Growing Pension Deficits and the Expenditure Decisions of Companies[1]

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ABSTRACT

Large deficits have opened up in defined benefit pension schemes in many OECD countries' since 2007, and at the same time investment expenditure has been subdued. We use privileged access to a unique new UK dataset from *The Pensions Regulator* and two identification schemes to investigate the effects of deficits and deficit recovery plans on UK companies' dividends, investment, wages and cash holdings. Identification is based on the close relationship between low long-term interest rates and pension deficits; and the external regulation of pension schemes by *The Pensions Regulator*. We show that firms with larger pension deficits *voluntarily* pay lower dividends, but do not invest less. However, firms that are *required* to make deficit recovery contributions by the regulator have lower dividend and investment expenditure compared to other firms, and more so if they are financially constrained. These effects are large for some individual companies, but macro-economically small compared to the stimulus offered by the Bank of England's quantitative easing policy.

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1. Introduction

The years since 2007 have been remarkable for the fact that large pension deficits have opened up on defined benefit (DB) funds. According to the OECD (2017), funding ratios on DB pension funds are estimated to have averaged less than 90% between 2012 and 2016 in Canada, Mexico, the UK and the US as low interest rates have raised the value of pension liabilities around the world. This suggests that the value of assets in firms' DB plans will be insufficient to cover pension liabilities. In this paper we consider detailed data from the UK private sector where the 6000 DB pension schemes are a significant source of retirement income, with around 11 million members and assets of around £1.5 trillion. The aggregate funding deficit that these schemes faced (on a Technical Provisions basis[2]) is estimated to have reached around £300 billion by 2015 (Chart 1), equivalent to more than 15% of annual GDP.

The scale of DB pension deficits has meant that the way that companies respond to them has become a significant policy issue in many countries. In the UK, which is the focus of our analysis, when pension schemes face a deficit, the trustees are required by the Pensions Act (2004) to put in place a recovery plan. Such a recovery plan may require the firm to divert resources to support the pension scheme and so make adjustments to other forms of spending. As pension deficits have grown, corporate investment has been subdued (Chart 2) and potentially the two are related.

In this paper we take advantage of privileged access to a unique new dataset from *The Pensions Regulator* (TPR) to consider whether UK firms responded to deficits and having to make recovery contributions by cutting investment, dividend payouts, or wages and whether they held more cash cash in anticipation of having to make higher future recovery contributions. We do so by matching our data on deficits to the accounting data of firms from the Worldscope database and using two novel identification schemes to explore the relationship between growing deficits and expenditure decisions of firms. We then evaluate the macroeconomic consequences of these decisions. To anticipate our contributions, our analysis allows us to differentiate between responses to deficits – which are *voluntary* until a scheme undergoes a triennial valuation – and responses to deficit recovery contributions, which are *mandatory* payments to close deficits once a valuation has taken place. This has not been possible before in the UK data. We show that larger pension deficits and recovery contributions in recent years have had large and economically important effects on firms' spending decisions. But relative to the scale of the estimated positive benefits from the Bank of England's quantitative easing policy (QE), which is likely to have made some contribution towards, these deficits, there was only a small dampening effect from larger deficits on the macroeconomy as a whole.

Our findings matter for *The Pensions Regulator,* which is the official body responsible for the regulation and sustainability of UK pension schemes, and for monetary and financial policymakers at the *Bank of England*, who focus on the implications for the economy and the financial sector. TPR need to understand the implications of the way that they regulate pension funds because they have an explicit objective to minimise any adverse impact on the sustainable growth of an employer.[3] The

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[2] Technical provisions basis refers to the measure of deficits that companies use when formulating recovery plans. The assumptions used to value future liabilities are scheme specific and are determined by the scheme trustees and actuaries, subject to the approval of The Pensions Regulator.

[3] TPR's remit requires them to take into account forecast cashflow of the employer after essential business spend and investment; employer's plans for sustainable growth – its proposed uses of its free cashflow after essential spend and investment; the difference between temporary factors restricting cash availability and longer-term structural trends; employer's debt structure and debt service obligations; employer's capital structure and resources; and the employer's dividend policy.

findings are also important to the Bank of England, partly because they need to understand whether companies' responses to pension deficits are affecting the macroeconomy in order to be able to set monetary policy appropriately, but also more specifically because monetary policy itself is likely to have contributed to larger pension deficits by lowering long-term interest rates. Joyce et al (2011, 2012) and Joyce and Tong (2012) estimate that the first £200 billion of Bank's quantitative easing (QE) programme depressed Gilt yields by around 100 basis points, although other monetary policies such as low Bank Rate and forward guidance and global factors will have played a role in lowering Gilt yields too. Depending on how companies responded to those deficits, there may have been some negative consequences for GDP that could have reduced the effectiveness of QE. Our findings are also likely to be applicable to other countries that have experienced global reductions in long-term bond yields and similar shortfalls in DB pension funding since the crisis.

Our paper is connected to the literature in a number of ways. At a company level, the scale of UK DB pension deficits has the potential to create a substantial shock to firms' internal finances which can be considered in the light of the corporate finance literature. In a world without information asymmetries (Modigliani and Miller, 1958), external finance would replace internal funds and expenditure would be unaffected, but when there are information asymmetries, current and future expenditure would fall and more so for firms that are financially constrained (Gilchrist and Himmelberg, 1995; Fazzari et al. 1988, 2000; Kaplan and Zingales, 1997, 2000). In this paper we investigate, first, whether rising deficits led companies to *voluntarily* reduce investment, dividend payments and wages. Second, we ask whether the imposition of agreed deficit recovery plans and the associated deficit recovery contributions (DRCs) that firms are *required* to make to restore their pension schemes to a sustainable position led firms to reduce investment, dividend payments and wages. Finally we consider whether firms that were more financially constrained reduced their spending by more than those that were less constrained.

Previous studies in the UK (Bunn and Trivedi, 2005; Liu and Tonks, 2013) and the US (Rauh, 2006; Bakke and Whited, 2012) have made important empirical contributions to understanding the effects of DB pension deficits on firms' investment, dividend payments and cash holdings. However, a key challenge for these authors has been the accurate measurement of DB pension deficits and recovery contributions in the UK data since TPR data has not previously been made available for research purposes. Using data on UK firms between 1983 and 2002, Bunn and Trivedi found a clear negative relationship between total pension contributions (including regular contributions on DB and DC schemes) and dividend payments but only weak evidence of any relationship with investment. Liu and Tonks (2013) find similar results over a more recent period (2002-07) using simulated mandatory contributions and controlling for funding status based on FRS17/IAS19 disclosures on company accounts, although their effects on dividends are quantitatively larger. But these UK studies cover the period prior to 2007, before recent large deficits opened up, and they do not use data on actual deficit recovery contributions, rather they rely on total pension contributions or imputed recovery contributions.

The novelty in our paper involves the use of a unique new dataset that is derived by matching accounting data from the Worldscope database with detailed micro-data on DB pension schemes supplied by TPR. This data, which is not publicly available, contains information on three important pension variables: the size of pension deficits for DB schemes during the period from 2005/06 to 2014/15; the length of deficit recovery plans; and the size of actual deficit recovery contributions made between 2010/11 and 2014/15. Use of this dataset offers a substantial improvement in the measurement of deficits and contributions compared to other UK studies in this area. We use this data to revisit the issue of how pension deficits and deficit recovery plans have affected the spending plans of UK companies.

In contrast to the findings of previous UK work, Rauh (2006) presents evidence from the US that higher mandatory pension contributions have large negative effects on investment. This work cleverly exploits a discontinuity in US pension funding rules to identify exogenous changes in mandatory contributions. Although subsequent literature has challenged the details of this study, we use a closely related approach to identity the effects of DB deficits on the real and financial decisions of firms through exogenous changes in mandatory contributions.[4]

We make use of two identification schemes that have not previously been used to examine the effects of pension deficits in the UK. The aggregate DB pension deficit has expanded at the same time that long-term interest rates have declined (Chart 1) and aggregate deficit recovery contributions (DRCs) have increased (Chart 4). We use these characteristics to help identify the firm-level response to growing deficits. Firstly, we exploit the fact that lower long-term interest rates increase the size of pension deficits for DB schemes *that were already in deficit*. For a scheme that is in deficit, lower Gilt yields (which may reflect domestic influences such as QE or global factors) raise the value of future liabilities by more than the value of assets. A historical deficit should not be endogenously determined with investment, cash holding or payouts, therefore we use these exogenous shocks to DB pension deficits faced by firms to identify the adjustment in expenditure. Secondly, we use the fact that companies have a legal obligation to put a plan in place to close deficits in the pension schemes that they sponsor. With TPR data on DRCs we can observe how these obligations impact on firms' investment and dividend payments. This is in a similar vein to the identification scheme used by Rauh (2006), based on US mandatory pension contributions, though the UK regulatory regime does not follow the functional approach to the calculation of DRCs used in the US. Each of our schemes therefore measures 'variation in cash flows that is uncorrelated with unobserved investment opportunities' (p. 1090) Bakke and Whited (2012). We discuss the details in later sections.

To implement our firm level analysis we examine, first, the effects of rising deficits on dividend payments, investment, wages and cash holdings, controlling for other determinants of these decisions using firm-specific characteristics. We then repeat the exercise to see how nature of recovery plans affects these expenditure decisions. Our results show that companies with larger pension deficits do not invest less or pay lower wages than companies with smaller deficits, but they do pay lower dividends.[5] However, once a firm is *required* to make deficit recovery contributions by TPR it changes its behaviour in a noticeable way, paying a lower dividend on average, and investing less than firms without deficit recovery plans. Moreover, the effects of recovery contributions on investment are even stronger for companies that are more financially constrained. These results

[4] Campbell, Dhaliwal and Schwartz (2012) extend Rauh's work and show how one of the channels through which increases in mandatory pension contributions reduce investment is via increases the cost of capital, although only for firms facing greater external financing constraints. However, Bakke and Whited (2012) find that the strong sensitivity of investment to mandatory contributions is based on a small number of heavily underfunded firms. They therefore question the wider relevance of the result and show that these heavily underfunded firms have different characteristics to the rest of the sample which may also have influenced their investment.

[5] Although we find a negative empirical relationship between dividends and pension deficits/DRCs and between investment and DRCs the sign of these relationships is ambiguous from a theoretical perspective. For example, Webb (2007) shows how firms acting in the interests of shareholders have incentives to pay dividends rather than fund pension plans and that deficits may, on the one hand, reduce investment by acting as a debt like overhang, but on the other, create incentives to undertake risky investments to be able to fund future commitments, particularly in the presence of pension benefit insurance schemes.

mirror those of Rauh (2006) for the US, but are potentially more serious for UK firms because the scale of the deficits is large relative to GDP.

To explore the macroeconomic effects of large DB pension deficits we consider their implications for UK GDP. The Bank of England's QE programme aimed to boost the macroeconomy by lowering long-term interest rates and stimulating spending. But those lower long-term interest rates are likely to have increased the size of deficits for schemes that were already in deficit and subsequently led to an increase in recovery contributions. Our results suggest that will have caused some of these firms to reduce their dividends and investment. However, the scale of these adverse consequences is likely to have been small. The most likely case is that growing deficits only reduced the level of GDP by around 0.1%, in total, since 2007 and only a portion of that can be attributed to QE. These numbers are small in relation to the scale of the estimated positive impact of QE on GDP that was estimated by Kapetanios et al (2012) and Weale and Wieladek (2016). We therefore conclude that while growing DB pension deficits have had substantial effects on the spending of some individual firms, they have only had small effects on the macroeconomy as a whole.

Our paper is structured as follows. The next section explains the data and identification issues. Section 3 describes our empirical specification and estimation methods. Section 4 sets out the results. Section 5 considers the macroeconomic effects and policy implications of those results. Finally, section 6 concludes.

2. Data and identification schemes

2.1 Data Sources and Variable Construction

Detailed micro-data on DB pension schemes were supplied by TPR, the public body overseeing workplace pensions in the UK. Trustees are required by the Pension Act (2004) to make triennial assessments of DB pension funds. TPR gathers information on the funding position of the schemes (defined as the difference between total liabilities and total assets) and on the proposed recovery plans for schemes that are in deficit. We use two types of data. First, we have information on the size of the deficits on a Technical Provisions (TP) basis, which is the measure that companies actually have to respond to when formulating their recovery plans. It allows the actuaries valuing the schemes to make assumptions that are specific to the nature of the scheme e.g. life expectancy of scheme members. Our study is the first to be able to use data on a TP basis, which is not publically available information.[6] Second, we have detailed information on deficit recovery plans, which is again not publically available data. Ours is the first UK study to use data on the length of recovery plans and size of actual rather than imputed deficit recovery contributions. This information is not widely reported by companies, is often combined with voluntary contributions to DB and defined contribution schemes, and where it is identified in notes to the accounts it is not always reported on a consistent basis between companies.

Using actual data on recovery contributions and recovery plan lengths is a major step forward in accurately estimating the effects on companies' other expenditure compared to previous UK

[6] The Technical Provisions measure allows the actuaries valuing a pension fund to use assumptions that they deem are appropriate for that individual scheme and is therefore the best measure to use when thinking about the true cost to the sponsoring company. Other measures typically use common assumptions across firms, even though there may be good reasons for different schemes to use different assumptions. The most readily available source of firm level data on pension deficits are deficits that are reported in companies' accounts under the FRS17/IAS19 reporting standard. In the UK this measure uses the AA corporate bond yield to discount liabilities. Other definitions include the s179 measure, which represents the cost to the Pension Protection Fund of taking over the scheme if it were to become insolvent, and the s75 or 'buy-out' measure, which is an estimate of the cost that a pension scheme would have to pay an insurer to take on the costs and risks associated with their liabilities.

studies that have had to rely either on total pension contributions that combine regular and recovery contributions (Bunn and Trivedi (2005) or estimates of imputed contributions (Lui and Tonks (2013)). Behaviourally, we can confidently differentiate between clearly delineated *voluntary* and *mandatory* payments, which has not been possible before in the UK data. We look only at the impact of mandatory contributions on companies' expenditure decisions.

Pension schemes are only required to conduct a valuation every three years. But for our analysis we have access to annual valuation data where data between the triennial assessments have been extrapolated by TPR using actuarial techniques and market indices for principal asset classes to create a dataset at annual frequency.

Each pension scheme does not necessarily have only one corporate sponsor. In many cases the same company or consortium of financially dependent companies may have owned several pension schemes or, alternatively, one pension scheme can been owned by several companies. For the purpose of our analysis, TPR establishes the identity of UK ultimate owners of the majority of pension schemes, which allows us to use a consolidated dataset with information at the national owner (company) level.

We match the TPR data on the funding of DB pensions schemes to company accounts data for listed companies from the Worldscope database. We match data on pension deficits for the financial years 2005/06 to 2014/15 and data on DRCs for the financial years 2010/11 to 2014/15, when TPR collected comprehensive data. Precise details of the matching process can be found in the Appendix. We focus only on listed companies to ensure we have high quality data on investment that is available for quoted companies via Worldscope.[7] The listed companies who can be matched to pension data account for almost half of the total universe of DB pension liabilities. However, we drop financial companies from our analysis because they have very different financial structures to non-financial companies. That leaves us with a sample of around 270 companies a year to use in our analysis with matched pension and complete accounting data.[8] These are typically large FTSE 350 companies and together they account for around a third of the aggregate liabilities of DB pension funds and a quarter of the aggregate deficit.[9]

In our analysis we scale the pension variables by the size of the company, either in relation to their sales or assets depending on the equation specification. Scaling by company size indicates the size of the strain placed on a company by its pension obligations. In our analysis of how recovery contributions affect corporate decisions, we add DRCs back onto cashflow so that cashflow is measured before recovery contributions are paid for the years that those data are available. Similarly, borrowing ratios are calculated using this adjusted data. In specifications that rely on data prior to 2010 when DRC data are unavailable, we use unadjusted cashflow for the whole sample period (i.e. as reported in the accounts). We describe how we construct other variables in the Appendix. Descriptive statistics on the data that we use are provided in Table 2A of the Appendix.

2.2 Two Identification Schemes.

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[7] Investment data for private companies are available from other sources such as Bureau van Dijk but they appear to be of lower quality and they have incomplete coverage.

[8] Table 1A in the Appendix reports the exact numbers of observations in each year.

[9] There are a large number of small schemes. According to the Government Actuary's Department (2017) "There are a large number of small DB schemes – in a universe of around 6,000 schemes, 10% of membership is spread across 81% of schemes.". Our coverage is focused on the largest schemes linked to FTSE 350 companies. Financial reporting for smaller firms contributing to smaller DB schemes is far less comprehensive.

An important concern with our analysis is whether companies can influence the size of their deficit and the contributions that they make towards closing any deficit and whether these are jointly determined with their other expenditure decisions e.g. investment, dividend payouts etc. In our estimation we rely on two identification schemes that help to ensure that the pension variables we consider are genuinely exogenous to the company.

The first identification scheme is based on the fact that lower long term interest rates increase the size of pension deficits for schemes that were already in deficit.[10] Because the discount rates used to value pension fund liabilities are typically linked to Gilt yields, lower long-term interest rates increase the value of future liabilities.[11] Even though the value of assets and liabilities may increase by the same proportion, if the pension fund is already in deficit then that would increase the absolute size of the deficit. In practice that is what happened to many pension schemes after 2007: around 40% of schemes were already in deficit prior to 2007 and others will have been drawn into deficit by the falls in equity prices that were associated with the financial crisis. While the value of assets held by UK pension funds almost doubled between 2007 and 2014, the value of liabilities increased by even more and so deficits widened (see Chart 5).

Changes in Gilt yields are likely to reflect global and domestic factors. World interest rates on government debt have fallen since 2007 (Chart 3).[12] In part that may reflect factors such as shifts in desired savings and investment, for example due to changes in demographics (Rachel and Smith (2015)). But domestic factors are likely to have been important too and UK rates fell by more than world rates after 2007. One of those domestic factors is likely to have been the Bank of England's asset purchase programme (or QE). Joyce et al (2011, 2012) and Joyce and Tong (2012) estimate that the first £200 billion of QE depressed Gilt yields by around 100 basis points. Both global factors and the Monetary Policy Committee's (MPC's) decision to stimulate the macroeconomy using QE should be completely independent of any individual company.

If lower long-term interest rates were the primary cause of pension deficits we should expect deficits to have been very persistent, with the companies that started with the biggest deficits before long-term interest rates began to fall having experienced the biggest increases in deficits as lower rates amplified these deficits. Chart 6 shows that this was the case in our sample. For the 10% of companies that had the biggest deficits in 2006/07, their average deficits in subsequent years are shown by the dark blue line on Chart 6. That line shows how these firms experienced the biggest increase in deficits after 2006/07 and how they had the biggest deficits in every subsequent year. Likewise, the 10% companies with the next biggest deficits (in the green line) saw the next biggest increase and had the next highest deficits throughout. The 60% of firms who had schemes in surplus in 2006/07 (who are represented by the light blue line on Chart 6) subsequently had the smallest deficits.

To implement the first stage of our first identification mechanism we limit the sample to those firms indexed by i that had a deficit in 2006/07. This was the last year before the financial crisis, the year that marked the most recent peak in long-term bond yields and was the last year before large aggregate pension deficits began to open up. Using the observed persistence in pension deficits we

[10] Bank of England (2012) discuss this in more detail and provide an illustrative example.

[11] The discount rate used to value liabilities may also include a risk premium, but since our identification scheme relies on changes in Gilt yields, that change in Gilt yields will be equal to change in the discount rate if risk premia are assumed to be constant.

[12] Data are for 20 advanced economies only. 10 year nominal government bond yields are weighted together using nominal GDP weights (the US has the largest weight in this index of around 40% on average). This is similar to the series used by Rachel and Smith (2015).

then predict deficits as a function of the deficit in the last year before the crisis and an interaction term between that and the change in Gilt yields (the exogenous shock to pension deficits). The second term allows for the fact that firms with *larger* deficits were *more adversely affected* by the exogenous shock of falling Gilt yields because their liabilities would have risen by more than their assets increased in value (a characteristic that is linked to the size of their deficit). The identification relies on the interaction of falling Gilts yields and a *pre-existing deficit* at the firm level, therefore the effect on current firm level deficits is firm-specific but independent of investment opportunities of firms. It is closely aligned with Bakke and Whited (2012): "Fluctuations in the funding gap are driven by the present value of the pension liabilities, by plan contributions, and by the performance of the invested pension assets…fluctuations in the market value of pension assets and in the present value of liabilities that accompany market interest rate changes are largely beyond the firm's control." (p 1090). In our case DB pension deficits are determined by pre-existing deficits and changes in Gilts yields, which we estimate at the firm level:

$$Deficit_{it} = \phi_1 Deficit_{i2006/7} + \phi_2 \Delta Gilt\ yields_{t-2006/07} {*} Deficit_{i2006/7} + \varepsilon_{it} \quad (1)$$

In our analysis we compare the results from actual and predicted DB deficit data, but using predicted DB deficits derived from the equation above has some advantages. First, these fit well and have good statistical properties. Second, they depend only on pre-determined data such as the deficit in 2006/07 and financial variables such as the change in Gilt yields that are not affected by the firm. Therefore they do not depend on endogenous decisions of the firm, and any change in the predicted deficit after 2006/07 should be exogenous to the firm and independent of their preferences/opportunities. It is still possible that the starting deficit in 2006/07 may not have been completely exogenous to the performance of the company, but in Table 3A of the Appendix we show how there is not a significant relationship between observable balance sheet characteristics and either the probability of having a deficit in 2006/07or the size of the deficit conditional on having a deficit in 2006/07.[13]

For our second identification mechanism we make use of the regulatory policies of TPR and that fact that companies have a legal obligation to clear pension deficits. This is closely tied to the exogenous source of variation in cashflows mentioned by Bakke and Whited (2012): "if one can find a source of variation in cash flows that is uncorrelated with unobserved investment opportunities, then, even though a regression of investment on cash flow may omit these unobservables, one can still estimate the causal effect of cash flow on investment" (p 1090). In our case the exogenous variation in cashflow results from the legal requirement to make deficit recovery contributions, which are determined by TPR, and are uncorrelated with unobserved investment opportunities.

Under UK law, the regulator has a responsibility to ensure that firms implement a viable deficit recovery plan if a pension scheme is in deficit. The Pensions Act 2004 requires trustees of pension schemes to carry out a triennial valuation to assess whether their scheme has sufficient funds to meet their obligations to pay member' benefits, both currently and in the future. Trustees have up to 15 months to agree a proposed valuation and recovery plan and submit these to TPR. TPR's

[13] The regressions in Table 3A also include controls for incorporation date and size quartile to allow for the fact that larger or older companies may be more likely to have promised generous pension benefits in the past and to have larger deficits as a result. The coefficients on these variables are not typically significant. But crucially, these regressions are conditional on being a publically quoted company with a defined benefit pension scheme. Within the full set of public quoted firms, older and larger companies are much more likely to have a DB pension scheme than smaller and younger firms. Moreover, incorporation date is not a perfect measure of legacy pension deficits. For example, some companies in our sample that have run DB pensions schemes for a long period of time were nationalised until the 1980s and therefore were only incorporated relatively recently, whilst other companies that have been in existence for a long time may have been taken over by more recently incorporated firms.

Code of Practice on funding DB schemes ensures recovery plans are "appropriate" to be able to make up the deficits, although the regulator may vary the size and duration of the deficit recovery payments to meet their objective of minimising the impact on the sustainable growth plans of the sponsoring employer.[14] While TPR can take into account the solvency of the firm, it does not adjust deficit recovery plans if the firm has a preference to divert resources towards investment, cash holdings or payouts.

As deficits increased after 2007, there was some increase in recovery contributions paid (Chart 4), but these recovery contributions increased by much less than deficits. That is because the length of recovery plans was also extended (Chart 7), implying that companies did not have to meet all of the additional costs immediately. As before, we predict recovery contributions using the 2006/07 deficit and the interaction with change in Gilt yields used in equation (1).

$$DRC_{it} = \Gamma\left(\widehat{Deficit}_{it}\right) = \gamma_1 Deficit_{i2006/7} + \gamma_2 \Delta Gilt\ yields_{t\text{-}2006/07} * Deficit_{i2006/7} + \eta_{it} \quad (2)$$

Here DRC is a function of the fitted deficit from equation (1). As before we have the actual DRC data for each firm in deficit and can compare the DRC values predicted by equation (2) against actual values.

3 Empirical Specifications and Estimation Methods

To a large extent we follow the existing literature in our empirical specifications and estimation methods, but because we have more detailed data from The Pensions Regulator and a clear identification strategy, we are able to extend the UK literature and estimate models using actual and predicted pension deficits/deficit recovery contributions rather than total pension contributions or imputed recovery contributions.

The framework that we use to analyse this issue is based around the budget constraint that companies face. We follow the same approach of the related UK literature (Bunn and Trivedi (2005), Benito and Young (2007) and Liu and Tonks (2013)) by estimating dynamic panel models of investment by firms. The specification for the investment equation is given by:

$$\frac{I_{it}}{TA_{it-1}} = \alpha^I + \sum_{j=1}^{2} \beta_{1j}^I \frac{I_{it-j}}{TA_{it-j-1}} + \beta_3^I Q_{it-1} + \beta_4^I \Delta S_{it} + \beta_5^I \frac{CF_{it}}{TA_{it-1}} + \beta_6^I \frac{Deficit_{it}}{TA_{it-1}}$$

$$+ \beta_7^I cgr_{it-1} + \beta_8^I br_{it-1} + \textstyle\sum_{t=t_0}^{T} \theta^{I'}{}_t \,.\, t + \mu^I{}_i + \omega_{it} \quad (3)$$

where $\frac{I_{it}}{TA_{it-1}}$ is the investment ratio, Q is Tobin's Q defined as market to book value, ΔS_{it} is firms' annual sales growth. We add $\frac{CF_{it}}{TA_{it-1}}$, the cashflow before recovery contributions are paid (scaled by lagged total assets), to indicate the extent to which firms use cashflows to finance their investment, which Fazzari et al (1988) take as an indicator of binding financial constraints.[15] The specification up to this point is similar to Eberley et al (2012). We introduce further controls for capital gearing (total debt to total assets), *cgr*, and the borrowing ratio (proportion of profits that are taken up by

[14] The regulatory regime implies that companies have an obligation to increase pension contribution to clear deficits, but there is some still some discretion about exactly how this is done, subject to the plan being deemed appropriate by TPR. For example, companies can choose to clear deficits more quickly than required by TPR and some additional flexibility may be afforded to companies in a more vulnerable financial position.

[15] This interpretation is not universally accepted, see Abel and Eberly (1999, 2011) and Kaplan and Zingales (1997, 2001), but it is central to our argument that cashflow affects expenditure decisions of firms and pension deficits can be interpreted as negative cashflow.

interest payments), *br*, proposed by Nickell and Nicolitsas (1999) to ensure that we allow for other financial pressures faced by the firm, we include year and sector dummies to capture common year and industry effects, and a constant. Further details on these variable definitions are provided in the Appendix.

The variable of interest is the pension deficit, $\frac{Deficit_{it}}{TA_{it-1}}$, which in common with other variables is scaled by the firms' lagged total assets. The deficit is included in some specifications as a single continuous variable, but in other specifications we introduce separate dummy variables for where the deficit lies between 0-5%, 5-20% and >20% of total assets respectively to allow for the possibility that the relationship between deficits and investment might be non-linear. We also estimate specifications using predicted rather than actual deficits to examine whether the potential endogenity of deficits might be affecting our results. After estimating equations including pension deficits, we then replace the deficit variable with deficit recovery contributions (again scaled by assets and using both actual and predicted data) to examine how the contributions that companies are required to pay affect investment.

The cash holding equation is very similar:

$$\frac{C_{it}}{TA_{it}} = \alpha^C + \sum_{j=1}^{2} \beta_{1j}^C \frac{C_{it-j}}{TA_{it-j}} + \beta_3^C Q_{it} + \beta_4^C \frac{WC_{it}}{TA_{it}} + \beta_5^C \frac{CF_{it}}{TA_{it}} + \beta_6^C \frac{Deficit_{it}}{TA_{it}}$$

$$+ \beta_7^C \frac{I_{it}}{TA_{it}} + \beta_8^C \frac{DIV_{it}}{TA_{it}} + \beta_9^C \frac{TD_{it}}{TA_{it}}_{it} + \sum_{t=t_0}^{T} \theta^{C'}{}_t \,.\, t + \mu^C{}_i + \omega_{it} \tag{4}$$

where $\frac{C_{it}}{TA_{it}}$ is the ratio of cash to total assets, *WC* is working capital, *TD* is total debt. Chen et al (2017) suggest that borrowing, which would be reflected by an increase in total debt relative to total assets, was likely to be stockpiled as cash (especially before the financial crisis) reflecting the pervasive shift towards higher saving in the corporate sector. All other variables are defined as before. Our expectation is that higher deficits will prompt greater precautionary saving by firms (Opler,1999) and increase the option value of holding more cash when external finance is constrained (Denis and Sibilkov, 2010). Therefore we expect higher deficits to promote cash holding. Due to the sensitivity of cash balances to cashflow, (see Almeida et al., 2004; Faulkender and Wang, 2006) firms that are more constrained (proxied here by cashflow) should hold more cash.

We model corporate decisions over investment and cash holdings (and wage growth) using the GMM-System estimator. This approach is widely used in analysis of corporate decisions and can deal with both fixed effects and lagged dependent variable bias (c.f. Blundell and Bond (1998)). For consistency, the GMM-System estimator requires there to be evidence of significant negative first-order serial correlation and no evidence of second-order serial correlation in the first-differenced residuals. Both of these assumptions are testable, and relevant test statistics are reported along with the Sargan test for over-identifying restrictions. All specifications that we report pass these tests.

The dividend payout equation follows a similar specification based on previous work by Bunn and Trivedi (2005), Benito and Young (2007) and Liu and Tonks (2013) in the UK. The specification for the dividend payouts by firms is given by:

$$\frac{DIV_{it}}{S_{it}} = \alpha^D + \ +\beta_2^D \Delta S_{it} + \beta_3^D \frac{CF_{it}}{S_{it}} + \beta_4^D cgr_{it-1} + \beta_5^D br_{it-1} + \ \beta_6^D \frac{Deficit_{it}}{S_{it}} + \ \sum_{t=t_0}^{T} \theta^{D\prime}{}_t \, . \, t + \mu^D{}_i + \varphi_{it} \quad (5)$$

Where variables are defined as in equation (3) but scaled by sales rather than lagged total assets. Coefficients with a superscript D are estimated using random effects Tobit methods. Chen et al. (2017) suggest that dividend payments have historically been "sticky", and less responsive to earnings of the firm than other expenditure variables.[16]

Once again the variable of interest is the deficit, $\frac{Deficit_{it}}{S_{it}}$, which in common with other variables is scaled by the firms' sales. Again, we estimate specifications using both actual and predicted deficits and we estimate similar specifications using recovery contributions in place of deficits.

For dividends we estimate a random effects Tobit models that take account of the censoring of dividends around zero and the panel structure of the data. Around 15% of the companies in our dataset did not pay a dividend. However we also cross-check our results using the GMM System estimator, which can better deal with potential endogeneity of the lagged dependent variable, but which ignores the censoring issue.

4. Results

This section summarises the results of our econometric analysis. Section 4.1 presents the results that are relevant to our identification scheme of (i) predicting deficits based on the interactions with lagged deficits and macroeconomic variables and (ii) predicting recovery contributions based on the average relationship of those predicted deficits and actual recovery contributions. Section 4.2 contains the main results showing how pension deficits affect companies' expenditure decisions, followed by Section 4.3 where we document how the nature of recovery plans affects these decisions. This section focusses on our econometric results but the main results are also evident in the descriptive data too: these are summarised in Charts 4A to 8A of the Appendix.

4.1 Predicting pension deficits and recovery contributions

As discussed in Section 2.2 we use two identifications schemes. The first is that lower long term interest rates will have increased the size of pension deficits for schemes that were already in deficit before rates fell. In Table 1 we estimate equation (1) and examine whether deficits from 2007/08 to 2014/15 can be predicted by the deficit in 2006/07 and the interaction of the deficit in 2006/07 subsequent changes in UK Gilt yields. Column 1 reports the results for all firms, including those that were not in deficit, while column 2 reports results only for companies with a deficit. There is no clear relationship when considering all firms, but the results in column 2 show the expected relationship, consistent with the theoretical prediction that lower long-term interest rates only raise deficits for those already in deficit.

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[16] In Chen et al (2017) Fig 3 p10, every dollar increase in gross operating surplus increases cash by 0.74 cents (scaling both variables by gross value added), while dividends do not show any statistically significant response to a dollar increase in gross operating surplus.

The positive and significant coefficient on the deficit in 2006/07 in explaining future deficits in the regressions in Table 1 shows that deficits are persistent, and the negative and significant coefficient on the interaction term shows that a change in Gilt yields leads to a greater deficit for those schemes that had larger deficits in 2006/07. The coefficient on the 2006/07 deficit/Gilt yields interaction in column 2 implies that a one percentage point fall in Gilt yields since 2006/07 increases the deficit by approximately the same amount as the original 2006/07 deficit (i.e. the coefficient on that interaction is close to one).

Pension deficits depend on movements in equity prices as well as long-term interest rates, although these would only affect the asset side of the balance sheet, whereas long-term interest rates potentially affect both assets and liabilities. Column 3 of Table 1 shows that an interaction between starting asset values and changes in equity prices since 2006/07 has a negative and statistically significant effect on future deficits too, implying that lower asset prices raise deficits, all else equal. This adds a modest amount of explanatory power to the equation, raising the R^2 from 0.82 to 0.85. Overall, the relatively high R^2 demonstrates how we are able to explain a large amount of the variation in pension deficits with this relatively simple approach.

Lower UK long-term interest rates are likely to reflect both global and domestic factors. Column 4 of Table 1 demonstrates how both of these factors have raised pension deficits. We use the size of the Bank of England's asset purchase programme as a proxy for domestic factors, given that it is likely to have been one of the most important domestic influences that lowered long term yields. Global factors are assumed to be captured by developments in world interest rates.[17] When we construct interactions between the starting deficit and world interest rates and QE purchases as separate variables we find that both have statistically significant effects in the regression shown in column 4. The results show that the larger the asset purchase programme (implying lower Gilt yields) and the larger the starting deficit, the larger is the predicted deficit. In most years after the asset purchase programme had begun, the implied contribution to increased deficits from asset purchases is larger than that from lower world interest rates. Whilst some of it is likely to be – the objective of QE was to stimulate the economy by lowering long-term interest rates, encouraging investors to rebalance their portfolios and raising the prices of other assets – the MPC's decision to add additional monetary stimulus to the economy was correlated with a deterioration in short to medium term UK growth prospects, which itself would have been likely to put downward pressure on Gilt yields, and some of that effect will also be picked up by the QE term. In practice there will also have been other domestic factors affecting Gilt yields aside from QE, such as conventional monetary policy and changes in views around the long-term growth prospects of the UK economy, which we do not capture in our model.

The second identification scheme refers to the fact that pension schemes are obliged to agree a recovery plan with TPR to close deficits that exist after an actuarial valuation. Although companies have a legal obligation to address deficits in pension schemes that they sponsor, the precise link between a deficit and the exact format of a recovery plan is not mechanical and there is at least the potential for different types of companies to negotiate differently structured plans. We therefore use the fitted relationship between DRCs and predicted deficits to estimate predicted recovery contributions. Those predicted recovery contributions are based only on the 2006/07 deficit and

[17] This series is defined in footnote 12.

changes in Gilt yields, which should remove any possibility that the format of a recovery plan for a given deficit is in any way related to individual decisions about spending made by firms.

Column 5 of Table 1 reports the regression for predicted recovery contributions from equation (2) interacted with year dummies to allow for any possible change in the way deficit plans have been formulated as deficits have increased, and indeed the coefficients on the predicted deficits are always statistically significantly different from zero in each year. This approach can explain just over 70% of the variation in recovery contributions.

Overall, our two identification strategies are able to predict a large proportion of the variation in both deficits and recovery contributions. As a result it does not make a big difference whether we use the actual deficit/DRC measure or a prediction based on pre-determined deficits in 2006/07 and changes in Gilts yields. This implies there is little endogeneity in either the size of deficits or the structure of recovery plans that could potentially limit the analysis below. We now turn to the estimates of dividend payout and investment equations and their relationships with deficits and deficit recovery contributions.

4.2 Pension deficits and company behaviour

4.2.1 Results

Table 2 reports results from random effects Tobit equations for dividends as a percentage of sales estimated between 2005/06 to 2014/15. These econometric results show that higher pension deficits are associated with paying lower dividends. We would expect deficits to be treated as 'negative' cashflow (Liu and Tonks, 2013), which according to the trade-off and pecking order theories of finance should reduce dividend payouts. In the equation in column 1 the coefficient on pension deficits is negative and statistical significantly different from zero at the 1% level. Column 2 reports an alternative specification which relaxes the assumption used in column 1 that each extra pound of deficit leads to the same reduction in dividends and instead includes a set of dummy variables for having different sized deficits (where the reference group is being in surplus). In equation 2, the groups with larger deficits pay lower dividends, all else equal, and the effects are relatively linear.

The finding that higher pension deficits lead to lower dividends is robust to using predicted deficits in place of actual deficits. Column 4 shows that the coefficient on predicted deficits is again negative and significantly different from zero, although the coefficient is slightly bigger than that from column 1 using actual deficits.[18] The broadly similar results from the two approaches imply that endogeneity is not an important factor in explaining the relationship between dividends and pension deficits.

The coefficients from a Tobit model do not have a direct interpretation, but marginal effects for both the probability of paying a dividend and the marginal effects on dividends conditional on paying a dividend can both be calculated.[19] These are also reported in Table 2. Using the equation in column 1, each extra pound of pension deficit is estimated to lead to a 1.8 pence reduction in dividends, all else equal.[20] This effect rises to 2.2 pence using predicted deficits in column 4. The

[18] The results are also similar if predicted changes in deficits since 2006/07 are used rather than the predicted total deficit. See Table 4A in the appendix for more details.
[19] Only around 15% of companies with a DB scheme do not pay a dividend and so we focus more on the marginal effects on dividends conditional on paying a dividend.
[20] The coefficients can be interpreted in this way because both dividends and pension deficits are scaled by sales in the equations.

marginal effects from column 2, using a set of dummy variables for having deficits of different sizes, imply that a firm with a deficit of 5-20% of sales pays lower dividends equivalent to 0.27% of sales compared to a similar company with a scheme in surplus. That effect rises to 0.56% of sales if the deficit were in excess of 20% of sales.

The effects of pension deficits on dividends are estimated to be larger for companies that are more financially constrained (defined as those in the upper quartile of the distribution of the Nickell-Nicolitsas borrowing ratio) with the rest assumed to be less constrained.[21] The results in column 3 of Table 2 show how the more constrained firms are estimated to reduce dividends by 2.8 pence for each extra pound of deficit compared to 0.9 pence for the less constrained. Both effects are statistically significant, and they are significantly different from each other. The fact that the magnitude is three times larger for constrained firms shows that growing deficits are likely to affect firms with fewer external borrowing opportunities much more than firms with greater financial flexibility.

A similar analysis of the way that pension deficits affect spending can be conducted for investment. Table 3 reports the results with these equations being estimated using the GMM system estimator. The point estimates for actual pension deficits and predicted deficits in columns 1 and 3 are both negative, but only the predicted deficit has a statistically significant coefficient. Column 2 reports an alternative specification which relaxes the assumption used in column 1 that each extra pound of deficit leads to the same reduction in investment and instead includes a set of dummy variables for having different sized deficits (where the reference group is being in surplus). But like in column 1, the results are not statistically significant. This gets to the heart of the issue, since closure of growing DB pension deficits appears have less importance for firms than investing in capital equipment so long as the decision is *voluntarily made* by the firm and not imposed by the regulator.

Overall, the results suggest that the existence of a DB pension deficit in itself was not enough to lower investment spending by firms, even though it was enough to reduce the dividend payouts offered by those firms by around 2 pence in the pound.[22] Deficits themselves do not compel firms to divert funds towards reducing pension liabilities, and in order to investigate what happens when companies are *required by law* to start making recovery contributions we will use DRC data in section 4.3 to shed more light on company behaviour.

4.2.2 Robustness

The negative relationship between dividend payments and pension deficits is found to be robust to a number of different measures of pension deficits and to using different estimators. In the above analysis we focus on the TP measure of deficits in relation to the size of the company, which is the measure that companies have to respond to when formulating their recovery plans. But we also estimate statistically significant effects on dividends if we use the S75 definition of deficits instead (the measure that would be needed to sell out to an insurance company), the FRS17/IAS19 metric (the measure reported in company accounts), the deficit at the last actuarial valuation (rather than the current market value on a TP basis), or the TP funding ratio. The results are also robust to

[21] Profits are measured before deficit recovery contributions are paid in calculating the borrowing ratio. The more constrained group includes companies spending more than about a third of profits on interest and those making a loss. This is likely to be a good indicator of whether firms have funds available to spend on unexpected expenditures. Constrained firms are likely to have lower profits, higher debt levels or higher interest rates, which should all be positively correlated with perceived credit risk.

[22] We also included deficit variables in equations for wages and cash stocks, but did not find significant effects using either actual or predicted deficits. These results are reported in Tables 6 and 5A (the latter is in the appendix).

using the GMM system rather random effect Tobit estimator, which ignores the censoring issue but may be better placed to deal with possible endogeneity of the lagged dependent variable, and to estimating a probit model for the probability of paying a dividend. All of these additional results are reported in Table 4A of the Appendix.

4.3 Recovery plans and company behaviour

Companies that have a pension deficit are not obliged to immediately divert funds towards reducing pension liabilities just because they are in deficit. But after a triennial valuation a firm with a deficit is obliged put a recovery plan in place and start making recovery contributions to close that deficit, and this compulsory obligation is enforced by The Pensions Regulator. In this respect DRCs might be expected to have a different effect on corporate behaviour to deficits, but previous studies in the UK have not had access to TPR data to be able to accurately evaluate this distinction. DRCs are not readily discernible from company accounts where the data simply show the pension contributions in total, whether for DB or defined contribution schemes, and voluntarily or to meet legal obligations. In this respect our analysis of the effects of recovery plans using TPR data on firms spending takes the literature into new territory.

But the level of DRCs is not the only consideration. Companies with large pension deficits can have a recovery plan that commits them to either large recovery contributions made over a relatively short period of time or to smaller recovery contributions over a longer period. As already noted TPR must take into account pension scheme and employer circumstances. The trustees of pension funds in deficit may negotiate a longer or a shorter recovery period, but in all cases TPR must be convinced that the pension scheme will be brought back to a sustainable position. This suggests that the recovery plan length is also likely to be a material consideration in evaluating the effects of a recovery plan. We have data on recovery plan lengths from TPR and can include this data in our analysis below.

4.3.1. Results

Our analysis shows that both higher current DRCs *and* having a longer recovery plan are associated with paying lower dividends. The results are reported in Table 4.[23] The coefficient on deficit recovery contributions in column 1 is negative and statistically different from zero, which shows that DRCs in themselves reduce dividend payouts. As was the case with deficits, the effects of paying DRCs on dividends are larger for more financially constrained companies (column 2) compared to less constrained firms. Furthermore, when the recovery plan length is included as an additional explanatory variable alongside DRCs in column 3 both coefficients are negative and significant. The coefficient on recovery contributions retains its significance at the 10% level, and the coefficient on recovery plan length is negative and significant at 1%. The marginal effects show that, conditional on paying a dividend, companies reduce dividends by 9 pence for each extra pound of recovery contribution and that each extra year on the length of a recovery plan reduces dividends by a further 0.03% of sales.

Whilst deficits and DRCs are correlated, they are not perfectly correlated, for example because recovery plans are typically only updated every three years whilst deficits will reflect more recent asset price developments. Deficits may add some explanatory power over and above DRCs, and to

[23] These equations are estimated over a shorter time period than the deficit equations (2010/11 to 2014/15 rather than from 2005/06) because recovery contribution data were not collected by TPR in those earlier years.

investigate this possibility we modify our specification is to include the deficit and current DRC in one regression in column 4 of Table 4. Both have a negative effect, although the coefficients on both variables are only significant at 10% level, perhaps reflecting the correlation between the two. This implies that there is evidence that companies voluntarily pay lower dividends over and above the effects of the current mandatory DRCs when they have large deficits. This may reduce the potential for higher mandatory DRC payments in the future when the recovery plan is reviewed. Behaviourally, firms may prefer to have an element of control by front-loading adjustments to dividends to help cover future recovery contributions and give themselves some insurance against any future deterioration in the funding position of their pension scheme.

Predicted recovery contributions are also estimated to have a significant negative effect on dividends (column 5 of Table 4) and the effects are noticeably larger than implied by the equations using actual recovery contributions. Using the model from column 5, each extra pound of predicted recovery contributions is estimated to reduce dividends by 32 pence for those paying a dividend.[24]

Turning to investment, we find a distinct difference between the results for deficits reported in Table 3 and results for deficit recovery contributions in Table 5. The deficits have a negative coefficient that is not significant but the coefficient on current recovery contributions is negative and strongly significant. A higher level of DRCs lowers investment for the firm. The main difference between deficits and deficit recovery contributions, as we have already discussed, is that the DRCs are *compulsory payments* that the firm must honour, while deficits only create an incentive for a firm to *voluntarily* close a funding shortfall, but not a requirement to do so. In column 1 of Table 5 we observe that the coefficient on the current recovery contributions variable is significant at the 5% level; it implies that each extra pound of DRCs reduces investment by 27 pence. When we add recovery plan length (column 2) the coefficient on that variable is close to zero and there is little change in the other coefficient estimates. If deficits are included in the regression alongside DRCs, deficits do not have significant effects and the coefficient is positive, but the size of the coefficient on DRCs increases a little (column 3 of Table 5). Predicted recovery contributions are associated with lower investment as well as actual contributions. In column 5 of Table 5 the coefficient on predicted recovery contributions is negative and significantly different from zero at the 5% level, implying DRCs reduce investment by about 33 pence in the pound, slightly larger than the estimate of 27 pence using actual recovery contributions. The conclusion that higher DRCs are associated with lower investment is robust to using actual and predicted deficits, implying that endogeneity is not likely to a key factor in explaining this relationship.

If firms operated in a world of perfect information with no information asymmetries then external funding could be used to support viable investment projects, but in world of asymmetric information this is not possible. Rather, following Fazzari et al. (1988, 2000) and Rauh (2006) we might expect firms with greater financial constraints to be more negatively influenced by larger DRCs than firms with fewer financial constraints.[25] In Table 5 we explore this assumption by again partitioning firms into more and less financial constrained groups based on their position in the borrowing ratio distribution.

[24] Note that it is not possible to include both predicted recovery contributions and predicted deficits because the predicted DRCs are just a simple function of the predicted deficit, and so the larger effect of predicted DRCs in column 5 is likely to picking up both the recovery contribution and deficits effects from the earlier equations.

[25] More financially constrained companies are likely to have fewer other ways in which to adjust to any increase in recovery contributions and so may have no other options but to cut back on investment. A larger effect is also consistent with the broader literature, going back to Fazzari et al (1988), which suggests that financially constrained companies often behave differently to less constrained firms.

We find that the effects of recovery contributions on investment are estimated to be much larger for companies that are more financially constrained (quartile with the highest borrowing ratios) than those that have few financial constraints (the remainder). Column 4 of Table 5 shows that financially constrained firms are estimated to reduce investment by 44 pence for each pound of DRC, although that coefficient is only significant at the 10% level. The effects for financially constrained firms are also larger using predicted DRCs (column 6 of Table 5).

4.4 Other relationships

We also investigated whether there was a link between recovery contributions and cash holdings. Almeida et al (2004) argue that the cashflow sensitivity of cash may be a better indicator of financial constraints, and Opler (1999) and Denis and Sibilkov (2010) propose that there are precautionary savings arguments and a higher option value of holding more cash when external finance is constrained. Firms that faced higher deficits or were required to paid higher recovery contributions might hold more cash in anticipation of future payments they have to make. We report results in Table 6.

In equations with the *level* of the stock of cash over total assets as the dependent variable, the coefficients on pension deficits and DRCs are positive but the coefficient on deficits is not statistically significant (column 1) whilst the coefficient on DRCs is only significant at the 10% level (column 2). When we explore the effects on the *change* in cash stocks in relation to DRCs we find a negative and significant relationship (column 3) that suggests that companies face a budget constraint that binds them to reduce cash on the balance sheet, at least in the short term. The coefficient implies that companies reduce cash stocks by 35 pence for each pound of DRC paid. The finding that the *level* of cash balances is, if anything, higher for firms who have to make higher DRCs despite the *change* being negative implies that companies are likely to be building up funds in advance of having to make those payments.

The results around changes in cash stocks are again very different for more and less financially constrained companies. The effect of paying DRCs on changes cash stocks is negative and significant for the less constrained firms at 45 pence for every pound of DRC, but there is no effect for the more constrained firms. The more financially constrained companies are likely to have less cash in the first place, they pay larger proportions of their profit to cover debt repayments and use cashflow to cover immediate and necessary expenditure. These firms may have little scope to make cuts to already meagre cash holdings. That can help to explain why these more constrained firms make larger cuts to their dividends and investment. Less financially constrained firms should have more cash and are likely to be able to cut liquid assets if necessary, which is what our results show.

Finally, we also considered whether there was a relationship between recovery contributions and wages. The coefficient on actual recovery contributions in our wage regression was negative but was not statistically significant (see Table 5A in the appendix for details). Given the relatively small sample and fact that our analysis uses average wage per employee, which for some companies in our sample may include a substantial overseas workforce, it may be more difficult to uncover a small effect on wages. This is underlined by the fact that Bell and Whittaker (2017) did find a small but statistically significant link between wages and deficit recovery contributions using potentially better quality data on wages at the worker level from the ASHE dataset.[26]

5. QE and the macroeconomic implications of large deficits

In order to assess the importance for the macroeconomy of the effects of lower dividends and investment associated with defined benefits pensions we consider their effect on GDP. To do this we take our regression models for dividends and investment and estimate (in £billion) how much higher dividends/investment would have been within the estimation sample if deficits/recovery contributions were zero in all years.[27] We then scale these effects up to get economy wide effects on dividends and investment by assuming that companies outside of the estimation sample with pension deficits behave in a similar way to those who are in it..[28]

The results from Section 4 underscore the reality that by addressing pension deficits UK firms have needed to make material reductions in dividends and investment spending. The magnitudes of these effects reported there imply that total dividends paid by UK companies have been on average 3% lower per year since 2009 because pension deficits have increased (Chart 8 shows the year by year effects). Over the same period the level of business investment is estimated using our findings in Section 4 to have been around 2.5% lower in aggregate (Chart 8). Considering the effects (in £billion) and looking only at changes since 2006/07 (the period over which deficits have opened up), lower dividends due to pension deficits account for around three quarters of the up to £7.5 billion a year estimated reduction in companies' expenditure on account of pensions (Chart 9).[29]

Despite these large figures, the effects of lower spending on dividends and investment on account of pension deficits is only likely to have had small effect on GDP. Considering the expenditure measure of GDP, investment feeds through one-for-one into GDP, but dividends will necessarily have a much smaller effect on household consumption. First, more than half of the shares in UK companies are owned abroad: in 2014, only 12% were held by private individuals.[30] Second, the marginal propensity to consume out of dividend income is likely to be less than one: we use an estimate of 0.4.[31] Therefore, taking these two points together, only 5% of the dividends paid by UK companies paid end up in household consumption. Taken together the dividend and investment effects associated with rising DB pension deficits would have reduced the level of GDP by around 0.1% relative to 2006/07, with most of that effect accounted for by investment (Chart 10).[32] The fact that this figure is so small is due to the low ownership of UK company shares by UK households and the propensity to consume out of dividend income.[33, 34]

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[26] Bell and Whittaker (2017) estimate that a one pound increase in recovery contributions lowers wages by around 10 pence. The comparable figures from our work are 12 to 16 pence (see columns 2 and 3 of Table 5A in the appendix), although as discussed above, these are not statistically different from zero.

[27] This is based on the dividend equations in column 2 of Table 2 (each pound of deficit lowers dividends by 1.8 pence in the pound), and the investment equation in column 1 of Table 5 (each pound of DRC lowers investment by 27 pence).

[28] Companies in the sample that we use in our econometric analysis account for around a quarter of the economy wide pension deficit and total deficit recovery contributions made. We therefore scale up the £billion estimates for the effects on dividends and investment for our sample by a factors of approximately 4 to get aggregate level numbers.

[29] £7 billion a year accounts for about 3.5% of the £200 billion deficit that has opened up since 2006/07.

[30] Share ownership data are taken from the ONS Ownership of UK quoted shares release.

[31] 0.4 is around the middle of the range of estimates for the pre-tax marginal propensity to consume out of dividend income produced Baker et al (2007).

[32] We do not consider any effects via wages in this exercise. If did we assume that companies reduced wages by 10p for each extra pound of recovery contributions paid, consistent with estimates form Bell and Whittaker (2017) and close to our statistically insignificant estimates, and that 90% of that lower wage income was passed through into lower household spending, then the effects through this channel would only be around one-third of the size of our investment effects. Therefore, this would not change the conclusion that the effects on the macroeconomy are small.

[33] The exercise discussed above considers the direct effects of companies with pension deficits/paying recovery contributions changing their dividends and investment. We acknowledge that in practice there would also have been other more general equilibrium effects e.g. accelerator effects that

Relative to the estimated benefits of QE, the adverse effects for GDP via pension funds appear to have been relatively small. The initial £200bn of QE that took place in 2009 is estimated to have had a peak impact on the level of GDP of 1½-3% (Kapetanios et al, 2012; and Weale and Wieladek, 2016), and the total effect on GDP from all waves of QE is likely to have been larger than that.[35] Those effects are much larger than the estimated negative effects from pension deficits of just 0.1% of GDP, and only a portion of that pensions effect can be attributed to QE given that substantial deficits had already opened up before QE began and world interest rates and other domestic factors are likely to have had a negative effect on deficits apart from the effects of QE.[36] We therefore conclude that the effects of pension deficits do not materially alter the calculation of the net benefits of QE to GDP.

6. Conclusions

Since 2007 pension deficits have been growing in many countries as low interest rates have increase pension liabilities. A number of the 6000 DB pension schemes in the UK have experienced large and growing deficits, and in aggregate the DB deficit is estimated to have increased to around £300 billion by 2015, or more than 15% of annual GDP. At the same time that deficits have risen, investment has been subdued. This is a common experience in a number of OECD countries. Using privileged access to TPR microdata, and two novel identification schemes, we investigate how deficits and deficit recovery contributions have affected the expenditure decisions of UK companies.

First, we verify that the widening of pension deficits and the deficit recovery contributions that companies have had to make to close those deficits have been largely exogenous to individual companies. Firms whose pension schemes were already in deficit experienced shocks to their internal finances as, firstly, lower long term interest rates increased the size of pension deficits for schemes that were already in deficit, and then secondly, TPR placed them under a legal obligation to put a plan in place to close deficits.

Second, while firms with larger pension deficits had an incentive but not an obligation to act in response to these deficits they paid lower dividends on average, but they did not invest less. We are able to isolate the effects of *mandatory contributions* and *recovery plan lengths* using data that was not available to previous authors. We show that *obligations* under recovery plans agreed with TPR

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would further reduce investment and employment by companies with second round effects on GDP. According to Bernanke et al (1999) comparisons of a model with and without an accelerator mechanism under a variety of different shocks raises the output effect by about 50%. But acting against that, the additional DRCs that companies contributed to their pension schemes would have been invested in other financial assets, raising asset prices and lowering financing costs for companies without deficits, and supporting investment. Quantifying these additional general equilibrium effects or even the direction of the net effects has not been attempted. But given that we estimate the direct effects to be worth no more than 0.1% off GDP since 2006/07, these indirect channels would make little difference to our overall conclusion that the macroeconomic effects of pension deficits have been small.

[34] Another important reason why the effects on investment and GDP have not been larger is because the increase in deficit recovery contributions since 2007 (which were shown on Chart 5) has been much more modest than the increase in pension deficits (Chart 1). That is partly because TPR have allowed companies to extend the length of their recovery plans as deficits have increased (as shown in Chart 7).

[35] Although the total size of the asset purchase programme had risen to £375 billion by the end of our sample period, the peak GDP effects cannot be directly scaled up from the total size of the asset purchase programme. The effects of QE may not be constant across time and the GDP effects from the first wave will have begun to diminish from their peak by the time that later waves were launched.

[36] Combining the results from equation 2 of Table 1 in this paper with the estimate that the first £200 billion of QE depressed Gilt yields by around 100 basis points from Joyce et al (2011, 2012) and Joyce and Tong (2012) would suggest that the first phase of QE may have accounted for around a fifth of the increase in the aggregate deficit on DB pension funds and therefore a fifth of the estimated GDP effect. By 2012/13, Gilt yields were around 300 basis points lower than in 2006/07. To the extent it can be used to explain the aggregate deficit, Equation 2 of Table 1 predicts the change in the aggregate deficit in 2012/13 as approximately 2 times the starting deficit in 2006/07 of those in deficit (3 times for the level of the deficit rather than the change) plus 3 times the starting deficit again (x1 for each 100 basis point fall in Gilt yields). A 100 basis point fall in Gilt yields from the first £200 billion of QE is therefore a fifth of the change in the aggregate deficit. The total QE effect may also have been larger, although as with scaling up estimates of the macro effects of QE, that will have been dependent on the extent to which effects from the first wave of QE had diminished when later waves were launched.

prompted firms to adopt a different pattern of behaviour compared to their more *voluntary* responses to deficits. Firms making contributions to close those deficits did reduce investment and dividend payments on average. These effects were greater for firms that were financially constrained, reflecting the more limited options available to them to use external or other internal funds to smooth out their expenditures. The scale of these effects was large for many FTSE 350 companies with DB deficits, and responses to them can explain some of the weakness in aggregate dividends and investment observed since 2007.

Third, while the effects for some firms were large, by contrast the effects at the aggregate level have been small in macroeconomic terms, and are dwarfed by the estimated positive impact of QE. QE is estimated to have boosted the level of GDP by in the region of 1½-3% (Kapetanios et al, 2012; and Weale and Wieladek, 2016), while the negative effects of deficits are only estimated to have reduced GDP by around 0.1% GDP since 2007.[37] Given that, and the fact that not all of the pension effects can be attributed to QE, the adverse effects for GDP of QE via pension funds are likely to have been small and they are unlikely to have substantially reduced the effectiveness of QE.

These findings suggest that the regulatory approach undertaken by The Pensions Regulator has balanced the need to close growing deficits with the aim of allowing businesses to continue operating in a sustainable way. They also show that unconventional monetary policies such as QE, which were implemented by the Bank of England, are likely to have had predominantly positive effects at the macroeconomic level even after taking account of the impacts on pension funds. It implies - for the UK and other countries in similar positions - that large DB pension deficits can have significant effects on investment and other expenditure decisions at the firm-level, but for the UK at least, the macroeconomic consequences have been relatively small.

[37] The effects on investment and GDP have been only been modest because DRCs (the only variable that we find matters for investment) have risen by much less than deficits as TPR has allowed the length of recovery plans to be extended.

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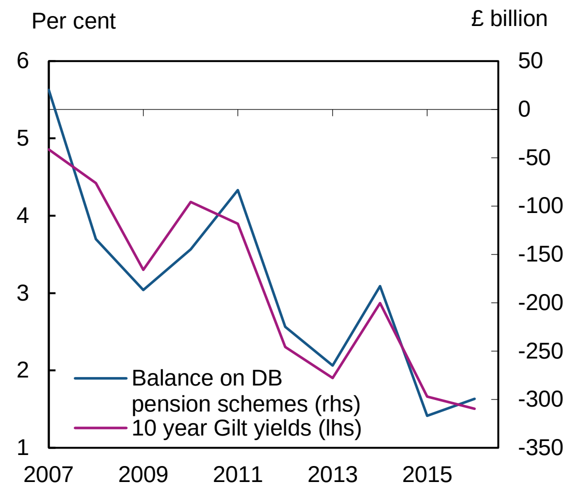
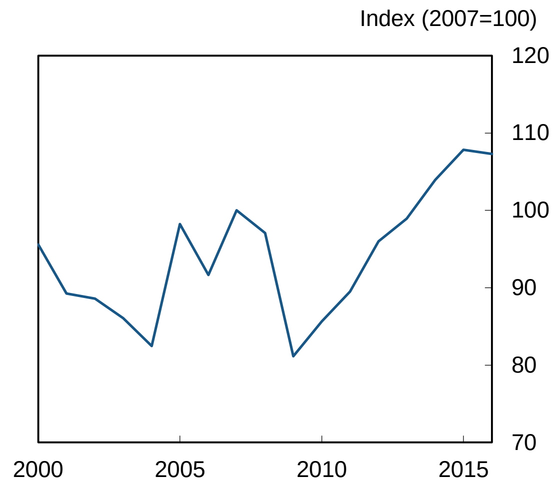
Charts and Tables

Chart 1: Balance on DB pension funds and Gilt yields[(a)]



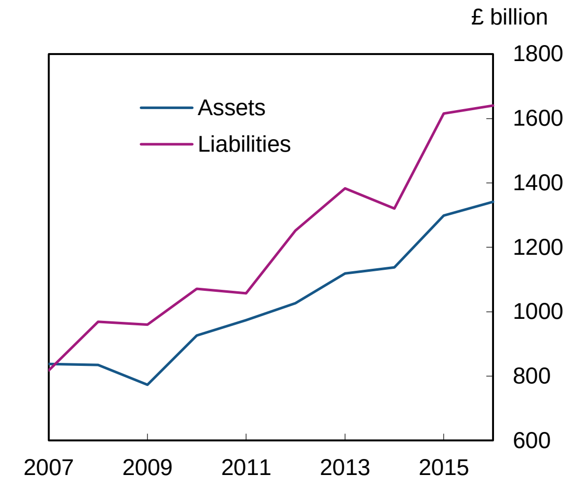
(a) All data are as of 31 March in each year. Liabilities are valued on a Technical Provisions basis.

Chart 2: Real business investment[(a)]



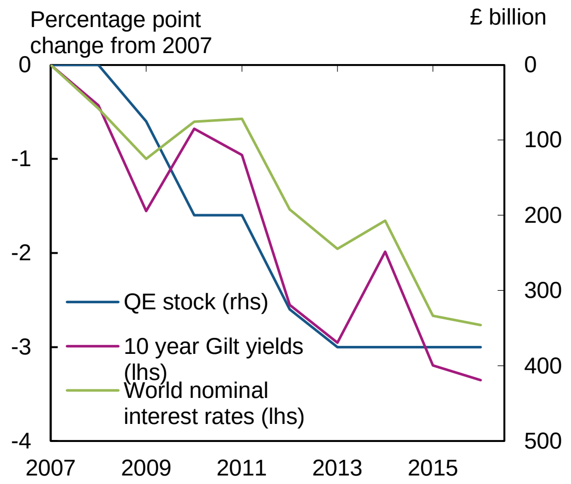
(a) National Accounts data. Chained volume measure.

Chart 3: Assets and liabilities of DB pension funds[(a)]



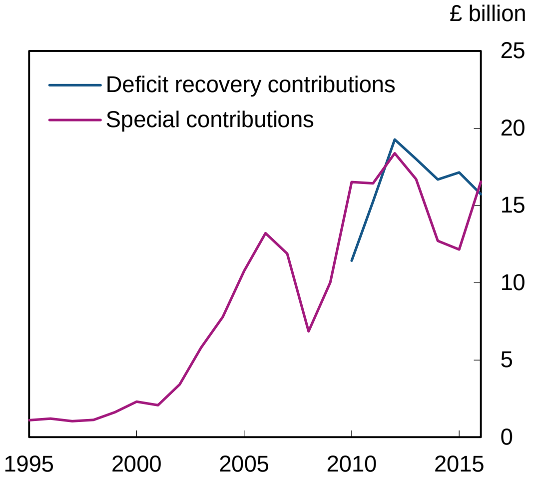
(a) All data are as of 31 March in each year. Liabilities are valued on a Technical Provisions basis.

Chart 4: Changes in long-term interest rates and QE[(a)]



(a) All data are as of 31 March in each year.

Chart 5: Aggregate deficit recovery contributions[(a)]



(a) Calendar year data. DRC data have only been collected by the Pensions Regulator since 2010. Special contributions are collected by the ONS in earlier years, and while they are not exactly equal to recovery contributions, they are likely to provide an approximation.

Chart 6: Persistence of pension deficits

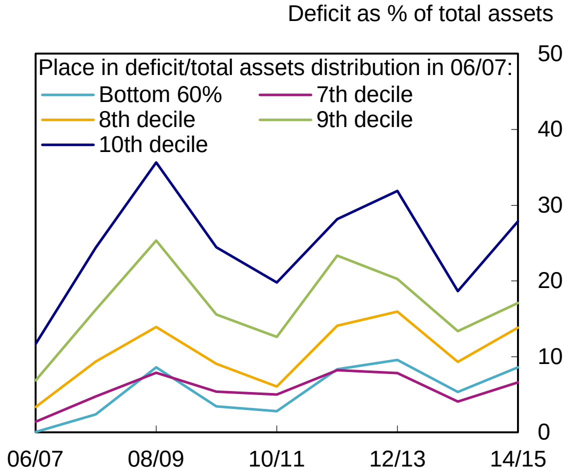
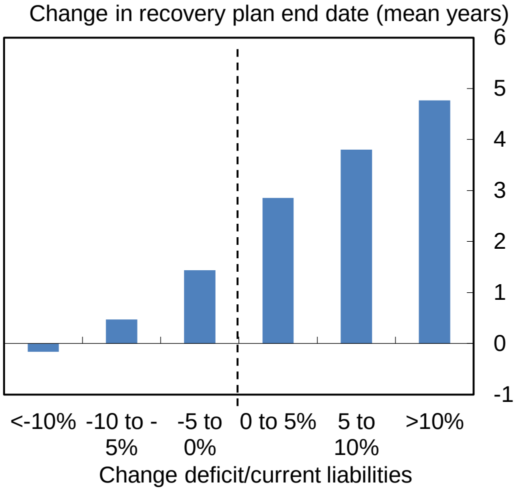


Chart 7: Changes in deficits and recovery plan lengths after triennial valuations[(a)]



(a) Estimated using data on all firms with DB pension schemes that underwent valuations between 2012 and 2014 (including non-listed and financial companies).

Chart 8: Effect of pensions on level of aggregate dividends and investment

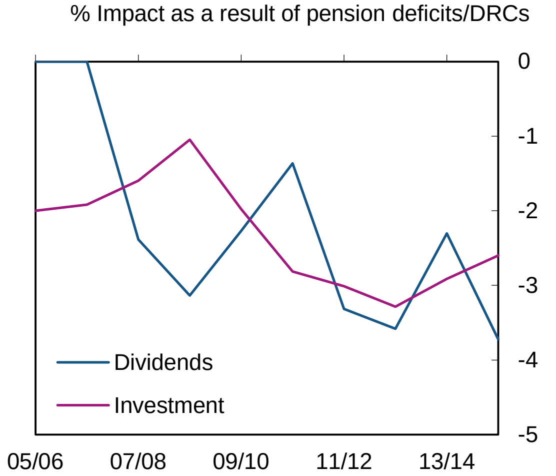


Chart 9: Effect of pensions on aggregate dividends and investment since 2006/07

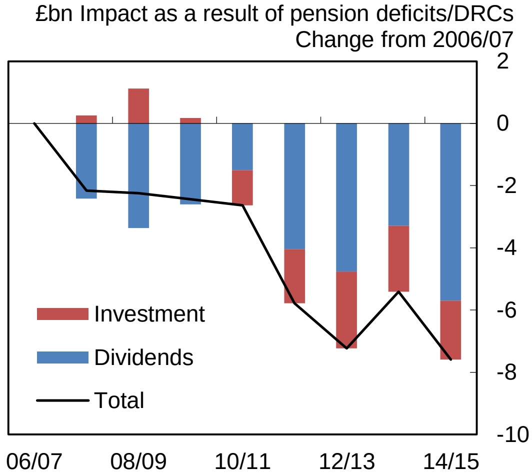


Chart 10: Estimated impact of pensions GDP since 2006/07

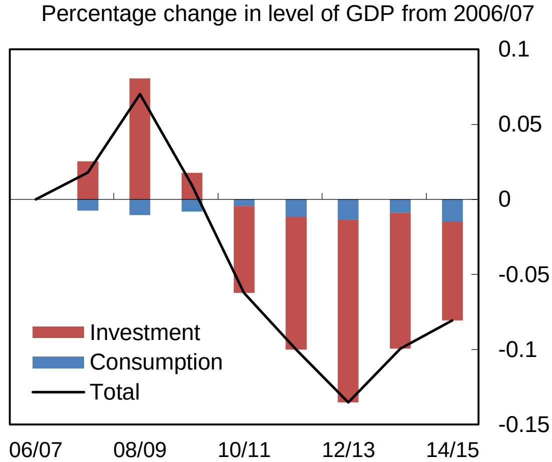


Table 1: Regressions to predict deficits and recovery contributions

Sample	All	In deficit in 06/07 only			
Dependent variable	Deficit	Deficit			DRC
Time period	07/08 to 14/15	07/08 to 14/15			10/11 to 14/15
	(1)	(2)	(3)	(4)	(5)
06/07 deficit	0.167**	2.958***	1.873***	1.430***	
	(0.084)	(0.136)	(0.142)	(0.154)	
06/07 deficit interacted with:					
Change in UK Gilt yields since 06/07 (pp)	0.226***	-0.950***	-1.320***		
	(0.041)	(0.072)	(0.069)		
Change in world interest rate since 06/07 (pp)				-0.689***	
				(0.149)	
QE stock (£bn)				0.008***	
				(0.001)	
06/07 asset value interacted with			-0.004***	-0.006***	
% change in equity prices since 2006/07			(0.000)	(0.000)	
Predicted deficit from (4) interacted with:					
2010/11 dummy					0.061***
					(0.005)
2011/12 dummy					0.054***
					(0.003)
2012/13 dummy					0.106***
					(0.004)
2013/14 dummy					0.059***
					(0.004)
2014/15 dummy					0.055***
					(0.004)
Observations	1,929	974	974	974	586
R-squared	0.032	0.818	0.853	0.860	0.720

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All equations are estimated by OLS.

Table 2: Dividends and pension deficit regressions

Sample	All firms with DB scheme (05/06 to 14/15)							In deficit in 06/07 (07/08 to 14/15)		
	(1)			(2)			(3)	(4)		
		Marginal effects			*Marginal effects*				*Marginal effects*	
		Pr(Div>0)	*E(Div/sales | Div>0)*		*Pr(Div>0)*	*E(Div/sales | Div>0)*			*Pr(Div>0)*	*E(Div/sales | Div>0)*
Cashflow(t)	0.117***			0.117***			0.123***	0.078***		
	(0.007)			(0.007)			(0.009)	(0.012)		
Capital gearing(t-1)	-0.018***			-0.017***			-0.018***	-0.034***		
	(0.003)			(0.003)			(0.003)	(0.005)		
Sales growth(t)	-0.023***			-0.023***			-0.022***	-0.018***		
	(0.002)			(0.002)			(0.002)	(0.004)		
Borrowing ratio(t)							0.002			
							(0.001)			
Pension variables:										
Deficit(t)	**-0.029*** **	*-0.003*** *	*-0.018*** *							
	(0.005)	*(0.001)*	*(0.003)*							
- if less financially constrained(t)							**-0.018*** **			
							(0.005)			
- if more financially constrained(t)							**-0.049*** **			
							(0.008)			
^Deficit 0-5% sales(t)				**-0.229** **	*-0.022** *	*-0.149** *				
				(0.097)	*(0.009)*	*(0.064)*				
^Deficit 5-20% sales(t)				**-0.414*** **	*-0.041*** *	*-0.266*** *				
				(0.118)	*(0.012)*	*(0.077)*				
^Deficit >20% sales(t)				**-0.905*** **	*-0.096*** *	*-0.555*** *				
				(0.167)	*(0.019)*	*(0.102)*				
Predicted deficit(t)								**-0.034*** **	*-0.003*** *	*-0.022*** *
								(0.009)	*(0.001)*	*(0.005)*
Observations	2,674			2,674			2,625	965		
Number of firms	319			319			316	130		

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
All equations estimated for firms with DB schemes using random effects tobit estimator and also include year dummies, industry dummies and a constant.
Dividends, cashflow and pension deficits are scaled by sales. A financially constrained firm is defined as being in the top borrowing ratio quartile in each year.
^ Dummy variable, reference category is companies with a pension scheme in surplus.

Table 3: Investment and pension deficit regressions

Sample	All firms with a DB scheme (05/06 to 14/15)		In deficit in 2006/07 (07/08 to 14/15)
	(1)	(2)	(3)
Investment(t -1)	0.190***	0.192***	0.190***
	(0.043)	(0.043)	(0.056)
Investment(t -2)	0.089***	0.089***	0.090**
	(0.027)	(0.027)	(0.037)
Sales growth(t)	0.030***	0.030***	0.013
	(0.007)	(0.007)	(0.013)
Q(t-1)	0.001	0.001	0.000
	(0.002)	(0.002)	(0.004)
Cashflow(t)	0.110***	0.109***	0.135***
	(0.022)	(0.022)	(0.031)
Capital gearing(t-1)	-0.012	-0.012*	0.012
	(0.008)	(0.007)	(0.015)
Borrowing ratio(t-1)	-0.005**	-0.004**	-0.007*
	(0.002)	(0.002)	(0.004)
Pension variables:			
Deficit(t)	**-0.002**		
	(0.009)		
^Deficit 0-5% assets(t)		**0.038**	
		(0.217)	
^Deficit 5-20% assets(t)		**-0.102**	
		(0.226)	
^Deficit >20% assets(t)		**-0.035**	
		(0.300)	
Predicted deficit(t)			**-0.024****
			(0.010)
AR(1)-p	0.000	0.000	0.000
AR(2)-p	0.100	0.103	0.540
Hansen-p	0.506	0.436	0.509
Observations	2,486	2,486	922
Number of firms	304	304	130

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
All equations estimated for firms with DB schemes using system GMM estimator and also include year dummies, industry dummies and a constant. Lagged investment and sales growth are treated as endogenous using instruments up to t-4.
Investment, cashflow and pension deficits are scaled by lagged total assets.
^ Dummy variable, reference category is companies with a pension scheme in surplus.

Table 4: Dividends and recovery plan regressions

Sample (10/11 to 14/15)	All firms with DB scheme								In deficit in 2006/07		
	(1)	(2)	(3)			(4)			(5)		
				Marginal effects Pr(Div>0)	Marginal effects E(Div/sales | Div>0)		Marginal effects Pr(Div>0)	Marginal effects E(Div/sales | Div>0)		Marginal effects Pr(Div>0)	Marginal effects E(Div/sales | Div>0)
Cashflow(t)	0.116***	0.117***	0.118***			0.117***			0.142***		
	(0.011)	(0.013)	(0.011)			(0.011)			(0.017)		
Capital gearing(t-1)	-0.019***	-0.019***	-0.018***			-0.019***			-0.027***		
	(0.004)	(0.005)	(0.004)			(0.004)			(0.006)		
Sales growth(t)	-0.024***	-0.023***	-0.023***			-0.025***			-0.026***		
	(0.004)	(0.004)	(0.004)			(0.004)			(0.006)		
Borrowing ratio(t)		0.001									
		(0.002)									
Pension variables:											
DRCs(t)	-0.204**		-0.144*	-0.015*	-0.090*	-0.160*	-0.016*	-0.100*			
	(0.085)		(0.085)	(0.009)	(0.053)	(0.088)	(0.009)	(0.055)			
- if less fin. constrained(t)		-0.175*									
		(0.091)									
- if more fin. constrained(t)		-0.322**									
		(0.137)									
Recovery plan length(t)			-0.047***	-0.005***	-0.029***						
			(0.016)	(0.002)	(0.010)						
Deficit(t)						-0.013*	-0.001*	-0.008*			
						(0.007)	(0.001)	(0.004)			
Predicted DRCs(t)									-0.488***	-0.049***	-0.317***
									(0.155)	(0.016)	(0.101)
Observations	1,347	1,328	1,305			1,345			581		
Number of firms	299	295	295			299			125		

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
All equations estimated for firms with DB schemes using random effects tobit estimator and also include year dummies, industry dummies and a constant.
Dividends, cashflow and recovery contributions are scaled by sales. A financially constrained firm is defined as being in the top borrowing ratio quartile in each year.

Table 5: Investment and recovery plan regressions

Sample (10/11 to 14/15)	All firms with a DB scheme				In deficit in 2006/07	
	(1)	(2)	(3)	(4)	(5)	(6)
Investment(t -1)	0.139*	0.122	0.145*	0.124	0.212**	0.210**
	(0.079)	(0.082)	(0.078)	(0.077)	(0.086)	(0.085)
Investment(t -2)	0.099**	0.085*	0.102**	0.091**	0.170**	0.170**
	(0.045)	(0.046)	(0.044)	(0.044)	(0.065)	(0.066)
Sales growth(t)	0.021*	0.020	0.020	0.019	0.003	0.004
	(0.012)	(0.012)	(0.012)	(0.012)	(0.017)	(0.017)
Q(t-1)	-0.001	-0.000	-0.000	-0.001	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Cashflow(t)	0.093***	0.094***	0.091***	0.091***	0.112***	0.098***
	(0.028)	(0.030)	(0.027)	(0.031)	(0.033)	(0.037)
Capital gearing(t-1)	0.003	0.005	0.003	0.003	0.002	0.002
	(0.008)	(0.008)	(0.008)	(0.008)	(0.012)	(0.012)
Borrowing ratio(t-1)	-0.005**	-0.005**	-0.005**	-0.005**	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Pension variables:						
DRCs(t)	**-0.272****	**-0.282****	**-0.365*****			
	(0.125)	**(0.132)**	**(0.129)**			
- if less financially constrained(t)				**-0.259***		
				(0.135)		
- if more financially constrained(t)				**-0.439***		
				(0.245)		
Recovery plan length(t)		**0.025**				
		(0.031)				
Deficit(t)			**0.015**			
			(0.010)			
Predicted DRCs(t)					**-0.334****	
					(0.163)	
- if less financially constrained(t)						**-0.272**
						(0.183)
- if more financially constrained(t)						**-0.555*****
						(0.185)
AR(1)-p	0.000	0.000	0.000	0.000	0.000	0.000
AR(2)-p	0.878	0.588	0.943	0.892	0.791	0.770
Hansen-p	0.727	0.820	0.710	0.726	0.898	0.876
Observations	1,229	1,194	1,227	1,222	551	549
Number of firms	281	280	281	278	123	122

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
All equations estimated for firms with DB schemes using system GMM estimator and also include year dummies, industry dummies and a constant. Lagged investment and sales growth are treated as endogenous using instruments up to t-4.
Investment, cashflow and recovery contributions are scaled by lagged total assets.
A financially constrained firm is defined as being in the top borrowing ratio quartile in each year.

Table 6: Cash stock regressions

Dependent variable	Cash/total assets		ΔCash/total assets	
	(1)	(2)	(3)	(4)
Cash(t -1)	0.507***	0.569***		
	(0.035)	(0.048)		
Cash(t -2)	0.087***	0.038		
	(0.031)	(0.041)		
ΔCash(t-1)			-0.072**	-0.071*
			(0.037)	(0.038)
Working capital(t)	-0.077***	-0.058***		
	(0.012)	(0.013)		
ΔWorking capital(t)			-0.280***	-0.278***
			(0.030)	(0.030)
Cashflow(t)	0.091***	0.097**	0.218***	0.226***
	(0.026)	(0.040)	(0.036)	(0.040)
Q(t)	-0.006**	-0.003		
	(0.003)	(0.003)		
Investment(t)	-0.264***	-0.264***	-0.324***	-0.321***
	(0.042)	(0.062)	(0.055)	(0.055)
Dividends(t)	0.028	-0.033	-0.406***	-0.405***
	(0.084)	(0.104)	(0.075)	(0.076)
Debt(t)	-0.050***	-0.050***		
	(0.013)	(0.015)		
ΔDebt(t)			0.102***	0.099***
			(0.026)	(0.027)
Borrowing ratio(t)				-0.001
				(0.004)
Pension variables:				
Deficit(t)	**0.009**			
	(0.013)			
DRCs(t)		**0.375***	**-0.348****	
		(0.203)	**(0.143)**	
- if less financially constrained(t)				**-0.452*****
				(0.163)
- if more financially constrained(t)				**0.067**
				(0.438)
AR(1)-p	0.000	0.000	0.000	0.000
AR(2)-p	0.347	0.962	0.796	0.731
Hansen-p	0.381	0.801	0.526	0.443
Observations	2,501	1,265	1,304	1,286
Number of firms	308	287	294	291

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
All equations estimated for firms with DB schemes using system GMM estimator and also include year dummies, industry dummies and a constant. Lagged cash is treated as endogenous using instruments up to t-4.
Cash stocks, working captial, cashflow, investment, dividends, debt and pension variables are scaled by total assets.
Equation 1 is estimated from 05/06 to 14/15. Equations 2, 3 and 4 are estimated from 10/11 to 14/15.

Appendix

Chart 1A: Dividends and investment of the estimation sample

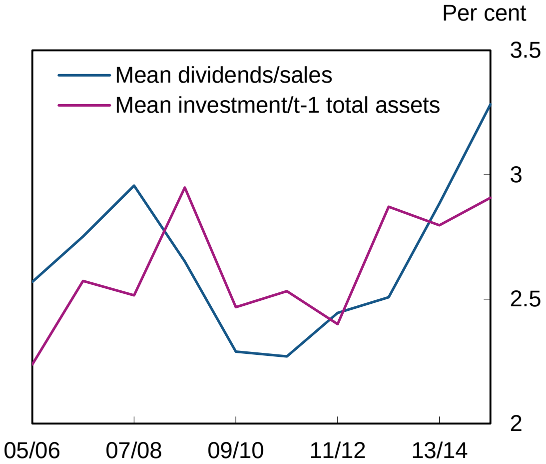


Chart 2A: Distribution of pension deficits

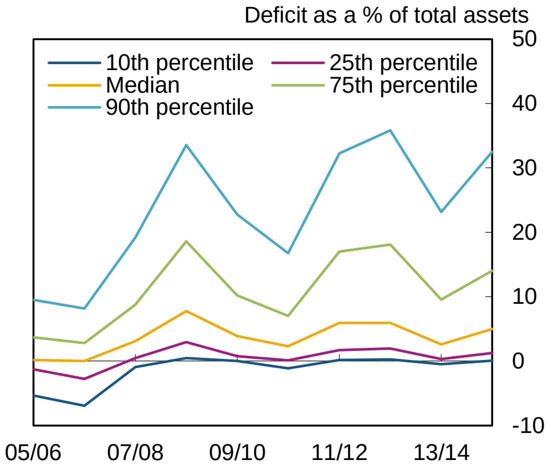


Chart 3A: Distribution of DRCs

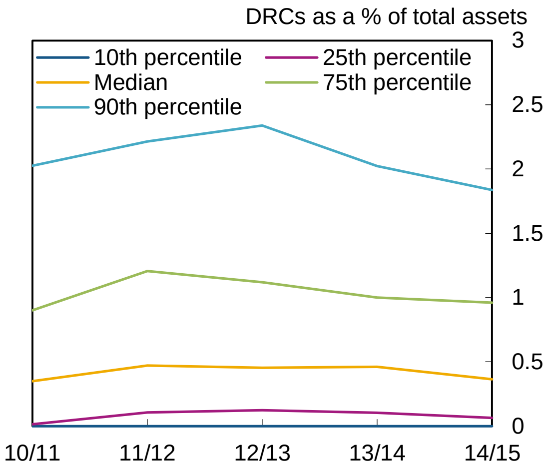


Chart 4A: Dividends and pension deficits

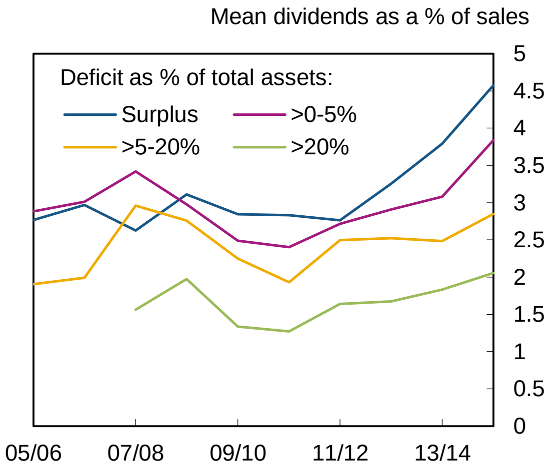


Chart 5A: Investment and pension deficits

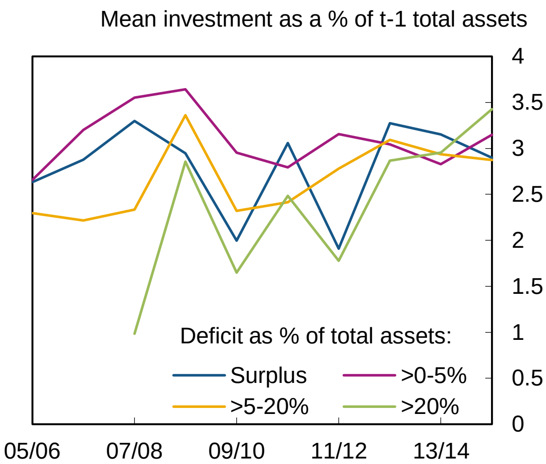


Chart 6A: Dividends and DRCs

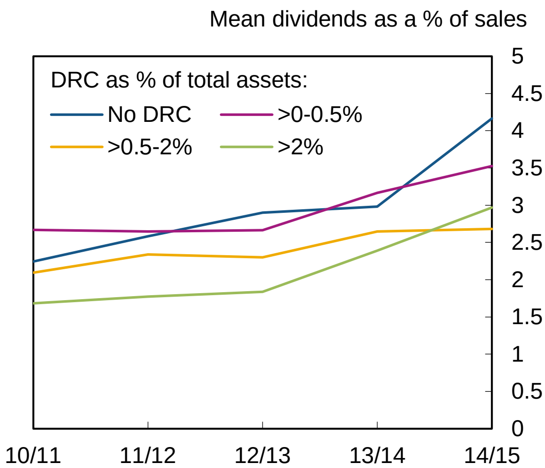


Chart 7A: Investment and DRCs

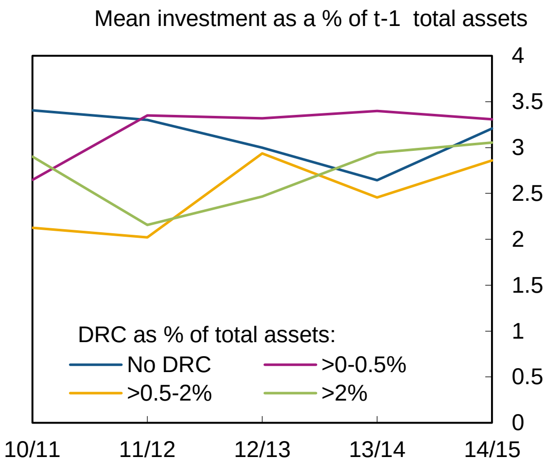


Chart 8A: Investment and DRCs

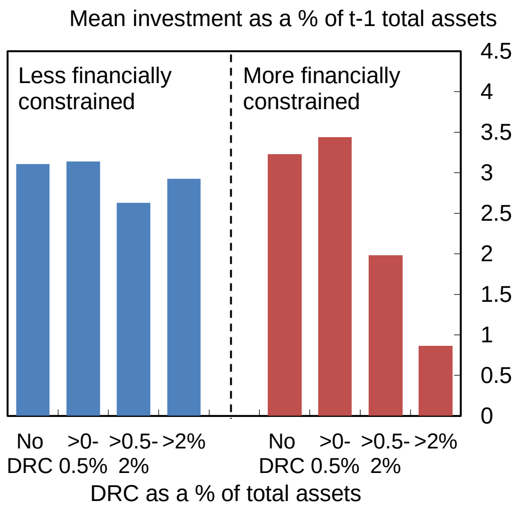


Table 1A: Number of observations per year

	With deficit data	With DRC data
2005/06	266	n/a
2006/07	264	n/a
2007/08	263	n/a
2008/09	263	n/a
2009/10	269	n/a
2010/11	272	261
2011/12	283	275
2012/13	281	274
2013/14	281	276
2014/15	271	266
Total	2713	1352

Table 2A: Descriptive statistics

Ratio (all shown as percentages)	2005/06 to 2014/15			2010/11 to 2014/15		
	Mean	Median	Standard deviation	Mean	Median	Standard deviation
$Dividends_t/sales_t$	2.7	2.0	2.5	2.7	1.8	2.6
$Cashflow_t/sales_t$	8.8	7.6	7.0	9.5	8.2	7.1
Capital $gearing_t$	13.7	14.0	18.7	12.6	12.7	18.1
Sales $growth_t$	6.0	4.8	13.3	4.5	3.7	10.5
$Investment_t/assets_{t-1}$	2.8	2.2	3.6	2.9	2.2	3.2
Q_t	105.5	93.3	64.4	109.2	95.8	68.0
$Cashflow_t/assets_{t-1}$	9.0	8.5	6.2	8.9	8.4	5.9
Borrowing $ratio_t$	33.6	16.6	39.0	28.5	12.9	37.1
Pension $deficit_t/sales_t$	7.1	3.1	9.8	8.6	3.9	11.2
Pension $deficit_t/assets_{t-1}$	8.2	3.5	11.0	9.8	4.6	12.2
Pension scheme funding $ratio_t$	86.5	86.0	13.5	84.7	84.5	11.0
$DRCs_t/sales_t$	n/a	n/a	n/a	0.7	0.4	0.8
$DRCs_t/assets_{t-1}$	n/a	n/a	n/a	0.8	0.4	0.9
Recovery plan $length_t$ (years)	n/a	n/a	n/a	6.2	6.0	3.9

Table 3A: Regressions investigating relationship between pension deficits in 2006/07 and firm characteristics

	Probit for having a deficit in 2006/07	OLS regression for size of deficit in 2006/07 if have one
	(1)	(2)
Cashflow(t)	-0.026	0.032
	(0.028)	(0.143)
Q(t)	-0.001	-0.011
	(0.002)	(0.009)
Gearing(t)	0.008	-0.038
	(0.008)	(0.039)
Borrowing ratio(t)	-0.009*	0.026
	(0.005)	(0.028)
Dividends(t)	0.031	-0.079
	(0.057)	(0.269)
Investment(t)	-0.002	-0.001
	(0.022)	(0.111)
Cash stock(t)	-0.001	-0.023
	(0.017)	(0.082)
^ Incorporated before 1950	-0.216	0.378
	(0.218)	(1.131)
^ Incorporated 1950-1969	0.206	-1.355
	(0.305)	(1.410)
^ Incorporated 1970-1989	0.112	-0.558
	(0.247)	(1.190)
Size quartile:		
# 2nd quartile	0.257	-0.966
	(0.253)	(1.182)
# 3rd quartile	-0.124	-0.741
	(0.257)	(1.319)
# 4th quartile	-0.340	-2.622*
	(0.263)	(1.376)
Industry dummies (F-test p value)	0.841	0.417
Observations	244	126

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Pension deficit, cashflow , dividends, investment and cash stock are all scaled by total assets.

^ Dummy variable, reference category is companies incorporated from 1990 onw ards.

Dummy variable, reference category is the quartile of companies w ith the low est sales (w ithin the sample) in each year (the 1st size quartile).

Table 4A: Additional dividends and pension deficit regressions

Dependent variable	Dividends/sales								Pay dividend dummy
Estimator	Tobit							GMM system	Probit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
TP deficit(t)	-0.029***							-0.007**	-0.040***
	(0.005)							(0.003)	(0.008)
TP deficit(t-1)		-0.030***							
		(0.006)							
TP funding ratio(t)			0.024***						
			(0.004)						
S75 deficit(t)				-0.012***					
				(0.002)					
FRS17/IAS19 deficit(t)					-0.030***				
					(0.008)				
TP deficit last valuation(t)						-0.028***			
						(0.007)			
Change in predicted TP deficit from 2006/07(t)							-0.037***		
							(0.009)		
Observations	2,674	2,317	2,669	2,672	2,460	2,277	965	2,524	2,674
Number of firms	319	309	319	319	299	303	130	309	319

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
All pension deficit variables are scaled by sales.
All equations also include cashflow/sales, sales growth, lagged capital gearing, year dummies, industry dummies and a constant.

Table 5A: Wage regressions

Sample	DB only			In deficit in 2006/07	
	(1)	(2)	(3)	(4)	(5)
Log wage per employee(t-1)	0.617***	0.599***	0.602***	1.092***	1.188***
	(0.076)	(0.093)	(0.100)	(0.408)	(0.303)
Log wage per employee(t-2)	0.153***	0.144***	0.130***	0.153	0.164
	(0.038)	(0.047)	(0.049)	(0.109)	(0.105)
Log sales per employee(t-1)	0.105***	0.115***	0.119***	-0.047	-0.087
	(0.031)	(0.037)	(0.040)	(0.135)	(0.109)
Deficit/wagebill(t)	-0.004				
	(0.008)				
DRCs/wagebill(t)		-0.161	-0.118		
		(0.120)	(0.111)		
Recovery plan length(t)			0.000		
			(0.001)		
Predicted deficit/wagebill(t)				-0.001	
				(0.013)	
Predicted DRCs/wagebill(t)					0.153
					(0.437)
AR(1)-p	0.000	0.002	0.003	0.052	0.072
AR(2)-p	0.226	0.226	0.394	0.936	0.446
Hansen-p	0.282	0.282	0.422	0.986	0.985
Observations	1,216	980	950	541	432
Number of firms	271	264	263	118	116

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
All equations estimated for firms w ith DB schemes using system GMM estimator and also include year dummies, industry dummies and a constant. Lagged w ages are treated as endogenous using instruments up to t-4.
Dependent variable is the log of the average annual w age per employee.
Equations 1 and 4 are estimated from 09/10 to 14/15. Equations 2, 3 and 5 are estimated from 10/11 to 14/15.

Data appendix

Company accounts data

All variables are taken from the Worldscope company accounts database unless stated. Data are classified into financial years where a financial year runs from 1 June to 31 May in the following calendar year.

Industry data on UK 2007 SIC codes are merged in from the Bureau van Dijk FAME dataset along with data on wages (the Worldscope database only includes total remuneration, which combines data on wages and pension costs together).

Financial sector companies are excluded. We also exclude a small number of companies who report very extreme values for our key variables: companies whose cashflow exceeds their net sales, firms whose investment exceeds their total assets and firms who report that they pay out more than 20% of sales revenue in dividends.

Pension data

Scheme level microdata on DB pension funds were supplied by The Pensions Regulator (TPR). The identity of the ultimate corporate sponsor for each scheme was identified by TPR (based on information available as of 30 September 2016) and data were then consolidated into a company level dataset.

Data on pension scheme funding for each triennial actuarial valuation are collected by TPR. As well as these actuarial valuations, the dataset that TPR supplied to us contained estimates of the value of each scheme on 31 March in each year on both a Technical Provisions and S75 basis. Where this does not correspond to a triennial actuarial valuation, the value was estimated by TPR using actuarial techniques and market indices for principal asset classes. Valuation data were available from 2006 to 2015.

Estimates of deficit recovery contributions (DRCs) paid were provided by TPR on a calendar year basis for the years 2010 to 2015 based on returns provided to them. DRCs are assumed to be paid at the start of each year of the recovery plan when TPR produced this data.

The TPR data also contain information on the start and end dates of recovery plans put in place to close deficits. Recovery plan length is defined as the difference between these two dates. This data is weighted by scheme size where an employer sponsors multiple schemes.

Matching

We merge accounting data from the Worldcope database with TPR data on DB pension funds. TPR data on pension scheme funding for 31 March in each year are matched to company accounts for the equivalent financial year. For companies whose financial year end is in the second half of the calendar year (most commonly 31 December), DRC data for that calendar year are merged in. Where companies have a financial year end in the first half of the calendar year (most frequently 31

March), DRCs for that financial year are assumed to be an average of DRCs in that calendar year and the previous year. Recovery plan lengths are available for schemes valued from 22 September to 21 September the following year, these are also matched to the nearest financial year (defined as 1 June to 31 May).

Variable construction

All continuous variables are top coded to the 5th and 95th percentiles for that variable in each year. In the analysis, variables are scaled by either sales or lagged/contemporaneous total assets. Below we summarise how each variable is constructed and provide the Worldscope identifiers where applicable (as shown by the WC prefix).

Sales (and sales growth)

Net sales or revenues (WC01001).

Debt

Total debt (WC03255).

Cash stock

Cash (WC02003).

Working capital

Current assets (WC02201) less current liabilities (WC03101) and cash (WC02003).

Total assets

Total assets (WC02999).

Tobin's Q

Market capitalisation (WC08001) plus total debt (WC03255) less cash holdings (WC2003) all divided by total assets (WC02999).

Capital gearing

Total debt (WC03255) less cash holdings (WC2003) all divided by total assets (WC02999).

Cashflow

Pre-tax profits (WC01401) less income taxes (WC01451) plus depreciation (WC01148). Where DRC data are available, DRCs are added onto cashflow so that it is measured before DRCs, although this measure is only used in the regressions where it is available for the whole period over which the regression is estimated.

Borrowing ratio

Interest payments (WC01251) divided by pre-tax profits (WC01401) plus interest income (WC04149). DRCs are also added to the denominator where available as for cashflow.

Dividends

Cash dividends paid (WC04551).

Investment

Capital expenditure (WC04601) less disposals of fixed assets (WC04351).

Wages per employee

Wage data are taken from the Bureau van Dijk FAME dataset and divided by number of employees. We only use observations where the number of employees corresponds to the data in Worldscope data (WC07011).

Pension deficits

Provided by TPR (except when FRS/IAS 19 deficit is used in Table 4A, which is based on WC018821). Deficit is defined as pension fund liabilities less assets. Deficits are set to zero when pension fund assets exceed liabilities.

Deficit recovery contributions

Provided by TPR.

Recovery plan length

Provided by TPR.

Industry dummies

Industry dummies are included in all regressions for the following industries: production; construction; wholesale and retail; transportation and storage; accommodation and food; information and communication; professional, scientific and technical activities; administrative and support services; public administration and defence; arts and recreation; and other.