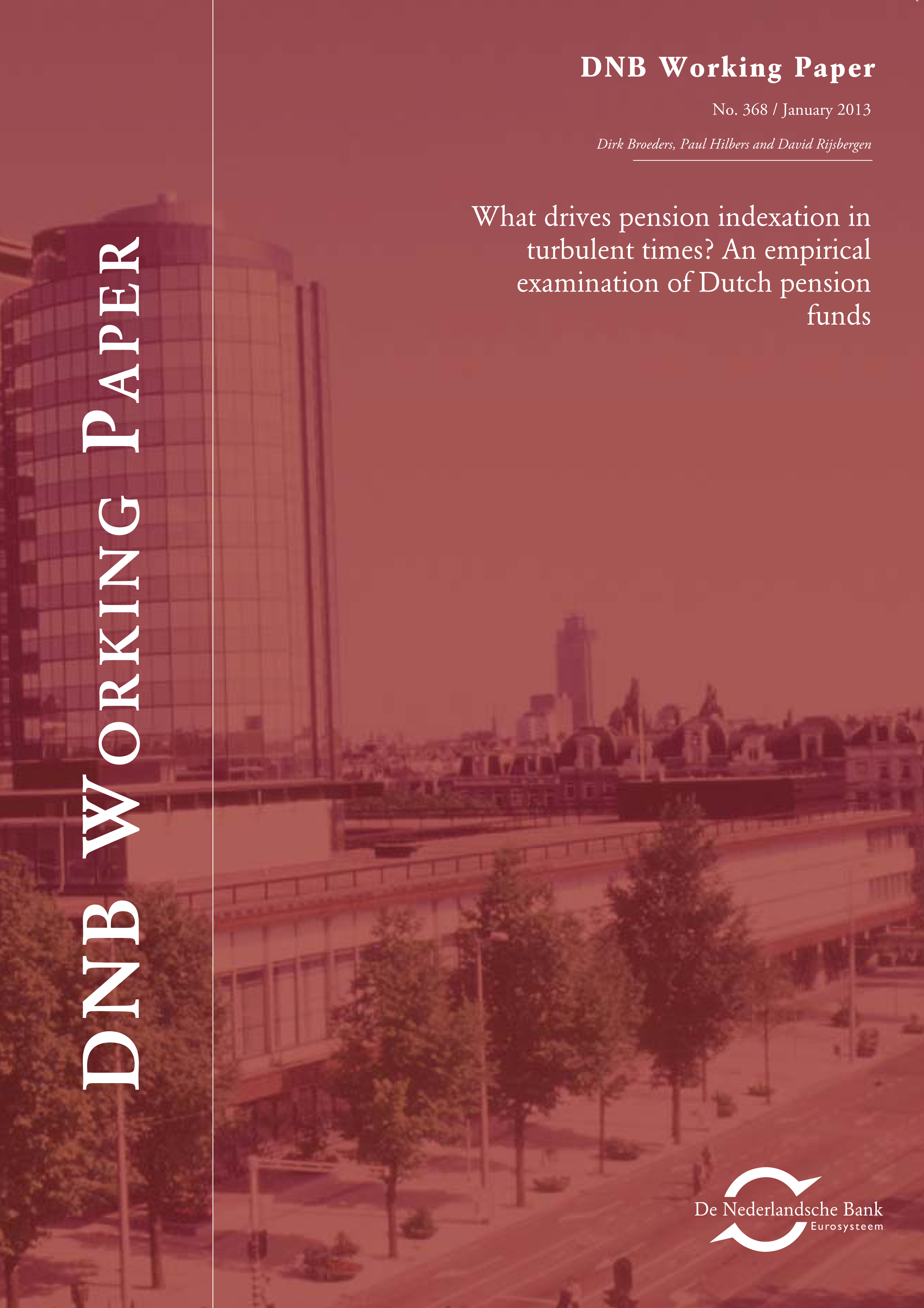

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* Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank.

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What drives pension indexation in turbulent times? An empirical examination of Dutch pension funds

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Abstract. This paper identifies the key factors driving indexation in turbulent economic times within defined benefit plans using a unique panel dataset of 166 Dutch pension funds from 2007 to 2010. Key drivers of indexation are the funding ratio, inflation and real wage growth. The type of pension fund and the interest rate exposure are also statistically significant, although the latter effect is nonlinear. The asset allocation has no significant effect on the level of provided indexation as this is already captured by the funding ratio. We also examine the relation between policy ladders and the actual level of provided indexation. This study finds that a policy ladder with an upper limit equal to a 100 percent real funding ratio is able to predict the actual level of indexation more accurately than a ladder with an upper limit based on a pension fund's required funding ratio.

Keywords: Indexation, policy ladders, defined benefit plans

JEL-Codes: G12, G13, G23

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1. Introduction

'Most economists using a standard life-cycle analysis would probably agree that the primary objective of a pension system is to provide a standard of living in retirement comparable with that enjoyed during the working years.' (Merton, 1983)

This paper contributes to existing literature by empirically examining the factors driving indexation in defined benefit plans during turbulent economic times. Pension schemes aim to maintain the standard-of-living of individuals after retirement. Decisions on indexation have an impact on the purchasing power of individuals. The level of indexation, for instance, has an important impact on the income of retirees and the pension accrual of active members in pension plans. Analyzing the factors driving indexation is therefore important, especially in the Netherlands, since the Dutch occupational pension system is relatively large and well-developed. As such, decisions on indexation have an impact on macro-economic developments in the Netherlands.

Given the long duration of pension contracts, beneficiaries typically face substantial inflation risk which may erode the purchasing power of their pension benefit.[1] Defined benefit plans aim to minimize this risk by means of indexation. Indexation is the adjustment of pension benefits to reflect changes in costs and standards of living. Pension income is typically related to the wage path during an individual's career (or to final pay), and usually indexed to inflation to protect purchasing power or to wage inflation to track the general increase in income (Beetsma and Bucciol, 2011). Indexation thus provides individuals with a real pension which is of great importance to pension beneficiaries. Without indexation, e.g., the real income of a pensioner with a remaining life expectancy of 15 to 20 years decreases by 25 to 33 percent if the average annual inflation rate is 2 percent.

Indexation is also an important feature in the Dutch occupational pension system. In the Netherlands, most pension arrangements are career average defined benefit plans with so called contingent indexation. This implies that only the nominal benefits are secured, while pension funds have the intention to annually provide (wage or price) indexation.

[1] Beneficiaries are also exposed to other risks, such as market risk, interest rate risk and longevity risk. This paper focusses on inflation risk.

Indexation, however, is typically made contingent on the funding level of the pension fund. Typical of contingent indexed liabilities is that the indexation of benefits depends on a future decision to be taken by the pension fund's board. The fulfillment of the indexation in practice depends on the financial position of the pension fund. If financial resources are abundant, indexation is fully granted. However, if the financial resources are poor, the pension fund might choose not to fully index pension benefits. This is often determined by a so-called policy ladder, which is part of the pension contract (Ponds and Van Riel, 2009). A policy ladder explicitly relates the level of granted indexation to the financial position of the pension fund.[2]

However since the financial crisis of 2008, Dutch pension funds find it increasingly difficult to grant indexation and fulfill their indexation ambitions. Table I presents the level of granted indexation as well as the indexation ambition for the 25 largest Dutch pension funds between 2007 and 2011. The table indicates that the granted level of indexation is substantially lagging the indexation ambition for both active members and pensioners since 2009. Over the entire period, active members and pensioners have only been granted approximately half of their indexation ambition, resulting in a decline in purchasing power of about 5 percent.

The difficulty to provide indexation can be attributed to several underlying causes. The first is the global financial crisis, which has severely affected the funding ratio of many pension funds through declining equity prices and lower discount curves increasing the value of liabilities. However, even before the financial crisis, pension funds faced a structural decline in their risk-bearing capacity due to demographic trends such as an ageing population and a lower proportion of younger people in the workforce, making it more difficult for pension funds to absorb risks through an increase in contributions (Broeders and Rijsbergen, 2010). The subsequent structural deterioration in the financial position of pension funds has hampered their ability to grant indexation during the last decade. At the same time, the Dutch pension system witnessed a transition from final pay to average pay schemes with contingent indexation. This transition created the option for pension funds to not only reduce indexation for pensioners in case of underfunding, but also apply indexation cuts for

[2] Note that the board of trustees typically has discretionary power to deviate from the policy ladder.

active members. As a result, indexation cuts became a more powerful and widely used instrument for pension funds to restore their financial position after the crisis.

<Insert Table I here>

Not surprisingly, pension fund indexation policies and the use of policy ladders have received significant academic attention. Several papers use extensive models to simulate indexation. Bikker and Vlaar (2007) use a stochastic pension asset and liability model to analyze to what extent indexation is likely to be granted in the Dutch context, given different indexation and contribution policies. One of their results is that the likelihood of indexation depends on earmarking reserves for indexation[3] and mark-ups on the cost-effective contribution level (Bikker and Vlaar, 2007). Other studies use simulation models to explore indexation policies in the context of optimal individual lifecycle investing. Ponds and Molenaar (2009) examine an age-dependent indexation policy which is partly related to the investment performance of the pension fund and partly related to wage growth, with the weight attached to the investment performance gradually declining with the age of the participant. This alternative comes close to what Beetsma and Bucciol (2011) call 'market-contingent' indexation. They analyze several non-uniform indexation policies and find that, at the aggregate level, only a 'market-contingent' indexation outperforms the traditional uniform indexation policy.

Bikker, Knaap and Romp (2011) use empirical data and model aggregate policy responses to changes in the funding ratio of Dutch occupational pension funds for the period 1993 to 2007. In general, they find that pension rights increase with the funding ratio. The authors also examine additional explanatory variables and find that both 'grey' and large pension funds tend to offer higher benefits to their participants.

The *first* goal of this paper is to contribute to existing literature by empirically examining the factors driving indexation in defined benefit plans during turbulent economic times. To do so, this study uses a unique panel dataset containing indexation data for 166 registered Dutch pension funds during the years 2007 to 2010. The sample period in our study starts

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[3] Note that Dutch pension funds are not required to determine the value of their indexation policy and to reserve assets for that purpose. In most cases, indexation is financed from investment returns.

in 2007 due to a lack of available data.[4] Moreover, we also examine whether pension fund characteristics such as size, type, age profile and asset allocation have an impact on the level of provided indexation.

A *second* objective of this study is to assess the accuracy of policy ladders in predicting the actual level of indexation. Though several studies have modeled hypothetical policy ladders to proxy the indexation levels (see, e.g., Ponds and Van Riel, 2009), they provide no empirical evidence on the plausibility of doing so. In order to assess the validity of such models, this paper replicates policy ladders as they are typically modeled and then empirically examines their accuracy in predicting actual indexation. Our sample period contains turbulent years due to the financial crisis, which provides an excellent period to examine the accuracy of policy ladders.

The remainder of this paper is structured as follows. Section 2 describes the structure of the Dutch pension system. Section 3 introduces the dataset and the explanatory variables that we use in our analysis. Section 4 explains the methodology and presents the empirical results regarding the drivers of indexation. The results for our policy ladder analysis are presented in Section 5. Our conclusions are set out in the final section.

[4] Furthermore, prior to 2004, many Dutch pension funds had final-pay plans which de facto provided unconditional indexation to active members.

2. Indexation in the Dutch pension system

Like many pension systems, the Dutch pension system consists of three pillars. Public pension schemes form the first pillar which is financed on a pay-as-you-go-basis. It offers a flat-rate pension to all Dutch inhabitants above the official retirement age. The second pillar consists of funded occupational pension plans with mandatory participation for employees. The Dutch occupational pension system is relatively large in terms of size. At the end of 2011, the value of assets under management amounted to approximately 802 billion euro, or little over 133 percent of Dutch gross domestic product (GDP). Moreover, several academic studies highlight the welfare-enhancing potential of collectively organized occupational pension funds. Due to the mandatory nature, individual participants of occupational pension funds benefit from low costs due to economies of scale (Bikker and De Dreu, 2009). In addition, mandatory participation potentially also leads to welfare benefits due to intergenerational risk sharing, as pension funds are able to share funding surpluses and deficits with future generations (Cui, De Jong and Ponds, 2011). Finally, the third pillar of the Dutch pension system is made up of private retirement savings accounts, which individuals undertake on their own initiative. This covers tax-favored pension saving, such as life annuities.

The occupational pension system in the Netherlands, which is the focus of this paper, is organized mainly in the form of funded defined benefit (DB) plans. As of 2011, approximately 94 percent of total participants were enrolled in a defined benefit plan. The benefit entitlement in these plans is determined by years of service and a reference wage, which may be final pay or the average wage over the years of service. Historically, pension plans in the Netherlands were generally structured as final pay DB plans with (*de facto*) full indexation at all times. After the turn of the century, pension funds suffered a decline in funding ratios. In order to improve their solvency risk management, many pension funds switched from the final pay plan structure to average-pay plans with contingent indexation. As a result, most Dutch participants in DB plans nowadays receive a benefit entitlement based on average wage over the years of service (about 97 percent in 2011).

Pension funds typically adjust contributions and indexation of accrued benefits as instruments to restore the funding ratio. Whereas higher contributions weigh on active participants, lower indexation hurts older participants most because accumulated pension benefits are increasing over an individual's working life. Furthermore, retirees and those close to retirement are left with little or no labor flexibility to make up for a loss of indexation. Hence, these groups are at particular risk under policies that resort to indexation cuts in order to restore the funding ratio (Beetsma and Bucciol, 2011).

In many cases, indexation is ruled by a so-called policy ladder, with indexation (and contribution) tied to the funding ratio (Ponds and Van Riel, 2009). In addition, pension fund boards have the discretionary power to deviate from the policy ladder under specific circumstances. This implies that although pension funds may have an ambition to provide indexation, their boards still annually review whether they will actually provide indexation and how much. Members therefore cannot derive prior rights from indexation and pension funds are not required to accumulate technical provisions for indexation in the Dutch supervisory framework (Broeders and Pröpper, 2010). Instead, they must strive for consistency between the expectations raised, the level of financing achieved and the degree to which contingent claims are awarded to members. This consistency needs to be grounded by the application of a long-term stochastic continuity analysis. In addition, pension funds are required to disclose their indexation ambitions to their members, including a realistic estimate of the likelihood that they are able to fulfill this ambition (Bikker and Vlaar, 2007).

<Insert Table II here>

Table II presents the indexation base for average-pay schemes in the Netherlands between 2007 and 2011. The predominant base for active members is related to wage movements as about 75 percent of Dutch pension participants have an indexation ambition that is tied to industry wage movements. The indexation base for pensioners, however, is more diversified. Little over half of the total pensioners have a pension plan that follows (industry) wage movements, while the indexation ambition for more than 40 percent of the pensioners is tied to overall price movements (CPI). As Table II displays, these percentages have been relatively stable over the last years.

3. Data

We use a detailed dataset with yearly information on 166 Dutch pension funds from 2007 to 2010. On average, these account for more than 85 percent of the total assets under management of all Dutch pension funds during the sample period. The data is from De Nederlandsche Bank, responsible for prudential supervision of pension funds. The sample is an unbalanced panel, as not all pension funds reported data for the entire sample period due to mergers and liquidations. We exclude inconsistent observations and observations with clear reporting errors.

3.1 Definition of variables

The dependent variable in our analysis is the indexation level. As pension funds may distinguish between active members and non-active members (retirees and sleepers[5]), we differentiate between both. In our analysis we use different types of explanatory variables.

External variables

The indexation is of course first and foremost determined by the level of inflation or wage growth. For *inflation* we use the annual consumer price index (CPI) for the Netherlands. With regard to *(real) wage growth*, Table II indicates that most pension funds relate their indexation target to industry specific wage growth. However, due to the impossibility of identifying industry wage growth target for each pension fund in our sample, we use aggregate national wage growth as an approximation. To prevent multicollinearity problems generated by the high correlation between wage growth and CPI we use real wage growth in the analysis instead.[6]

Pension fund specific variables

The *funding ratio* is another key explanatory variable as for most Dutch pension fund indexation is contingent on the financial position of the pension fund. The policy ladder creates a one-on-one relation between the funding ratio and indexation. This relation is 'kinked' around the minimum required funding ratio (of 105 percent) below which pension

[5] Retirees and sleepers are legally required to have the same level of indexation, while the active members' indexation could be different.

[6] During our sample period, the observed correlation between the annual inflation rate (CPI) and wage growth is 0.53.

funds are not allowed to provide indexation at all, and an upper boundary above which funds provide full indexation.

In addition to the funding ratio, this study also examines whether other pension fund characteristic variables influence the level of indexation. In particular, we investigate the size of the pension fund, the type of pension fund and the age profile of the pension participants.

Size might influence the level of indexation in two manners. First, large pension funds might profit from economies of scale and subsequently be able to provide, on average, higher indexation. Bikker and De Dreu (2009) and Bikker (2013) find that economies of scale can explain most of the variation in both investment costs and administration costs across Dutch pension funds. On average, their study suggests that an increase in the size of pension funds by 1 percent leads to a rise in administration costs of only 0.64 percent and a rise in investment costs of only 0.78 percent. In addition to economies of scale, the size of a pension fund can also influence indexation through the sophistication of their investment policy. De Dreu and Bikker (2012), for instance, observe less sophisticated investment policies in medium and small sized pension funds. With data from 1996 to 2006, they find that smaller pension funds tend to exhibit limited diversification and a stronger home bias. Although De Dreu and Bikker (2012) do not evaluate whether it is more rewarding to adopt a sophisticated investment policy, they do point out the possibility that large pension funds suffer from overconfidence. Hence, it might be possible that large pension funds exhibit more generosity in granting indexation, either because large pension funds are more overconfident about their investment skills or because they indeed have superior investment skills. In this study, we measure the size of pension funds by using the logarithmic value of the technical provisions.

The *type* of pension fund might also influence the level of indexation. In the Netherlands, there are three types of pension funds. The first is the industry-wide pension fund, organized for a specific sector of industry (e.g., the government or the health care sector). Participation in an industry-wide pension fund is mandatory for all firms operating in the sector.[7] Unlike industry-wide pension funds with mandatory participation and standardized uniform pension benefits, companies with corporate pension funds may need to compete for employees by offering attractive pension arrangements (Clark and Bennett, 2001). This competition for employees may result in a more attractive indexation policy within corporate pension funds. Finally, the third type of pension fund is the professional group pension fund, organized for a specific group of professionals such as doctors and pharmacists.

The *age profile* of the pension participants is also a relevant explanatory variable. Life-cycle models predict that the equity allocation of pension funds is lower when the beneficiaries are on average older. Hereby age acts as a proxy for human capital. The key argument is that young workers have more human capital than older workers. As long as the correlation between labor income and stock market returns is assumed to be low, young workers may better diversify away equity risk with their large holding of human capital. This model is described, e.g., in Bodie, Merton and Samuelson (1992) and Campbell and Viceira (2002).[8] Bikker et al. (2012) confirm that Dutch pension funds with a higher average age of participants have significantly lower equity exposures than funds with younger participants. We model the age profile of a pension fund through two variables, namely the average age of all active members in the pension fund and the average age of all pensioners in the fund.

Asset allocation variables

In the Netherlands, indexation is typically financed from investment returns. Therefore it might seem obvious to include asset allocation variables in our model. Even when other factors like the funding ratio are the same across pension funds, differences in asset allocation might lead to different levels of indexation. While the funding ratio reflects the actual financial position of a pension fund, the asset allocation may predict the performance in the future.

[7] An industry-wide pension fund loses its mandatory status if a pension fund fails a performance test based on the so-called Z-score. Participating companies can then opt out and either establish their own fund or join another pension fund.

[8] Benzoni, Collin-Dufresne and Goldstein (2007) offer a contradicting view on age and asset allocation by arguing that labor income and capital income are highly correlated in the long run.

Pension funds typically invest a (significant) portion of their investment portfolio in risky assets such as equities under the assumption that these investments exhibit a positive correlation with inflation.[9] This is based on conventional finance theory which states that equities should provide an effective hedge against inflation as they represent ownership of the income generated by real assets (Fama, 1981). The inflationary hedging characteristics of common stocks, however, are debated. Bodie (1976) and Fama and Schwert (1977), for instance, document negative relations between real stock returns and both the expected and unexpected components of inflation. Moreover, Bekaert (2009) examines the relation between (nominal) stock returns and inflation in 60 countries and finds a negative relation between stock returns and inflation in 48 of the 60 investigated countries. Even on a longer horizon, the relation between stock returns and inflation is unclear. Steehouwer (2005), for example, documents a positive relation between stock returns and inflation on a long horizon. Attie and Roache (2009), however, examine the relation between stock returns and (unexpected) inflation and stock returns and find that equities suffer short-term losses from an inflation shock from which they consequently fail to recover over the longer term. If equities provide a long-term hedge against inflation, we hypothesize that pension funds with a higher allocation towards common stock should be able to provide more indexation than funds with a lower equity allocation. We, therefore, include the equity allocation of pension funds as a variable in our sample.

Furthermore, we also include the allocation towards real estate in our sample, as real estate is also generally viewed as a hedge against inflation. Fama and Schwert (1977) examine the relation between residential property and inflation and find that the asset class provided a complete hedge against both expected and unexpected inflation between 1953 and 1971. More recent papers somewhat nuance these findings. In the Netherlands, for instance, Kapiteyn and Worms (2009) find a positive correlation of 0.417 between returns on direct real estate and inflation during 1995 and 2008.

Finally, we also examine the relation between the interest rate exposure of a pension fund and its ability to provide indexation. To reduce the volatility of the funding ratio, pension funds can opt to hedge interest rate risk in the domestic or international capital markets

[9] Note that this is typically not the only argument for pension funds to invest in equities. A belief in mean reversion of equity returns over the long run might also be used as an argument. Bodie (1995) caves the validity of this argument.

using long-term bonds or derivatives to lengthen the duration of their assets so that they are better matched with the duration of their liabilities. This form of interest rate hedging mainly applies to nominal liabilities as it is difficult for pension funds to fully hedge inflation risks via the capital markets.[10] However, hedging nominal interest rate risk leads to only moderate protection in real terms as nominal and real funding ratios typically react differently to inflation shocks (Broeders and Rijsbergen, 2009). We, therefore, hypothesize that a pension funds at least need some interest rate exposure to be able to provide indexation. We define interest rate exposure as the difference between the value increase of the liabilities and fixed income assets when market interest rates drop by 1 percentage point. This interest rate sensitivity is based upon figures provided by pension funds regarding their solvency requirements.

3.2 Descriptive statistics

Table III presents the mean and standard deviation of the variables used in this study for all four years in the sample period (2007 – 2010). As Table III highlights, the average level of indexation has steadily declined during this period. On average, the indexation for active members has dropped from 2.5 percent in 2007 to 0.5 percent in 2010. At the same time, the average level of indexation also declined for inactive members from 1.8 percent in 2007 to 0.3 percent in 2010. The observed fallback in indexation is related to the deterioration of the financial position of Dutch pension funds after the financial crisis. Table III, for instance, reports that the average funding ratio for pension funds in our sample declined from 143.5 percent in 2007 to 106.4 percent in 2010.

<Insert Table III here>

Table III also illustrates the ageing of the Dutch pension population. Although the average age of active members remained relatively stable, we see that the average age of pensioners increased by almost 0.8 years between 2007 and 2010. This reflects the ageing society during the sample period. Furthermore, Table III reports some interesting trends in the asset allocation variables. After the large drop in equity prices in 2008, pension funds on average invested less than 25 percent of their portfolio in equities. In the next two years, the

[10] Instruments such as inflation-linked bonds, inflation swaps and inflation-linked structured products exist, but in practice their availability is limited and they typically have low liquidity.

proportion of equities gradually increased to about 30 percent due rebalancing strategies and a general recovery of stock prices. However, this was still below the 2007 level of 35 percent. The allocation towards real estate, on the other hand, remained relatively stable during the sample period.

To illustrate the descriptive statistics of our sample graphically, we also include two figures. Figure 1 depicts the average indexation of active and inactive members versus wage growth, CPI and the average funding ratio. Panel A.1 presents the mean indexation of active members compared to the wage growth. Note that with the exception of 2007 average indexation for active members was well below the wage growth in the Netherlands. Panel A.2 shows how closely the average indexation of active members relates to the development of the average funding ratio over time. Panels B.1 and B.2 display similar graphs for inactive members. Finally, in panel B.1 we compare the indexation with CPI as the indexation ambition for more than 40 percent of the inactive members is linked to overall price movements (CPI). The most striking observation from panel B.1 is the difference between indexation and CPI since the financial crisis in 2008.

Figure 2 illustrates the range of indexation in the full sample statistics for corporate, industry wide and professional group pension funds. Actual indexation is presented for both active and inactive members. The five horizontal lines in each box stand for 5%, 25%, 50%, 75%, 95%, percentiles, respectively. Note that these lines can be overlapping. The dots stand for the outliers. The average indexation level is more or less the same between corporate and industry wide pension funds. However, it seems that professional group pension funds grant higher indexation on average, and are more unlikely to give zero indexation than others. Also note that the average indexation of active members typically exceeds the indexation of inactive members.

4. Empirical results on the drivers of indexation

Our first empirical analysis is to identify the key factors driving indexation of pension benefits. In the first section below we describe the methodology of the Tobit regressions we will use. Then we analyze the impact of pension fund specific and asset allocation variables on the indexation level by examining different marginal effects of the Tobit regressions.

4.1 Methodology

It is important to note that Dutch pension funds are legally prohibited from granting negative indexation to beneficiaries.[11] Indexation in the Dutch pension system is thus constrained to be non-negative. As a result, we have a dependent variable (indexation) in our model that is subject to a lower bound, in this case 0. As a result, indexation has a number of its values clustered at zero. In this context, a typical Ordinary Least Square (OLS) regression model is not appropriate as it will yield inconsistent estimates.[12] We therefore turn to the standard Tobit model (Wooldridge, 2002). A Tobit model is a maximum likelihood estimation technique that combines probit analysis with regression analysis.[13]

In our model, we define the dependent variable $I_{i,t}$ as the actual level of indexation in a given year and $I^*_{i,t}$ as the latent variable that represents the level of indexation if it would not be non-negatively constrained. As a result, we have the following equation in our model:

$$I_{i,t} = \begin{cases} I^*_{i,t} \text{ if } I^*_{i,t} > 0 \\ 0 \text{ if } I^*_{i,t} \leq 0 \end{cases} \qquad (1)$$

To interpret the estimation results of a Tobit model, the marginal effects of the independent variables on some conditional mean functions will be examined. In this paper we therefore consider two different conditional means:

1. The first type of conditional mean from the Tobit model is the expected value of the actual level of indexation, conditional on indexation being positive $E\left(I_{i,t} \mid 0 < I_t < \infty\right)$. In this setting, the estimation results indicate how a one unit change in an independent variable affects the observed indexation, given that it is positive.
2. The second type of conditional mean is the unconditional expected value of the observed level of indexation $E(Z_{i,t})$ with $Z_{i,t} = \max[0, \min[I_t \ , \infty]]$. This dependent

[11] Note that pension funds are allowed, under strict circumstances, to reduce accrued benefits. This can be considered as a form of negative indexation. In our sample, we observe no reductions in accrued benefits.

[12] More specifically, an OLS regression model would result in a downward biased estimation of the slope and an upward bias of the intercept of the regression. The degree of the bias is empirically related to the proportion of data censored.

[13] The standard equation in the Tobit model is: $y^*_i = X_i\beta + \varepsilon_i$, where $\varepsilon_i \sim N(0, \sigma^2)$. y^* is a latent variable that is observed for values greater than γ and censored otherwise. The observed variable y_i is defined by the following equation:

$$y_i = \begin{cases} y^* \text{ if } y^* > \delta \\ \delta_y \text{ if } y^* \leq \delta \end{cases}$$

variable is determined in the Tobit model by multiplying the probability of being uncensored with the expected value of indexation conditional on being positive.

However, as the Tobit model is a non-linear model, the marginal effects depend on the values of the independent variables. This implies that the values of the independent variables have to be fixed in order to determine marginal effects. As a result, we fix the values of the independent variables at their sample means so that the estimation results indicate the marginal effects for an 'average pension fund'.

Finally, the application of the Tobit model has consequences for measuring the 'goodness-of-fit'. The standard R-squared statistic typically employed in OLS regression models is not appropriate for Tobit models, because the Tobit model does not minimize variances to estimate parameters, but maximizes the likelihood functions. We therefore use the McKelvey and Zavoina R^2 to approximate the 'goodness-of-fit' of the models used in this study (Veall and Zimmermann, 1994).

In the remainder of this section we will first show the results of the Tobit regression followed by the two marginal effects outlined earlier.

4.2 Tobit regression results

We first present the result of the Tobit regressions on the latent dependent variable $I^*_{i,t}$. In other words, in this section we examine the impact of independent variables on the level of indexation, given that indexation could also be negative. For that, our first empirical specification reads as follows

$$I^*_{i,t} = \alpha_0 + \alpha_1 F_{i,t-1} + \sum_j \alpha_{2,j} YD_j + \varepsilon_{i,t} \qquad (2)$$

where $I^*_{i,t}$ is the indexation given in year t and $F_{i,t-1}$ is the funding ratio from the previous year.[14] The year dummy variables *YD* are included to take into account all annual developments over the sample period. Finally, the error term is represented by $\varepsilon_{i,t}$.

[14] It is important to note that decisions on indexation are typically made towards the end of a year. E.g., a pension fund might decide on indexation on the first of October of 2010 based on the wage growth over 2010 and the funding ratio as of September 2010. Subsequently, the indexation will be granted to the

<Insert Table IV here>

Panel A in Table IV shows the results of (2). Column (1) shows that, under the interpretation of the Tobit coefficient, for active members a ten percent increase in the funding ratio (e.g., from 100 to 110 percent) implies that the absolute level of indexation given to them would increase by 0.34 percentage points. For inactive members in column (3) the equivalent number is 0.38 percentage points.

One key parameter in the annual indexation decision is of course the indexation base, which is either the inflation (CPI) rate or the real wage growth. To measure their impact we take the following, alternative, specification of our model

$$I_{i,t}^{*} = \alpha_0 + \alpha_1 F_{i,t-1} + \alpha_3 CPI_{t-1} + \alpha_4 RWG_{t-1} + \varepsilon_{i,t} \qquad (3)$$

where CPI_{t-1} represents the one year lagged annual inflation rate (CPI) and RWG_{t-1} the lagged annual real wage growth. Table IV, column (2) reveals that, for active members, an increase in CPI of one percentage point increases the annual average indexation by 0.50 percentage points. Additionally an increase in the real wage growth of one percentage point, results in an increase of the indexation with 0.37 percentage points. For inactive members the outcome in column (4) is somewhat similar for CPI, while the coefficient for real wage growth is not statistically different from zero. This is plausible as indexation for inactive members is less related to wage growth.

Panel B of Table IV reveals the regression results if we include additional explanatory variables in formulas (2) and (3). These alternative specifications read as follows

$$I_{i,t}^{*} = \alpha_0 + \alpha_1 F_{i,t-1} + \sum_j \alpha_{2,j} YD_j$$

$$+\alpha_5 \log(size)_{i,t-1} + \alpha_6 Dind_{i,t-1} + \alpha_7 Dprof_{i,t-1} + \alpha_8 Age_{i,t-1} + \varepsilon_{i,t} \quad (2.1)$$

beneficiaries as of January 2011. So the indexation in 2011 should be compared to the wage growth over 2010.

$$I_{i,t}^{*} = \alpha_0 + \alpha_1 F_{i,t-1} + \alpha_3 CPI_{t-1} + \alpha_4 RWG_{t-1}$$
$$+\alpha_5 \log(size)_{i,t-1} + \alpha_6 Dind_{i,t-1} + \alpha_7 Dprof_{i,t-1} + \alpha_8 Age_{i,t-1} + \varepsilon_{i,t} \quad (3.1)$$

where $\log(size)_{i,t-1}$ is the lagged logarithm of the total assets of the pension fund, *Dind* is a dummy variable equal to 1 if the pension fund is an industry wide pension fund, *Dprof* is a dummy variable equal to 1 if the pension fund is an professional group pension fund, and *Age* represents either the lagged average age of active participants or, alternatively the average age of pensioners. We discuss the findings below.

Pension fund size. The log of pension fund size appears statistically significant at the 10 percent level for active members. The economic effect, however, is small. Multiplying the size by 10 (e.g., an escalation from 10 million to 100 million) increases the average annual indexation by only 0.01 percentage points. The results for inactive members are similar.

Pension fund type. Type is a dummy variable indicating whether a pension fund is an industry-wide pension fund or a professional group pension fund. Holding size and all other variables equal, industry-wide pension funds, on average, grant 0.08 percentage points less indexation annually to active members than corporate pension funds. For inactive members this is about 0.04 percentage points less. Both findings are statistically significant at the 1 percent level. This phenomenon could be the result of the fact that corporates need to compete more to attract good employees which may result in higher contributions to corporate pension funds. Competition for employment is less strong for industry wide pension plans because employees often choose between companies within the same industry. The reason why professional group pension funds grant 0.02 percentage points higher indexation to their members has most likely to do with the fact that they work for the somewhat richer professions. This result, however, is only statistically significant at the 10 percent level.

Age. Surprisingly, the average age of active members does not appear to have a significant effect on the level of indexation. The average age of pensioners does have an impact, but the economic and statistical significance is small.

Panel C of Table IV reports the regression results if we include explanatory variables related to the asset allocation in formulas (2) and (3).[15] These alternative specifications read as follows

$$I_{i,t}^{*} = \alpha_0 + +\alpha_1 F_{i,t-1} + \sum_j \alpha_{2,j} YD_j$$
$$+\alpha_9 equity_{i,t-1} + \alpha_{10} real\ estate_{i,t-1} + \alpha_{11} \log(IRE)_{i,t-1} + \varepsilon_{i,t} \qquad (2.2)$$

$$I_{i,t}^{*} = \alpha_0 + \alpha_1 F_{i,t-1} + \alpha_3 CPI_{t-1} + \alpha_4 RWG_{t-1}$$
$$+\alpha_9 equity_{i,t-1} + \alpha_{10} real\ estate_{i,t-1} + \alpha_{11} \log(IRE)_{i,t-1} + \varepsilon_{i,t} \qquad (3.2)$$

where *equity* is the fraction of the portfolio invested in equities, *real estate* represents the fraction of the portfolio invested in real estate and *log(IRE)* is the logarithm of the interest rate exposure. We discuss the findings below.

Equity and real estate allocation. There appears to be no significant relation between the portion of equity or real estate in a pension fund's investment portfolio and the level of provided indexation. Table IV, Panel C reports that the outcome for all six model specifications is not statistically significant for both variables. Moreover, for active members the coefficients of both variables are negative, indicating that an increase in equity or real estate tends to result in a lower provided level of indexation.

Interest rate exposure. As Panel C presents, we find a significant positive relation between a pension fund's interest rate exposure and the level of provided indexation for both active members and pensioners. The results are statistically significant at the 1 percent level for active members and at the 5 percent level for pensioners. The coefficient for interest exposure is approximately 0.002. This means that after correction for all other factors, pension funds with a higher interest rate exposure were able to provide somewhat higher indexation.

[15] Note that the number of observations in these estimations is less (483 instead of 630), which is due to a lack of data for the 'interest rate exposure' variable.

However, increasing the interest rate exposure further and further might no longer be optimal as this also increases the overall riskiness of the pension fund through an increasing mismatch between assets and liabilities. To explore this we test a non-linear specification of (3.2) by including a quadratic term of the interest rate exposure. The coefficient of this additional term is significantly different from zero and negative.[16] This outcome suggest that there is a tradeoff between interest rate hedging and indexation and that partially hedging nominal interest rate risk leads to a moderate protection in real terms.

4.3 Marginal effects for actual observed indexation

The previous section described the results of the Tobit regression on the latent indexation. Although these results are important, we are also interested in the relation between the independent variables and the actual (observed) level of indexation. Table V reports these results. The values of the independent variables are fixed at their sample means so that the estimation results represent the marginal effects for both active (columns 1 and 2) and inactive members (columns 3 and 4) in the 'average pension fund'.

<Insert Table V here>

The first way of examining this relation is by investigating the marginal effect on the expected value of the observed level of indexation, conditional on indexation being positive $E\left(I_{i,t}\,|0 < I_t < \infty\right)$. In this case, the estimation results indicate how a one unit change in an independent variable affects the observed indexation, given that it is positive. These outcomes are presented in columns (1) and (3) of Table V for respectively active and inactive members. Table V also reports the marginal effects on the unconditional expected value of the observed level of indexation $E(Z_{i,t})$, with $Z_{i,t} = \max[0, \min[I_t\ , \infty]]$. These results indicate how a one unit change in an independent variable (from its mean) affects the actual observed indexation for both active (column 2) and inactive members (column 4) in the 'average pension fund'.

[16] In the interest of brevity, these results are not reported here.

Panel A, column (2) shows that a 10 percentage point increase in the funding ratio of the average pension fund (e.g., from 115 to 125 percent) implies that the actual level of indexation for active members would increase by 0.34 percentage points. Consequently, column (1) reports that this increase is only 0.24 percentage points if indexation is already positive. Both findings are statistically significant at the 1 percent level. Apparently, an increase in the funding ratio has less impact on the level of indexation when the latter is already provided. We find a similar finding for inactive members (see columns 3 and 4).

For active members, real wage growth also appears to have a statistically significant effect on the actual level of indexation. Panel A, column 2 reports that if the average real wage growth increases by 100 basis points, the actual level of indexation becomes 37 basis points higher. Panel B, column (1) shows that the subsequent increase (26 basis points) is even lower when indexation is already provided. Both findings are statistically significant at the 1 percent level. These results imply that active members, on average, lose about two-thirds of a percentage point in purchasing power per year on their benefit accrual between 2007 and 2010. For inactive members, we find somewhat similar results regarding the impact of CPI.

Table V, Panel B reports that the marginal effects regarding the impact of pension fund specific variables are broadly in line with our earlier findings. For instance, industry-wide pension funds appear to grant 0.04 percentage points less indexation to active members, while professional group pension funds provide about 0.12 percentage points more annual indexation compared to other type of pension funds (see column 2). These differences are smaller when indexation is already provided (see column 1). Moreover, size appears to have a (statistically) significant positive effect on the actual level of indexation, although the economic effect is small. Finally, we find no relation between the average age of beneficiaries and the actual level of indexation.

Panel C reports the marginal effects of asset allocation variables on the actual level of indexation. For the average pension fund, we find no statistically significant relation between the actual level of indexation and the fraction of assets invested in either equity or real estate. The interest rate exposure, on the other hand, does have a statistically significant effect on the actual level of indexation. The economic significance, however, appears relatively small. For the average pension fund, a tenfold increase of the interest rate exposure leads to an increase in the actual indexation for active members of 0.012 percentage points (see column 2). For inactive members, the equivalent outcome is smaller, with 0.008 percentage points (see column 4).

5. Empirical results on policy ladders

The second analysis we perform in this paper concerns the design of policy ladders. The central aim of this analysis is to investigate which policy ladder predicts actual indexation best. The actual indexation is contingent on the funding ratio. Typically, if the funding ratio is below the minimum required funding ratio of approximately 105 percent, then there is no indexation at all.[17] This represents the lower boundary of the policy ladder. Full indexation, on the other hand, will only be provided if the funding ratio is sufficiently high. This is the policy ladder's upper boundary.[18] In between the lower and the upper boundaries, the amount of indexation typically depends linearly on the funding ratio. For our analysis, we consider two different specifications of the upper boundary of policy ladders. Finally, we use the same sample of observations as in the rest of the paper.

5.1 Methodology

In the first considered specification, the upper limit equals a real funding ratio of 100 percent. In the Netherlands, the liabilities of pension funds are based on the accrued benefit obligations. These are also known as nominal liabilities. In order to calculate the real funding ratio, we compute the level of real liabilities by including future indexation. Assume the nominal liabilities are equal to L, we then approximate the real, or fully indexed, liabilities L_r by

$$L_r = L(1 + \bar{\pi})^{dur} \qquad (4)$$

where $\bar{\pi}$ represents the average future indexation of the pension fund and *dur* denotes the pension fund specific duration of the nominal liabilities. As a result, a pension fund with 100 nominal liabilities, an average indexation target of 2.5 percent per year and a duration of 16 years will have real liabilities of approximately 150.

Pension funds periodically report the value and duration of their nominal liabilities. Therefore, the only unknown in calculating the real liabilities will be the parameterization

[17] Pension funds must at least have a funding level in excess of the minimum required funding level. This follows from the fact that the Dutch Pension Act is based upon the European directive on the activities and supervision of institutions for occupational pensions (2003/41/EC).

[18] This is not an absolute maximum. If the funding ratio is even higher, a pension fund might decide to grant additional indexation to compensate for missed indexation in the past.

of the indexation target. Theoretically this should be the market consistent expectation of long term inflation or wage growth derived from inflation linked bonds. The long-term inflation expectation cannot be directly observed from market prices as the Dutch government does not issue these kinds of bonds.[19] It can, however, be derived indirectly from surveying professional forecasters. Alternatively, it is also feasible to use the parameterization requirements from legislations. Dutch pension fund legislation identifies a few broad categories for which it stipulates the maximum or minimum expected values that pension funds must use when making long term projections. This includes a minimum expected value of CPI and wage growth of respectively 2 and 3 percent.[20] We will use these numbers in our analysis as long term expectations for inflation and wage growth.

The specification of the policy ladder in this case reads as follows

$$IPL_t = \begin{cases} 0 & \text{if} \quad F_t \leq F_{min} \\ \frac{F_t - F_{min}}{F_{real} - F_{min}} \pi_t & \text{if} \quad F_{min} < F \leq F_{real} \\ \pi_t & \text{if} \quad F_t > F_{real} \end{cases} \tag{5}$$

where IPL_t is the indexation suggested by the policy ladder in year t, F_t the actual funding ratio, F_{min} the minimum required funding ratio, F_{real} the nominal funding ratio that would be equal to a real funding ratio of 100 percent and π_t the actual CPI or wage growth in year t.

In the second considered specification, the upper limit of the policy ladder equals the pension fund specific required funding ratio. Pension funds are required to retain sufficient additional capital over the technical provisions to be able to absorb losses in case of adverse events. Typical adverse events include a sharp decline in interest rates, a large fall in stock prices and the realization of lower than expected mortality rates. The required funding ratio is therefore pension fund specific and based on a Value-at-Risk (VaR) risk measure on a one-year horizon and a confidence level of 97.5 percent. This means that, theoretically, the required funding ratio is at least enough to prevent the assets from falling below the level of

[19] Deriving market inflation expectations would be possible using, e.g., inflation linked bonds issued by other governments. This however would create a basis risk as Dutch inflation is likely to deviate from inflation in other countries.

[20] A dedicated commission has been installed by the Dutch Government to advice on these numbers. The commission is requested to update and revise its opinion every three years.

the technical provisions with a level of probability of 97.5 percent in the subsequent year. On average the required funding ratio is 120 percent. This is lower than the real funding ratio discussed above.

The specification of the policy ladder in this case reads as follows

$$IPL_t = \begin{cases} 0 & \text{if} \quad F_t \leq F_{min} \\ \frac{F_t - F_{min}}{F_{req} - F_{min}} \pi_t & \text{if} \quad F_{min} < F \leq F_{req} \\ \pi_t & \text{if} \quad F_t > F_{req} \end{cases} \qquad (6)$$

where F_{req} represents the required funding ratio and the other variables are the same as in formula (5).

For both types of policy ladders we use an Ordinary Least Square (OLS) regression model to estimate the relation between the actual indexation level and the indexation level suggested by the relevant policy ladder. In contrast to our model in Section 4, the dependent variable in this Section (difference between actual indexation and suggested indexation by the policy ladder) is uncensored. This implies that the dependent variable is not non-negatively constrained and that an OLS regression model is therefore suitable. Some interaction terms are also added to investigate whether the difference between actual indexation ($I_{i,t}$) and indexation suggested by the policy Ladder ($IPL_{i,t}$) vary across different types of funds.[21] The estimation models we use can be summarized as follows

$$I_{i,t} - IPL_{i,t} = \beta_0 + \beta_1 IPL_{i,t} + \beta_2 Type_i + \beta_3 IPL_{i,t} * Type_i + \varepsilon_{i,t} \qquad (7)$$

where $I_{i,t}$ is the actual provided indexation and can either represent the indexation level for active members or the indexation level for pensioners, $IPL_{i,t}$ is an explanatory variable represents the level of indexation suggested by a policy ladder. The upper limit of the policy ladder can either be based on a real funding ratio or on the required funding ratio. *Type* is a dummy variable indicating whether a pension fund is an industry-wide fund or a professional group pension fund. Finally we also include an error term.

[21] Size may also be added as an explanatory variable. We find that size does not appear to matter in this case. Large pension funds do not deviate more or less from the policy ladder compared to small pension funds. In the interest of brevity we do not report these results.

5.2 Policy ladders

Table VI shows the results regarding the predictability of the different policy ladders specifications for the actual level of indexation provided. If the policy ladder accurately predicts the dependent variable, then the difference between the actual indexation granted and the indexation suggested by the policy ladder should not be statistically different from zero.

<Insert Table VI here>

Panel A presents the results under the assumption that the upper limit of the policy ladder equals a real funding ratio of 100 percent. In this context, we find that a policy ladder based on full wage indexation predicts actual indexation fairly accurately for both active members (models 3 and 4) and for inactive members (models 7 and 8) as the coefficients are not statistically different from zero. This is not surprising as most Dutch pension funds have a wage-based indexation target, at least for active members and to a lesser extent for inactive members (see Table II).[22] From this point of view, it is more appropriate to use a real funding based on wage growth in the ladder to predict indexation compared to using a real funding ratio based upon inflation.

Panel B reports the results under the assumption that the upper limit of the policy ladder is represented by the pension fund specific required funding ratio. The results indicate that, in this case, a policy ladder based on wage growth does not predict actual indexation well as all coefficients are significantly different from zero. Moreover, actual indexation is significantly lower compared to what the policy ladder predicts. This can be attributed to the fact that the required funding ratio is typically lower than a real funding ratio of 100 percent, which results in a policy ladder that provides full indexation at a relatively lower funding level. Note that this policy ladder does a somewhat better job in predicting indexation if it is benchmarked against CPI.

[22] Table II reports that in 2011, approximately 90 percent of the active members in a Dutch pension fund followed a wage-based indexation target, while this applied for about 57 percent of inactive members.

In general, we conclude that a policy ladder with an upper limit equal to a 100 percent real funding ratio is able to predict the actual level of indexation more accurately than a ladder with an upper limit based on the required funding ratio.

A second analysis is to test whether policy ladders will over- or underestimate actual indexation of different types of pension funds. For that analysis, we estimate whether $\beta_0 + \beta_2 * Type = 0$. Unless this equation holds, pension funds will deviate in granting from what the policy ladder suggests. In both Panel A and Panel B of Table VI, the constants, and the coefficients of dummy variable "Professional" are positive in every specification. This confirms that all policy ladders tend to underestimate the actual pension benefits in professional group pension funds. According to specification (4) on average by (0.0064+0.0147)*100=2.11 percent, which is considerably large. However, for industry-wide pension funds, the underestimation is much smaller in all specifications of both panels. For example, in specification (2) in panel A, the policy ladder model underestimates indexation by only (0.0055 – 0.0045)*100=0.10 percent.

A reason for the observed underestimation may be that pension funds tend to over-index to what they are actually capable of. This can be explained by the discretionary power that the pension fund's trustees have to deviate from what the policy ladders suggests. Of course it is also possible that the policy ladder models have a systematic specification error.

6. Conclusions

This paper studies the key factors driving indexation of pension benefits in defined benefit plans in turbulent economic circumstances over the period 2007 to 2010. Pension schemes aim to maintain the standard-of-living of individuals after retirement. Decisions on indexation therefore have an impact on the purchasing power of individuals. Typical in Dutch pension schemes is that indexation depends on a future decision to be taken by the pension fund's board. The fulfillment of the indexation in practice depends on the financial position of the pension fund. If financial resources are abundant, indexation is fully granted. However, if the financial resources are poor, the pension fund might choose not to fully index pension benefits. The indexation therefore is typically linked to the funding ratio of the pension fund. This linkage is known as the policy ladder. In this paper we report several observations:

First, we find that the key drivers of indexation are the funding ratio, inflation and real wage growth. An increase in the funding ratio of 100 basis point leads to an increase in indexation of 3 to 4 basis points for the average pension fund. An increase in CPI of 100 basis points increases the annual average indexation for active members by approximately 30 basis points. Additionally if there is a real wage growth of 100 basis points, the indexation for active members increases by about 20 to 25 basis points. Note, however, that real wage growth does not seem to impact indexation for inactive members.

The age composition, the type of pension fund and the interest rate exposure are also statistically significant, while the asset allocation does not significantly affect indexation. The latter is explainable as the impact of asset allocation is already captured by the funding ratio. We also find that industry-wide pension funds, on average, grant 4 basis points less indexation annually to active members than corporate pension funds. For inactive members this is 2 basis points less. This could be the result of the fact that corporates need to compete more to attract good employees which may result in higher contributions to corporate pension funds.

Finally, we find that a policy ladder with an upper limit equal to a 100 percent real funding ratio is able to predict the actual level of indexation more accurately than a ladder with an upper limit based on a pension fund's required funding ratio. Policy ladders based on the required funding ratio tend to overestimate the actual level indexation. This implies that many pension funds do not use the required funding ratio as the upper limit in their policy ladder. This is a prudent approach towards indexation.

Indexation is a complex feature in Dutch pension arrangements. There are major changes ahead in the Dutch occupational pension system. The pension system is currently going through one of its biggest modifications ever. The existing defined benefit contracts will be slightly modified into 'nominal contracts' with contingent indexation. In addition, an innovative pension contract will be introduced. The new contract is considered a 'real contract' as benefits will be automatically indexed. The indexation target in this new contract must be at least equal to inflation. As a result, indexation is likely to become even more important in the near future. Therefore it will remain important to study the key drivers of indexation.

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Figure 1: Average indexation of active and inactive members versus wage growth, CPI and funding ratio

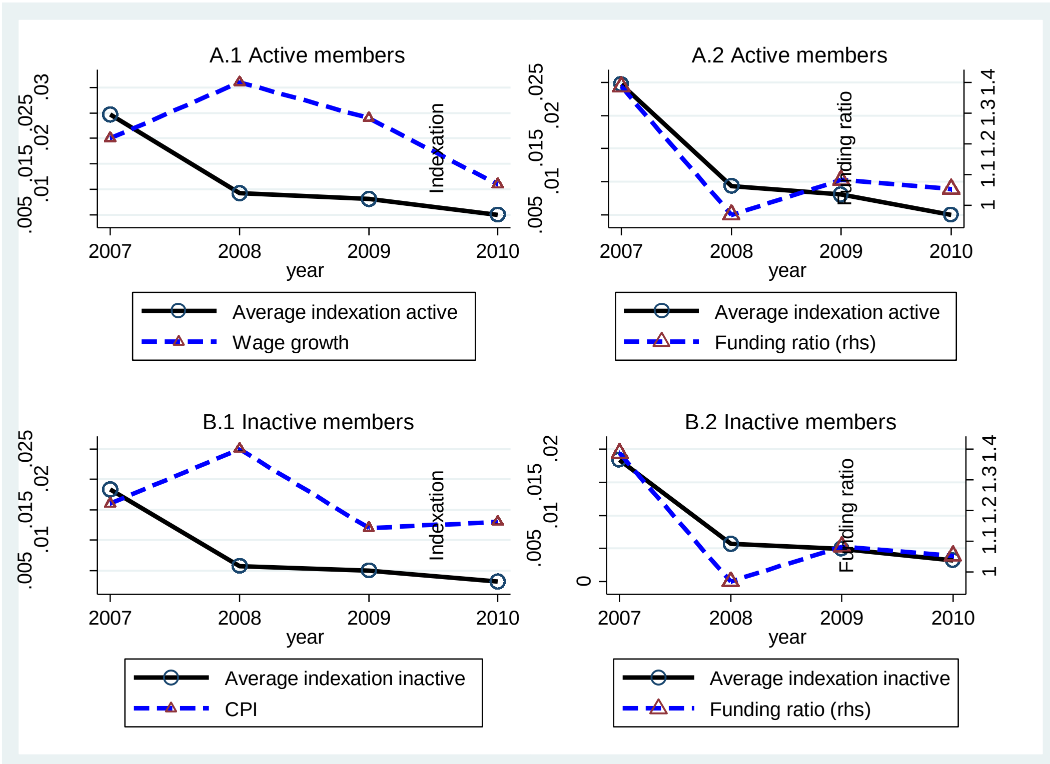
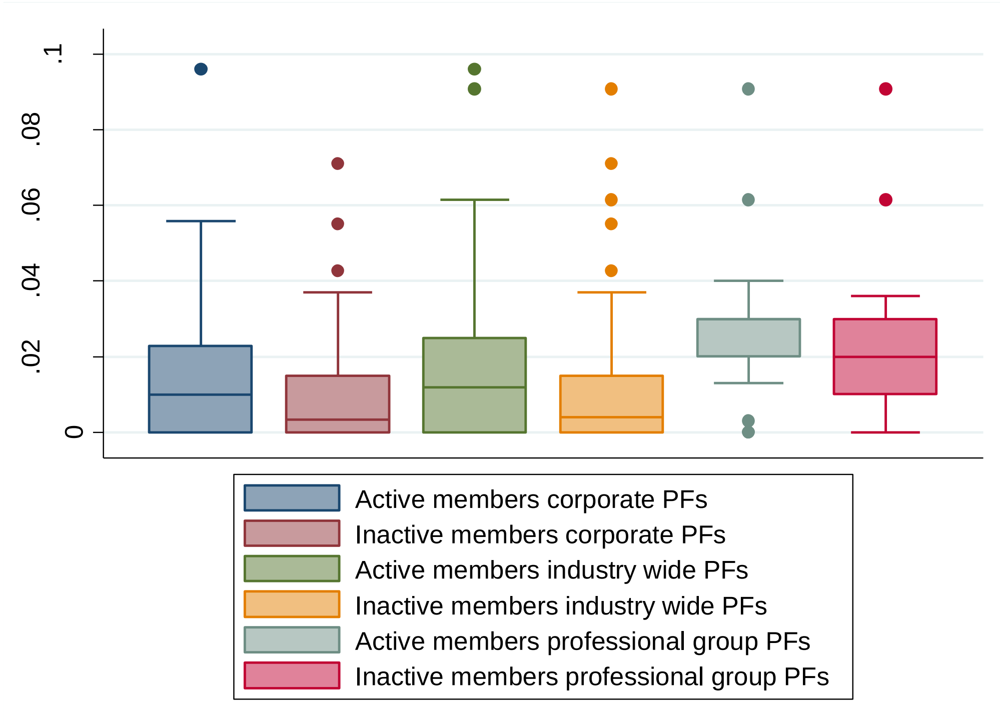


Figure 2 Sample statistics of indexation for different types of pension funds



Note: This figure illustrates the range of indexation in the full sample statistics for corporate, industry-wide and professional group pension funds. Actual indexation is presented for both active and inactive members. The five horizontal lines in each box stand for 5%, 25%, 50%, 75%, 95%, percentiles, respectively.

Table I
Granted Indexation versus Ambition Level for 25 Largest Dutch Pension Funds

Table I reports the indexation levels for the 25 largest Dutch pension funds during the years 2007 to 2011. The coefficients under the "Indexation Active Members" columns represent the annualized granted indexation as well as the ambition level for active members. The coefficients under the "Indexation Inactive members" columns report the same numbers, but then for pensioners and sleepers.

	Indexation Active Members		Indexation Inactive Members	
	Granted	Ambition	Granted	Ambition
2007	2.1%	2.2%	2.1%	2.3%
2008	2.8%	2.0%	2.9%	1.8%
2009	0.2%	3.7%	0.2%	3.8%
2010	0.4%	2.3%	0.4%	1.7%
2011	0.0%	1.1%	0.0%	1.3%
cumulative	5.6%	11.8%	5.7%	11.4%

Source: De Nederlandsche Bank (2012)

Table II
Indexation Base for Participants in Dutch Average-pay Schemes

Table II reports the indexation base for all participants in Dutch average-pay schemes during the years 2007 to 2011. The coefficients in the table represent the number of participants in a certain category as a percentage of total Dutch pension participants. Panel A presents the indexation base for active members, while Panel B shows the indexation base for inactive members. Note that the indexation ambition for active members is generally based on industry wage developments, while the indexation ambition for inactive members is either based on industry wage developments or on overall price movements.

	Overall price movements	Overall wage movements	Company wage movements	Industry wage movements	Other
Panel A: Active Members					
2007	10.5%	2.7%	4.6%	72.9%	0.3%
2008	17.7%	1.7%	3.6%	76.7%	0.3%
2009	10.2%	11.5%	4.7%	73.4%	0.2%
2010	10.2%	10.1%	5.4%	74.2%	0.2%
2011	9.8%	10.7%	4.5%	74.8%	0.2%
Panel B: Inactive Members					
2007	39.7%	1.5%	1.7%	55.9%	1.2%
2008	40.2%	1.4%	1.3%	55.4%	1.7%
2009	40.5%	1.5%	1.4%	55.4%	1.2%
2010	41.5%	1.0%	1.2%	55.6%	0.6%
2011	41.5%	1.0%	0.5%	56.5%	0.5%

Source: De Nederlandsche Bank (2012)

Table III
Descriptive Statistics of Sample Variables

Table III reports the descriptive statistics of the key variables used in this study for the years 2007 to 2010. The coefficients under the "Years" columns represent the mean of the variable, while the numbers in square brackets present the standard deviation of each variable in a specific year. The variables 'Indexation Active Members' and 'Indexation Inactive Members' represent the annually provided indexation for respectively active and non-active (sleepers and retirees) members. 'CPI' and 'Real Wage Growth' present the annual inflation and real wage growth in the Netherlands, while 'Funding Ratio' reports the average funding ratio of all pension funds in the sample. The variable 'Pension Fund Size' is the log value of the technical provisions. The average age of active members ('Age Active Members') and pensioners ('Age Pensioners') is also presented on an annual basis. Asset allocation variables include 'Equity Allocation', 'Fixed Income allocation' and 'Real Estate Allocation', which show the fraction that each asset class represents compared to total asset value. 'Interest Rate Exposure' stands for the log of the difference between the interest rate sensitivity of pension liabilities minus the interest rate sensitivity of fixed income assets assuming a one percent interest rate decrease. The final row reports the total number of pension funds included in the sample for each year.

	Years				
Series	2007	2008	2009	2010	Full Sample
Indexation Active Members	0.025	0.009	0.008	0.005	0.012
	[0.014]	[0.014]	[0.010]	[0.010]	[0.014]
Indexation Inactive Members	0.018	0.006	0.005	0.003	0.008
	[0.011]	[0.010]	[0.010]	[0.007]	[0.011]
CPI	0.016	0.025	0.012	0.013	0.017
	.	.	.	.	[0.005]
Real Wage Growth	0.004	0.006	0.012	-0.002	0.005
	.	.	.	.	[0.005]
Funding Ratio	1.435	1.000	1.105	1.064	1.156
	[0.211]	[0.124]	[0.132]	[0.095]	[0.227]
Pension Fund Size	12.61	12.89	12.93	13.37	12.95
	[1.789]	[1.764]	[1.753]	[1.642]	[1.759]
Age Active Members	43.85	43.88	44.15	44.03	43.97
	[4.373]	[4.511]	[4.558]	[3.705]	[4.322]
Age Pensioners	68.65	68.94	69.24	69.43	69.05
	[5.751]	[5.349]	[5.179]	[4.872]	[5.316]
Equity Allocation	0.350	0.245	0.295	0.309	0.300
	[0.111]	[0.085]	[0.100]	[0.090]	[0.104]
Fixed Income Allocation	0.531	0.626	0.595	0.567	0.580
	[0.128]	[0.124]	[0.126]	[0.128]	[0.131]
Real Estate Allocation	0.081	0.084	0.076	0.075	0.079
	[0.067]	[0.060]	[0.051]	[0.050]	[0.054]
Log Interest Rate Exposure	9.86	10.02	10.06	10.35	10.07
	[2.078]	[1.987]	[2.032]	[1.935]	[2.014]
N	166	165	165	134	630

Table IV
Marginal Effects on Latent Pension Fund Indexation

Table IV presents the results of Tobit panel regressions to examine the impact of external, pension fund specific and asset allocation factors on indexation for active and inactive participants of 166 pension funds during the full sample period (2007-2010). Panel A reports the results for four different estimation models. Models 1 and 2 represent the indexation for active members, while models 3 and 4 display the indexation for inactive members. To prevent multicollinearity problems generated by the high correlation between wage growth and CPI we use real wage growth instead. Year dummy variables are also included in models 1 and 3 to capture annual (macroeconomic) developments over the years in the sample period. The numbers in squared brackets report the t-statistics. *,**,*** represent the statistical significance at the 10 percent, 5 percent and 1 percent level. The different panels report the number of pension funds in the sample (N) and the McKelvey and Zavoina R^2. All panels report the results for Tobit regressions.

	Panel A: External Variables			
	(1)	(2)	(3)	(4)
	Active members		Inactive members	
Funding Ratio	0.0343***	0.0595***	0.0382***	0.0552***
	[5.86]	[9.90]	[6.22]	[10.26]
CPI		0.502***		0.438**
		[3.51]		[3.27]
Real Wage Growth		0.371**		0.153
		[2.97]		[1.48]
Year Dummy 2008	-0.0119***		-0.0073***	
	[-4.01]		[-2.39]	
Year Dummy 2009	-0.0136***		-0.0103***	
	[-5.93]		[-4.36]	
Year Dummy 2010	-0.0218***		-0.0145***	
	[-7.17]		[-5.02]	
Constant	-0.0246***	-0.0755***	-0.0365***	-0.0720***
	[-2.99]	[-9.32]	[-4.33]	[-10.10]
N	630	630	630	630
McKelvey & Zavoina R^2	0.349	0.306	0.410	0.383

Table IV (continued)

	Panel B: Pension Fund Specific Variables			
	(1)	(2)	(3)	(4)
	Active members		Inactive members	
Funding Ratio	0.0321***	0.0597***	0.0361***	0.0547***
	[7.02]	[10.61]	[8.66]	[11.74]
CPI		0.525***		0.454***
		[3.66]		[3.48]
Real Wage Growth		0.403**		0.176
		[3.24]		[1.76]
Log Size	0.0012*	0.0010*	0.0011**	0.0010**
	[2.49]	[2.09]	[2.85]	[2.62]
Type of Fund: Industry	-0.0076***	-0.0081***	-0.0043**	-0.0046***
	[-4.29]	[-4.64]	[-3.13]	[-3.37]
Type of Fund: Professional	0.0178*	0.0158*	0.0164**	0.0149*
	[3.23]	[2.40]	[2.76]	[2.49]
Age Active Participants	0.0004	0.0002		
	[1.70]	[1.16]		
Age Pensioners			0.0003*	0.0003*
			[2.07]	[2.21]
Year Dummy 2008	-0.0128***		-0.0081**	
	[-4.55]		[-3.10]	
Year Dummy 2009	-0.0146***		-0.0110***	
	[-6.69]		[-5.42]	
Year Dummy 2010	-0.0233***		-0.0159***	
	[-8.06]		[-6.27]	
Constant	-0.0500***	-0.0978***	-0.0649***	-0.0102***
	[-4.06]	[-7.14]	[-6.34]	[-9.83]
N	625	625	630	630
McKelvey & Zavoina R^2	0.417	0.368	0.476	0.440

Table IV (continued)

	Panel C: Asset Allocation Variables			
	(1)	(2)	(3)	(4)
	Active members		Inactive members	
Funding Ratio	0.0405***	0.0618***	0.0374***	0.0550***
	[6.02]	[8.62]	[5.67]	[8.45]
CPI		0.4320*		0.373*
		[2.44]		[2.57]
Real Wage Growth		0.319*		0.0825
		[2.20]		[0.75]
Equity Allocation	-0.0202	-0.0194	-0.0163	-0.0157
	[-1.36]	[-1.26]	[-1.33]	[-1.22]
Real Estate Allocation	-0.0320	-0.0383*	0.0139	0.0084
	[-1.81]	[-2.15]	[0.88]	[0.52]
Log Interest Rate Exposure	0.0021***	0.0021***	0.0015**	0.0015**
	[3.44]	[3.47]	[3.02]	[3.03]
Year Dummy 2008	-0.0109**		-0.0091**	
	[-3.17]		[-2.67]	
Year Dummy 2009	-0.0121***		-0.0114***	
	[-4.75]		[-4.46]	
Year Dummy 2010	-0.0189***		-0.0145***	
	[-5.81]		[-4.79]	
Constant	-0.0461***	-0.0894***	-0.0464***	-0.0814***
	[-4.51]	[-8.53]	[-4.50]	[-9.08]
N	499	499	499	499
McKelvey & Zavoina R^2	0.362	0.328	0.414	0.383

Table V
Marginal Effects on Pension Fund Indexation

Table V presents two types of marginal effects on the observed variables. Columns (1) and (2) present the results for active members which are based on the second model of Table IV. Column (1) displays the marginal effects for the expected value of the actual level of indexation conditional on indexation being positive $E(I_{i,t} | 0 < I_t < \infty)$. Column (2) shows the marginal effects on the unconditional expected value of the observed level of indexation $E(Z_{i,t})$ with $Z_{i,t} = \max[0, \min[I_t \ , \infty]]$. The z statistics are shown in parentheses. *,**,*** indicate statistically significance at 10%, 5% and 1%, respectively. Columns (3) and (4) display the results for inactive members and are calculated in a similar manner as the results for active members.

	Mean	$E(I_{i,t} \| 0 < I_t < \infty)$ (1)	$E(Z_t)$ (2)	$E(I_{i,t} \| 0 < I_t < \infty)$ (3)	$E(Z_t)$ (4)
		Panel A: External Variables			
		Active members		Inactive members	
Funding Ratio	1.156	0.024***	0.034***	0.020***	0.027***
		[10.97]	[10.09]	[10.62]	[10.48]
CPI	0.017	0.203***	0.287***	0.158***	0.218***
		[3.44]	[3.42]	[3.21]	[3.18]
Real Wage Growth	0.005	0.150**	0.212**	0.055	0.076
		[2.93]	[2.92]	[1.48]	[1.48]
		Panel B: Pension Fund Specific Variables			
Funding Ratio	1.156	0.026***	0.037***	0.021***	0.029***
		[12.23]	[12.24]	[13.19]	[13.16]
CPI	0.017	0.230***	0.328***	0.174***	0.243***
		[3.53]	[3.53]	[3.41]	[3.39]
Real Wage Growth	0.005	0.177***	0.252***	0.067	0.094
		[3.17]	[3.17]	[1.75]	[1.74]
Log Size	12.97	0.0004**	0.0006**	0.0004***	0.0005***
		[2.09]	[2.09]	[2.63]	[2.63]
Type of Fund: Industry	0	-0.003***	-0.004***	-0.002***	-0.002***
		[-4.67]	[-4.68]	[-3.50]	[-3.55]
Type of Fund: Professional	0	0.009**	0.012**	0.008**	0.011**
		[1.98]	[2.10]	[1.98]	[2.10]
Age Active Participants	43.97	0.0001	0.0002		
		[1.15]	[1.15]		
Age Pensioners	69.05			0.0001**	0.0001**
				[2.19]	[2.18]

Table V (continued)

	Panel C: Asset Allocation Variables				
Funding Ratio	1.156	0.025***	0.035***	0.020***	0.028***
		[9.46]	[9.45]	[8.71]	[8.64]
CPI	0.017	0.214***	0.304***	0.121**	0.167**
		[2.95]	[2.94]	[2.17]	[2.16]
Real Wage Growth	0.005	0.152***	0.202***	0.018	0.025
		[2.70]	[2.70]	[0.45]	[0.45]
Equity Allocation	0.300	-0.005	-0.008	-0.005	-0.007
		[-0.94]	[-0.94]	[-1.05]	[-1.05]
Real Estate Allocation	0.079	-0.012	-0.016	0.004	0.005
		[-1.69]	[-1.69]	[0.69]	[0.69]
Log Interest Rate Exposure	9.86	0.0008***	0.0012***	0.0005***	0.0008***
		[3.39]	[3.38]	[3.09]	[3.08]

Table VI
Pooled OLS Regression on Policy Ladders

This table presents the results of pooled OLS regressions that examine the extent to which different specifications of policy ladders can explain actual indexation levels. Panel A assumes that the upper limit of the policy ladder is based on the pension fund's specific indexation ambition (or their real funding ratio), while Panel B assumes that the upper limit equals the pension fund specific required funding ratio. The lower limit of the policy ladder in both panels is the minimum required funding ratio. The dependent variable is the difference between the actual indexation and the indexation suggested by the policy ladder. CPI Ladder and Wage Ladder variables are the indexation levels calculated assuming that the indexation target is CPI, respectively wage growth. Due to the multicollinearity problem, both variables do not enter the model simultaneously. Two dummy variables indicate the type of pension fund and some interaction variables. The numbers in square brackets are the t-statistics. *,**,*** indicate statistically significance at the 10 percent, 5 percent and 1 percent, respectively. N is the number of observations.

Panel A: Policy Ladder – Upper Limit Based On Real Funding Ratio

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Active members				Inactive members			
CPI Ladder	0.2740***	0.1380			0.110*	0.0387		
	[3.70]	[1.50]			[2.01]	[0.58]		
Wage Ladder			0.1070	0.0012			-0.0458	-0.0958
			[1.52]	[0.01]			[-0.87]	[-1.49]
Type: Industry Fund		-0.0045***		-0.0040**		-0.0008		-0.0005
		[-3.48]		[-3.15]		[-0.88]		[-0.55]
Type: Professional Fund		0.0146***		0.0147***		0.0114***		0.0116***
		[4.53]		[4.58]		[4.88]		[4.90]
CPI*Industry		0.3340*				0.0994		
		[2.22]				[0.91]		
CPI*Professional		0.0243				0.5300*		
		[0.07]				[2.16]		
Wage*Industry				0.256				0.0472
				[1.79]				[0.45]
Wage*Professional				0.0134				0.510*
				[0.04]				[2.12]
Constant	0.0043***	0.0055***	0.0054***	0.0064***	0.0014**	0.0013*	0.0024***	0.0022***
	[6.60]	[6.69]	[8.49]	[7.96]	[2.92]	[2.23]	[5.10]	[3.75]
N	640	640	640	640	640	640	640	640

adj. R^2	0.019	0.096	0.002	0.074	0.005	0.116	-0.000	0.103

Table VI (continued)

Panel B: Policy Ladder – Upper Limit Based On Required Funding Ratio								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Active members				Inactive members			
CPI Ladder	0.0079	-0.1200			-0.0709	-0.1230*		
	[0.12]	[-1.42]			[-1.47]	[-2.07]		
Wage Ladder			-0.2770***	-0.3720***			-0.3350***	-0.3660***
			[-5.43]	[-5.77]			[-9.01]	[-7.91]
Type: Industry Fund		-0.0052***		-0.0053***		-0.0012		-0.0010
		[-3.71]		[-3.66]		[-1.17]		[-0.97]
Type: Professional Fund		0.0145***		0.0155***		0.0118***		0.0126***
		[4.05]		[4.22]		[4.67]		[4.79]
CPI*Industry		0.3120*				0.0830		
		[2.34]				[0.88]		
CPI*Professional		0.1490				0.4780*		
		[0.44]				[1.99]		
Wage*Industry				0.2380*				0.0463
				[2.34]				[0.63]
Wage*Professional				0.0076				0.2670
				[0.03]				[1.45]
Constant	0.0043***	0.0057***	0.0046***	0.0060***	0.0011*	0.0011	0.0014**	0.0013*
	[6.05]	[6.42]	[6.35]	[6.61]	[2.18]	[1.73]	[2.65]	[1.98]
N	622	622	622	622	622	622	622	622
adj. R^2	-0.002	0.082	0.044	0.121	0.002	0.119	0.114	0.209

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