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Stock market performance and pension fund investment policy: rebalancing, free float, or market timing?

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Abstract
This paper is the first that examines the impact of stock market performance on the investment policy of pension funds. We find that stock market prices influence the asset allocation of Dutch pension funds in two ways. In the short term, outperformance of equities over bonds and other investment categories automatically results in a higher actual equity allocation (and *vice versa*), as pension funds do not continuously rebalance their investment portfolios. Each quarter, pension funds rebalance, on average, around 39 percent of excess equity returns, leaving 61 percent for free floating. In the medium term, outperformance of equities induces pension funds to increase their strategic equity allocation (and *vice versa*). These findings suggest that the investment policies of pension funds are partially driven by the cyclical performance of the stock market. Pension funds respond asymmetrically to stock market shocks: rebalancing is much stronger after negative equity returns. On average, this strategy led to negative excess returns over the period under consideration. Investment policies of large funds deviate from that of small funds: they hold more equity and their equity allocation is much more strongly affected by actual equity returns, reflecting less rebalancing. The largest funds react highly asymmetrically to positive excess equity returns, adjusting their portfolios by significantly more than 100%, reflecting 'overshooting' of free floating, or positive feedback trading. Apparently, managers of large funds demonstrate great risk tolerance, particularly in bull markets.

Keywords: Pension fund returns, portfolio choice, excess returns, strategic equity allocation, size effects, asymmetrical behavior.

JEL classification: G11, G23;

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1 Introduction

The optimal equity allocation of pension funds is subject to considerable debate. A high percentage of assets invested in equities results in significant exposure of pension wealth to fluctuations in stock market prices. While nominal defined-benefit pension liabilities are best resembled by bond returns, considerable equity holdings may be optimal when indexation of benefits is contingent on the funding ratio of the pension fund.[1] During the nineties abundant equity returns led to premium reductions and even contribution holidays for pension plan sponsors. However, the risks of equity holdings surfaced after the collapse of the stock market in 2000-2002, which resulted in large losses for pension funds. In reaction, pension benefits were curtailed and contributions steeply increased. This episode raised a debate on the investment strategies of Dutch pension funds and, particularly, on their exposure to equity markets.

The investment strategy of Dutch pension funds is of key importance to society, as it involves more than € 600 billion in assets, or over € 37,500 per inhabitant. The way in which these assets are invested has a significant influence on the level of required premiums or final benefits. A one percent lower annual return over the lifecycle of a typical worker translates into 27 percent lower accumulated pension assets.[2] Consequently, one of the most important responsibilities of pension funds' trustees is to maximize the expected return at an acceptable level of risk, *e.g.* measured in terms of the probability of underfunding.

This study investigates whether stock market performance influences pension funds' investment policies. In particular, we examine two ways in which stock market performance impacts the equity allocation of pension funds: (i) in the short term, as a result of market timing or imperfect rebalancing, and (ii) in the medium term, as a result of adjustments to strategic asset allocation. Consecutively, we examine the value added of active market timing decisions. This is particularly relevant for industry-wide pension funds. In the Netherlands, participation in these sector funds is compulsory for companies operating in that specific sector. If the performance of such funds, measured as a five-year moving average, drops below a certain threshold, the affiliated companies may apply for dispensation from joining that sector fund.[3]

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[1] Nominal defined benefit pension liabilities are best resembled by nominal government bonds. Instead, defined benefit pension liabilities that are fully indexed to prices are best resembled by inflation linked bonds. In many Dutch defined benefit pension deals, indexation is contingent on the funding ratio of the pension fund. The market value of this contingent indexation can be derived using option pricing theory. In this case it might be optimal to have considerable equity exposure, see *e.g.* Broeders (2006).

[2] The three main components determining the costs of pensions are the quality of the pension scheme, the rate of return on investments and administrative and investment costs (see also Bikker and de Dreu, 2007).

[3] This is known as the 'Star-test' which is based on the so-called *z*-score. The threshold is based upon a reference portfolio, usually the strategic asset allocation of the pension fund.

Table 1 presents the asset allocation of Dutch pension funds over the following five broad classes: Equities, Bonds, Real Estate, Cash, and Other Assets. Pension fund investment policy includes the strategic asset allocation decision, which refers to choosing the investment percentages in each asset class. Of the aforementioned asset classes, equities have the highest expected return but also the highest volatility. For most pension funds it is the largest asset category. Consequently, equity allocation is one of the key policy variables determining the risk-return profile of a given pension fund.

Table 1: Pension fund strategic and actual asset allocation 1999:I – 2006:IV (in %)

Asset classes	Average strategic asset allocation	Standard deviation	Average actual asset allocation	Standard deviation
Equities	42	15	41	15
Bonds	39	20	45	19
Real Estate	10	6	10	6
Cash	1	11	1	10
Other	8	11	3	11
Total	*100*		*100*	

Note: The asset shares are averages over de Dutch pension funds and weighted by total investments.
Source: De Nederlandsche Bank.

Pension funds generally determine their strategic asset allocation policies using asset and liability management studies, in which they consider long-term expected returns, return variances and covariances of broad asset classes, given the size and characteristics of their pension liabilities, see *e.g.* Campbell and Viceira (2002).[4] The strategic asset allocation is typically set on a three to five year horizon. For many pension funds, the strategic asset allocation includes bandwidths for the actual asset allocation to drift. These bandwidths are chosen in such a way that the maximum *ex ante* tracking error does not exceed a given threshold. This tracking error (*TE*) is usually defined as $TE = w'\Sigma w$, where w is the vector of actual portfolio weights minus the vector of strategic portfolio allocation and Σ is the variance-covariance matrix.

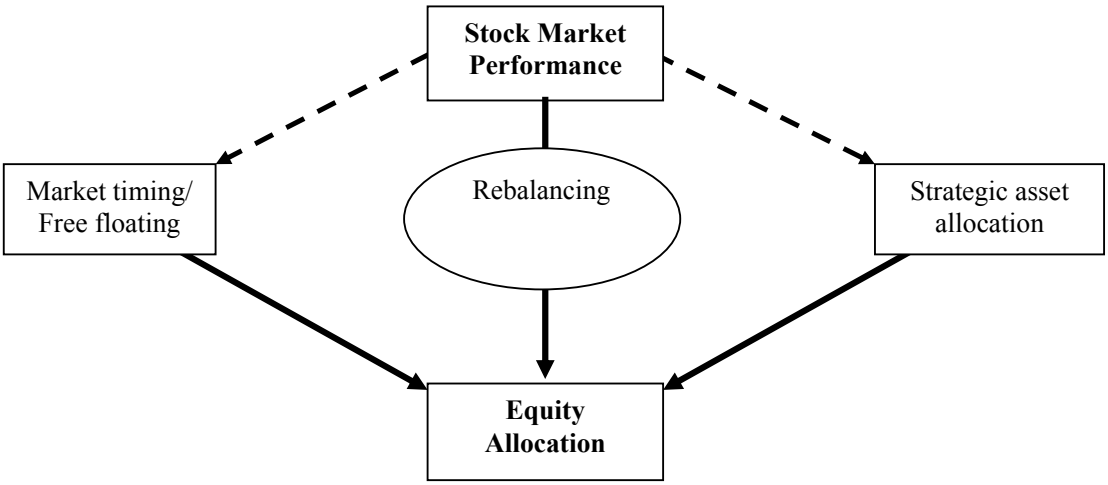
As investment opportunities change over time, deviations in expected returns from their long-term averages may warrant changes in the investment mix.[5] Choosing actual portfolio weights that deviate from the strategic asset allocation is known as 'tactical asset allocation' or 'market timing'. Market timing refers to taking short-term (informed) bets on the relative asset class returns. It can be implemented through actually buying and selling the underlying securities, although in practice,

[4] Shefrin and Statman (1997) use behavioural finance theory to explain the asset allocation of pension funds. They argue that investors build portfolios as pyramids of assets, layer by layer. In contrast to mean-variance theory, covariance between asset classes are generally ignored resulting in suboptimal portfolios.
[5] Predictability in expected asset returns may affect the optimal portfolio choice of investors with long horizons (see *e.g.* Barberis, 2000; Pastor and Stambaugh, 2001).

derivatives are also commonly used as an efficient manner to change a fund's asset allocation. However, the potential extra return through market timing is limited, as indicated also by the so-called fundamental law of active management, see Grinold and Kahn (1999).[6]

This study examines the impact that higher or lower returns on stocks compared to the other asset categories have on the equity allocation of pension funds. To the best of our knowledge this is the first study that examines this relationship. Figure 1 shows the various factors that influence the equity

Figure 1: The impact of stock market performance on equity allocation



allocation of pension funds. Over the long term equity allocation is determined by a fund's strategic asset allocation. However, several factors influence asset allocation in the short to medium term. We distinguish the following three equity investment strategies that pension funds may use to respond to positive or negative stock market returns: rebalancing, free float, and market timing.

Rebalancing refers to the investment process applied to ensure that a fund's actual equity allocation continuously equals its strategic equity allocation, which implies selling equities after relative high stock market returns and buying after relative low equity returns. This might also be indicated as a form of negative-feedback trading referring to buying past losers and selling past winners, see *e.g.*

[6] This law states that the information ratio equals the information coefficient times the square root of the number of independent investment decisions. The information ratio is the risk-adjusted excess return over a passive investment strategy. An information ratio of 0.5, which is considered high, requires that asset managers earn a 50 basis points excess return ('alpha') per 1 percent of residual risk on a yearly basis. The information coefficient measures the skill of the asset manager, and is defined as the correlation between his forecasts on investment returns and the actual outcomes. The number of independent investment decisions is four, if the pension fund makes quarterly market timing decisions. To generate a market timing information ratio of 0.5 requires, in that case, an information coefficient of 0.25, which is considered extremely high. It would require the asset manager to forecast the direction of the stock market correctly 63 out of 100 times. Therefore, the potential added value of market timing is limited.

Lakonishok *et al.* (1992a). This form of trading is commonly a part of the argument that institutional investors stabilize asset prices. By contrast, we use *free float* to indicate a passive investment strategy, in which pension funds allow their equity allocation to drift with market developments.[7] Finally, as mentioned above, *market timing* refers to a temporary higher or lower weighting of equities (or other asset classes) relative to the pension fund's strategic asset allocation, motivated by short-term return expectations. Note that where no equity trades are made, it is difficult to distinguish between free float (passive management) and market timing (active management), as allowing the asset allocation to drift could be seen as an active investment decision.

A number of studies show that strategic asset allocation dominates portfolio performance. In particular, strategic asset allocation is shown to explain more than 90 percent of the variability in pension fund returns over time, while the additional variation explained by market timing is less than 5 percent (Blake, Lehmann and Timmermann, 1999; Brinson *et al*., 1986, 1991; Ibbotson and Kaplan, 2000).[8] Moreover, in line with the efficient market theory, evidence shows that pension funds are unsuccessful in exploiting market timing to generate excess returns. In particular, market timing is shown to cause an average loss of 20-66 basis points per year (Blake *et al*., 1999; Brinson *et al*., 1986, 1991; Daniel *et al*., 1997).

While a number of empirical studies examine the impact of investment policy on returns,[9] very few papers investigate the impact of market developments on investment policy. Blake *et al*. (1999) and Kakes (2006) report a negative correlation between asset class returns and net cash flows to the corresponding asset class, which points to rebalancing. However, Blake *et al.* (1999) also find that the asset allocation for UK pension funds drifts toward asset classes that performed relatively well, in line with a free-float strategy. Apparently, UK pension funds only partly rebalanced their investments in

[7] Pension funds can rebalance continuously, thereby ensuring that their asset allocation always matches their strategic asset allocation. However, pension funds are known to use rebalancing strategies, which have some free float component. Examples include *calendar* rebalancing, whereby pension funds rebalance their portfolio back to its strategic weights at regular intervals, and *band rebalancing* whereby pension funds create bands around each asset class and rebalance their portfolio as soon as one asset class breaches its band.

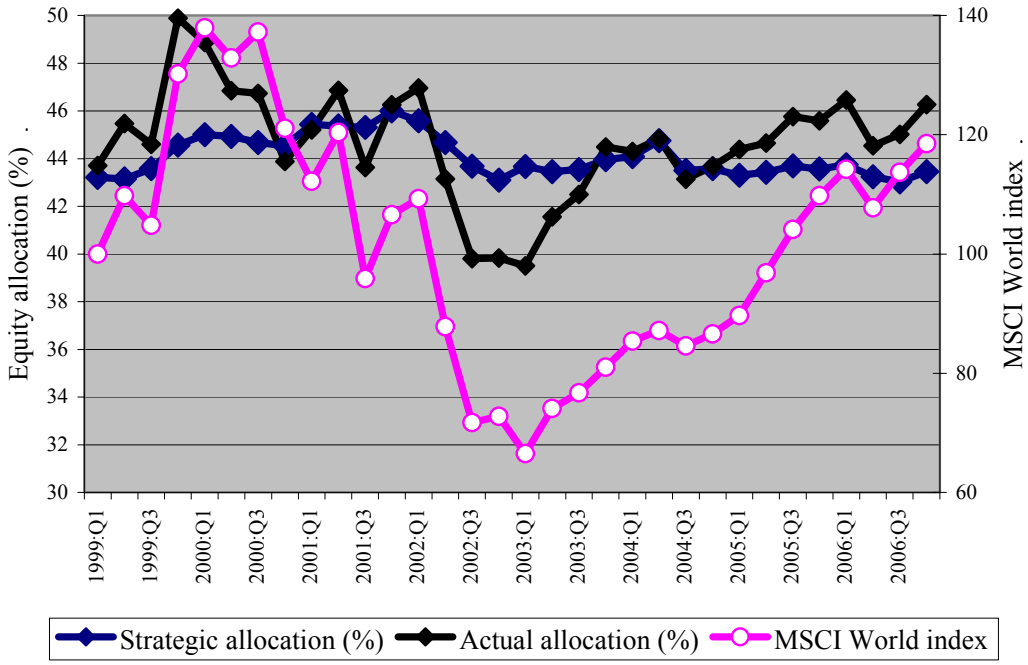
[8] A shortcoming of these studies is that the (average) difference between actual and strategic asset allocation is not reported. This difference between actual investments and investment policy is likely to be related to the percentage of return variability that can be attributed to market timing.

[9] The literature investigating the effectiveness of stock picking and market timing in improving investment performance is extensive. Most studies focus on US mutual funds and find that fund managers are not able to exploit selectivity and timing to generate excess returns (*e.g.* Fama (1972), Henriksson and Merton (1981), Kon and Jen (1979) and Kon (1983)). Agnew *et al.* (2003) report that equity allocation of participants in 401(k) plans are positively related to the previous day's equity return (feedback trading). However, no significant correlation is found between changes in equity allocations and returns over the following three days suggesting the absence of market-timing abilities. The seminal paper by Lakonishok *et al.* (1992b) examines the US money management industry and shows that investments by pension funds have consistently underperformed the market. The authors attribute this finding to extra layers of agency problems in the pension fund industry. However, this finding is contested in a recent paper by Bauer *et al.* (2007), who show that pension funds perform close to their benchmarks while mutual funds underperform strongly. The latter authors argue that pension funds are less exposed to hidden agency costs than mutual funds, since they have better negotiating power and monitoring capacity and more efficiently pool their funds.

response to different returns across asset categories. Hence, the degree of rebalancing versus free float in pension fund asset allocation remains an open question.

This paper uses quarterly data from Dutch pension funds over 1999:I – 2006:IV. Although this period is relatively short, it contains a significant stock market bubble as well as burst. Figure 2 presents a preview of the empirical results, depicting the strategic and the actual equity allocation for Dutch pension funds, as well as the MSCI World Index. Three patterns stand out from this figure. *First*, the actual equity allocation tends to have a pattern similar to the MSCI World Index, but with some reversion to the strategic asset allocation. Generally, actual equity allocation increases when the stock market goes up, and *vice versa*. The main explanation for this pattern is that pension funds tend to rebalance their asset allocation only partly in response to changes in the value of their equity portfolio.

Figure 2: Stock market returns and equity investments (1999:I – 2006:IV)



Second, Figure 2 points to interaction between stock market performance and strategic asset allocation. The strategic equity allocation appears to follow the performance of the equity market, although with a time lag. Following the stock market boom in the second half of the 1990s, the strategic equity allocation increased until the end of 2001, but decreased from 2002 to 2003 in response to the fall of the stock market, starting in 2000. Generally, funds adjust their strategic equity allocation gradually and with a substantial delay in response to stock market movements.

Third, the figure suggests that pension funds may have lost money from market timing over the business cycle. They seem to have gradually increased their equity allocation until the downturn of the stock market was well under way, confronting them with relatively large losses. Conversely, pension funds did not significantly increase their equity allocation portfolio investments to reap the full benefit of the subsequent upward stock market trend.

The structure of this paper is as follows. Section 2 presents the data used in the analyses. Section 3 investigates the influence of market movements on asset allocation, whereas rebalancing is more closely examined in Section 4. The next section analyses the relationship between stock market returns and strategic asset allocation. The question whether pension funds are successful in adjusting their equity allocation in anticipation of expected market movements is explored in Section 6. Finally, the last section summarizes and concludes.

2 Description of the data

We use a detailed dataset with quarterly information on 748 Dutch pension funds for the 1999:I – 2006:VI period. The data is from De Nederlandsche Bank, responsible for the prudential supervision of pension funds and their regulatory compliance. For each pension fund data is available on strategic asset allocation, asset sales and purchases, the market value of investments in different asset classes and their time-weighted returns.[10] We use the MSCI World total return index denominated in euros as our principal benchmark to assess the impact of stock market returns on actual and strategic equity allocation and to evaluate the performance of market timing strategies.[11]

The sample is an unbalanced panel, as not all pension funds reported data for the entire sample period due to new entrants, mergers, terminations, and reporting failures.[12] Since our aim is to study asset allocation over time, we exclude pension funds with less than two years of data. Finally, we exclude inconsistent observations and observations with clear reporting errors.

Our final sample includes data on 748 pension funds from 1999:I – 2006:IV, representing around 85% percent of total pension fund assets in the Netherlands. Table 2 presents summary statistics on the

[10] For each pension fund, we calculate the average of its log returns over time, convert these averages to simple returns, and calculate the average of these simple returns across pension funds. This three-steps procedure avoids a distortion in calculating average returns resulting from the fact that the log of an average is not equal to the average of logs.

[11] Alternatively, in some cases we use the AEX index as a benchmark for stock market returns in the Netherlands, although it should be noted that pension funds generally have broader and more international equity portfolio allocations than captured by the latter index.

[12] We also ran regressions for a balanced sample of only 382 pension funds that reported at least seven years of data. The regression results were similar to those reported in Tables 5-7, suggesting that survivorship bias is not a significant issue.

investment portfolios of pension funds in our sample. The size of pension funds in the sample is hugely divergent: the smallest pension funds have assets worth less than € 1 million, while the largest funds have assets of more than € 200 billion. The average and median sizes of pension fund assets equal € 799 million and € 53 million, respectively. We distinguish between size classes and types of pension funds and between types of pension plans. Small funds tend to invest relatively less in equity compared to larger funds, and more in bonds, reflecting lower risk appetite. Although large in number (70% of the sample), small funds administer only a minor share (less than 3%) of all pension fund investments.

Table 2: Investments across size classes and pension fund types (1999:I – 2006:IV)

Size classes based on total investments (mln euro)	Number of pension funds	Average total investments (mln euro)	Average bond investments (%)	Average equity investments (%)	Max – min actual equity investments over time (%)	Max – min strategic equity allocation over time (%)	Investment gap (%) [a]
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
0-100 (Small)	524	29	62	29	18	12	0.4
100-1000 (Medium)	177	320	51	37	18	13	0.2
>1000 (Large)	47	8,276	37	43	16	13	0.8
Average / total	*748*	*799*	*39*	*42*	*16*	*13*	*0.8*
Type of pension fund [b]							
Industry (all)	95	3,798	35	41	14	12	1.1
- Compulsory	76	4,412	36	41	14	12	1.1
- Non-Compulsory	19	1,099	35	45	16	15	1.7
Company	631	280	45	43	20	13	0.1
Professional group	10	2,292	51	42	18	12	0.5
Plan type							
DB	592	926	39	42	16	13	0.8
DC	56	78	51	37	19	14	0.3

Note: All statistics are averages weighted by total investments except for the first and last column (Average total investments and Number of pension funds).
[a] Investment gap is the absolute difference between the strategic equity allocation and the actual percentage of equity portfolio investments; [b] Ten pension funds belong to other categories.

Our sample includes 631 company funds, 95 industry-wide funds, and 10 professional group funds.[13] Compulsory industry funds are largest in terms of investments. All funds invest between 41 and 45 percent in equity. Company funds and professional group funds invest relatively more in bonds than other types of funds, reflecting their stronger risk aversion. Industry funds invest substantially more in real estate. On average, defined benefit (DB) funds have higher equity and lower bond investments than defined contribution (DC) funds, suggesting that DB funds may take higher risks since they can benefit from intergenerational risk sharing.

[13] Company funds provide pension plans to the employees of their sponsor company. They are separate legal entities, but are run by the sponsor company and employee representatives. Industry funds provide pension plans for employees working in an industry. Such pension plans are based on a collective labor agreement between an industry's companies and the labor unions, representing the employees in this industry. Finally, professional group funds offer pension schemes to specific professional groups (*e.g.* general practitioners, public notaries).

Columns 5 and 6 indicate how, respectively, the actual and strategic equity allocation vary over time. For the average pension fund, the range of the actual equity allocation is 16% and of the strategic equity allocation is 13%. Thus, both actual and strategic equity allocation move significantly over time. The last column shows that the difference between strategic and actual equity allocation is, on average, 0.8 percentage point.

Table 3 shows that the strategic and actual equity allocation differs significantly across pension fund observations. A small majority of funds invest 20-40 percent of their assets in equities. A quarter of the funds invest more than 40 percent in equities, while around one-fifth of the funds invest less than 20 percent in equities.

Table 3: Distribution of equity allocation across pension funds (1999:I – 2006:IV; in %)

Range*	Equity allocation strategy	Actual equity allocation
0 - 20	15.2	20.4
20 - 40	55.6	53.6
40 - 60	26.3	23.8
60 - 80	2.4	1.9
80 - 100	0.4	0.3
Total	100.0	100.0

* The allocation in each class is calculated as a percentage of total observations.

Pension funds use derivatives for hedging purposes and also to efficiently adjust their tactical asset allocation, while avoiding the buying or selling (costs of) the underlying assets. Table 4 presents the use of derivatives by pension funds of various size classes. The use of derivatives increases with the size of pension funds, but even the largest pension funds (*i.e.* with total investments larger than € 1 billion) hold only 2 percent of their equity positions through derivatives. For small pension funds (below € 100 mln total investments), the notional value of quarterly purchased futures and forwards (Column 5) is small compared to the net purchase of equities (Column 4). However, for the largest pension funds, the notional value of net purchased futures and forwards is high and in fact exceeds the net purchase of equities. In contrast, the net premium paid or received for options and warrants is relatively small for all funds, although again increasing with fund size. Overall, we conclude that only the largest pension funds make significant use of derivatives.

Table 4: The use of derivates across pension funds (1999:II – 2006:IV)

Total investments (mln euro)	Number of pension funds	Average equity investments (mln euro)	… of which using derivatives (%)	Net purchase (in mln euro) of Equities	Futures and forwards	Options and warrants
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
0-100 (Small)	524	8	0.0	1	0	0
100-1,000 (Medium)	177	117	0.7	6	0	0
>1,000 (Large)	47	3545	2.0	133	94	1
Average / total	748	334	1.9	16	8	0

Notes: All statistics are simple averages. For net purchases of futures and forwards we report notional amounts. For options and warrants the premium is reported.

3 Relative stock-market returns and short-term changes in equity allocation

To start our empirical analysis, this section examines the short-term impact of stock market performance on equity allocation.[14] Over time, actual equity allocation may change either (i) due to excess returns on equities compared to other asset classes (free floating) or (ii) due to net purchases or net sales of equities (rebalancing and market timing). To investigate the impact of relative stock market returns on pension funds' equity allocation, we estimate the following equation:

$$w_{i,t} = \alpha_1 + \Sigma_{j=0}^{k} \beta_j \left(r_{t-j}^{E} - r_{i,t-j}^{T} \right) + \gamma_1 Policy_{i,t-1} + \delta_1 Size_{i,t-1} + \varepsilon_{i,t} \qquad (1)$$

The dependent variable $w_{i,t}$ is the actual percentage of the portfolio invested in equities of pension fund i ($i = 1,...,N$) at quarter t ($t = 1,...,T$). The variable ($r^E - r^T$) is used to measure excess stock market returns compared to other investment categories on a quarterly basis. For stock market return (r^E) we use the return on the MSCI World index and for the return on the total pension fund portfolio (r^T) we multiply the strategic asset allocation of four key asset classes by representative broad market indexes.[15] We consider two variants of Equation (1). The base model is without lagged stock market returns ($k = 0$), whereas alternatively, we include excess stock market returns with time lags ($k = 5$) to investigate whether past returns influence pension funds' investments with some delay. The strategic equity allocation (*Policy)* also expressed as a percentage, is included to control for pension fund investment policy. *Size*, which is measured as the logarithm of the total investment portfolio, controls for the tendency of larger funds to invest relatively more in equities. The *Policy* and *Size* are included

[14] For practical reasons, we ignore that equity price changes may also affect (or go hand in hand with) prices in real estate, hedge funds and private equity.

[15] We consider five investment categories: equities, bonds, real estate, money market instruments and other assets. For bonds we use the JP Morgan EMU bond index, for real estate we use the FTSE EPRA Netherlands real estate index and for money-market investments we use the 3-month Euribor interest rate. We assume that the fifth category 'other assets' is proportionally invested in the previous four investment categories (or have a similar return). We calculate excess returns as follows: excess return = return MSCI – [(return on bonds * bond investments + return on real estate * real estate investments + 3-months Euribor * money market investments) / (bond investments + real estate investments + money market investments)].

with one time lag to avoid endogeneity problems and since it may take some time before changes in these variables lead to changes in the equity portfolio investment. The panel is unbalanced, which implies that the number of observations varies across pension funds.

3.1 Empirical results of the impact of stock returns on actual equity allocation

Table 5 presents estimates of the impact of short-term relative stock market returns on the percentage of equity portfolio investments, using Equation (1). A one percentage point relative outperformance of the MSCI leads to an increase in equity allocation of 0.159 percentage point in the subsequent quarter (first column). The second column shows that excess equity returns also have a significant impact on equity allocation up to five quarters later. The impact decreases over time, indicating that pension funds rebalance gradually or infrequently.

Table 5: Estimates of the pension funds' equity investments model (1999:II – 2006:IV)

	All funds		**Small funds**	**Medium sized funds**	**Large funds**
	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Excess return MSCI	0.159***	0.163***	0.144***	0.196***	0.260***
Idem, lagged 1 quarter		0.114***	0.103***	0.134***	0.139***
Idem, lagged 2 quarters		0.083***	0.071***	0.101***	0.138***
Idem, lagged 3 quarters		0.060***	0.051***	0.079***	0.079***
Idem, lagged 4 quarters		0.058***	0.053***	0.065***	0.111***
Idem, lagged 5 quarters		0.047***	0.044***	0.056***	0.060***
Total effect excess returns		*0.525*	*0.466*	*0.631*	*0.787*
Investment policy (t-1)	0.927***	0.918***	0.933***	0.892***	0.869***
Size (t-1)	0.003***	0.002***	0.003***	-0.002	0.005***
Intercept	-0.005	0.010***	-0.002	0.068***	-0.019
Number of observations	17,290	14,216	8,601	4,330	1,285
R^2, adjusted	0.87	0.88	0.87	0.85	0.86

Notes: ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. The standard errors have been corrected for possible heteroskedasticity or lack of normality using the Huber-White sandwich estimators.

Hence, stock market outperformance induces increases in the equity allocation in the following periods, although the impact decays over time. Table 5 reveals also that a one percentage point increase in the strategic equity allocation causes a significant rise of around 0.927 percentage point in actual equity portfolio investments in the next period. Apparently, pension fund investment managers adjust their equity portfolio investments almost solely in response to changes in the strategic equity allocation. Finally, the positive sign for the size of investments affirms that larger funds invest relatively more in equities, except medium-sized funds.[16] A possible explanation is that large pension funds tend to be less risk averse than small pension funds.

[16] Table 1 shows that larger pension funds have relatively higher equity investments than smaller ones.

If we consider the investment behavior across size classes (last three columns), where size classes are defined as in Table 4, we observe that the impact of excess stock market returns on equity allocation increases with the pension fund size, both immediately and in the long run. Apparently, large funds allow more free floating, whereas smaller funds rebalance more. In line with this result, larger funds react less to changes in the investment policy, compared to smaller funds.

As a robustness test we repeat the estimations of Table 4 and later tables with balanced samples with pension funds which have at least 28 quarters with all required data, instead of 8 quarters as in the current data set. For all tables, the results are fairly similar. As a second test, we re-estimated with fixed effects for pension funds and years. The Hausman test rejected random effects. The results are again fairly similar, except for Table 7.[17] These results confirm that our outcomes are quite robust.

3.2 Excess stock market returns and rebalancing

The positive impact of excess equity returns on equity allocation in the previous section may be (partly) due to imperfect rebalancing by pension funds. Excess equity performance will lead to changes in equity allocation if pension funds do not keep their investment portfolios fully balanced at all times. This section presents an empirical rebalancing model, which is used to estimate to what extent pension funds rebalance, that is, adjust their asset allocation in response to excess equity returns.[18] This model is derived as follows, starting from the definition of the actual equity allocation:

$$w_{i,t} = E_{i,t} / TA_{i,t} \tag{2}$$

where $E_{i,t}$ represents the equity investments of pension fund i at time t, and TA stands for total assets. Taking first differences of Equation (2), we obtain:

$$\begin{aligned} w_{i,t} - w_{i,t-1} &= \frac{E_{i,t}}{TA_{i,t}} - \frac{E_{i,t-1}}{TA_{i,t-1}} = \frac{E_{i,t-1}(1 + r_{i,t}^{E} + NCF_{i,t}^{E})}{TA_{i,t-1}(1 + r_{i,t}^{T} + NCF_{i,t}^{T})} - \frac{E_{i,t-1}}{TA_{i,t-1}} \\ &= w_{i,t-1}\frac{(1 + r_{i,t}^{E} + NCF_{i,t}^{E})}{(1 + r_{i,t}^{T} + NCF_{i,t}^{T})} - w_{i,t-1}\frac{(1 + r_{i,t}^{T} + NCF_{i,t}^{T})}{(1 + r_{i,t}^{T} + NCF_{i,t}^{T})} \\ &= w_{i,t-1}\frac{(r_{i,t}^{E} - r_{i,t}^{T} + NCF_{i,t}^{E} - NCF_{i,t}^{T})}{(1 + r_{i,t}^{T} + NCF_{i,t}^{T})}, \end{aligned} \tag{3}$$

[17] In that table, the coefficients level of significance are substantially lower. Apparently, the pension funds' fixed effects picked up a part of the variation in the explanatory variables.

[18] An alternative approach to measure rebalancing based on pension' funds equity sales and purchases is presented in the appendix.

where NCF^T is short for new investments as a fraction of total investments, NCF^E for new equity investments also as a fraction of equity investments, r^E for the return on equities over the last quarter, and r^T for the return on total assets (all for fund i and quarter t). Dividing both sides by $w_{i,t-1}$ results in:

$$\frac{w_{i,t} - w_{i,t-1}}{w_{i,t-1}} = \frac{r_{i,t}^E - r_{i,t}^T}{1 + r_{i,t}^T + NCF_{i,t}^T} + \frac{NCF_{i,t}^E - NCF_{i,t}^T}{1 + r_{i,t}^T + NCF_{i,t}^T} \tag{4}$$

This equation explains the percentage change in equity allocation by: (i) excess equity returns, and (ii) net cash flows to equities, where both variables are scaled by the change in the total portfolio size. The first right-hand term is exogenous, since excess returns are determined by market developments and net cash flows into the pension fund are based on decisions by employers and employees rather than on equity allocation. Given the small size of pension fund investments relative to total stock market capitalization, we can safely assume that changes in equity allocation do not affect stock market returns. The second right-hand term, however, is endogenous. While net cash flows to equity investments directly influence the equity allocation of pension funds, the reverse can also be true: changes in the equity allocation may sway pension funds to adjust their net cash flows to equity investments. Thus, there is mutual causality between changes in equity allocation and net cash flows to equity investments. To estimate the impact of excess equity returns on equity allocation, we apply the above decomposition, ignoring the endogenous second right hand term. This results in the following empirical regression model:

$$\frac{w_{i,t} - w_{i,t-1}}{w_{i,t-1}} = \alpha_2 + \beta_2 \left(\frac{r_{i,t}^E - r_{i,t}^T}{1 + r_{i,t}^T + NCF_{i,t}^T} \right) + \gamma_2 \left(\frac{\Delta Policy_{i,t-1}}{Policy_{i,t-2}} \right) + \varepsilon_{i,t} \tag{5}$$

The percentage change or growth in the strategic equity allocation (*Policy*) is included to control for changes in investment policy. This variable is included with a time lag of one quarter, since it may take some time before changes in policy lead to adjustments in the actual equity portfolio investments. In Equation (5), β_2 estimates the degree of free float or market timing and $1\text{-}\beta_2$ assesses the rebalancing percentage. As an alternative model we split the excess equity return variable further into positive and negative equity returns. This allows us to observe possible asymmetric effects in response to changes in excess equity returns.

3.3 Empirical results of rebalancing

Table 6 presents the estimated impact of excess equity returns on equity allocation. The results show that pension funds rebalance, on average, around 39 percent of excess equity returns, leaving 61 percent for free floating. Thus 61 percent of excess equity returns translate into increases of the equity

allocation in the next period. Column (2) shows that pension funds rebalance differently in response to positive and negative equity returns. Only 12 percent of positive equity returns are rebalanced, against 49 percent of negative equity returns. Apparently, whereas pension funds do not automatically sell equities in bull markets, they do tend to buy additional equities in bear markets. In line with expectations, changes in policy affect the actual allocation positively (significant at the 1% level), with a lag of one quarter.

Table 6: Estimates of the equity allocation model: rebalancing versus free float (1999:II – 2006:IV)

	All funds		**Small funds**		**Medium sized funds**		**Large funds**	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Excess equity returns	0.613		0.615		0.591		0.698	
Positive excess equity returns		0.878		0.843		0.852		1.214
Negative excess equity returns		0.506		0.529		0.478		0.483
Change in policy (t-1)	0.074	0.075	0.096	0.108	-0.003	0.024	-0.049	-0.021
Intercept	0.012	0.003	0.016	0.006	0.012	0.001	0.009	-0.008
Number of observations	11,867	11,867	5,817	5,817	4,653	4,653	1,397	1,397
R^2, adjusted	0.19	0.20	0.17	0.18	0.22	0.23	0.29	0.32

Notes: All symmetric and asymmetric excess equity returns effects are significant at the 1% level. The standard errors have been corrected for possible heteroskedasticity or lack of normality using the Huber-White sandwich estimators.

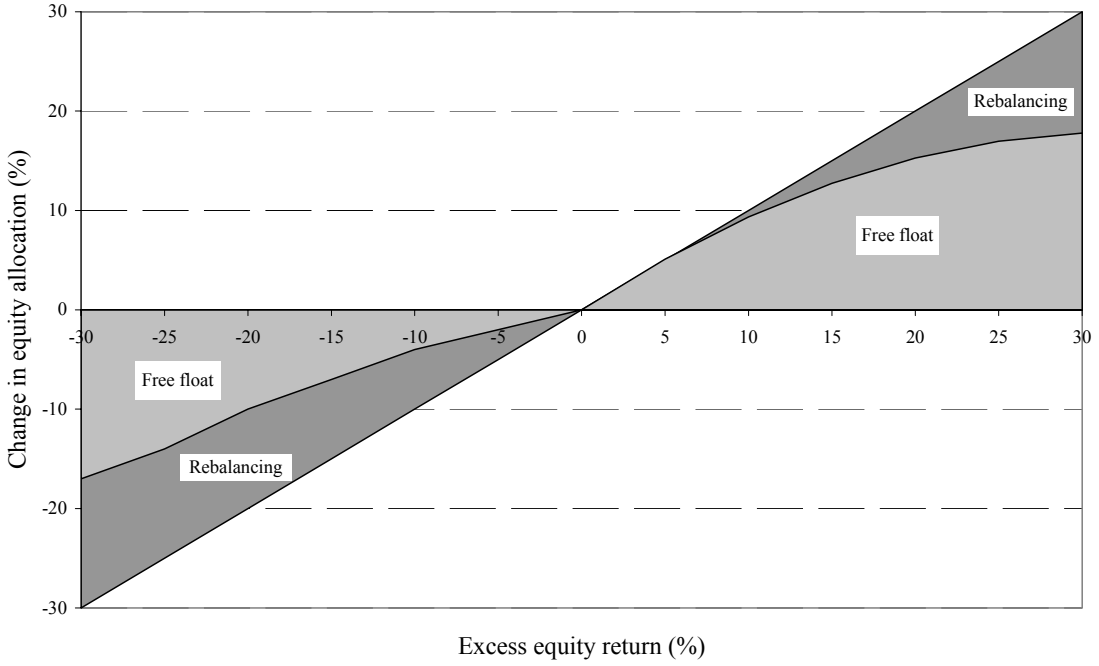
Columns (3) to (8) present the model estimates for the various size classes. In line with the results of Section 3.1, we observe that, in the symmetric model variant, large funds, at 30 percent, rebalance less than the small and medium-sized funds (around 40 percent), leaving 70 percent for free floating. Changes in the one quarter lagged strategic equity allocation (*Policy*) affect actual allocation significantly (at the 1% level) for the small funds only.[19] If we turn to the asymmetric effects on excess equity returns, we observe that the positive effects increase significantly with pension fund size, while the negative effects are similar across the size classes. The positive returns coefficient for the largest funds is, at 1.21, even above 1, indicating that large funds invest additional funds in equities in response to excess returns in the last month. This suggests that excess equity returns are perceived by large pension funds to provide a positive signal for future returns, leading pension funds to increase their stakes. This is in line with results in Table 5, which indicate that large funds respond more strongly to excess equity returns than small ones. A possible explanation is that managers of large funds have more freedom to use market timing strategies in response to market developments.

Figure 3 presents the asymmetric relation between excess equity returns and rebalancing discussed above.[20] If pension funds used a free float strategy and did not rebalance at all, excess equity returns

[19] We estimated also an alternative specification with interaction term excess equity return times size instead of three size classes. However, the coefficient of this interaction terms was insignificant.
[20] To estimate this figure we adjusted Equation 5 by adding three additional terms: squared excess equity returns and excess and squared equity returns multiplied with 0-1 dummies indicating positive and negative returns.

would go in full to proportionate increases in equity allocation. This is represented by the diagonal line. Instead, with full rebalancing, excess equity returns would have no impact on equity allocation, marked off on the x-axis. The curvature dividing the free float and rebalancing areas reflects the actual rebalancing behavior of Dutch pension funds. Strikingly, rebalancing by pension funds depends on both the sign and size of excess equity returns. Small positive equity returns (of around 0-5%) are not rebalanced at all, but the degree of rebalancing increases with the size of excess equity returns. Instead, small negative returns (of around 0 to -10%) are rebalanced for the largest part, but the degree of rebalancing decreases with the size of negative excess returns.

Figure 3: Reaction of pension funds to excess equity returns: rebalancing and free float



4 Excess stock market returns and medium-term changes in strategic equity allocation

The previous section described the effects of excess equity returns on actual equity allocation. This section investigates the impact of (annual) stock market performance (ar^E - ar^T) on pension funds' strategic equity allocation (*Policy)*. Therefore, we estimate the following equation:

$$Policy_{i,t} = \alpha_3 + \beta_3\left(ar_{i,t}^{E} - ar_{i,t}^{T}\right) + \gamma_3 Policy_{i,t-1} + \delta_3 Size_{i,t-1} + \varepsilon_{i,t} \qquad (6)$$

The excess stock market performance has been taken on an annual basis, indicated by $(ar^E - ar^T)$, where *a* refers to annual.[21] We assume that the pension fund trustees base their policy on longer-term measures of performance, as also reflected by the empirical results.[22] As above, *Size* controls for the tendency of larger funds to invest relatively more in equity portfolios. We also include a lag of the dependent variable *Policy*, as we expect only gradual changes in policy over time. Hence, the equation describes the quarterly adjustments in policy.[23]

4.1 Empirical results of the impact of stock market returns on strategic equity allocation

Table 7 shows the impact of excess stock market returns on strategic equity allocation. The investment policy is adjusted significantly to changes in equity returns, irrespective of whether they are measured by the MSCI or by the actual investment returns earned by pension funds. This shows that investment policy is not constant over time but, to some extent, follows market developments. The coefficient of the lagged dependent variable, 0.97, indicates how slowly the strategic equity allocation reacts to changes in the quarterly returns. On average, 97 percent of the equity investment policy is determined by the previous quarter's investment policy, whereas market developments account for the remaining 3 percent. These market developments, captured by the yearly excess return, have a small but very significant impact, both based on the MSCI and on the actual equity return of the pension fund. Their final impact on equity investment policy over time is 0.28 (= 0.0096/(1 – 0.9660)). The size effect is also small but significant.[24] While this equation shows how investment policy is influenced by market

Table 7: Estimates of the strategic equity allocation model (1999:II – 2006:IV)

	All funds		Small funds	Medium sized funds	Large funds
	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Equity investment policy (t-1)	0.9660***	0.9716***	0.9652***	0.9656***	0.9768***
Yearly excess return MSCI	0.0096***		0.0094***	0.0099***	0.0110**
Yearly excess pension fund's equity return		0.0068***			
Size (t-1)	0.0009***	0.0006**	0.0010**	0.0006	0.0008
Intercept	0.0009	0.0034***	0.0006	0.0068	-0.0021
Number of observations	16,340	11,273	10,118	4,822	1,400
R^2, adjusted	0.95	0.954	0.940	0.941	0.954

Notes: ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. The standard errors have been corrected for heteroskedasticity using the Huber-White sandwich estimators.

[21] Excess equity return compares the MSCI World index to other investment categories, as above.
[22] Annual returns provide better results than quarterly returns.
[23] An alternative model, with first differences of Policy as the dependent variable, instead of gradual adjustment, leads to similar estimation results (not reported here).
[24] We estimate also an alternative specification of Equation (6), with as dependent variable the first difference of equity investment instead of its level, so that we drop the lagged 'equity investment policy' term. In that specification, the various 'yearly excess return' coefficients are all a fraction higher and equally significant. The variable 'size' is no longer significant. Where equity levels are higher for large pension funds compared to small funds, the adjustment of the strategic equity allocation does not deviate significantly between large and small funds.

developments, it does not provide a model of the underlying investment policy decisions, which are generally based on asset liability management studies.

The results across pension fund size classes seem similar. However, the slight increases in the coefficients of the lagged dependent variable and the yearly excess return for the larger funds imply an increase in the long-run effect of the yearly excess return from 27% (small funds) to 47% (large funds).

5 The impact of market timing on pension fund returns

Sections 3 and 4 show that both actual and strategic asset allocation of pension funds are influenced by the relative performance of equity markets. Here we investigate whether the variations of actual and strategic asset allocation have generated excess returns. Pension fund investment managers may profit from market timing in their decisions on the actual equity allocation, provided they have some ability in forecasting stock market trends. To earn higher risk-adjusted portfolio returns, skilled investors can create a positive information ratio through increasing equity allocation before the start of a bull market and conversely, decreasing them ahead of a bear market. Similarly, pension fund trustees may profit from market timing in their decisions on the strategic equity allocation. This section examines whether pension funds indeed have profited from market timing during the sample period. We use the following three equations to split excess returns that can be attributed to market timing (ER_{MT}) into three sources:[25]

$$ER_{MT}(1) = \sum_{t=1}^{T} (Policy_{i,t} - \overline{Policy_i})(r_t^E - r_{i,t}^T)/T \tag{7}$$

$$ER_{MT}(2) = \sum_{t=1}^{T} (w_{i,t} - \overline{w_i})\ (r_t^E - r_{i,t}^T)/T \tag{8}$$

$$ER_{MT}(3) = \sum_{t=1}^{T} (w_{i,t} - Policy_{i,t})\ (r_t^E - r_{i,t}^T)/T \tag{9}$$

By approximation (9) equals (2) minus (1) as, for each pension fund, the average $Policy_{i,t}$ is in line with the average $w_{i,t}$. The variable $(r^E - r^T)$ equals the quarterly excess return of pension fund i at time t as defined before. *Policy* and w are again, respectively, the strategic and actual equity weights in the asset portfolio. Equation (7) estimates the average excess return from varying the strategic equity

[25] Equations (7) and (8) are adapted from Grinblatt and Titman (1993). The performance measure proposed by Grinblatt and Titman (1993) is different from ours in two ways. First, they compare current portfolio weights to portfolio weights in the previous period instead of average portfolio weights. Second, they do not specifically focus on market timing but instead study whether active stock picking generated positive risk-adjusted returns.

allocation over time,[26] Equation (8) measures the added value of varying the actual equity allocation over time, and Equation (9) determines the extra return from allowing the actual equity allocation to differ from the strategic equity allocation. The equations estimate the average quarterly return that would have been realized by applying a market timing strategy to investments in broad market indices.[27] Under the null hypothesis that the portfolio manager has no ability in forecasting expected stock market returns, the excess equity returns are uncorrelated to over- or underweighting of equity allocations relative to their mean and excess equity returns would be close to zero.

Table 8: The average impact of market timing on returns (1999:II – 2006:IV; in %)

Market timing measure	Average absolute weight	Average s.d. of weights over time	Average excess equity returns
(1) Varying strategic equity allocation over time			
a) Small funds	2.6	3.3	-0.05
b) Medium sized funds	3.1	3.8	-0.06
c) Large funds	3.1	3.8	-0.06
d) Full sample	3.1	3.8	-0.06
(2) Varying actual equity allocation over time			
a) Small funds	3.5	4.4	-0.07
b) Medium sized funds	3.6	4.5	-0.07
c) Large funds	3.2	4.0	-0.05
d) Full sample	3.2	4.1	-0.05
(3) Deviating actual from strategic equity allocation			
a) Small funds	2.5	3.2	-0.03
b) Medium sized funds	2.9	3.8	0.00
c) Large funds	2.2	2.9	0.01
d) Full sample	2.3	3.0	0.01

Notes: All statistics are averages weighted by total investments. The average absolute weights are calculated for the different measures as follows: (1) the average of the absolute deviation between the strategic equity allocation and the average strategic allocation calculated over time, (2) the same for actual equity allocation, and (3) the average of the absolute deviation between actual and strategic equity allocation.

Table 8 presents the estimation results of Equations (7) to (9). The first column shows that the average absolute weight, on which excess returns from market timing can be earned, is small. However, as the middle column indicates, the variation of the equity allocation is significant.[28] The last column presents both the variation of the strategic and actual equity allocation over time and shows that the average negative excess return is no less than between 5 and 7 basis points per euro invested per quarter, that is, 20-25 bps annually. In contrast, the effect from deviating actual from strategic equity

[26] The bars above $Policy_i$ and w_i indicate the respective averages over t (time).
[27] We calculate the average returns in three steps. For each pension fund, we first calculate the average of its log returns over time. Next, we convert these averages to simple returns. Finally, we calculate the average of these simple returns across pension funds. This procedure avoids a distortion in calculating average returns resulting from the fact that the log of an average is not equal to the average of logs.
[28] Significance is based on the annualized standard deviation of the calculated 'excess returns', which is around 0.9%, well above the 'average excess returns' in Table 8.

allocation on excess returns has been close to zero. Note, however, that none of the results are significantly different from zero. Differences across size categories appear to be small.

The costs of market timing are not fully internalized into the figures presented. The inclusion of transaction and personnel costs would result in even more negative excess returns from market timing. Overall, these results show that for the average pension fund, market timing led to negative, non-significant excess returns during the sample period.

6 Conclusions

This paper is the first to examine the interaction between stock market performance and the investment policy of pension funds. We find that stock market performance influences the asset allocation of pension funds in two ways. In the short term, the outperformance of equities over bonds and other investment categories automatically results in higher equity allocation (and *vice versa*), as pension funds do not continuously rebalance their asset allocation. Each quarter, pension funds rebalance, on average, around 39 percent of excess equity returns. The remaining 61 percent leads to higher or lower equity allocation as a result of free floating, which are further rebalanced in subsequent quarters. In the medium term, outperformance of equities induces pension funds to increase their strategic equity allocation (and *vice versa*). Overall, our estimates indicate that the investment policy of pension funds is partially driven by the (cyclical) performance of the stock market. Apparently, pension funds suffer from myopic investment behavior: they tend to base investment decisions excessively on recent stock market performance, rather than on long term trends.

We also find that pension funds react asymmetrically to stock market shocks. Equity reallocation is higher after underperformance of equity investments then after outperformance. In particular, only 16 percent of positive excess equity returns is rebalanced, while 48 percent of negative shocks results in rebalancing. Thus, pension funds strictly limit any decline in equity allocation in response to underperformance but they allow higher exposures to equities when these outperform other investments. Apparently, equity portfolio managers have more funds available for investment, when they gain excess returns.

We observe that strategic and actual equity allocation of pension funds vary significantly over time. However, pension funds are not rewarded for market timing. On average, both the market timing strategy proposed by the pension fund administration and actual market timing executed by investment managers leads to negative or zero excess returns over the period under consideration, depending on the measure used. In line with most empirical evidence, we find that the market timing strategy of Dutch pension funds does not generate excess returns, indicating that Dutch pension fund managers

are unable to predict market movements. Overall, this paper suggests that, over the sample period, the value added of market timing is limited and consequently pension funds would do better by spending resources on deriving the best strategic asset allocation strategy and to use rebalancing to invest accordingly.

Large funds' investment behavior is different from that of small funds. They invest more in equity and their equity allocation is affected much more strongly by actual equity returns. The latter implies that large funds rebalance less, possibly because managers enjoy more freedom in implementing market timing strategies. We find asymmetric effects on excess equity returns, where the positive effects increase significantly with pension fund size. The coefficient of positive returns of the largest funds is, in fact, significantly above 1, reflecting 'overshooting' of free floating, or 'positive feedback trading'. A possible explanation is that managers of large funds have more freedom to respond to market developments and, particularly in bull markets, demonstrate great risk tolerance.

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APPENDIX: PENSION FUNDS' EQUITY PURCHASES AND SALES

An alternative procedure to estimate rebalancing is to use the purchases and sales of equity investments as the dependent variable. Equation (8) estimates the impact of excess equity returns on net equity sales.

$$Equity\ \ sales_{i,t} = \alpha_4 + \beta_4(r^E_{i,t} - r^T_{i,t}) + \gamma_4 \Delta Policy_{i,t-1} + \delta_4(Policy_{i,t-1} - w_{i,t-1}) + \varepsilon_{i,t} \quad (8)$$

Equity sales$_{i,t}$ is defined as net equity purchases or sales of fund *i* at quarter *t* as a percentage of total equity. The explanatory variables are the same as before: $(r^E - r^T)$ measures excess stock market returns compared to other investment categories, $w_{i,t}$ is the percentage of pension fund equity investments, while *Policy* is the strategic equity allocation. Additionally, we consider asymmetric effects of excess equity returns on equity transactions. We control for changes in the strategic equity allocation (Δ*Policy*) and for differences between the strategic equity allocation (*Policy* – *w*) and actual equity investments (the 'investment gap'), both lagged one quarter.

Table 9 presents evidence on rebalancing, as the percentage of equity portfolio sales and purchases are significantly affected by excess equity returns. Negative equity returns are the main force behind this phenomenon (see Column 3). The investment gap is also a significant driver of equity portfolio sales and purchases. Although the rebalancing and investment gap effects are significant, only a tiny portion of the variation in equity portfolio sales and purchases is explained by our model (see adjusted R^2).

Table 9: Estimates of the equity purchases and sales model (1999:II – 2006:IV)

	All funds			**Small funds**	**Medium-sized funds**	**Large funds**
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Excess equity returns	-0.27***	-0.27***		-0.27***	-0.28***	-0.22***
Positive excess equity returns			0.03			
Negative excess equity returns			-0.41***			
Change in strategic equity allocation (t-1)		0.10	0.12	0.12**	0.10**	-0.01
Investment gap (t-1)		0.37***	0.35***	0.44***	0.33***	0.26***
Intercept	0.02***	0.02***	0.01***	0.03***	0.02***	0.01***
Number of observations	12,468	11,787	11,787	5,703	4,672	1,412
R^2, adjusted	0.04	0.06	0.07	0.06	0.07	0.06

Notes: ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. The standard errors have been corrected for heteroskedasticity, using the Huber-White sandwich estimators.

Turning to the size class estimates, we find less rebalancing behaviour of the larger funds compared to small funds. This is further emphasized by the observation that larger funds also react less than small funds to changes in the policy and investment gap.