Heterogeneity in the Offset Effect of the Pension Wealth on Other Private Wealth[1]

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Abstract

Numerous attempts have been made in the literature to establish the empirical relationship between the pension wealth and private wealth. However, most existing studies focus on the average effect only. In this paper, we provide empirical evidences on individual heterogeneity in the offset effects. The results suggest that typical estimates of the mean offset effect of pension wealth on non-pension wealth based on OLS provide a rather incomplete characterization of the impact of pension wealth on non-pension wealth.

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1 Introduction

The relationship between pension wealth and wealth of other sources has been heavily explored in empirical works. Most of studies have been focused on the "crowding out" effect of pension rights on other sources of household wealth accumulation. Although a simple classical life cycle model with perfect consumption smoothing predicts a perfect offset between different sources of wealth, the impact of liquidity constraints, income uncertainty, bequest motives among other factors discussed in the literature makes the size of the offset effect an empirical question. See for example Cagan (1965), Feldstein (1974) and Gale (1998). The findings are mixed due to varieties of econometric strategy or diversified data sets. Most of these analysis are based on US data. Recently, Hernæs and Zhu (2007) look at Norwegian data and find that there exists a crowding out effect of public pension on private savings in Norway[1]. As most studies in the literature, their study also focuses on the estimated mean relationship. Though the mean effects are important measures of the relationship between pension wealth and non-pension wealth, it does not provide a full picture of the relationship unless we impose quite restrictive conditions.

In this paper, we start with the question: "Is there evidence of individual heterogeneity in the offset effects of pension right?" We try to shed light on not only the mean relationship between this unobserved heterogeneity and certain household characteristics but also the whole picture of the conditional distribution. Despite ample studies on the household savings behavior, few has directly explored this question in the literature. Coates and Humphreys (1999) commenting on Feldstein (1974) and Feldstein (1996), conclude that the impact of pension wealth on consumption (saving) is not constant across the level of wealth. Although they only show the nonconstant offset effect between pension wealth and other wealth, they do shed lights on the need to account for the individual heterogeneity in offset effect of pension wealth on other wealth. Kang and Lim (2006) provide another empirical work on

[1] See Hernæs and Zhu (2007) for a more detailed literature review on the empirical studies of the offset effects.

the crowding-out effect between the pension wealth and other wealth by estimating the regression models on several sub samples based on household characteristics. They find that there are considerable differences in the estimated offsets for different subgroups. The crowding-out effect in constant surplus households is larger than in constant deficit households. Also the crowding-out effect in households of government employees is smaller than in those of the non-government employees. However, there is still little empirical evidence in the literature on the hypothesis of homogeneity in the crowding out effects.

This paper try to contribute to this strand of literature. Based on Norwegian household data, this study intends to investigate the potential heterogeneity in the offset effect using the quantile regression model proposed by Koenker and Bassett (1982). The quantile regression allows us to investigate the offset effect for both tails of the wealth distribution rather than just in the mean, since the quantile regression models can be used to characterize the entire conditional distribution of the non-pension wealth given individual characteristics, pension rights and earnings history and etc.

Engelhardt and Kumar (2006) is probably the only study that apply a quantile regression framework to study the offset effect. Based on US data, they find that there is strong evidence that there is substantial heterogeneity in the pension-saving offset across the wealth distribution, with zero or very small positive offsets at quantile at or below the median, but significant offsets of 70 percent in the upper quantiles.

This study differs from Engelhardt and Kumar (2006) mainly in the way on how to deal with the unobserved heterogeneity in household savings behavior[2]. Engelhardt and Kumar (2006) applied an instrument variable Quantile regression (IVQR) technique developed by Chernozhukov and Hansen (2004). They use a simulated instrument which is generated by constructing the pension wealth for a set of synthetic workers. We cannot construct a

[2]Note that this is not the same as main focus of our paper: the heterogeneity in the offset effects. Using a simple linear regression model as an example, the unobserved heterogeneity in household savings behavior in our context can be presented as the differences in the intercept, while the heterogeneity in the offset effects is represented as the difference in the slope coefficient.

similar instrument for our study, since the variability in Norwegian pension system is not as abundant as in US. Utilizing the panel structure of the Norwegian data set, we try to deal with this problem using a fixed effect model instead.Another problem mentioned in Engelhardt and Kumar (2006) is the measurement error in self-reported pension wealth in US data. This problem does not apply to our data, since the pension wealth is generated using administrative registers and no such measurement error exists.

The rest of this paper is organized as follows. Section 2 establishes the basic analytical framework for studying of the household wealth accumulation. Section 3 presents the data. In section 4, we discuss the modeling of heterogeneity after a simple illustration of existence of the unobserved heterogeneity. Section 5 presents the empirical results. Section 6 concludes.

2 Household Wealth Accumulation

In this section we discuss briefly the basic analytical framework and its empirical specification for studying of the household wealth accumulation.

2.1 The Analytic Framework

The analytic framework for our empirical analysis is the wealth accumulation model used in Hernæs and Zhu (2007). It follows from a discrete time lifecycle model in the spirit of Gale (1998). The individuals (households) are assumed to maximize the discounted life time utility. The periodic utility function is based on the isoelastic form of the so called "extra" consumption, $C_t - \gamma_t$, where γ_t denotes a certain level of consumption that is considered necessary. The minimum consumption has been proved to be useful in many applications, see for example Dagsvik and Strøm (2006). In short:

$$U_t = \frac{(C_t - \gamma_t)^{1-\rho}}{1-\rho}$$

The main concern of the model is the allocation of earnings between consumption and savings. With the assumption that the timing of retirement is exogenous, the model predicts that the non-pension wealth at age τ, W_τ depends on accumulated earnings up to age τ $E(\tau)$, the accumulated minimum consumption $\gamma(\tau)$, as well as discounted life time earnings E^T, pension income P^T, minimum consumption γ^T. In short, the wealth accumulation function they derived is as follows[3]:

$$W_t = E(\tau) - R(\tau,r)(E^T + P^T) + \left[R(\tau,r)\gamma^T - \gamma(\tau)\right] \tag{1}$$

The factor $R(\tau, r)$ is first introduced by Gale (1998). It depends on both age and the return on savings r. In the empirical study below, we assume that $r = 0.04$.

2.2 The Empirical specification and data construction.

Based on the wealth accumulation function (1), an empirical relationship between non-pension wealth and accumulated pension wealth can be written as, for household i:

$$W_{i\tau} = \alpha + \beta R(\tau,r)P_i^T + \phi_E E_i(\tau) + \phi_R R(\tau,r)E_i^T + \phi\tilde{z}_{i\tau} + \varepsilon_{i\tau} \tag{2}$$

where α, β and ϕs are unknown parameters to be estimated from the data. The dependent variable $W_{i\tau}$ is non pension wealth. In addition to pension wealth P_i^T, life time earnings E_i^T and accumulated income up to the year of observation, $E_i(\tau)$, we include a vector of household characteristics $\tilde{z}_{i\tau}$ as well. We assume that family structure (number and age distribution of children) influences minimum consumption. Furthermore, we also believe that the education level will affect the propensity to plan further behavior and therefore savings (Ameriks etal, 2003). Therefore we assume that $\tilde{z}_{i\tau}$ include the number of children below age 17 and the average years of education of the husband and the wife.

Among the unknown parameters, the main concern is the parameter β which measures the "crowding out" effect of higher pension benefits/wealth

[3]The readers are referred to Hernæs and Zhu (2007) for a detailed discussion and derivation of the model.

on other types of household wealth. The classical life cycle model with perfect consumption will predict $\beta = -1$.

In this study for the dependent variable $W_{i\tau}$, we use financial (non-pension) wealth, which is available in the annual tax file. Hernæs and Zhu (2007) also look at another definition of non-pension wealth, namely the total non-pension wealth, which includes financial wealth, debt, and all kinds of assets including real estate. Since our main focus is to look at the heterogeneity of the offset effect, we choose to use financial wealth to avoid the complication caused by the potential problem related to housing wealth which is discussed in Hernæs and Zhu (2007).

As mentioned in Engelhardt and Kumar (2006), most offset studies have used wage regressions to impute the missing earnings history or simply include individual employment and demographic characteristics directly into the wealth accumulation functions. In this study, we take advantage of our register data, and construct the earnings history using a special pension right measure which is available from 1967. Based on these data, we estimate instead the pension right profiles, which are then used to predict future earnings in terms of pension points for an individual up to age 67 (normal retirement age). Construction of $E_i(\tau)$ and E_i^T is straightforward with these predicted earnings.

Pension wealth P_i^T is constructed according to the pension rules. There are mainly three types of pensions in Norway[4]: an old age pension from the National Insurance System (NIS), which all Norwegian residents are entitled to; occupation based pensions (OP), public and private, usually scheduled to start at age 67, supplement the NIS pension; an early retirement scheme (AFP), company based and covering the whole public sector and participating private sector companies. This study is limited to the non-AFP eligible individuals, for whom pension wealth is defined as the sum of NIS and OP.

[4] A description of the institutional setting in Norway can be find in Hernæs and Zhu (2007).

3 Data

3.1 Data sources

The empirical analysis is based on register data files covering all residents in Norway. TThese data, which are received from Statistics Norway with permission from the Data Inspectorate in Norway, are collected for administrative purposes, but are also used for construction of statistics and research. A unique, permanent, personal identification number for each resident in Norway allows linking over time and across registers. In the data sets received by the Frisch Centre, this number has been replaced by an encrypted number in order to preserve confidentiality. The data give information on gender, age, marital status, education, spells of work, employer, and spells of unemployment, spells of sickness, and spells of disability, retirement, income, wealth and social benefits. The data also link families. For the present study, we use the demographic file for the year 1997, the pension points file from 1967 onwards (the only file which starts before 1992), the employee register files over the period from 1992 to 1997 and the wealth files for period 1994 to 2003.

3.2 Samples

We restrict the sample by including only households where both husband and wife are employees. This is motivated by the assumption that self-employed are in a different setting with regard to pension. In particular, they are self-financing any pension apart from the mandatory inclusion in the Norwegian public pension system. It is well documented in the literature that married couples and single individuals have quite different preferences of saving. we would like to limit the influence of this type of heterogeneity, so only the married couples are included. For the same reason, we exclude also immigrant households. The age of the husbands are restricted to 45-50 in year 1997, which covers age 42 to 56 during period 1994 to 2003. As we discussed above, we only consider households where the husband is not eligible to the early retirement scheme (AFP). This result in a sample with

Variable	Mean	Std
Accumulated financial wealth to year of observation	951.32	4680.41
Age of household head at 1997	47.63	1.71
Accumulated life-time income, adjusted RE^T	5197.37	2143.12
Accumulated life-time pension, adjusted RP^T	979.56	413.09
Accumulated income to year of observation	10313.63	4853.82
Number of kids<17 years	0.95	1.02
Average education years of household	10.84	1.94

Table 1: Sample descriptive statistics

18258 households, and for each household we have 10 observations. The summary statistics of data used in this analysis can be found in Table 1[5].

4 The Unobserved Heterogeneity in wealth accumulation

4.1 An illustration of unobserved heterogeneity in offset effects.

To illustrate the unobserved heterogeneity in the offset effects, three subgroups are constructed using non pension wealth: low, middle and high wealth. The low wealth group is defined as those with financial wealth between 50,000 NOK and 500,000 NOK, the middle wealth group is defined as those in the interval [500,000, 3,000,000], and the high wealth group is defined as between 3 million and 10 million. Simple OLS regressions are performed based on the model (2), while controlling education, number of kids younger than 17 and life-time accumulated income etc on cross section data for year 1997. Table 2 shows clearly that the financial wealth changes differently not only at the levels(constant terms) but also at the slope β (offset effect). The big difference in constant term (intercept) means that the financial wealth differs in average levels for different wealth groups, which indicates possible heterogeneity among households. The differences between

[5] All income variables are measured in 1000 NOK. 5.4 NOK=1 USD in Jan, 2008.

Variable	low wealth	middle	high wealth
offset(β)	-0.016	-0.160	-0.269
constant	141.3	842.8	4230.3

Table 2: An illustration of unobserved heterogeneity in offset, OLS regression by financial wealth groups.

βs shows the possibility of the heterogeneity in offset effect of pension wealth on financial wealth.

There are many reasons that the household wealth accumulation differs across households. For example, Poterba, Venti, and Wise (2004) claim that individuals differ in "taste" for saving. Some households are "savers", some are not. Heterogeneity can also be caused by variation in the possibility of consumption smoothing. For example, low income households may have limited liquidity and face credit rationing which makes the offset negligible.

4.2 Modeling the heterogeneity

As illustrated above, there are clear evidences of unobserved heterogeneity in household wealth accumulations. This section will focus on modeling the heterogeneity.

4.2.1 The random effect setup

One way to incorporate this heterogeneity problem is to use the "random coefficient" setup, namely, we extend the basic model (2) and assume that[6]

$$W_{i\tau} = \alpha_i + (\beta + \eta_i)x_{i\tau} + \phi z_{i\tau} + \varepsilon_{i\tau}. \tag{3}$$

For notation simplicity, we can write $x_{i\tau} = R(\tau, r)P_i^T$ and put the earnings variable $E_i(\tau)$ and E_i^T together with individual characteristics $\tilde{z}_{i\tau}$. So z

[6] An important assumption I make here is that neither β or η_i is age dependent. Under this assumption, all the variation of offset effect across age is captured by $R(\tau, \rho)$. This assumption is certainly restrictive. A simple solution is to add an interaction term between age and pension wealth in formulation (3). However, I focus on heterogeneity across different individuals in this paper and have not explore further in this direction.

represents all other variables included in the regression.

In this specification, two important issues must be clarified before we can obtain a consistent estimate of β.

Possible correlation between x_i and α_i.

α_i is included to capture the individual specific effect on wealth levels. Even with same earnings, the household specific "taste" on saving may lead to different wealth accumulation patterns across different households. Savers enjoy accumulating all types of wealth, including pension wealth. As discussed in Poterba, Venti, and Wise (2004), Engelhardt and Kumar (2006) and Chernozhukov and Hansen (2004), this may result in correlation between x and α. When α_i correlated with x_i, OLS estimation on equation (3) will lead to an biased estimate of β even under the assumption that $\eta_i = 0$. This problem has long been recognized in the literature and many different methods have been proposed. Basically it involves either to use an instrument variable method on cross section data or apply a fixed effect model in panel data. Finding a proper instrument for this problem is not straightforward. Engelhardt and Kumar (2006) use a simulated instrument which is generated by constructing the pension wealth for a set of synthetic workers. Chernozhukov and Hansen (2004) use 401k eligibility as instrument for 401k participation. In this study, we avoid the difficulty of finding a valid instrument by making use of the panel data structure and a fixed effect model:

$$\Delta W_{i\tau} = (\beta + \eta_i)\Delta x_{i\tau} + \phi \Delta z_{i\tau} + \Delta \varepsilon_{i\tau}, \tag{4}$$

where $\Delta W_{i\tau}$ denote the deviation of non-pension wealth from it's average over the observation period. $\Delta x_{i\tau}$ and $\Delta z_{i\tau}$ are defined similarly. Note that household characteristics that are constant over time will drop out after the "demeaning".

The mean independence assumption $E(\eta|x, z) = 0$.

In contrast to most studies in the literature, we explicitly assume that the offset effect is individual specific by including a random effect η_i. In (3)

, the offset is defined as the partial effect of x_i on W_i, namely

$$\frac{\partial W_{i\tau}}{\partial x_{i\tau}} = \beta + \eta_i$$

Without loss of generality, it can be assumed that $E[\eta] = 0$. It follows that $E[\beta+\eta] = E(\frac{\partial W_{i\tau}}{\partial x_{i\tau}}) = \beta$. So β can be interpreted as the average partial effect (APE) of x, in our context, the average offset effect. However, to obtain a consistent estimate of the APE β, using standard OLS technique requires the assumption that η is mean independent of x and z, namely, $E(\eta|x, z) = 0$. This assumption is quite strong and implies that there is no correlation between observed household charateristics and the offset effect. As we argued above in the introduction, the empirical evidences do not support this assumption.

In this analysis, we relax this assumption and assume that η will correlate with time invariant household characteristics such as education level, life time accumulated earnings etc. In short, we assume that

$$E(\eta|x, z) = E(\eta|z^*) = \varphi z^*, \tag{5}$$

we can then rewrite

$$\eta_i = \varphi z_i^* + \tilde{\eta}_i, \text{ with } E(\tilde{\eta}|x, z) = 0. \tag{6}$$

So the wealth accumulation model (3) can be rewritten as

$$\begin{aligned} W_{i\tau} &= \alpha_i + (\beta + \varphi z_i^* + \tilde{\eta}_i)x_{i\tau} + \phi z_{i\tau} + \varepsilon_{i\tau} \qquad (7) \\ &= \alpha_i + \beta x_{i\tau} + \varphi x_{i\tau} z_i^* + \phi z_{i\tau} + \tilde{\varepsilon}_{i\tau}. \end{aligned}$$

where $\tilde{\varepsilon}_{i\tau} = \tilde{\eta}_i x_{i\tau} + \varepsilon_{i\tau}$.[7] Interaction terms $\varphi x_{i\tau} z_i^*$ are introduced into the wealth accumulation function to account for the unobserved heterogeneity. Of course, the assumption can be quite restrictive in two ways. First, the

[7] We see from this definition that the new error term will be both heteroscedastic and autocorrelated. Thus, OLS on this specification will be inefficient but it can still provide consistent and unbiased estimators.

redundant assumption that $E(\eta|x, z) = E(\eta|z^*)$ (i.e. only z^* enters into the conditional expectation) can be questioned. More importantly, the linear specification of $E(\eta|z^*)$ is a very simple maybe quite crude approximation of the more complex "true" relationship. Nonparametric analysis can be called into to solve this problem, as in Hægeland and Jia (2008) . However, there is a problem of curse of dimensionality and might be very computational demanding. For this reason, we will stick to the simple specification (5) in this paper. Under this specification, the fixed effect version of the wealth accumulation model (4), can be written as

$$\Delta W_{i\tau} = \beta \Delta x_{i\tau} + \varphi z_i^* \Delta x_{i\tau} + \phi \Delta z_{i\tau} + \Delta \tilde{\varepsilon}_{i\tau}. \tag{8}$$

Note that the above specification is only one of the possible ways to look at the heterogeneity in offset effects between private savings and public pension wealth.

4.2.2 Quantile Regression Method

Although above model (7) and (8) explicitly account for the heterogeneity in the offset effects between private savings and pension wealth, standard methods using variants of Least Squares will only report the mean effects. It says nothing about its spread, skewness and other more sophisticated statistics measures of a random variable and cannot provide a full picture of the relationship unless we impose quite restrictive conditions.

Quantile regression method introduced by Koenker and Bassett (1982) provide a solution to this problem by modeling the conditional quantiles. This method is a natural extension of the linear regression model. It is possible to achieve a more complete understanding of the relationship between the dependent variable and the explanatory variables. Unlike OLS coefficients, QR estimates capture changes in distribution shape and spread, as well as changes in location. This method is widely used in the literature to look at the heterogeneity responses. See for example, Arias, Hallock, and Sosa-Escudero (2001), Hallock, Mdalozzo, and Reck (2006) and others.

One may think that the simple illustrations at beginning of this section can be used for such a purpose as well. Namely, we divide the individuals into subgroups according to the dependent variable's unconditional distribution. However, Heckman (1979) argues that this "truncation of the dependent variable" may create biased parameter estimates and should be avoided. For the quantile regression, this problem does not arise, since quantile regression makes use of the full data set. See Zietz, Zietz, and Sirmans (2007) for a detailed discussion on this issue.

A quantile regression model corresponding to (7) assumes that the p^{th} conditional quantiles of wealth distribution can be written as:

$$Q^{(p)}\left(W_{i\tau}|x_{i\tau},z_{i\tau}\right)=\alpha_i^p+\beta^p x_{i\tau}+\varphi^p x_{i\tau}z_i^*+\phi^p z_{i\tau}, \tag{9}$$

where $0<p<1$ indicates the proportion of the population having a non pension wealth below the quantile at p. In contrast to OLS regressions, where we assume the conditional mean of the error term is zero, we assume that the p^{th}-quantile of the error terms is zero instead.

Note that the β^ps no longer have the interpretation that it is the conditional offset effects as β in equation (7). (For illustration purpose, we suppose for now the interaction terms $x_{i\tau}z_i^*$ do not enter the model). Namely

$$\beta^p \neq E\frac{\partial\left(W|x,z\right)}{\partial x}$$

Instead it measures the marginal contribution of covariate x to the conditional quantiles:

$$\beta^p=\frac{\partial Q^{(p)}\left(W|x,z\right)}{\partial x}$$

In fact, there is a link between β^p in the quantile regression (9) and β in the random coefficient model (7). If we assume that the p^{th} quantile of error term is 0, we have:

$$\beta^p=\frac{\partial Q^{(p)}\left(W_{i\tau}|x_{i\tau},z_{i\tau}\right)}{\partial x_{i\tau}}=\beta+\frac{\partial Q^{(p)}\left(\tilde{\varepsilon}_{i\tau}|x_{i\tau},z_{i\tau}\right)}{\partial x_{i\tau}}=\beta+G(p;x_{i\tau},z_{i\tau}),$$

where G is some transformation of the conditional distribution function of the error term. Here, β^p can be interpreted as a measure of "quantile partial effect" of pension wealth on private savings for a given $p \in (0, 1)$. Thus, quantile regression can be viewed as a specially formulated regression model with individual specific (conditional quantile specific, more precisely) parameters. It can also be used to study the differences of responses, although from a quite different perspective compared with the conventional random coefficient approach.

A test of the hypothesis of heterogeneity : $\beta^p = \beta$ for all p can be performed by testing whether the estimated offset effects differ across quantiles. This test does not impose any parametric distributional assumption on the error terms.

What makes our model differ from standard quantile regressions is the existence of the fixed effect α_i^p in (9). It is tempting to apply quantile regression technique directly on the demeaned equation (8). However, there is a serious drawback. The quantile regression estimators of the offset effect from a demeaned version will not reflect the change the pension wealth directly in private savings, since quantiles of the sum of two random variables are not equal to the sum of the quantiles of each random variable. A fixed effect quantile regression model has been introduced by Koenker (2004). Unfortunately, it seems that the solution of the linear programming problem generated by the fixed effect quantile regression model is quite demanding when the number of observations is large. Certain sparse matrix manipulation is needed to make the computation feasible. We are not able to stimate such a fixed effect quantile model in this analysis given our sample size. However, if the main purpose is to investigate whether there is evidence of individual heterogeneity in the offset effects of pension right, the complete fixed effect quantile model is not needed. If we reject the homogeneity hypothesis in the demeaned equation (8), we can safely reject the homogeneity hypothesis in the original equation (7).

5 Empirical results

This section presents the empirical results from the above analytical settings.

5.1 Results from OLS regressions

Table 3 shows the results from OLS regression based on the wealth accumulation specification (7). T-values generated using white's robust standard error estimates are presented in parentheses. Namely, we assume that the offset effects are individual specific and depend on both life time accumulated earnings and the education level of the household. The first column shows the regression result when we ignore the individual fixed effect, namely $\alpha_i = \alpha$. The second column uses the panel data setup (8) and tries to account for the fixed effect. Note that since we have subtracted the sample mean from both accumulated life-time income and education years when we interact them with pension, the coefficient associated with pension income β is an unbiased estimator of the average partial effect.

For the setting where the fixed effect is ignored, the estimated offset effect $\hat{\beta}$ is -0.324. The estimate of the average offset effect β for the model which accounts for the fixed effect (-0.529) is significantly lower. This suggests an average household will save about one third (or one half) Kroner less in other forms of wealth if the household knows he will get one Kroner more in the discounted life-time pension wealth. This difference indicates that ignoring the fixed effect may lead to the biased OLS estimates.

The significantly positive estimate of the coefficient associated with the interaction term between pension and income shows that if a household's accumulated life-time income exceeds the average, this household will offset less than the average household. Similarly, the positive estimate of the coefficient associated with the interaction term between pension and education suggests that the offset effect among the households with high educational levels is lower. Note that this result does not imply that low education and low income households will save more. In the contrary, it implies that given the same pension benefits, higher income household and higher educated household will accumulate more financial wealth.

Variable	OLS	Fixed Effect
Accumulated income till year of observation	0.066 (28.09)	-0.06 (-4.71)
Accumulated life-time pension, adjusted	-0.324 (-47.73)	-0.529 (-15.84)
Interaction term between pension and income/1000	0.022 (24.09)	0.070 (18.34)
Interaction term between pension and education	0.007 (4.58)	0.014 (3.45)
Accumulated life-time income, adjusted	-0.024 (-10.2)	0.17 (12.11)
Number of kids < 17 years old	12.19 (8.69)	
Average education years of households	13.91 (7.53)	
constant	266.9 (12.94)	
Note: T-values are presented in the parentheses.		

Table 3: Offset effect of pension wealth on financial wealth: Results from OLS and Fixed Effect Model

5.2 Results from quantile regression

To have more detailed picture of the heterogeneity of the offset effects, we also estimated the model (7) and (8) using quantile regression.

The model that ignores the fixed effect (i.e. we assume that $\alpha_i^p = \alpha^p$ for all i in (9)) is estimated for ten quantiles: $p = 0.1, 0.2, 0.3, ..., 0.8, 0.9$. The results are reported in Table 4. Bootstrapped standard errors of the estimates are reported in parentheses. Instead of having the mean offset effect, the quantile offset effects are obtained. They are defined as the derivative of the respective conditional quantile with respect to adjusted accumulated life-time pension (x), $\partial Q_p (W|x, z) / \partial x$. As the wealth accumulation equation includes interaction terms between adjusted accumulated life-time pension and demeaned accumulated life-time income (z_1^*) and adjusted accumulated life-time pension and demeaned education (z_2^*), the offset is given by:

$$\frac{\partial Q_p (W|x, z)}{\partial x} = \beta^p + \varphi_1^p z_1^* + \varphi_2^p z_2^* \quad (10)$$

As shown in Table 4, all of the estimates for β^pat different quantiles are significantly negative. Specifically, for an average household, we see that one more kroner in the accumulated pension wealth induces 0.055, 0.368 and 1.623 units less saving at quantile 0.10, 0.50 and 0.90 respectively. To indicate the offset effect for other households, we have calculated the quantile offset effect by using (10). Table 5 presents the offset effect of pension wealth on financial wealth by education and life-time income groups. Three income levels are considered: low accumulated life-time income which is one deviation lower than the mean, mean and high accumulated life-time income which is one deviation higher than the mean. Three education levels are considered, namely, 9, 12, 16 years of education. The trend of the offset effects across the wealth distribution is obvious: for all groups, the offset effect increases as the quantile rises. At the end of the wealth distribution, the offset effect more than one hundred percent for most of the groups.

For the case with fixed effect, as we mentioned before, we can not find the quantile offset effect of the conditional wealth distribution from the simple quantile regression on equation (8). Nonetheless, we still can estimate the offset effects across the conditional distribution of wealth change. Results are reported in Table 6. They are not directly comparable with results from Table 4. The quantile offset effects increases as we move from the lower quantile to higher quantile of the wealth change distribution. It is rather difficult to interpret this result since there is no direct link between the quantiles and the households. However, as discussed earlier, it is still of interest to test of the equivalence between the β^ps across quantiles.

The effects of accumulated income and eduction level on the offset effects are quite robust across all the OLS and quantile regressions. Namely higher accumulated income and higher education will induce more private savings given the pension wealth.

5.3 Tests for equivalence of the offset effects across quantiles

Obviously, the differences between quantiles are numerically apparent. However, whether this apparent heterogeneity is statistically significant needs further investigation. Therefore, a Wald test is used to test the equivalence of any pair of the coefficients β_p and β_q corresponding to the same covariate

Quantile	Quantile offset effect for average households	Effect of life time Accumulated income/1000	Effect of household average education
0.1	-0.055 (-30.21)	0.008 (26.9)	0.003 (4.84)
0.2	-0.104 (-35.88)	0.012 (33.19)	0.006 (5.23)
0.3	-0.164 (-45.17)	0.017 (30.15)	0.010 (8.46)
0.4	-0.251 (-56.55)	0.024 (34.6)	0.014 (9.20)
0.5	-0.368 (-68.5)	0.031 (44.92)	0.020 (9.55)
0.6	-0.533 (-61.12)	0.042 (39.38)	0.030 (8.23)
0.7	-0.783 (-55.99)	0.061 (38.5)	0.043 (10.42)
0.8	-1.163 (-55.93)	0.098 (36.87)	0.063 (8.56)
0.9	-1.623 (-27.75)	0.211 (29.07)	0.109 (5.36)
Note: T-values are presented in the parentheses.			

Table 4: Quantile Regression Results, without fixed effect

Accu. life time earnings	Years of edu.	Quantile								
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
3 054	9	-0.08	-0.14	-0.22	-0.33	-0.47	-0.68	-0.99	-1.49	-2.05
5 197	9	-0.06	-0.11	-0.18	-0.28	-0.40	-0.59	-0.86	-1.28	-1.60
7 340	9	-0.04	-0.09	-0.15	-0.23	-0.34	-0.50	-0.73	-1.07	-1.14
3 054	12	-0.07	-0.12	-0.19	-0.29	-0.41	-0.59	-0.86	-1.30	-2.04
5 197	12	-0.05	-0.10	-0.15	-0.24	-0.35	-0.50	-0.73	-1.09	-1.59
7 340	12	-0.03	-0.07	-0.12	-0.18	-0.28	-0.41	-0.60	-0.88	-1.13
3 054	16	-0.06	-0.10	-0.15	-0.23	-0.33	-0.47	-0.69	-1.05	-2.02
5 197	16	-0.04	-0.07	-0.11	-0.18	-0.27	-0.38	-0.56	-0.84	-1.57
7 340	16	-0.02	-0.05	-0.07	-0.13	-0.20	-0.29	-0.43	-0.63	-1.12

Table 5: Offset effect of pension wealth on financial wealth at different wealth quantiles, by education and income groups

Quantile	Quantile offset effect for average households	Effect of life time Accumulated income/1000	Effect of household average education
0.1	-0.144 (-4.45)	0.014 (4.5)	-0.007 (-1.46)
0.2	-0.224 (-10.33)	0.021 (11.11)	0.01 (4.1)
0.3	-0.225 (-13.01)	0.026 (14.49)	0.018 (7.98)
0.4	-0.218 (-12.31)	0.029 (18.54)	0.022 (13.05)
0.5	-0.226 (-16.46)	0.031 (23.57)	0.025 (15.55)
0.6	-0.259 (-18.73)	0.032 (28.8)	0.023 (12.03)
0.7	-0.292 (-18.44)	0.032 (21.47)	0.021 (9.2)
0.8	-0.314 (-14.84)	0.032 (13.9)	0.016 (5.43)
0.9	-0.315 (-8.75)	0.033 (8.75)	0.004 (0.92)
Note: T-values are presented in the parentheses.			

Table 6: Quantile regression results: fixed effect model

but across distinct quantiles p and q. The null hypothesis is:

$$H_0: \quad \beta_p = \beta_q \tag{11}$$

Then the wald statistic is:

$$Wald \text{ statistic=}\frac{(\hat{\beta}_p - \hat{\beta}_q)^2}{\hat{\sigma}^2_{\hat{\beta}_p - \hat{\beta}_q}} \tag{12}$$

where $\hat{\sigma}^2_{\hat{\beta}_p - \hat{\beta}_q}$ is the estimated variance of the difference $\hat{\beta}_p - \hat{\beta}_q$, which is calculated as follows:

$$\hat{\sigma}^2_{\hat{\beta}_p - \hat{\beta}_q} = \hat{\sigma}^2_{\hat{\beta}_p} + \hat{\sigma}^2_{\hat{\beta}_q} - 2\hat{\sigma}_{\hat{\beta}_p, \hat{\beta}_q} \tag{13}$$

where $\hat{\sigma}^2_{\hat{\beta}_p}$, $\hat{\sigma}^2_{\hat{\beta}_q}$, and $2\hat{\sigma}_{\hat{\beta}_p, \hat{\beta}_q}$ are estimated variances of $\hat{\beta}_p$ and $\hat{\beta}_q$and co-variances of these two, which can be obtained from the simultaneous estimation of regression for all the quantiles, both variance and covariance are estimated. Under the null hypothesis (11), the Wald statistic distributes approximately χ^2 distribution with one degree of freedom.

The Wald tests are performed on parameter $\hat{\beta}_p$ which is associated with the accumulated pension wealth. Two tests are performed for each quantile estimates: (1) test of the equality between the estimates at pth quantile

	Panel A: Different from offset at $(p+0.1)^{th}$ quantile?	
Quantile	Without fixed effect	With fixed effect
0.1	306.47 (0.000)	20.19 (0.000)
0.2	664.12 (0.000)	0.01 (0.931)
0.3	838.71 (0.000)	0.69 (0.406)
0.4	1458.86 (0.000)	1.37 (0.242)
0.5	722.58 (0.000)	35.10 (0.000)
0.6	704.97 (0.000)	29.68 (0.000)
0.7	746.18 (0.000)	6.07 (0.014)
0.8	80.94 (0.000)	0.00 (0.956)
0.9		
	Panel B: Different from offset at median, 0.5^{th}quantile?	
	Without fixed effect	With fix effect
0.1	3359.55 (0.000)	9.05 (0.003)
0.2	2758.55 (0.000)	0.01(0.910)
0.3	2477.08 (0.000)	0.01(0.941)
0.4	1458.86 (0.000)	1.37 (0.242)
0.5		
0.6	722.58 (0.000)	35.10 (0.000)
0.7	1179.36 (0.000)	83.04 (0.000)
0.8	1757.20 (0.000)	60.95 (0.000)
0.9	456.400 (0.000)	9.53 (0.002)
p-values are given in the parenthesis		

Table 7: Tests of equivalence of offset effect across quantiles of wealth

against those at $(p + 0.10)$th quantile:

$$H_0 : \quad \beta_p = \beta_{p+0.10}$$

(2) test of the equality between the estimates at pth quantile against those at the median:

$$H_0 : \quad \beta_p = \beta_{0.5}$$

Panel A in Table 7 presents the equivalence tests for the β_p and $\beta_{p+0.10}$. The p-values show that the offset effect of pension wealth on financial wealth differs across quantiles for the random effect model. While for the model with fixed effect, β_p statistically differs from $\beta_{p+0.10}$ for some p, although not for all p, we can still reject the hypothesis that β_p equivalent for all quantiles. To be specific, we perform a joint test:

$$H_0 : \quad \beta_p = \beta \text{ for all } p \in \{0.1, 0.2, ..., 0.9\}$$

The null hypothesis is overwhelmingly rejected.

Panel B illustrates the equivalence tests for β_p and $\beta_{0.5}$. The p-values tell that β_p is significantly different from $\beta_{0.5}$ when there is no fixed effect in the model. When fixed effect taken into the model, β_p is significantly different from $\beta_{0.5}$ only for quantiles above 0.50. Again, we can conclude that there is heterogeneity in offset effect across wealth distribution even when we take into account individual fixed effect and random effect.

6 Conclusion

The main focus of this paper is to study the unobserved heterogeneity in the offset effect of pension wealth on non-pension wealth. Most studies in the literature have been more concerned on the mean effect and little attention paid to whether and how the effects differ across different households.

We used both standard regression and quantile regression techniques to look at this question based on Norwegian data. Our fixed effect model estimates suggest that both education level and (expected) life time earnings influence the offset effect. Using quantile regression techniques, we try to look at how the offset effect vary over the conditional distribution of the household wealth (changes of household wealth). The equivalence tests of the offset effect across quantiles show that there is heterogeneity in offset effects, even after we control for the effects of life time earnings and education level on the offset effect.

The existence of the heterogeneity suggests that typical estimates of the mean offset effect of pension wealth on non-pension wealth based on OLS provide a rather incomplete characterization of the impact of pension wealth on non-pension wealth and may provide a biased signal for the policy makers. This also indicates that pension reforms have to take into this heterogeneous response to the change of pension entitlements into account.

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Appendix: Institutional Setting in Norway[8]

From age 67, all Norwegian residents are entitled to an old age pension from the National Insurance System (NIS), which is an unfunded pay-as-you-go public pension (see The Ministry of Labour and Social Inclusion, 2008 for details). In addition to a basic component, there is an earnings related component, based on the 20 best years of pension accruing income and requiring 40 years with annual earnings above a minimum level ("G") to be paid in full. Fully matured, the current rules and income distribution imply a NIS pension bounded between a minimum pension at 1.8 G (approximately 35 per cent of average full time earnings) and a maximum pension at 3.93 G (approximately 72 per cent for average full time earnings). The "marginal return" in the form of increase in the NIS pension on an increase in the earnings level over the 20 accruing years, is 42 per cent up to 6 G, around average full time earnings, and thereafter 14 percent up to maximum pension accruing income (12 G), which is around 2.2 times average full time earnings. In contrast, contributions are levied proportionally on employees, on employers and on self employed, up to maximum pension accruing income.

Because benefits are not linked to contributions, neither at the individual level nor in government budgets, we assume that people view their contribution just as a tax, and consider benefits as an exogenous income stream. Some support for this assumption can be found by Kotlikoff (1979) who does not find clear evidence whether people in the US viewed contributions as savings or just another tax.

Occupation based pensions (OP), public and private, usually scheduled to start at age 67, supplement the NIS pension. The public sector OP is fully integrated with the NIS so that the total pension is the maximum of the NIS pension and 66 percent of final annual salary. In the private sector, the occupational pensions are company based and cover more than half the labour force in the observation period. During the observation period, most programmes were of the DB type, although there is a trend towards DC.[9]

[8] This section draws heavily from Hernæs and Zhu (2007).

[9] By the end of 2006, all private companies with at least two employees are required to

Contributions to occupational pensions, which are funded, are paid by the employers, and calculated to give an old age pension which together with the stipulated NIS pension is a certain percentage of final wage, often 66 %. To be tax-preferred, programmes must cover all employees in the company, and most programmes include disability and survivor insurance. For more details, see Hernæs et al. (2006) , Hernæs and Zhang (2006). We assume that employees do not view contributions as savings and view OP benefits as exogenous income.

There is also an early retirement scheme (AFP), company based and covering the whole public sector and participating private sector companies, presently comprising more than half of all private sector employees. The age of eligibility was gradually reduced from 66 at the start in 1989 to 62 from 1 July 1997. In addition to working in an AFP company, individual eligibility also depends on the income history. The amount of benefit in early retirement is identical to the NIS benefit up to age 67 for private sector retirees and up to age 65 for public sector retirees, when the latter start receiving their old age pension at 66 per cent of final salary. For early retirees, old age pension is calculated after prolonging normal earnings up to age 67, and taking up early retirement does not affect old age pension. The retirement decision is made by the employee, and there are indications that economic incentives as well as company characteristics are important for the decision (Hernæs, Iskhakov, and Strøm 2006).

The cost of the early retirement programme is split between the government, pooled contributions from participating employers and contributions from the company of the incumbents. We also assume that employees view the early retirement benefit as exogenous income, but we will take the conditional nature of this entitlement into account.

In 1999, 66 per cent of average pre-tax income among old age pensioners came from the NIS (Andersen et al. 2002). Other pensions, mostly occupation based (including public sector pensions) made up 17 per cent of pre-tax income, capital income made up 11 and labour earnings 4 per cent. Hence

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have an OP, either defined benefit (DB) or defined contribution (DC), and the minimum level is the equivalent of a 2 % DC exclusive of administration cost.

the NIS plays a very important role as income source for the elderly, although other pensions and capital income also play a role.