\,Assets_{i,t} \\ + \beta_{10} Total\,Accruals_{i,t} + \sum_{i=1}^{I} \gamma_i D_i + \sum_{t=1}^{T} \gamma_t D_t + \epsilon_{i,t,m} \end{aligned} \tag{4.7}$$

where Book/Market is the ratio between book value and market value, Size is market capitalisation, Beta is computed against the index using one year of returns, Price is share price, Age is calculated in years from IPO (or from 1988 if IPO was before then), Net operating assets are calculated as (operating assets - operating liabilities)/lagged total assets, Total Accruals are computed as (earnings - cash flow)/lagged total assets and dummies for years and company fixed effects. All control variables are included in their respective decile rank value, as in Picconi (2006), with the exception of Age, Net Operating Assets and Total Accruals that

are ranked in quintiles.[4] The ranks are assigned using fiscal year end values for all variables.

I use equation 4.7 above to investigate whether analysts incorporate the information about pension earnings that companies disclose in the notes to the financial statements in their forecasts for EPS. My other research questions center on the introduction of IAS 19R. To investigate whether analysts change their behaviour after the introduction of the revised standard, I add a dummy called POST, set equal to one when companies report under IAS 19R and zero otherwise. The interaction between the POST dummy and my variable of interest identifies the difference in effect between the two reporting regimes. To investigate H3 and isolate the effect of the first year of IAS 19R I add another dummy called REV that takes value of 1 only when a company is reporting for the first time using IAS 19R. Using it together with the POST dummy and the corresponding interaction allows me to investigate the additional effect specific to the year when IAS 19R was introduced.

4.4.2 Data and descriptive statistics

I use as my sample all FTSE 350 constituents at 31/12/2012, the day before IAS 19R was introduced. My analysis starts in 2009, as I need 2 prior years of information to construct the informed forecasts for ΔPensionCost. The assumptions I need are disclosed by the companies only from 2006/2007 onwards (from the introduction of the original version of IAS 19).

After excluding duplicates and investment vehicles, I am left with 293 companies of which 210 have a DB pension. I exclude companies that change their fiscal year end date over the sample and drop Xstrata because of its merger with

[4]Using buckets for the control variables allows me to mute the effect of outliers and use variables that have different scales in the same regression.

Glencore, Qinetic as it is the only early adopter of IAS 19R and Go-Ahead Group because of its unique pension arrangements (it is part of collective schemes, making its reporting and hence the predictions significantly more complicated and uncertain). Table 4.1 illustrates the composition of my sample. I include in the regression analysis only companies for which I can compute ΔPensionCost, all the control variables[5] and I have at least one year with the full 12 month of consensus earnings estimate. That leaves me with 201 unique companies and 1413 observations. Pension liabilities are on average close to 40% of market capitalisation for firms in the sample, but the median is about 25%, with the mean driven by a handful of companies with a huge pension scheme. The absolute value of ΔPensionCost over EPS shows that the difference between informed and base forecasts shrinks significantly after the introduction of IAS 19R, because of the reduced discretion that companies enjoy in setting the assumptions determining pension cost under the revised standard (the value for 2009 is due to a denominator effect, EPS are lower than in the other years in the sample).

Table 4.1: Sample description

year	companies	with DB	with all data	Pension liabilities (as % of Market cap)	ΔPensionCost (as % of EPS)
2009	278	202	168	48.73%	5.03%
2010	286	206	170	40.77%	3.34%
2011	292	208	176	42.84%	2.86%
2012	293	210	185	44.43%	1.75%
2013	292	210	185	37.12%	2.24%
2014	286	208	174	37.67%	2.39%
2015	274	204	181	40.74%	1.08%
2016	263	200	174	43.04%	0.85%

Table 4.1 describes the companies in the sample. Pension liabilities and market capitalisation are retrieved at the balance sheet closing date. The ratio between ΔPensionCost and EPS is in absolute value to show the difference between informed and base forecasts.

All the balance sheet data are retrieved at the balance sheet closing date from

[5]The only exceptions are net operating assets and total accruals, which have more missing values than the rest of the controls. I set their quintile at zero for companies that have a missing value.

Bloomberg. For companies that do not report in Sterling, I converted the data into Sterling using the closing exchange rate on the balance sheet closing date. Bloomberg is the source also for consensus earnings forecasts, collected at the end of each calendar month.

Table 4.2: Accuracy of informed and base estimates of net interest cost components

Panel A: absolute difference between realized and forecasts, pence per share

			obs	mean	difference	t statistic	top 10%	top 5%
interest		simple	1413	0.771	0.237	6.419	1.674	3.000
cost		informed	1413	0.534				
expected	pre	simple	781	1.407	0.247	4.804	1.391	2.161
return		informed	781	1.160				
	rev	simple	179	1.473	1.022	7.271	3.293	5.071
		informed	179	0.450				
	post	simple	453	0.867	0.502	6.687	1.706	2.463
		informed	453	0.365				

Panel B: absolute difference between realized and forecasts, as percentage of EPS

			obs	mean	difference	t statistic	top 10%	top 5%
interest		simple	1413	2.53%	1.03%	2.952	1.67%	3.00%
cost		informed	1413	1.50%				
expected	pre	simple	781	4.51%	1.05%	3.282	3.79%	5.55%
return		informed	781	3.45%				
	rev	simple	179	3.50%	2.50%	7.089	8.00%	10.72%
		informed	179	0.99%				
	post	simple	453	2.67%	1.68%	2.436	3.35%	6.06%
		informed	453	0.98%				

Table 4.2 shows the accuracy of informed and base forecasts for interest cost and expected return on assets with respect to realized values, both in terms of pence per share and as a percentage of EPS. The data for expected return are divided in 3 panels, pre refers to data before the introduction of IAS 19R, rev data for the first year when companies adopted the revised standard and post for the following years.

Table 4.2 illustrates the difference between the informed and base forecasts for the components of net interest cost in my sample. The informed forecasts are consistently better in predicting the components of net interest cost, in terms of both pence per share and as a percentage of earnings. Using informed estimates for

interest cost rather than the base one improves the forecasts by 1% of net earnings on average and more than three times as much for the companies with the biggest pension schemes. I divided the forecasts for expected return on pension assets in 3 panels: before the introduction of IAS 19R, the first year in which IAS 19R was introduced and the latter period. In general the improvement of forecasts using informed estimates is higher for expected return than for interest cost, especially in the first year of IAS 19R (as expected, since the ERR on pension assets moved to the discount rate). In that year, using the base forecast rather than the informed one for expected return implies a worsening of the forecasts of 2.5% of earnings and of more than 8% for a tenth of companies.

4.5 Estimation and Results

Table 4.3 presents the estimation results for equation 4.7 in my sample and two partitions of it, investigating if analysts use the disclosure in the notes to the financial statements in their forecasts. I regress the forecast errors in consensus estimates for next year's earnings starting four months after the end of each company's fiscal year until the end of that year, stopping when earnings are realised. As specified in the timeline (figure 4.1), this assures that the annual reports for year 0 are available when I start analysing the error in consensus forecasts for year 1 earnings. In all three panels of table 4.3 the average monthly forecast error is negative and monotonically reducing as companies approach their reporting date, indicating that on average analysts are too optimistic about the companies' EPS.

Using the full sample as in panel A it seems that analysts persistently fail to incorporate all available information about DB pensions when making forecasts: ΔPensionCost is consistently positive and significant. This indicates that the difference between the informed and base forecasts for the financial component of

pension cost explains the consensus earnings' forecast error, over and above the battery of controls specified in equation 4.7 and notwithstanding the demanding econometric specification with firm and years fixed effects (in all the regressions standard errors are clustered at the company level). The coefficient on my variable of interest is very close to one in months 5 to 10, while it shrinks in the last two month before the closing of the balance sheet. This could be explained by analysts gradually improving their forecasts over time using the information announced by the companies during their fiscal year, as in Picconi (2006), but in this case only partially.

The two following panels of results present the same model on different subsamples: before the introduction of IAS 19R for panel B and after its introduction for panel C.[6] The results in panel B are very close to the ones for panel A: the difference between informed and base forecasts for net interest cost helps to explain the error in consensus earnings' forecasts. The result is econometrically strong even in this subsample, with the point estimates for the coefficient on ΔPensionCost slightly decreasing over time, hinting that analysts improved their forecasts over time but not enough to fully include the expected change in pension earnings. The results in Panel C are along the same lines as the regressions above, only much less strong. I attribute this to the limited sample size as the dynamics do not seem to be markedly different from panel A.[7]

Next I turn my attention to the effects of the introduction of IAS 19R. In order to do so I rely on the same model described in section 4.4.1, adding a dummy called POST that takes the value of 1 if a company reports under IAS 19R and interacting it with ΔPensionCost to isolate the difference in analysts' estimates under the two

[6] I did not include the first year of data under the new accounting regime in panel C because of its peculiar behaviour, which is analysed later using the results in table 4.4.

[7] As a further robustness test, I tried a regressing equation 4.7 on a sample merging panels B and C, identifying the difference between the two panels with a dummy. Also this test fails to show any significant difference between the two subsamples.

Table 4.3: Forecast errors and net interest cost

	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Panel A: All sample									
average FE	-0.050	-0.044	-0.041	-0.039	-0.038	-0.037	-0.035	-0.030	-0.031
ΔPensionCost	0.640**	0.841***	1.076**	0.906**	0.862**	0.975**	0.937**	0.604**	0.586**
	(0.320)	(0.302)	(0.459)	(0.394)	(0.395)	(0.386)	(0.397)	(0.285)	(0.293)
N	1371	1373	1373	1375	1372	1375	1374	1373	1373
r2	0.599	0.727	0.706	0.69	0.713	0.689	0.688	0.698	0.72
Panel B: Before revision									
average FE	-0.051	-0.041	-0.039	-0.037	-0.037	-0.036	-0.035	-0.033	-0.033
ΔPensionCost	0.811*	0.885**	0.755**	0.567*	0.418	0.477*	0.493*	0.487**	0.483**
	(0.446)	(0.386)	(0.379)	(0.340)	(0.270)	(0.245)	(0.253)	(0.243)	(0.242)
N	755	758	757	759	757	758	758	758	759
r2	0.666	0.814	0.830	0.809	0.847	0.841	0.832	0.836	0.841
Panel C: After revision									
average FE	-0.046	-0.045	-0.040	-0.037	-0.036	-0.034	-0.031	-0.026	-0.026
ΔPensionCost	1.170	0.747	1.305	0.818	0.549	1.563*	1.369	1.308	1.178
	(1.260)	(1.342)	(1.357)	(1.117)	(0.960)	(0.909)	(0.892)	(0.904)	(0.843)
N	441	439	441	441	440	442	441	441	440
r^2	0.812	0.850	0.785	0.795	0.812	0.753	0.756	0.750	0.769

Table 4.3 presents our estimation results to investigate whether analysts use the disclosure in the notes to better estimate pension income when making earnings forecasts. The full specification is:

$$FE_{i,t+1,m} = \alpha + \beta_1 \Delta PensionCost_{i,t+1} + \beta_2 EPS_{i,t} + \beta_3 FE_{i,t} + \beta_4 Book/Market_{i,t} + \beta_5 Size_{i,t} + \beta_6 EPS/Price_{i,t}$$
$$+\beta_7 Age_{i,t} + \beta_8 Net\,Operating\,Assets_{i,t} + \beta_9 Total\,Accruals_{i,t} + \sum_{i=1}^{I} \gamma_i D_i + \sum_{t=1}^{T} \gamma_t D_t + \epsilon_{i,t,m}$$

where all the control variables not reported in the table are scaled in their respective decile rank by year (but for Age, Net Operating Assets and Total Accruals that are in quintiles). The dependent variable is consensus forecast error at the end of each month, where the month numbering follows each firm fiscal year as specified in figure 4.1. All specifications include firm and year fixed effects, the standard errors are clustered at the firm level. Panel A includes all observation from 2009 to 2016, panel B only companies reporting under the original IAS 19 in the 2009-2013 period and panel C only firm reporting under IAS 19R but not in their first year under the revised standard (2014-2016).To mute the effect of outliers I excluded the top and bottom 1% of FE and ΔPensionCost in each monthly regression.

regimes (panel A of table 4.4). In panel B of the same table I also add a dummy called REV that takes value of 1 when a company is reporting under IAS 19R for the first time and the corresponding interaction, with the goal of investigating H3, so to asses if the year when the reform was introduced is different from the following ones.

Table 4.4 presents the results. In panel A the coefficient on ΔPensionCost is significant and close to 1, as I would expect given the estimates in table 4.3. Its interaction with the POST dummy is indistinguishable from zero until month 10, but in the last two months becomes negative and significant. This would indicate that analysts adjust their estimates to take into account the mechanical effect of changes in pension cost on earnings under the revised version of IAS 19 but not under the original standard.

This finding is however challenged by the results in panel B. Highlighting the first year in which IAS 19R was mandatory tells a different story, as the coefficient on the interaction between POST and ΔPensionCost turns positive, even if it is weakly estimated. This would indicate that analysts do not change their behaviour under IAS 19R, still avoiding to take into account the mechanical effect of changes of pension costs on earnings. Panel B makes clear that the negative coefficient on the POST interaction that I found in panel A was entirely due to the first year of companies reporting under IAS 19R: the interaction between the REV dummy and ΔPensionCost is negative in all months, even if shy of significance in most of them. This result indicates that analysts paid attention to the changes in DB pension costs when IAS 19R was first introduced, but did not use the disclosure in the notes to estimate the financial component of NPPC in the following years. This finding also reconciles the results of table 4.4 with what I found in panel C of table 4.3, where I found that analysts did not incorporate the mechanical effect of ΔPensionCost in their forecast in a sample that includes all but the first year

Table 4.4: Accounting reform

Variable	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Panel A: IAS 19 versus IAS 19 R									
ΔPensionCost	0.585	0.782**	0.86**	0.888**	0.839*	0.865**	0.842**	0.821**	0.811**
	(0.468)	(0.396)	(0.383)	(0.437)	(0.461)	(0.372)	(0.385)	(0.38)	(0.395)
ΔPensionCost	0.215	0.15	0.547	-0.032	0.03	0.299	0.23	-0.641*	-0.701*
* POST	(0.6)	(0.68)	(0.953)	(0.522)	(0.508)	(0.779)	(0.805)	(0.371)	(0.363)
POST	0.006	-0.002	-0.007	-0.009	-0.004	-0.001	-0.004	-0.004	-0.007
	(0.021)	(0.016)	(0.014)	(0.011)	(0.012)	(0.012)	(0.011)	(0.01)	(0.009)
N	1371	1373	1373	1375	1372	1375	1374	1373	1373
r^2	0.599	0.727	0.706	0.69	0.713	0.689	0.688	0.698	0.72
Panel B: Separating the revision year									
ΔPensionCost	0.57	0.768*	0.844**	0.872**	0.81*	0.851**	0.819**	0.802**	0.796**
	(0.463)	(0.391)	(0.379)	(0.43)	(0.447)	(0.362)	(0.371)	(0.369)	(0.385)
ΔPensionCost	-0.869	-0.937	-1.111	-1.083	-1.716	-2.383*	-2.321	-1.735	-1.322
* REV	(1.241)	(1.248)	(1.379)	(1.171)	(1.379)	(1.366)	(1.438)	(1.132)	(1.068)
ΔPensionCost	1.142	1.15	1.692	1.154	1.759	2.54	2.394	0.971	0.572
* POST	(1.196)	(1.302)	(1.8)	(0.981)	(1.154)	(1.601)	(1.704)	(0.925)	(0.821)
POST	-0.038	-0.048	-0.059*	-0.071**	-0.064**	-0.071**	-0.065**	-0.047*	-0.048**
	(0.032)	(0.03)	(0.031)	(0.029)	(0.027)	(0.028)	(0.028)	(0.024)	(0.023)
REV	0.039**	0.04**	0.045**	0.054**	0.052**	0.059**	0.052**	0.035*	0.035*
	(0.018)	(0.018)	(0.02)	(0.023)	(0.022)	(0.023)	(0.023)	(0.02)	(0.02)
N	1371	1373	1373	1375	1372	1375	1374	1373	1373
r^2	0.599	0.728	0.707	0.692	0.716	0.693	0.692	0.701	0.722

Table **??** presents our estimation results to identify the effects of the introduction of IAS 19R. The full specification for panel B is:

$$FE_{i,t+1,m} = \alpha + \beta_1 \Delta PensionCost_{i,t+1} + \beta_2 \Delta PensionCost_{i,t+1} * REV + \beta_3 \Delta PensionCost_{i,t+1} * POST$$
$$+\beta_4 REV + \beta_5 POST + \beta_6 EPS_{i,t} + \beta_7 FE_{i,t} + +\beta_8 Book/Market_{i,t} + \beta_9 Size_{i,t} + \beta_{10} Beta_{i,t} +$$
$$\beta_{11} EPS/Price_{i,t} + \beta_{12} Age_{i,t} + \beta_{13} Net\,Operating\,Assets_{i,t} + \beta_{14} Total\,Accruals_{i,t} + \sum_{i=1}^{I} \gamma_i D_i + \sum_{t=1}^{T} \gamma_t D_t + \epsilon_{i,t,m}$$

while panel A omits the REV dummy and the consequent interaction term. All the control variables not reported in the table are scaled in their respective decile rank by year (but for Age, Net Operating Assets and Total Accruals that are in quintiles). The dependent variable is consensus forecast error at the end of each month, where the month numbering follows each firm fiscal year as specified in figure 4.1. All specifications include firm and year fixed effects, the standard errors are clustered at the firm level. To mute the effect of outliers I excluded the top and bottom 1% of FE and ΔPensionCost in each monthly regression.

of IAS 19R.

Overall the results in table 4.4 suggest that analysts did pay attention to the introduction of IAS 19R, but later went back to ignoring the mechanical effect of changes in pension assumptions on EPS. This behaviour could be driven by the publicity of the change in accounting standard. Changes in accounting are a long process, with the new standard published two years before its introduction date. Companies also warned user of financial statements of this change in their latest annual report before the introduction date of IAS 19R. As these warnings faded, analysts reverted to ignoring the small print of pension disclosure. Another possible driver of this behaviour has to do with analysts' incentives: as table 4.2 makes clear, the effect of EPS is much bigger in the revision year. This could have helped analysts anticipate the fact that the introduction of IAS 19R would have had negative impact on the EPS of most of the companies they covered.

4.6 Conclusion

This paper investigates whether analysts use all available information in the notes to the financial statements when forecasting future earnings. I find that they repeatedly fail to take into account changes in the income effect of defined benefit pensions, despite the fact that those changes can be reliably estimated well in advance using publicly available information. This happens under both the accounting regimes that I analyse in my sample, with no considerable difference after the introduction of IAS 19R.

The exception if the year in which IAS 19R was introduced: in this case analysts did anticipate its effect on EPS, even if not fully. They had all the incentive to so, as ignoring this would have increased their forecast error considerably. Moreover the reform was widely publicized, by both the standard setting body and the

companies themselves.

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