# Compensating Wage Differentials for Defined Benefit and Defined Contribution Occupational Pension Scheme Benefits

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Abstract: The theory of equalizing differences suggests that employer provided pension benefits should be compensated by reduced wage benefits for an employee's given productivity potential. This paper presents an empirical analysis of compensating wage differentials for occupational pension scheme benefits in the UK using the newly available English Longitudinal Study of Ageing. The data allows us to differentiate between Defined Benefit (DB) and Defined Contribution (DC) schemes and to consider different measures of pension benefits based on current contributions and changes in accrued pension benefit rights. In our preferred specifications we find evidence for perfect compensating wage differentials for both occupational DB and DC pension scheme benefits.

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## 1. Introduction

Labor theory predicts that employees select themselves into occupations, which offer a mix of wage and non-wage (or fringe) benefits that matches their preferences (see Woodbury (1983) or Black (1987)). The theory of equalizing differences summarized by Rosen (1986) implies that employees receiving higher fringe benefits are paid a lower wage than otherwise identical employees preferring lower fringe benefits. Hence, the sign of a fringe benefits variable in a correctly specified wage regression should turn out negative after controlling for qualification and other characteristics affecting wages. The magnitude of the estimated coefficient should be one in absolute terms unless fringe benefits increase the productivity of employees, in which case the coefficient should be less than one in absolute terms.

The theory of equalizing differences or compensating wage differentials has been tested for various kinds of employer provided fringe benefits: health insurance (see Olson (2002) and the survey by Currie and Madrian (1999) on earlier work), maternity benefits (Gruber (1994)), compensation insurance for work-related injury and illness (Gruber and Krueger (1991)), paid vacation leave (Altonji and Usui, 2005) and pension benefits (see references below). The results are not always in favor of the compensating wage differential hypothesis: in particular for health insurance fringe benefits the expected negative relationship is rarely established. Correspondingly, Altonji and Usui talk about the "sorry history of compensating differentials studies." Usually, findings contradicting the theoretical expectations are explained by an omitted variable bias triggered by insufficient observable information on ability (see Currie and Madrian for an extensive discussion).

The goal of this article is a quantification of the wage differentials implied by occupational pension scheme benefits in the UK. The recent discussion of a possible introduction of additional mandatory contributions in the UK as a mean to increase retirement savings (compare the first report of the Pensions Commission, 2004) clearly demands for an analysis of compensating wage differentials. If additional contributions reduce earnings by the same magnitude, one has good reason to assume that crowding out of existing savings occurs, which mitigates the effectiveness of the policy instrument (see Gale (1999) for an overview of the savings and public pensions literature. Attanasio and Rohwedder (2003) indeed find that the earnings-related tier of the UK public pension system serves as a perfect substitute for private saving). On the other hand, if wages increase with occupational pension benefits as reported by Hemming and Harvey (1983) for the UK then an increase in mandatory contributions will increase the cost of the factor labor.

Gunderson et al. (1992) review the findings of the earlier literature on compensating wage differentials for pension benefits. Similar to the literature on health insurance benefits the empirical evidence is very mixed. The results from 13 studies range from a significant negative relationship between wage and pension benefits to a significant positive relationship. The most encouraging results in favor of the theory of equalizing differences are obtained by Schiller and Weiss (1980), Ehrenberg (1980), Gunderson et al. (1992) and Montgomery et al. (1992) using US data on occupational Defined Benefit pension schemes. Schiller and Weiss calculate the additional pension rights an employee accrues over a certain year and find that these pension benefits are at least partially offset by lower wages. Montgomery et al. follow a similar approach but focus on a lifetime trade-off between wage and pension benefits. The authors cannot reject a perfect one-for-one pension-wage trade-off. Ehrenberg includes the separate components of the Defined Benefit formula such as the normal retirement age and the minimum years of service in a regression of annual labor income and finds that more generous plan characteristics are associated with lower salaries. He also discusses the consequences of underfunding: employees may demand higher wages as the extent of underfunding increases. This is related to the valuation approach for defaultable Defined Benefit pension liabilities developed by Inkmann and Blake (2004). The appropriate discount rate for defaultable pension benefits is higher than for default-free pension benefits, which implies that the present value of future pension benefits is reduced and should be compensated by higher wages according to the theory of equalizing differences.

This study employs the first wave of the English Longitudinal Study of Ageing (ELSA), which contains very detailed information on the occupational pension arrangements for a sample from the population of age 50+ in the UK. In contrast to the earlier literature, compensating wage differentials are estimated for both Defined Benefit and Defined Contribution (DC) plans. The trend from DB to DC occupational pension arrangements is well established for the US and the UK. Results for the US indicate that contrary to early fears there is no evidence that employees with DC plans have to expect smaller pensions during retirement than employees covered by a DB plan (see Poterba et al (2001) and Samwick and Skinner (2004)). While the decision to enrol in a DB or DC plan has been analyzed by Cocco and Lopes (2004) for the UK, the earnings impact of DB and DC pension arrangements remains to be analyzed and is the main goal of the present paper. The specific institutional details of the occupational pension system in the UK will be taken into account, e.g. the possibility to increase mandatory contributions by Additional Voluntary contributions, which are of DC nature in most cases but sometimes of DB nature in the sense that they can be used to purchase additional years of service.

The structure of the paper is as follows: Section 2 reviews in short the institutional details of occupational pension schemes in the UK. Section 3 introduces the data source, ELSA, provides summary statistics and an in-depth discussion of the response behavior to a question asking for employer contributions to the occupational pension scheme. It turns out that DB scheme members are much less likely to provide this information and therefore under-represented in the subsequent analysis. The resulting sample consists roughly of as many DC scheme members as of DB scheme members, which might be considered as advantageous for the intended DB/ DC scheme comparison. Section 4 provides empirical evidence for the theory of equalizing differences using current contributions to the occupational pension scheme as a measure of pension benefits. It turns out that instead of generating compensating wage differentials current employer contributions increase earnings. Employee contributions, however, are perfectly compensated. In Section 5 an alternative measure based on changes in pension benefit rights earned in the current period is investigated for DB plans. The results of this section provide clear evidence for a perfect trade-off between wage and pension benefits for both occupational DB and DC pension schemes. Section 6 summarizes and draws some policy conclusions.

## 2. Occupational Pension Schemes in the UK

Blake (2003) provides a detailed overview of the United Kingdom pension system. Here it suffices to review the institutional details relevant for occupational pension schemes (see also Cocco and Lopes (2004), and Banks and Blundell (2005)). Employees earning more than the so called lower earnings limit (LEL, which was 75 GBP/ week in 2002, the year the data was collected) automatically participate in the state second pension (S2P), the earnings-related (with an upper earnings limit of 585 GPB/ week in 2002) tier of the UK public pension system which was introduced in its current form in April 2002. Employees may join an employer provided occupational pension scheme either on parallel or as an alternative to S2P. The latter option is called “contracting-out” and reduces the employee’s National Insurance (NI) contributions. There is neither an obligation for employers to offer an occupational pension scheme nor for employees to participate in such a scheme once it is offered. Usually, occupational pension schemes are exempt approved which means that income tax relief is given on the employee’s total contributions up to a limit of 15% of his gross earnings. Higher employee contributions are explicitly ruled out in exempt approved schemes. Corporation tax relief is given on employer contributions without an upper bound. Also a tax-free lump sum payment may be received at retirement age from an exempt approved scheme.

An employer must contribute to exempt approved schemes at least 10% of the sum of employee and employer contributions. Employee contributions are not compulsory for exempt approved schemes. Usually, however, mandatory contributions are a condition for scheme membership imposed by the employer. Exempt approved schemes can be of a Salary-Related or Defined Benefit (DB) type, of a Money-Purchase or Defined Contribution (DC) type or of some hybrid type. Similar to the trend in the US there has been a significant shift from DB to DC scheme arrangements in the UK in recent years (see the Pensions Commission (2004)). Employees may top-up mandatory scheme contributions by Additional Voluntary (AV) contributions and/or Free-Standing (FS) contributions. AV contributions can be used in some cases (public sector) to purchase additional years of service for DB schemes or are paid into a DC scheme offered by the employer. FS contributions are paid into a DC scheme provided externally.

## 3. Data, Contributions and Missing Values

The empirical analysis carried out in this paper is based on the first wave of the English Longitudinal Study of Ageing (ELSA) collected in 2002/03. ELSA surveys people aged 50 and over and their younger partners living in private households in England on a biannual basis. The sample of the first wave is drawn from households that had previously responded to the Health Survey for England (HSE) between 1998 and 2001 and contains data from 12,100 individuals.[1] ELSA shares many questions with the US Health Retirement Study (HRS) and the Survey of Health and Retirement in Europe (SHARE). For our purposes ELSA is unique in providing extremely detailed information on the occupational pension scheme arrangements of employees in the UK.

*insert Table 1 around here*

Table 1 provides descriptive statistics of all the variables used in the following for the selected sample of employees in dependent work who report weekly gross earnings above the lower earnings limit (75 GBP/ week in 2002) and are covered by an occupational pension scheme. In addition we focus on sample members below the state pension age, which is 60 for women and 65 for men. We exclude a small number of individuals reporting own contributions over 15% of gross earnings or employer contributions exceeding 25%.[2] The left column of Table 1 ("Including F-Missing Values") describes the sample of employees reporting own contributions to the pension scheme but not necessarily employer provided contributions (F) on their behalf. The right column of Table 1 ("Excluding F-Missing Values") describes the restricted sample, which results from removing those individuals not providing information on F. This differentiation is carried out because it turns out that missing values in employer contributions seriously restrict the sample size available for the subsequent regres-

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[1] ELSA results from a cooperation between UCL, IFS and the National Centre for Social Research. The data is available from the UK data archive at the University of Essex.

[2] Remember that employees are not allowed to contribute more than 15% of their gross wage to a tax-exempt occupational pension scheme. This includes all forms of contributions, namely mandatory, Additional Voluntary and Free-Standing contributions.

sions. It is therefore important to understand which individuals are likely to drop out from the sample. Note that the original sample size of 12,100 reduces to 803 employees after imposing the mentioned selection criterions and controlling for missing values. This number further reduces to 432 after removing employees with missing values in employer contributions. The average individual in the less restricted sample earns 2557 GBP per month and contributes 5.54% of these earnings to the occupational pension scheme. The average person in the restricted sample earns 2490 GBP and contributes 5.63%. Non-missing employer contributions are slightly larger with 6.19%. More important are the sample differences in gender composition. While one third of all members of the unrestricted sample are females, only one quarter of the members of the restricted sample are females. This indicates that women are much less likely to report employer provided contributions to the pension scheme. Another notable difference exists with respect to the firm size of the individual's employer. Small firms are over-represented in the restricted sample, which suggests that employees working in small firms have a better understanding of employer provided pension scheme contributions. The most striking difference exists with respect to the DB/ DC plan composition of the two samples. A huge fraction of DB plan members drops out from the unrestricted sample. The fraction of DB plan members reduces from roughly two-third to one-half in the restricted sample. This may be a sign of the better transparency of DC plans in comparison to DB plans. DC plan members are likely to see their employer's pension scheme contributions on their monthly pension account statements.

In order to shed more light on the answering pattern for the employer contribution variable a Probit regression is carried out where the dependent variable indicates non-missing values in the employer contribution variable. The first column of Table 2 shows the estimation results for the 772 employees meeting the selection criterions and providing all required information.

*insert Table 2 around here*

We find that women and employees with low qualification levels are significantly less likely to provide employer contribution information. A dummy variable indicating that an employee reports that she has obtained sufficient information on her expected pension in retirement, which we interpret as a measure of financial literacy, turns out to be insignificant. The employee's own contributions to the occupational pension scheme are insignificant as well. A union membership indicator does not significantly affect the answering behavior. Firm size, however, appears to be a significant predictor confirming the relationship already discussed. As expected, DB scheme members are significantly much less likely to provide information on employer contributions.

Given the importance of the employer contribution variable we consider computing imputations of this variable as a fraction of monthly gross wages for missing values.[3] A two-limit Tobit model (see Maddala (1983), ch. 6.7) is employed for this purpose with lower and upper bounds equal to 0.00 and 0.25, respectively. We include the same explanatory variables as in the Probit model. Table 2 displays the estimation results. The results show that it is much more difficult to find good predictors for the size of reported contributions than for the likelihood to answer the contribution question at all. The employee's own contributions have a weakly significant positive impact. The same holds for a dummy variable indicating a contracted out pension scheme. The most important variable, however, appears to be the financial literacy indicator described before, which has a large positive and highly significant impact. This may indicate that well-informed employees negotiate higher employer contributions. All other variables are insignificant. For the sub-sample of non-censored observations the Tobit model generates an (adjusted) $R^2$ of (0.1073) 0.1421. We consider the performance of this regression as far too weak to further pursue the idea of computing imputations of employer contributions.

In summary, we have to bear in mind that the restricted sample used in the following under-represents DB scheme members. For the purpose of comparing wage differentials for DB and DC scheme pension benefits, however, the much more balanced sample composition of roughly 50% DB and DC scheme members in the restricted sample is certainly welcome.

[3] Horowitz and Manski (1998) discuss identification in regressions with missing explanatory variable information. While the conditional mean impact of the affected variable is not identified without additional assumptions, the author provide bounds for the conditional mean impact and show that a regression that uses missing value imputations reveals an impact of the affected variable which falls into these bounds.

## 4. Compensating Wage Differentials for Pension Scheme Contributions

### 4.1 Basic Regressions

Schiller and Weiss (1980) propose a simple framework for a test of the compensating wage differential hypothesis (or the theory of equalizing differences) formulated by Rosen (1986). They start from a standard Mincer-Becker type wage regression of the form

$$\log W = \alpha + \beta_1 S + \beta_2 E + \beta_3 E^2 + \varepsilon \qquad (1)$$

where W is (in our case) monthly gross labor income, the error term $\varepsilon$ is assumed to be independent and identically distributed, S denotes the years an individual spent in school and occupational education and E denotes experience which enters the regression in linear and squared term to capture a possible non-linearity in the age-earnings profile. We will use a combination of the age at which an individual left school and a set of dummy variables describing different levels of occupational qualification (increasing from Level 1 to Level 5)[4] for S. Thus we assume that the impact of schooling is linear and allow for nonlinear effects of different occupational degrees. ELSA does not contain a direct measure of experience or tenure. Usually researchers tend to avoid using the direct measure anyway because of a potential endogeneity problem. Instead empirical researchers frequently refer to potential experience defined as current age minus age at labor market entry after finishing education. We use an alternative measure where E is defined as the years of membership in the occupational pension scheme. Like potential experience this measure avoids the endogeneity problem but unlike potential experience it has the advantage of generating a simple earnings – membership years profile estimator, which is used in later sections. Both the age at labor market entry and the years of pension scheme membership are divided by ten to scale all estimated coefficients to a similar magnitude. Schiller and Weiss (1980) add employer provided fringe benefits F to the left hand side of the regression (1)

$$\log(W + F) = \alpha + \beta_1 S + \beta_2 E + \beta_3 E^2 + \varepsilon \qquad (2)$$

[4] Level 1: NVQ1/CSE and below, level 2: NVQ2/GCE O Level equivalent, level 3: NVQ3/GCE A Level equivalent, level 4: Higher education without degree, level 5: NVQ4/NVQ5 or equivalent.

and argue that the total benefit package should matter to compensate the employee's productivity potential.[5] For given productivity the theory of equalizing differences suggests that any granted fringe benefits will be compensated by a corresponding wage differential. In the present case F is the amount of monthly contributions paid by the employer to the employee's occupational pension scheme. Some simple modifications of (2) generate a regression that allows for a test of equalizing differences. With $f = F/W$ it follows that

$$\log(W(1+f)) = \alpha + \beta_1 S + \beta_2 E + \beta_3 E^2 + \varepsilon \tag{3}$$

$$\Leftrightarrow \log W = \alpha + \beta_1 S + \beta_2 E + \beta_3 E^2 - \log(1+f) + \varepsilon \tag{4}$$

$$\Leftrightarrow \log W = \alpha + \beta_1 S + \beta_2 E + \beta_3 E^2 + \gamma f + \varepsilon \tag{5}$$

under the null hypothesis $H_0 : \gamma = -1$ and using $\log(1+f) \approx f$ for small f in (5). Equation (5) has been used for several types of fringe benefits. Schiller and Weiss and the studies cited in Gunderson et al. (1992) consider pension benefits, Gruber and Krueger (1991) contributions to insurance for work-related injury, Gruber (1994) investigates maternity benefits, Altonji and Usui (2005) paid vacation leave, and the papers cited in Currie and Madrian (1999) explore health insurance benefits. While ELSA contains information on employer provided health benefits as another form of fringe benefits in addition to pension benefits it turns out that none of the individuals in our sample is covered by an employer sponsored health insurance. Hence, in line with recent policy debates in the UK, we restrict our attention to pension benefits. Table 3 contains estimation results for regressions (1) and (5).

*insert Table 3 around here*

The standard Mincer-Becker type regression in column (A) of Table 3 produces results in line with expectations: higher qualification levels are associated (in a nonlinear way) with higher labor income, female wages are ceteris paribus lower by around 140 GBP/month and life cycle earnings peak at 29 years of pension scheme membership. All variables turn out highly

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[5] For readability and notational simplicity we leave the symbols for the regression coefficients and the error term unchanged throughout the paper. Changing the left hand side variable of the regression is likely to alter the coefficients and the error term. This, however, will be obvious to the reader.

significant for the sample size of 844 employees. As discussed before the sample size shrinks down to 432 employees in column (B) of Table 3, which contains the results for the basic wage differential equation (5) because of a large number of missing values in the employer contribution variable. The estimate of the coefficient $\gamma$ of the ratio of employer contributions to gross wage is 1.35. Remember that the theory of equalizing differences predicts –1 for $\gamma$. This hypothesis is clearly rejected in the regression. Instead of reducing gross earnings by the same magnitude, every pound contributed by the employer to the employee’s pension plan increases the employee’s earnings by more than another pound. Compensating wage differentials are negative and occupational pension schemes seem to render the factor labor much more expensive.

### 4.2 Extended Regressions

Finding a positive coefficient of the fringe benefit variable in a wage differential regression is not unusual. Currie and Madrian (1999) overview a number of studies investigating health insurance provisions which come to similar conclusions. The authors also review the arguments, which are usually given to explain the unexpected outcome. The first argument is an economic interpretation. Employees receiving fringe benefits may work more productively and thus earn higher wages. Askildsen and Ireland (2003) review possible sources of productivity gains: pension benefits may be used to protect investments in firm specific human capital (see Johnson (1996)), to reduce shirking (see Akerlof and Katz (1989), Curme and Kahn (1990)) through the deferred wage characteristics of pension benefits and to attract the desired type of employee by offering the particular wage and fringe benefit compensation package this type of employee is likely to demand (see Ippolito (1997)). While the qualitative impact of these different productivity sources appears obvious, a quantitative impact in the magnitude found here can be hardly explained by productivity gains.

The second argument, which is usually given to explain a positive coefficient of the fringe benefit variable is an econometric one: the education and qualification variables as well as the experience variables are imperfect measures of general and firm specific human capital. If the associated measurement error is positively correlated with the fringe benefit variable, an OLS estimator of the latter variable’s coefficient will be biased upwards and may eventually switch sign form negative to positive. In the case of occupational pension schemes we have an opportunity to further explore the latter argument, which has not been exploited in the literature to our knowledge. We decompose gross earnings into the employee's own contributions (C) to the occupational pension scheme and the gross earnings net of these contributions (Y = W – C). Hence, (5) is modified to obtain

$$\log(Y + C) = \alpha + \beta_1 S + \beta_2 E + \beta_3 E^2 + \gamma f + \varepsilon \quad (6)$$

$$\Leftrightarrow \log(Y(1 + c)) = \alpha + \beta_1 S + \beta_2 E + \beta_3 E^2 + \gamma f + \varepsilon \quad (7)$$

$$\Leftrightarrow \log Y = \alpha + \beta_1 S + \beta_2 E + \beta_3 E^2 + \gamma f + \delta c + \varepsilon \quad (8)$$

where $c = C / Y$ and the theory of equalizing differences predicts $H_0 : \gamma = \delta = -1$. Table 4 gives descriptive statistics for the employer and employee contribution shares, f and c. Due to the different scaling, f is based on W in the denominator while c is based on Y, both variables have exactly the same magnitude of 6.2% in the dataset.

*insert Table 4 around here*

Column (C) in Table 5 contains the estimation results for regression (8). Here and in the following regressions we do not longer report the results for the education and qualification variables since the estimation results for these variables hardly differ from those reported in Table 3. While the estimate of $\gamma$ from regression (C) remains close to the one obtained in (B), the estimate of $\delta$ turns out to be –1.07, statistically insignificant different from –1, and therefore in line with the theoretical prediction. If there is measurement error in the education and qualification variables then it seems difficult to argue that the error is correlated with employer provided contributions to the pension scheme and uncorrelated with employee contributions. In this sense we have gained confidence in the employed specification of the earnings regression in the tradition of Mincer-Becker.

*insert Table 5 around here*

In the following we investigate possible differences between Defined Benefit and Defined Contribution schemes by decomposing employer contributions into DB and DC scheme contributions, $F = F^{DB} + F^{DC}$

$$\log Y = \alpha + \beta_1 S + \beta_2 E + \beta_3 E^2 + \gamma_1 f^{DB} + \gamma_2 f^{DC} + \delta c + \varepsilon . \tag{9}$$

and employee contributions into $C = C^{DB} + C^{DC}$ or $C = C^{DB}_{MD} + C^{DB}_{AV} + C^{DC}$, where the latter specification distinguishes between mandatory and Additional Voluntary contributions to the DB pension scheme (we do not observe the magnitude of any Free-Standing contributions)

$$\log Y = \alpha + \beta_1 S + \beta_2 E + \beta_3 E^2 + \gamma_1 f^{DB} + \gamma_2 f^{DC} + \delta_1 c^{DB} + \delta_2 c^{DC} + \varepsilon \tag{10}$$

$$\log Y = \alpha + \beta_1 S + \beta_2 E + \beta_3 E^2 + \gamma_1 f^{DB} + \gamma_2 f^{DC} + \delta_1 c^{DB}_{MD} + \delta_2 c^{DB}_{AV} + \delta_3 c^{DC} + \varepsilon . \tag{11}$$

Small letters in the regressions (9)-(11) again refer to ratios of the underlying capital letter F and C variables to W and Y, respectively. Descriptive statistics for all components are again given in Table 4. Employer contributions to DB schemes exceed DC scheme contributions by 1.21 percentage points. The corresponding difference for employee contributions is 0.69 percentage points. Additional Voluntary contributions account for an average of 15.56% of total employee DB contributions.

Note that in regressions (10) and (11) one of the DB and DC components for the employer and employee contributions is zero for every employee because employers do not offer both plans at the same time to the same employee. The null hypotheses to be tested are $H_0 : \gamma_1 = \gamma_2 = -1$ in (9), $H_0 : \gamma_1 = \gamma_2 = \delta_1 = \delta_2 = -1$ in (10), and $H_0 : \gamma_1 = \gamma_2 = \delta_1 = \delta_2 = \delta_3 = -1$ in (11). While the employee's contributions to a DC plan could be disentangled correspondingly into mandatory and Additional Voluntary components, the potential insights are smaller since both components have DC characteristics. As described in Section 2 only the mandatory part of DB contributions is of DB nature while Additional Voluntary contributions are usually paid into a separate DC type scheme in the UK.

Regression (D) in Table 5 leaves employee contributions in aggregated form, but disentangles employer contributions into DB and DC components. Both components have an estimated coefficient around 1.36, which is in exactly the same magnitude obtained in the aggregated contribution regression (C). There are no significant differences between DB and DC schemes in (D). The coefficient of the employee's own contributions remains –1.07. Distinguishing between employee contributions to DB and DC schemes in regression (E) in Table 5 increases the absolute impact of DB contributions to –1.53 and renders insignificant the impact of DC contributions. The null hypothesis that these coefficients are equal to –1 cannot be rejected in both cases. Essentially, the same result is obtained from further differentiating mandatory and Additional Voluntary employee DB contributions in regression (F) in Table 5. Only the mandatory part of DB contributions has a significant impact in the smaller sample but the coefficient –2.35 now indicates a serious overcompensation of employee contributions. At the same time, the coefficient of employer DB contributions increases to 1.76. Thus, the joint impact of employer and employee DB contributions on earnings is roughly zero. Since both employer and employee contributions to DC schemes are insignificant, the same result emerges for DC plans.

This, actually, seems to be the bottom line of the current section, which is looking for compensating wage differentials for employer and employee contributions to occupational DB and DC schemes: there are compensating wage differentials in the expected magnitude for employee DB contributions, which, however, are wiped out by the opposite impact of employer contributions to DB schemes. The impact of DC contributions and DC-type Additional Voluntary contributions to DB schemes is insignificant. Pension scheme contributions do not seem to affect the remuneration of human capital and come as an additional burden, which increases the cost of the production factor labor. It may be the case, however, that current contributions to the pension scheme are an inappropriate measure of the pension benefits earned in the current month. We will further investigate this idea below.

## 5. Compensating Wage Differentials for Changes in Pension Benefit Rights

For DC schemes current contributions to the pension plan adequately measure the change in pension benefits earned in the current period. Benefits are further increased by the interest gained on the existing DC scheme assets. This return on plan assets, however, should not be compensated by a reduction in current earnings since wages may be used to accumulate an interest-generating capital stock as well. Current contributions to DB schemes may not be an adequate measure of the change of value of the pension benefit promise earned in the current period. To further assess this argument we have to consider the way contribution and funding decisions are made for occupational DB pension schemes. In the UK (and very similar in the US) a Board of Trustees is responsible for determining the contribution and asset allocation decisions. Usually these decisions are reviewed on an annual basis during the preparation of the financial statements. The Board is guided by actuarial projections for the pension benefits accrued by current employees. The actuary (or an independent financial advisor) also provides contributions (employee and employer) and asset allocation recommendations, which are usually targeted to achieve a certain funding ratio of plan assets over plan liabilities in a given time. For example, a plan that is currently underfunded could try to achieve a 100% funding target in five years time. In fact, this target corresponds to current UK regulation for underfunded occupational DB pensions schemes. Assume that contributions are structured to guarantee that an annuity of the size of the pension accrued over the employee's current number of service years can be purchased at the employee's retirement date. In this case, current contributions appropriately reflect the change in pension benefits earned in the present period. This changes, however, if contributions are determined to satisfy targets, which do not rule out the possibility that the pension promise cannot be met by the DB pension scheme. In this case, plan assets will differ from scheme liabilities at the employee's retirement age, DB scheme benefits are subject to default, and current contributions are an inappropriate measure of the change of pension benefits. The same argument applies if the sponsoring company itself is subject to default.[6] A sponsoring company that declares

[6] While this default risk is mitigated to some extent by insurance vehicles like the Pension Benefit Guarantee Corporation (PBGC) in the US and the Pension Protection Fund (PPF) in the UK, the latter was not introduced before 2005 while our dataset was collected in 2002.

bankruptcy will stop paying contributions to the pension scheme and the pension promise is unlikely to be met unless the plan was running above 100% funding at the time of bankruptcy. Default on DB pension obligations is not an event with negligible probability as historical evidence clearly shows.[7] Default is not an issue for DC plans, which are organized like personal accounts.

Inkmann and Blake (2004) adopt a structural model of corporate bond valuation to the related pension liability valuation problem and show that defaultable DB pension liabilities are correctly valued by referring to a risk-adjusted discount rate, $(1+G)(1+\Delta)$. G denotes the yield of a default-free real government bond with maturity equal to the average remaining service years of the pension scheme members (we use 10 years in the empirical analysis) and $\Delta$ is the default spread defined as

$$\Delta = \exp(-\log(1-\pi+\pi\rho))-1 \tag{12}$$

where $\pi$ denotes the probability of default in the maturity interval and $\rho$ the funding ratio (recovery ratio, $0 \leq \rho \leq 1$) in case of default.[8]

Instead of using current contributions to the occupational pension scheme we consider the change in promised DB pension benefits earned in the current period as the relevant variable for estimating compensating wage differentials. This strategy has been used before by Schiller and Weiss (1980), Gunderson et al. (1992) and Montgomery et al. (1992). These au-

[7] Between its foundation in 1975 and 2003 the PBGC had to secure 3,287 involuntary plan terminations in the US affecting 834,000 employees. Recent examples of companies declaring default on pension obligations include United Airlines in the US, and Allied Steel and Wire in the UK. These examples have attracted extensive media coverage in both countries.

[8] Both the US and the UK accounting standards for pension obligations (FAS 87 and FRS 17) allow sponsoring companies to value their pension liabilities using a discount rate, which is higher than the yield of a default-free bond. Usually the yield of a long tem AA rated corporate bond is used for accounting purposes which corresponds to assuming a default probability of 0.0085 over a ten years interval (historical value for Standard & Poor's AA rated credits, cf. Standard & Poors (2005)).

thors, however, attribute the whole change in pension benefits to the employer, which overlooks the employee's own contributions to the pension scheme. The left hand side variable of the earnings or wage regression used to provide evidence for compensating wage differentials has to be reduced by the employee's own scheme contributions. We will emphasize further differences to existing work below.

In line with pension accounting standards we consider both the change in the Accumulated Benefit Obligation (ABO) and the Projected Benefit Obligation (PBO). The ABO is the present value of the future pension calculated on the basis of the current pensionable income (gross monthly wage in the following) while the PBO is the corresponding value on the basis of the projected pensionable income at retirement age (see Bodie (1990) for a discussion of ABO and PBO). Hence the latter concept takes into account future wage increases.

Denote the current year by t. We define monthly changes in ABO and PBO as $\Delta ABO = \frac{1}{12}\left(ABO_t - ABO_{t-1}\right)$ and $\Delta PBO = PBO_t - PBO_{t-1}$. Let E denote again the employee's number of membership (or service) years in the pension scheme, R the remaining years until retirement, and L the maximum number of years in retirement (assuming a maximum attainable age of 100 in the empirical analysis). Figure 1 depicts the underlying time scale.

*insert Figure 1 around here*

A simple Defined Benefit formula yields the required $ABO_t$ and $PBO_t$ variables

$$ABO_t = ac \cdot E \cdot \hat{P}_t \frac{pr_{t,R}}{\left[(1+G)(1+\Delta)\right]^R} \sum_{\ell=1}^{L} \frac{pr_{t+R,\ell}}{\left[(1+G)(1+\Delta)\right]^{\ell}} + LS_{t+R} \frac{pr_{t,R}}{\left[(1+G)(1+\Delta)\right]^R} \tag{13}$$

$$PBO_t = ac \cdot E \cdot \hat{P}_{t+R} \frac{pr_{t,R}}{\left[(1+G)(1+\Delta)\right]^R} \sum_{\ell=1}^{L} \frac{pr_{t+R,\ell}}{\left[(1+G)(1+\Delta)\right]^{\ell}} + LS_{t+R} \frac{pr_{t,R}}{\left[(1+G)(1+\Delta)\right]^R} \tag{14}$$

where the only difference between (13) and (14) is the reference period used for estimating (see below) the pensionable income which refers to the current period, $\hat{P}_t$, in case of $ABO_t$ and to the retirement period, $\hat{P}_{t+R}$, in case of $PBO_t$. Note that $\hat{P}_t$ changes over time while

$\hat{P}_{t+R}$ remains constant because R decreases with increasing t. The variables $pr_{t,R}$ and $pr_{t+R,\ell}$ denote R- and $\ell$-years survival probabilities given the employee's gender and her age at time t and t + R, respectively.[9] The first parts of the right hand side sums in (13) and (14) are equal to the present value of an annuity of size $ac \cdot E \cdot \hat{P}_t$ and $ac \cdot E \cdot \hat{P}_{t+R}$, respectively, where ac is an accrual factor which usually takes values of 1/80 or 1/60 in the UK. In the latter case an employee needs to contribute 40 years to the pension scheme in order to achieve a pension in the magnitude of 2/3 of his final salary in a final salary DB plan. The second parts of the right hand side sums in (13) and (14) refer to the present value of a lump sum payment of magnitude $LS_{t+R}$ at retirement by the pension scheme.[10]

The dataset distinguishes three different types of DB schemes with respect to the calculation of the pensionable income: final salary schemes, average salary schemes and average final five years salary schemes. Let $\hat{Q}_e$ be an estimate of annual gross earnings of an employee with e years of scheme membership and I the time-invariant rate of wage-inflation. Then we can describe the three scheme types by

$$\hat{P}_{t+h} = \begin{cases} \frac{1}{E+h}\sum_{e=1}^{E+h} \hat{Q}_e (1+I)^h & \text{for average salary plan} \\ \hat{Q}_{E+h}(1+I)^h & \text{for final salary plan} \\ \frac{1}{5}\sum_{e=E+h-4}^{E+h} \hat{Q}_e (1+I)^h & \text{for average final five years salary plan} \end{cases} \tag{15}$$

where $h = 0$ ($h = R$) is relevant for $ABO_t$ ($PBO_t$). We obtain the earnings – service years profile estimates $\hat{Q}_e$ for $e = 1,\dots,E,\dots E + R$ from a variation of service years in the Mincer-Becker type earnings regression (1)[11]

[9] These probabilities are calculated from the cohort life tables provided online by The Government's Actuaries Department (www.gad.gov.uk).

[10] Optimally, we would like to distinguish between accrued and projected lump sum payments for the ABO and PBO calculations. This is not possible because the dataset only contains information on expected lump sum payments at retirement. There is no information on the formula determining these payments.

[11] In all calculations we account for the scaling (division by ten) of scheme membership years in the regressions.

$$\hat{Q}_e = 12 \cdot \exp\left(\hat{\alpha} + \hat{\beta}_1 S + \hat{\beta}_2 e + \hat{\beta}_3 e^2\right). \tag{16}$$

Note that it is not without problem to estimate a life-cycle earnings profile from a cross-section of employees aged 50+. However, the descriptive statistics in Table 1 show that only a small fraction of roughly 15% of the sample members has an average salary plan where the whole earnings profile becomes relevant. For all other sample members only the final (5 years) salary is relevant which should be approximated very well from our sample of employees close to retirement. In addition, the Mincer-Becker regression (A) in Table 3 that is used for (16) yields very reasonable parameter estimates, which imply a life-cycle earnings peak after 29 years of scheme membership, despite the fact that only individuals in the latest part of their life-time labor market history are observed. Robinson (2000) obtains very similar life-cycle earnings profiles on the basis of the much more extensive General Household Survey for the UK covering around 8,000 men and women in each year between 1974 to 1997. She reports earnings peaks between 25 (low education) and 30 (high education) years. Therefore we are confident that the measurement errors we create by using a cross-section of elderly people instead of using a long panel (or at least repeated cross-sections as in Robinson (2000)) of the relevant birth cohorts 1938-1952 are negligible for our purposes.

As Table 1 also shows, the scheme type information (final vs average salary) is missing for roughly 20% of the sample members. In order to not reduce the already small sample size further, a final salary plan is assigned to those individuals, which is the most frequent scheme type in the UK (and in the sample as well). Similarly, we assign an accrual factor of 1/80 to those individuals not reporting ac, and a lump sum payment of 3/80 times the number of service years times the pensionable income at retirement to missing values in the lump sum benefit variable. This particular combination of pension and lump sum payment is particularly common in the UK.

The changes in $ABO_t$ and $PBO_t$ attributed to the current month follow as

$$\Delta ABO = \frac{ac}{12}\left[E \cdot \hat{P}_t \cdot pr_{t,R} - (E-1)\cdot \hat{P}_{t-1}\frac{pr_{t-1,R+1}}{(1+G)(1+\Delta)}\right]\sum_{\ell=1}^{L}\frac{pr_{t,R+\ell}}{[(1+G)(1+\Delta)]^{R+\ell}} + \frac{LS_{t+R}}{12}\left[pr_{t,R} - \frac{pr_{t-1,R+1}}{(1+G)(1+\Delta)}\right]\frac{1}{[(1+G)(1+\Delta)]^{R}} \tag{17}$$

$$\Delta PBO = \frac{ac}{12}\left[E \cdot \hat{P}_{t+R} \cdot pr_{t,R} - (E-1)\cdot \hat{P}_{t+R} \cdot \frac{pr_{t-1,R+1}}{(1+G)(1+\Delta)}\right]\sum_{\ell=1}^{L}\frac{pr_{t,R+\ell}}{[(1+G)(1+\Delta)]^{R+\ell}} + \frac{LS_{t+R}}{12}\left[pr_{t,R} - \frac{pr_{t-1,R+1}}{(1+G)(1+\Delta)}\right]\frac{1}{[(1+G)(1+\Delta)]^{R}} \tag{18}$$

and replace both mandatory employee and employer contributions to the DB pension scheme in the regression (11). Since these contributions are scaled by different variables, Y and W, we have to find a way to decompose $\Delta ABO$ and $\Delta PBO$ into components earned by the employee and by the employer on behalf of the employee. A straightforward solution consists of assigning to the employer and the employee fractions of $\Delta ABO$ and $\Delta PBO$ that correspond to their current share of total contributions

$$f^{DB}_{ABO} = \frac{F^{DB}}{C^{DB}_{MD} + F^{DB}}\frac{\Delta ABO}{W}, \quad c^{DB}_{ABO} = \frac{C^{DB}_{MD}}{C^{DB}_{MD} + F^{DB}}\frac{\Delta ABO}{Y} \tag{19}$$

$$f^{DB}_{PBO} = \frac{F^{DB}}{C^{DB}_{MD} + F^{DB}}\frac{\Delta PBO}{W}, \quad c^{DB}_{PBO} = \frac{C^{DB}_{MD}}{C^{DB}_{MD} + F^{DB}}\frac{\Delta PBO}{Y}. \tag{20}$$

We use the average annual real yield of a default-free government bond with ten years maturity in 2002, 2.39%, for G and the rate of inflation implied by the difference between nominal and real yields in 2002, 2.47%, for I. We compute $\Delta ABO$ and $\Delta PBO$ for both a ten years default probability of $\pi = 0.0\%$ (default-free) and of $\pi = 6.1\%$. The latter corresponds to the historical ten years cumulative default probability for credits rated BBB (lowest investment grade category) by Standard and Poor's (cf. Standard and Poor's (2005)). A recovery value of $\rho = 0.75$ is used which means that available plan assets cover 75% of pension scheme liabilities in the event of pension scheme default. Descriptive statistics for the resulting variables in (19) and (20) are again given in Table 4. Note that the ABO variables in (19) are almost three times as large as the total contributions to the DB scheme. Thus, there is huge discrepancy between the change in pension liabilities and the contributions paid to finance these liabilities. This can be explained in part by the low average discount rates in 2002. Accounting for default and thus increasing the discount rate by a default premium $\Delta$ in (12) of 1.55 percentage points, however, reduces the $\Delta$ABO variables by only one percentage point. While the level impact of discount rates on liabilities is large, the impact on first monthly differences is small. Note that the same default probability is assigned to each individual's DB pension scheme in the sample. Thus, there is no variation in default probabilities and any difference in compensating wage differentials reported for the pension benefit measures using $\pi = 0.0\,\%$ and $\pi = 6.1\%$, respectively, is only due to the decrease of the liabilities in the latter case. Correspondingly, coefficients are expected to increase by the same magnitude. Unfortunately, ELSA does not contain information on the industry in which the employee is working. This prevents us from using industry specific default probabilities (as e.g. used by Curme and Kahn (1990)), which would identify the wage differential attributed to the probability of pension scheme default.[12] The difference between $\Delta$ABO and $\Delta$PBO variables in Table 4 is around 1.5 percentage points on average. While the PBO measure usually exceeds the ABO measure, unless we consider an individual which is located in the declining part of the life-cycle earnings profile (i.e. has more than 29 years of scheme membership) and covered by a final salary scheme, $\Delta$ABO usually exceeds $\Delta$PBO because the pensionable income $\hat{P}_t$ used for ABO in (13) changes over time while $\hat{P}_{t+R}$ used for PBO in (14) remains constant.

The modified regression models result from substituting (19) and (20) for $f^{DB}$ and $c_{MD}^{DB}$ in (11)

$$\log Y = \alpha + \beta_1 S + \beta_2 E + \beta_3 E^2 + \gamma_1 f_{ABO}^{DB} + \gamma_2 f^{DC} + \delta_1 c_{ABO}^{DB} + \delta_2 c_{AV}^{DB} + \delta_3 c^{DC} + \varepsilon \qquad (21)$$

$$\log Y = \alpha + \beta_1 S + \beta_2 E + \beta_3 E^2 + \gamma_1 f_{PBO}^{DB} + \gamma_2 f^{DC} + \delta_1 c_{PBO}^{DB} + \delta_2 c_{AV}^{DB} + \delta_3 c^{DC} + \varepsilon\,. \qquad (22)$$

The null hypothesis to be tested remains $H_0 : \gamma_1 = \gamma_2 = \delta_1 = \delta_2 = \delta_3 = -1$. These regressions differ form earlier work by (i) using earnings net of employee contributions as the dependent variable, (ii) including both DB and DC scheme contribution information, (iii) differentiating

[12] The only employer information contained in the dataset is firm size. We have not been able to find information on size specific pension plan default rates but we continue to look for these for a future extension of this research.

between mandatory and Additional Voluntary DB scheme contributions, (iv) considering both ABO and PBO type increases in pension benefits. Table 6 contains the estimation results.

*insert Table 6 around here*

It turns out the null hypothesis of perfect compensating wage differentials for the employer part of mandatory contributions to DB schemes cannot be rejected if the accrued pension benefit rights are measured by the PBO variable (estimates around –0.94). The ABO variable is slightly undercompensated (estimates around –0.71). For the employee part of mandatory contributions to DB schemes the empirical findings indicate that the PBO variable is slightly overcompensated (estimates –1.45) while the null hypothesis of perfect compensating wage differentials cannot be rejected for the ABO variable (estimates around –1.22). These results hold regardless of assuming $\pi = 0.0\%$ or $\pi = 6.1\%$ for the probability of default. Additional Voluntary contributions turn out insignificantly in all regressions. Employer DC scheme contributions are insignificant while employee DC scheme contributions are significant. Both, however, are statistically insignificant different from –1. In summary, the results of this section provide empirical evidence for the theory of equalizing differences with respect to occupational pension scheme benefits. Note also that the regressions of the present section are more successful in terms of (adjusted) $R^2$ in explaining (log) earnings variation than the regressions employed in the previous section. The results of the present section should be preferred on grounds of both economic and statistical reasoning.

**6. Conclusions**

Attempts to estimate compensating wage differentials for all kinds of employer provided fringe benefits have often produced outcomes which leave the researcher somewhat puzzled because the estimated signs and magnitudes of the fringe benefit variables in labor income regressions turn out to be wrong to an extent which can be hardly explained by any economic or econometric reasoning. The first and probably most straightforward approach to estimate wage differentials for occupational pension scheme benefits employed in this paper, which is based on current scheme contributions as a measure of benefits, seems to continue the “sorry history of compensating differentials studies” (Altonji and Usui (2005)). However, by extending the compensation theory to the scheme contributions paid by the employee himself we already obtain a clear hint that evidence in line with the theory of equalizing differences can be extracted from the data. This extension serves as a kind of informal specification test for the underlying labor income regression which has been overlooked before.

Using an alternative benefit measure of pension benefits, which is based on the change in the actuarial value of future pension payments, we find empirical evidence for compensating wage differentials for pension benefits provided by occupational DB and DC pension schemes. The estimated coefficients are usually in line with theoretical predictions. Thus, we are able to confirm empirical evidence for compensating wage differentials for DB pension benefits obtained by Schiller and Weiss (1980), Ehrenberg (1980), Gunderson et al. (1992) and Montgomery et al. (1992) and to extend their results to DC scheme benefits.

The policy implications of this study seem straightforward. The retirement savings potential – which may differ from actual retirement savings, of course – of employees covered by an occupational pension scheme should remain largely unaffected by a policy which targets an increase in occupational pension scheme benefits, e.g. by introducing or increasing mandatory contributions. At the same time, such a policy will not increase the cost of the production factor labor since wage benefits are likely to adjust to account for higher fringe benefits.

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**Tables**

Table 1: Descriptive Statistics: English Longitudinal Study of Ageing (ELSA), 2002

| | Including F-Missing Values | | Excluding F-Missing Values | |
|---|---|---|---|---|
| Variable | Mean | Std. Dev. | Mean | Std. Dev. |
| Female | 0.3225 | 0.4677 | 0.2546 | 0.4362 |
| Age | 54.6812 | 3.2058 | 54.6597 | 3.2573 |
| Scheme Retirement Age | 62.6138 | 2.8331 | 62.8107 | 2.7767 |
| Gross Monthly Wage (W) | 2557.2 | 7330.0 | 2489.7 | 2308.1 |
| Employer Contributions (F / W) | - | - | 0.0619 | 0.0483 |
| Employee Contributions (C / W) | 0.0554 | 0.0399 | 0.0563 | 0.0402 |
| Gross Monthly Wage – C (Y) | 2408.3 | 6887.3 | 2346.1 | 2170.1 |
| Lump Sum Pension Payment | 31008.5 | 33487.1 | 35829.1 | 35929.1 |
| DB Scheme Member | 0.6750 | 0.4687 | 0.5231 | 0.5000 |
| DB Type: Final Salary | 0.4843 | 0.5002 | 0.4912 | 0.5010 |
| DB Type: Average Final Salary | 0.1516 | 0.3589 | 0.1726 | 0.3787 |
| DB Type: Average Salary | 0.1756 | 0.3808 | 0.1460 | 0.3539 |
| DB Accrual Rate: 1/60 | 0.2235 | 0.4170 | 0.2442 | 0.4306 |
| DB Accrual Rate: 1/80 | 0.3922 | 0.4887 | 0.4009 | 0.4912 |
| Years in Scheme/10 | 1.4689 | 1.0976 | 1.3477 | 1.1130 |
| Contracted Out | 0.4047 | 0.4911 | 0.4051 | 0.4915 |
| Small Size Firm Employer | 0.1525 | 0.3597 | 0.2284 | 0.4203 |
| Medium Size Firm Employer | 0.2013 | 0.4012 | 0.2424 | 0.4290 |
| Large Size Firm Employer | 0.6462 | 0.4784 | 0.5291 | 0.4997 |
| Union Member | 0.3783 | 0.4853 | 0.3164 | 0.4656 |
| Informed About Pensions | 0.7652 | 0.4242 | 0.7862 | 0.4105 |
| Labor Market Entry Age/10 | 1.6615 | 0.1689 | 1.6692 | 0.1727 |
| Qualification Level 2 | 0.2092 | 0.4070 | 0.1875 | 0.3908 |
| Qualification Level 3 | 0.1183 | 0.3232 | 0.1065 | 0.3088 |
| Qualification Level 4 | 0.1594 | 0.3663 | 0.1759 | 0.3812 |

| | | | | |
|---|---|---|---|---|
| Qualification Level 5 | 0.2740 | 0.4463 | 0.3009 | 0.4592 |
| Number of Observations | 803 | | 432 | |

Notes: Qualification Levels are explained in footnote 4. Small size firm: < 100 employees in the UK, medium size firm: >= 100 employees < 1000, large size firm: >= 1000 employees. The table shows differences between the sample of employees reporting their own contributions (C) to the pension scheme but not necessarily their employers' contributions (F) and the restricted sample of employees reporting both C and F.

Table 2: Missing Values in Employer Pension Scheme Contributions

| | Probit | | Tobit | |
|---|---|---|---|---|
| Variable | Estimate | Std. Error | Estimate | Std. Error |
| Intercept | -0.0131 | (0.5634) | 0.0098 | (0.0259) |
| Female | -0.3356 | (0.1055) | 0.0058 | (0.0053) |
| DB Scheme Member | -0.8861 | (0.1296) | 0.0087 | (0.0058) |
| Years in Scheme/10 | 0.0041 | (0.0497) | 0.0037 | (0.0024) |
| Pension Scheme Contributions | 0.5867 | (1.2492) | 0.1022 | (0.0593) |
| Contracted Out | 0.0247 | (0.1017) | 0.0099 | (0.0047) |
| Small Size Firm Employer | 0.6085 | (0.1585) | 0.0085 | (0.0063) |
| Medium Size Firm Employer | 0.2931 | (0.1251) | 0.0058 | (0.0057) |
| Union Member | -0.1419 | (0.1034) | -0.0066 | (0.0052) |
| Informed About Pensions | 0.1673 | (0.1146) | 0.0153 | (0.0057) |
| Labor Market Entry Age/10 | 0.1628 | (0.3596) | 0.0072 | (0.0164) |
| Qualification Level 2 | 0.1987 | (0.1488) | 0.0035 | (0.0075) |
| Qualification Level 3 | 0.1133 | (0.1846) | -0.0098 | (0.0089) |
| Qualification Level 4 | 0.4150 | (0.1719) | 0.0062 | (0.0076) |
| Qualification Level 5 | 0.5083 | (0.1723) | 0.0054 | (0.0081) |
| Number of Observations | 772 | | 401 | |

Notes: The Probit regression explains the probability of reporting employer pension scheme contributions (variable F). The Tobit model explains the reported magnitude of these contributions relative to gross monthly wages (variable f). A two-limit Tobit model is used in order to account for the censoring of the dependent variable from below at 0.00 and from above at 0.25. Smaller sample sizes in comparison to Table 1 because of deleted missing values.

Table 3: Compensating Wage Differentials – Basic Regressions

| | (A) | | (B) | |
|---|---|---|---|---|
| Variable | Estimate | Std. Error | Estimate | Std. Error |
| Intercept | 6.2130 | (0.1776) | 6.3114 | (0.2452) |
| Female | -0.3331 | (0.0317) | -0.2976 | (0.0513) |
| Employer Contributions (f) | | | 1.3518 | (0.4699) |
| Labor Market Entry Age/10 | 0.6266 | (0.1140) | 0.5912 | (0.1568) |
| Qualification Level 2 | 0.1228 | (0.0460) | 0.0781 | (0.0679) |
| Qualification Level 3 | 0.1381 | (0.0530) | 0.1963 | (0.0847) |
| Qualification Level 4 | 0.2558 | (0.0435) | 0.2146 | (0.0610) |
| Qualification Level 5 | 0.4616 | (0.0498) | 0.4023 | (0.0715) |
| Years in Scheme/10 | 0.2322 | (0.0474) | 0.1502 | (0.0737) |
| ... Squared | -0.0378 | (0.0317) | -0.0196 | (0.0216) |
| $R^2$ | 0.3681 | | 0.3468 | |
| Adjusted $R^2$ | 0.3621 | | 0.3329 | |
| Number of Observations | 844 | | 432 | |

<u>Notes:</u> The dependent variable is log W. Heteroskedasticity-consistent standard errors in parentheses.

Table 4: Descriptive Statistics for Scheme Contribution and Benefit Variables

| | Employer | | | Employee | | |
|---|---|---|---|---|---|---|
| Description | Symbol | Mean | Std. Dev. | Symbol | Mean | Std. Dev. |
| Total Contributions | (f) | 0.0619 | 0.0483 | (c) | 0.0616 | 0.0467 |
| ... to DB Scheme | $(f^{DB})$ | 0.0677 | 0.0497 | $(c^{DB})$ | 0.0649 | 0.0446 |
| ... to DB Scheme – Mandatory | | | | $(c^{DB}_{MD})$ | 0.0548 | 0.0355 |
| ... to DB Scheme – Voluntary | | | | $(c^{DB}_{AV})$ | 0.0101 | 0.0244 |
| ... to DB Scheme – ABO ($\pi = 0$) | $(f^{DB}_{ABO})$ | 0.1853 | 0.1619 | $(c^{DB}_{ABO})$ | 0.1815 | 0.1509 |
| ... to DB Scheme – ABO ($\pi > 0$) | $(f^{DB}_{ABO})$ | 0.1750 | 0.1578 | $(c^{DB}_{ABO})$ | 0.1711 | 0.1449 |
| ... to DB Scheme – PBO ($\pi = 0$) | $(f^{DB}_{PBO})$ | 0.1703 | 0.1242 | $(c^{DB}_{PBO})$ | 0.1673 | 0.1262 |
| ... to DB Scheme – PBO ($\pi > 0$) | $(f^{DB}_{PBO})$ | 0.1605 | 0.1235 | $(c^{DB}_{PBO})$ | 0.1605 | 0.1235 |
| ... to DC Scheme | $(f^{DC})$ | 0.0556 | 0.0460 | $(c^{DC})$ | 0.0580 | 0.0486 |
| Number of Observations | | 432 | | | 432 | |

Notes: Employer contributions in percentage of gross earnings (W). Employee contributions in percentage of gross earnings minus employee contributions (Y = W – C). Employee DC scheme contributions consist of mandatory and voluntary contributions.

Table 5: Compensating Wage Differentials – Extended Regressions

| Variable | Symbol | (C) | (D) | (E) | (F) |
|---|---|---|---|---|---|
| Employer Contributions | (f) | 1.3626 | | | |
| | | (0.4805) | | | |
| ... to DB Scheme | ( $f^{DB}$ ) | | 1.3557 | 1.5968 | 1.7593 |
| | | | (0.5183) | (0.5520) | (0.5602) |
| ... to DC Scheme | ( $f^{DC}$ ) | | 1.3723 | 1.0887 | 1.0158 |
| | | | (0.6467) | (0.7564) | (0.7585) |
| Employee Contributions | (c) | -1.0703 | -1.0707 | | |
| | | (0.5175) | (0.5182) | | |
| ... to DB Scheme | ( $c^{DB}$ ) | | | -1.5343 | |
| | | | | (0.5984) | |
| ... to DB Scheme – Mandatory | ( $c^{DB}_{MD}$ ) | | | | -2.3450 |
| | | | | | (0.8435) |
| ... to DB Scheme – Voluntary | ( $c^{DB}_{AV}$ ) | | | | 0.2139 |
| | | | | | (0.8335) |
| ... to DC Scheme | ( $c^{DC}$ ) | | | -0.6565 | -0.7136 |
| | | | | (0.7330) | (0.7341) |
| $R^2$ | | 0.3421 | 0.3421 | 0.3440 | 0.3482 |
| Adjusted $R^2$ | | 0.3265 | 0.3249 | 0.3252 | 0.3279 |
| Number of Observations | | 432 | 432 | 432 | 432 |

<u>Notes:</u> The dependent variable is log Y. Heteroskedasticity-consistent standard errors in parentheses. All regressions contain all the explanatory variables of regression (A) in Table 3.

Table 6: Compensating Wage Differentials – Extended Regressions

| | Symbol | (G) | (H) | (I) | (J) |
|---|---|---|---|---|---|
| Default Probability | ($\pi$) | 0.0000 | 0.0610 | 0.0000 | 0.0610 |
| Employer Contributions | | | | | |
| ... to DB Scheme – ABO | ($f^{DB}_{ABO}$) | -0.7089 | -0.7162 | | |
| | | (0.1445) | (0.1509) | | |
| ... to DB Scheme – PBO | ($f^{DB}_{PBO}$) | | | -0.9338 | -0.9434 |
| | | | | (0.1798) | (0.1843) |
| ... to DC Scheme | ($f^{DC}$) | -0.2937 | -0.2327 | -0.6068 | -0.5382 |
| | | (0.7776) | (0.7759) | (0.7892) | (0.7866) |
| Employee Contributions | | | | | |
| ... to DB Scheme – ABO | ($c^{DB}_{ABO}$) | -1.2002 | -1.2394 | | |
| | | (0.1579) | (0.1672) | | |
| ... to DB Scheme – PBO | ($c^{DB}_{PBO}$) | | | -1.4379 | -1.4754 |
| | | | | (0.1737) | (0.1817) |
| ... to DB Scheme – Voluntary | ($c^{DB}_{AV}$) | 1.0832 | 1.0463 | 1.1382 | 1.1292 |
| | | (0.6613) | (0.6748) | (0.6146) | (0.6237) |
| ... to DC Scheme | ($c^{DC}$) | -1.8635 | -1.8034 | -2.1901 | -2.1160 |
| | | (0.7486) | (0.7478) | (0.7536) | (0.7530) |
| $R^2$ | | 0.4196 | 0.4161 | 0.4304 | 0.4277 |
| Adjusted $R^2$ | | 0.4015 | 0.3979 | 0.4127 | 0.4099 |
| Number of Observations | | 432 | 432 | 432 | 432 |

Notes: The dependent variable is log Y. Heteroskedasticity-consistent standard errors in parentheses. All regressions contain all the explanatory variables of regression (A) in Table 3. The default probability $\pi = 0.061$ used in regressions (H) and (J) corresponds to the historical 10 years default probability of credits rated BBB (lowest investment grade category) by Standard & Poor's (cf. Standard and Poor's (2005)). A recovery value of $\rho = 0.75$ is used in these regressions.

**Figures**

Figure 1: Service and Retirement Periods