DNB Working Paper

No. 603 / August 2018

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DeNederlandscheBank

EUROSYSTEEM

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

Working Paper No. 603

August 2018

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Benchmark selection and performance*

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2 August 2018

Abstract

Using regulatory data that are free of self-reporting bias for 2007-2016, we decompose investment returns of 455 Dutch pension funds according to their key investment decisions, i.e. asset allocation, market timing and security selection. In extension to existing papers, we also assess the impact of benchmark selection, i.e. the pension funds' choice for proprietary benchmarks instead of standard benchmarks. Over time, asset allocation explains 39 percent of the variation of pension funds' returns, whereas benchmark selection, timing and selection explain 11, 9 and 16 percent, respectively. Across pension funds, asset allocation explains on average only 19 percent of the variation in pension fund returns. This is dominated by benchmark selection explaining 33 percent of cross sectional returns. Over time and across pension funds we document that benchmark selection is more important in driving returns than selection and timing.

Keywords: Pension funds; Asset allocation; Benchmark selection; Investment performance.
JEL classifications: G11, G23.

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Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank or the Centrale Bank van Aruba. We thank Aleksandar Andonov, Matteo Bonetti, Bart Bos, Kristy Jansen and participants of the research seminar at DNB for useful comments. Moreover, we are grateful to David Keijzer for the data gathering process and Henk van Kerkhoff for data handling.

1. Introduction and contribution

Pension fund trustees make important decisions on behalf of the pension fund's participants. Setting the investment policy is one of the most important decisions to be made by the trustees, next to liability hedging, contribution and pension benefit policy. The investment policy itself includes several key decisions affecting investment returns: the choice of the strategic asset allocation, the benchmark selection, the timing of investment decisions and security selection. The board of trustees is responsible for setting the overall strategic policy. Although the board of trustees is also responsible for the implementation of its investment policy, it typically delegates this to internal and external investment managers, see Van Binsbergen, Brandt and Koijen (2008).

Compared to previous studies on the impact of investment decisions on returns, our paper has two key contributions. *First*, we use data free of self-reporting bias, as the pension funds in our sample are required by law to report policy and actual statistics on asset allocations and returns for regulatory purposes. *Second*, we present an innovation in the decomposition of returns. In addition to the usual decomposition into asset allocation, market timing and security selection, we analyse the impact of benchmark selection. The choice of a benchmark reflects the investment universe that is specific to the investor and that the investor therefore used for return evaluation. Often such benchmarks are custom built for an investor. In the remainder of this paper we call such a benchmark a proprietary benchmark. The difference between a proprietary benchmark and a standard benchmark captures the effect of differences in investment universe on returns and risk. A pension fund may, e.g., exclude certain sectors in the economy from its investment universe. For example, a pension fund may not wish to have a strategic exposure to 'sin stocks'. These stocks are found in sectors that are perceived to make money from exploiting human weaknesses and frailties, e.g., alcohol, tobacco, and gambling. For this reason, such a pension fund may wish to use a proprietary benchmark that can be custom built or that can be based on a standard benchmark excluding these exposures. The benchmark can also be tailored to the pension funds' specific investment style, such as growth investing or value investing. Proprietary benchmarks are not only used for equity portfolios. A pension fund that wants to invest only in investment grade debtors may consequently want to use a proprietary bond benchmark for return analysis. Standard benchmarks for bonds are typically overweighed towards countries and other debtors that issue significant amounts of debt.

Especially if these benchmarks are value weighted. Therefore, they may be perceived to be more risky. Another example is a pension fund investing only in ‘green’ real estate and therefore uses a proprietary benchmark for returns analysis.

We analyse the impact of benchmark selection on performance in a specific case study, the Dutch occupational pension sector. With 1,281 billion euro in assets under management at the end of 2016Q3, the Dutch occupational pension sector resembles 187 percent of the GDP of the Netherlands. According to OECD (2017), the Dutch occupational pension sector in 2017 represents 54 percent of total pension assets in the euro area. This makes Dutch pension funds’ investment behaviour an interesting subject for further analysis. With our unique data we can determine the impact of different investment decisions on returns. Following the literature on return decomposition, we analyse pension funds’ returns from five different angles:

1. *Return decomposition.* We decompose pension fund returns into asset allocation policy, market timing and security selection following Brinson, Hood and Beebower (1986). We add to this the impact of benchmark selection.
2. *Contributions to return variation.* We unravel the impact of asset allocation policy, benchmark selection, market timing and security selection on time series and cross-sectional return variation following Brown, Garlappi and Tui (2010).
3. *Contributions to return variation net of market movements.* Similar to 2, but net of market returns.
4. *Returns from actively changing strategic asset allocation.* We decompose the time series and cross-sectional return variation with changes in strategic asset allocation following Andonov, Bauer and Cremers (2012).
5. *Risk adjusted returns from actively changing strategic asset allocation*. Similar to 4, using risk adjusted returns.

The plan of this paper is as follows. After reviewing the relevant literature in Section 2, we present our methodology in Section 3. In Section 4 we discuss the data, after which we give our analysis of portfolio returns in sections 5 and 6. Section 7 provides a robustness check and 8 concludes.

2. Literature review

This paper adds to the strand of literature on return decomposition. The classical paper of Brinson *et al.* (1986) decomposes quarterly returns of 91 US pension funds during 1974-1983 into returns due to asset allocation, market timing, and security selection. The authors calculate the respective contributions of each of those decisions to the return variation across time. They find that asset allocation policy contributes the bulk of variation across time. In an update for 82 US pension funds over 1977-1987, Brinson, Singer and Beebower (1991) confirm this finding. Ibbotson and Kaplan (2000) show that the greater part of the vast contribution of asset allocation policy to return variation across time is due to general developments in the capital markets, not to the pension funds' specific asset allocation policies. They also calculate contributions to return variation among pension funds, for which asset allocation policy contributes less.

Drobetz and Köhler (2002) analyse German and Swiss balanced mutual funds data. The authors document that the largest part of return variability over time and across mutual funds is explained by asset allocation policy. They show that more than 100 percent of the return level is explained by the policy return level. Brown *et al.* (2010) apply an analysis of asset allocation, market timing, and security selection on university endowment funds in the US, Canada and Puerto Rico over the period 1984-2005. They show that the risk adjusted excess performance of the average endowment is negligible. Xiong, Ibbotson, Idzorek and Chen (2010) show that market movements should be removed to analyse the pension fund specific characteristics by using excess market returns in time series analysis.

This paper also adds to the stream of literature on pension fund returns as such. Blake, Lehmann and Timmerman (1999) study WM Company data for 306 U.K. pension funds. They find that strategic asset allocation decisions account for most of the time-series variation in the pension funds' portfolio returns. Andonov *et al.* (2012) decompose returns and measure risk adjusted performance of pension funds in the US and Canada over 1990-2008 provided by CEM Benchmarking. They find that security selection explains most of the differences in pension fund returns and that large pension funds provide more value for their clients after accounting for investment related costs, both before and after risk-adjusting.

There are a few papers on Dutch pension funds. Bikker, Broeders and De Dreu (2010) focus on the impact of market timing on pension fund returns in the Netherlands. They conclude that the average contribution of market timing to returns is zero to negative. Huang and Mahieu (2012) study investment performance of about 60 industry-wide Dutch pension funds over 1998-2006. These pension funds are obliged to report their investment performance according to the so-called z-score.[1] The authors find that pension funds as a group cannot beat their self-reported benchmarks consistently. Gerritsen (2016), analysing equity investments of around 660 Dutch pension funds over 1999-2015, confirms this finding. Our paper decomposes returns, return variation and risk adjusted returns by investment policy across 2007-2016 for all types of Dutch pension funds, looking at all four broad asset classes: bonds, equities, real estate and other.

3. Asset allocation policy, benchmark selection, market timing, and security selection

Our point of departure is the methodology introduced by Brinson *et al.* (1986, 1991) to decompose returns into the components: asset allocation policy, market timing, and security selection.[2] This approach is also followed by Blake *et al.* (1999), Brown *et al.* (2010), Xiong *et al.* (2010) and Andonov *et al.* (2012). Instead of using this approach directly we extend it by including a fourth component, i.c., benchmark selection to capture the impact of choosing the investable universe. This way we take into account that each pension fund may use its own proprietary benchmark. The composition, and therefore the return and risk characteristics of this proprietary benchmark, deviates from standard benchmarks.

Our approach is as follows. The realised total portfolio return of pension fund i in period t can be written as:

$$R_{i,t} = \sum_{j=1}^{M} w_{i,j,t-1} r_{i,j,t} \ , \qquad (1)$$

[1] The z-score measurers the investment performance of an industrywide pension funds against a return of predefined portfolio that takes into account the risk profile of the pension fund.
[2] We assume readers are familiar with the seminal approach of Brinson et al. (1986).

where $w_{i,j,t-1}$ is the actual portfolio weight of pension fund $i = 1, \ldots, N$ in asset class $j = 1, \ldots, M$ at the end of period $t-1$, and $r_{i,j,t}$ the realised period-t return of pension fund i on asset class j. The realised total portfolio return can be decomposed into the impact of the underlying decisions in the following way. When $w_{i,j,t-1}^{AA}$ is the strategic asset allocation weight of pension fund i in asset class, $r_{j,t}^{SB}$ the standard benchmark return on asset class j, and $r_{i,j,t}^{PB}$ the proprietary benchmark return of pension fund i on asset class j, Eq. (1) can be decomposed into the following four components:

$$R_{it} = \sum_{j=1}^{M} w_{i,j,t-1}^{AA} r_{j,t}^{SB} + \sum_{j=1}^{M} w_{i,j,t-1}^{AA}\left(r_{i,j,t}^{PB} - r_{j,t}^{SB}\right) + \sum_{j=1}^{M} (w_{i,j,t-1} - w_{i,j,t-1}^{AA}) r_{i,j,t}^{PB} + \sum_{j=1}^{M} w_{i,j,t-1}(r_{i,j,t} - r_{i,j,t}^{PB})$$

$$\equiv R_{i,t}^{AA} + R_{i,t}^{BS} + R_{i,t}^{MT} + R_{i,t}^{SS}, \qquad (2)$$

where $R_{i,t}^{AA}$ is the portfolio return from *asset allocation* policy based on the standard benchmark, $R_{i,t}^{BS}$ is the additional portfolio return from *benchmark selection* given that the pension funds invests according to its strategic weights, $R_{i,t}^{MT}$ is the portfolio return from *market timing* based on the proprietary benchmark return and $R_{i,t}^{SS}$ the portfolio return from *security selection* based on the actual portfolio weights. Figure 1 shows the dependencies of the variables in Equation (2).

[insert Figure 1 here]

A pension fund's *asset allocation policy* return is a consequence of the investment policy adopted by the board of trustees if it would invest in standard benchmarks. The investment policy identifies the strategic asset allocation selected to meet a pension fund's objectives and to control the overall risk. This includes the selection of asset classes and strategic weights. To calculate the asset allocation policy return, we use the strategic asset allocation weights of all asset classes and a standard benchmark return assigned to each asset class.

The return from *benchmark selection* captures the choice of the investment universe. It follows from the decision of the pension fund to have a proprietary benchmark that deviates from a standard benchmark. Suppose a pension fund's restricts its investment universe to strategically not invest in carbon intensive industries, it will create a proprietary benchmark excluding this industry. This way the actual return can be fairly assessed against the proprietary benchmark. According to the fundamental law of active management of Grinold and Kahn (2000), the risk adjusted extra return over a passive return equals the predictive power of the asset manager times the square root of the number of independent investment decisions. This law suggests that the return potential from benchmark selection is small as it involves only a single investment decision.

The return from *timing* is the return of under- or overweighting an asset class relative to its strategic asset allocation weight. Its purpose is to enhance return or to reduce risk. Timing is undertaken to achieve incremental returns relative to the asset allocation policy return. If timing is bad, it decreases returns. Grinold and Kahn (2000) show that the potential extra return through market timing is limited. This again follows from the fundamental law of active management. If a pension fund makes quarterly market timing decisions, the annual number of independent investment decisions is four. It requires a highly predictive power for the pension funds to earn an excess return based on these four timing decisions.

The return from *security selection* is obtained by means of active selecting securities within an asset class. It is defined as the portfolio's actual asset class returns versus the passive proprietary benchmark returns and weighted by the strategic asset allocations. However, according to the fundamental law of active management the return potential is larger. Security selection out of thousands of different stocks, bonds and other assets means that the number of independent investment decisions is high. As a consequence, a pension fund requires only small predictive power ('skills') to earn a risk adjusted excess return.

4. Data

After the theoretical considerations in the previous section, we now turn to the data that we will use for analysing portfolio performance. We use quarterly unbalanced panel data on 480 Dutch pension funds' investments and returns during the period 2007Q1-2016Q3. These 480 pension funds represent 86 percent of the Dutch pension sector in terms of total investments. The proprietary data have been obtained from the supervisory statistics of De Nederlandsche Bank, which is the prudential supervisor of pension funds in the Netherlands.

We distinguish four asset classes that sum up to the total portfolio: (1) bonds, (2) equities, (3) real estate and (4) other. Bonds include both government and corporate bonds. Equities include listed stocks and private equity. Real estate covers direct real estate, indirect non-listed real estate and indirect listed real estate. The category other includes cash, hedge funds, commodities, etc.[3] For all four classes, we have pension fund-specific data on actual returns, actual asset allocations, strategic asset allocations and proprietary benchmark returns.[4] This makes our data quite unique. For example, Brinson *et al.* (1986, 1991) lacked details on strategic asset allocations. Therefore, they assumed that the 10-year average holding of each asset class was sufficient to approximate the strategic holding. They also did not have proprietary benchmark returns for each asset class for each pension fund. Therefore, they used standard market index returns for benchmark returns. Furthermore, they did not have complete data coverage on the 'other' category, so that this asset class was excluded from their analysis. Bauer *et al.* (2010) and Andonov *et al.* (2012) have pension fund proprietary benchmarks for US and Canadian pension funds but reporting in their sample is voluntary, not mandatory.

We clean the data for possible reporting errors and omissions. For that we reconcile and compare the actual reported portfolio return R_{it} and the reported strategic return R_{it}^{AA} with the outcomes of our own calculations of R_{it} and R_{it}^{AA}, according to the right hand side of identity (1) and the strategic weights and proprietary benchmark returns, respectively. We then determine the 5$^{\text{th}}$ and 95$^{\text{th}}$ percentiles of the distributions of the deviations from the two identities. We drop observations from the data for which the deviations from the two identities lie outside their respective 5$^{\text{th}}$ to 95$^{\text{th}}$ percentile range. In total 25 pension funds where dropped completely, leaving 455 pension funds in the sample. In addition to reporting errors and omissions, the relatively large number of observations dropped can also be due to the impact of the currency overlay on the portfolio return. Pension funds may hedge some (or all) of their currency exposure with derivatives. The impact of the currency overlay is included in the

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[3] We exclude the impact of 'overlay' structures. We do not take into account any interest rate hedging policy with interest rates swaps. Although these represent a synthetic allocation to bonds, these can only be assessed from a total balance sheet perspective, i.e. the assets and liabilities. In this paper we focus on the assets of pension funds only.

[4] Although we have self-reported benchmark returns, we have no specific details on the composition of these proprietary benchmarks (DNB, 2011).

overall reported portfolio return. It is however not included in the returns on individual asset classes. This difference may impact the reconciliation of returns, especially in times of high volatility in exchange rates. We cannot differentiate between reporting errors and omissions versus the impact of currency overlay. As a robustness check we also run all our regressions using the full sample in Section 7.

Figure 2 shows the strategic and the actual asset allocation for the four asset classes in this study. There is some time variation in both the strategic and actual asset allocations. These do not match exactly as the actual allocation is driven by market movements and pension funds do not continuously rebalance their asset allocation (Bikker *et al*., 2010). On average, pension funds allocate more to bonds compared to the strategic asset allocation around the financial crisis in 2008 and since 2011. The equity allocation follows the strategic asset allocation policy more closely. The actual allocation to real estate however is smaller than the strategic asset allocation until 2011 and larger thereafter. Other investments are under-allocated after 2011. Asset allocations can vary over time and between pension funds. To get a feeling for this, Table 1a shows the standard deviation across pension funds and time, for the actual and strategic asset allocation weights, respectively. It is apparent from this table that the dispersion of weights is largest for bonds and smallest for real estate. Again, this dispersion can be driven by pension funds changing their asset allocation over time or pension funds having dissimilar asset allocations. The large variation presented in Table 1a indicates that there are sufficient time series and cross-sectional differences for our analysis.

[insert Figure 2; Table 1a here]

Figure 3 shows the average quarterly realised returns and returns from asset allocation policy for the different asset classes and for the total portfolio return. Aggregate realised returns on average did not deviate much from returns from asset allocation policy, with the exception of other investment returns. Obviously, variation in equity returns is the largest being the most risky asset class. In the fourth quarter of 2008 pension funds on average lost more than 20 percent on their equity portfolio following the financial crisis. The fourth quarter of 2010 was particularly bad for bond returns following the euro debt crisis.

[insert Figure 3 here]

Pension funds report strategic returns on their proprietary benchmarks. For analysing the impact of benchmark selection we need standard benchmarks returns. For bonds we use the JPM Global Government Bond Index, for equities the MSCI World Index and for real estate GPR 250 Index.[5] All standard benchmark returns are total returns (coupons, dividends and other cash flows are reinvested) and converted into euro returns. Table 1b shows summary statistics of the difference between the returns on the proprietary benchmarks and these standard benchmarks. Obviously, on average, there is not much difference in the returns of these two types of benchmarks. The standard deviation of the return difference however reveals that there is quite some difference in returns over time and across pension funds. As there does not exist a standard benchmark for other investments, our calculation of the performance contribution of benchmark selection does not include other investments.[6]

[insert Table 1b here]

5. Analysis of pension fund portfolio returns

After describing the data, we can now turn to the empirical analysis. In this section we first present a decomposition of returns into asset allocation, benchmark selection, market timing and security selection in Section 5.1, followed by the measurement of the respective contributions to return variability in Section 5.2.

5.1 *Return decomposition*

Table 2 presents a decomposition of returns, using the framework presented in Section 3. For each year in the sample, quarterly means and standard deviations of actual returns of the pension funds are reported. Column (1) presents the mean actual returns and standard deviation. Column (2) gives returns from asset allocation policy based on standard benchmark returns.

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[5] Obviously there is some arbitrariness in choosing standard benchmarks. We tested several different standard benchmarks and the results are not materially influenced by the benchmark choice. The returns on the different benchmarks are highly correlated. All standard benchmark returns are based on total return indices in euros as pension funds also report total returns in euros. The MSCI returns are in gross returns as pension funds are exempt from paying dividend taxes.

[6] Differences in returns between the proprietary bond index and standard bond index can also be explained by differences in duration. We however don't have information on the duration of the proprietary bond indices to correct for this.

The active strategy can be split into benchmark selection, timing and selection in columns (3), (4) and (5) respectively. The contribution of policy, in column (6), is given by the difference between the active return and passive return $R - R^{AA}$ based on standard benchmark returns. Due to the unbalanced nature of the panel data, the numbers of pension funds vary over the years and are smaller than the total of 455 pension funds in the sample. The last row gives the means over the whole sample.

The average realized return over pension funds and time is 1.58 percent per quarter. This is equivalent to 6.47 percent per year over the 2007-2016 period.[7] The financial crisis year 2008 was the only one with a negative return of -9 percent annualized. The returns can be decomposed into four drivers following Equation (2). The return from asset allocation policy is 1.30 percent, the return from benchmark selection is 0.13 percent, the return from market timing 0.10 percent[8] and 0.05 percent from selection. Measured over time and across pension funds, the strategic asset allocation and the standard benchmark returns constitute the bulk, namely 82 percent, of actual returns.[9] Benchmark selection has the second biggest positive contribution and determines 8 percent of total return over the whole sample. However, note that the benchmark policy contributed negatively in half of the years in our sample (2008, 2010, 2011, 2014 and 2015). The active return contribution from timing and selection are slightly positive and compromise 6 and 3 percent of total return respectively. Timing on average only contributes negatively in 2009. Selection on average contributes negatively in 4 years of our sample. The relative importance of the asset allocation decision is consistent with theory and the existing literature. Obviously there is a wide dispersion of returns across pension funds. The standard deviation of the realized return over pension funds and time is 3.56 percent per quarter (or if we multiply by $\sqrt{2}$ it is equal to 7.12 percent annually). This is somewhat lower than the 3.68 percent standard deviation of the strategic policy. Also the standard deviation of the return from benchmark selection is quite large, with 2.97 percent per quarter. This implies that the benchmark choices of pension funds are different.

[Insert Table 2 here]

[7] $(1 + 0.0158)^4 - 1 = 0.0647$.

[8] In the appendix we split the return contribution of timing into the contribution of over and underweight decisions. Pension funds are more successful when deciding to overweight a certain asset class compared to underweighting decisions.

[9] $\frac{1.30}{1.58} * 100\% = 82\%$.

5.2 *Contributions to return variation*

In the previous section we analyzed returns over time and across pension funds simultaneously. Following the methodology of Ibbotson and Kaplan (2000), in this section we quantify how much the different policy decisions contribute to return variation over time and across pension funds, separately. The variability contribution *over time* is determined by running the following regressions:

$$R_{i,t} = a_i + b_i R_{i,t}^k + \varepsilon_{i,t}\,, \qquad i = 1, \ldots, N; \quad k = AA, BS, MT, SS \tag{3}$$

where N denotes the number of pension funds in our sample and $R_{i,t}^k$ is, in turn, $R_{i,t}^{AA}$, $R_{i,t}^{BS}$, $R_{i,t}^{MT}$ and $R_{i,t}^{SS}$.

For each pension fund-specific time series regression, we are interested in the coefficient of determination R^2, i.e., the contribution of the variation in the respective return component R^k to the variation of the overall pension fund return R.

Similarly, the variability contribution *across pension funds* is determined by running the following cross-sectional regression for each quarter t:

$$R_{i,t} = a_t + b_t R_{i,t}^k + \varepsilon_{i,t}, \qquad t = 1, \ldots, T; \quad k = AA, BS, MT, SS \tag{4}$$

Table 3 gives the results of these two tests. Panel A reports the summary statistics for the distribution of the adjusted R^2 coefficients for the time series regression (3), Panel B for the quarterly cross sectional regression (4). Following Andonov *et al.* (2012), we drop R^2 coefficients from time-series regressions with only few observations. Specifically, we set the minimum number of observations for the time-series regressions to 10, leaving 344 pension funds in that sample. Panel A shows that, on average, asset allocation explains 39.3 percent of the variation of pension funds' returns over time, whereas benchmark selection, timing and selection explain 11.1, 9.4 and 15.9 percent, respectively. Hence, the findings confirm the literature (e.g., Ibbotson and Kaplan (2000) for mutual funds, Brown *et al.* (2010) for university endowment funds) that asset allocation is the most important contributor to the variation in portfolio returns over time. Although in our analysis the importance is less paramount compared to these studies. Also note that security selection is more important compared to benchmark selection in explaining the time series variation in return.

However, as is apparent from these other studies as well, the picture changes when the results from the cross-sectional regression are considered. Panel B shows that asset allocation explains on average only 18.8 percent of the cross-sectional variation in pension fund returns. Across pension funds benchmark selection, with 33.3 percent, is dominant in explaining returns. Hence we conclude that benchmark selection matters in explaining cross sectional return variations across pension funds. Timing contributes 4.9 percent and security selection is responsible for 10.8 percent.

[insert Table 3 here]

5.3 *Contributions to return variation net of market movements*

Overall market movements dominate the time series analysis of returns. Xiong *et al.* (2010) argue that 'the market' accounts for about 80 to 90 percent of the total returns variation. The next step in our analysis is to analyze the impact of asset allocation policy and benchmark selection *net of market movements*. Following Andonov *et al.* (2012) we first define the 'average policy return' PR as the average of the equally weighted strategic asset allocation proprietary benchmark returns for a given quarter of all the pension funds in the dataset:

$$PR_t = \frac{\sum_{i=1}^{N_t} \sum_{j=1}^{M} w_{i,j,t}^{AA} r_{i,j,t}^{PB}}{N_t} \qquad (5)$$

where N_t represents the number of pension funds in year *t* and the other notation is as before. The average policy return in (5) serves as a proxy of the market return. Based on this we can calculate the asset allocation returns and benchmark selection returns in excess of the market, respectively. In fact, we define the policy return based on the standard benchmark returns (PB^{SB}) and the policy return differential based on the difference in return between the proprietary benchmark and the standard benchmark (PR^{PB-SB}) as follows:

$$PR_t^{SB} = \frac{\sum_{i=1}^{N_t}\sum_{j=1}^{M} w_{i,j,t}^{AA} r_{j,t}^{SB}}{N_t} \tag{5'}$$

$$PR_t^{PB-SB} = \frac{\sum_{i=1}^{N_t}\sum_{j=1}^{M} w_{i,j,t}^{AA}\left(r_{i,j,t}^{PB} - r_{j,t}^{SB}\right)}{N_t} \tag{5''}$$

Then, the decomposition of returns in excess of the market into our four components reads:

$$\begin{aligned} R_{it}' &= R_{i,t} - PR_t \\ &= \sum_{j=1}^{M} (w_{i,j,t-1}^{AA} r_{j,t}^{SB} - PR_t^{SB}) + \sum_{j=1}^{M} (w_{i,j,t-1}^{AA}\left(r_{i,j,t}^{PB} - r_{j,t}^{SB}\right) - PR_t^{PB-SB}) \\ &+ \sum_{j=1}^{M} (w_{i,j,t-1} - w_{i,j,t-1}^{AA}) r_{i,j,t}^{PB} + \sum_{j=1}^{M} w_{i,j,t-1}(r_{i,j,t} - r_{i,j,t}^{PB}) \\ &\equiv R_{i,t}^{AA'} + R_{i,t}^{BS'} + R_{i,t}^{MT} + R_{i,t}^{SS}, \end{aligned} \tag{6}$$

Using excess returns, the regression equations (3) and (4) change into:

$$R_{it}' = R_{i,t} - PR_t = a_i + b_i R_{i,t}^{k} + \varepsilon_{i,t}\ , \qquad i = 1, \ldots, N; \quad k = AA', BS', MT, SS \tag{7}$$

$$R_{it}' = R_{i,t} - PR_t = a_t + b_t R_{i,t}^{k} + \varepsilon_{i,t}\ , \qquad t = 1, \ldots, T; \quad k = AA', BS', MT, SS \tag{8}$$

Table 4 gives the time-series distribution of R^2 statistics for Equation (7). The explanatory power of asset allocation of return variability is 22.6 percent, which is 16.8 percentage points lower than in Table 3. As expected, removing market movements takes away part of the explanatory power of asset allocation. The contribution of benchmark selection increases by 24.2 percentage points to 35.3 percent. After correcting for market movements, benchmark selection becomes more important in explaining time variation of returns. The results for market timing and selection do not change much as these are only indirectly affected in the estimation of Equation (7) compared to Equation (2). Table 4 does not give the cross-sectional distribution of R^2 for equation (8), as this is identical to that of equation (4) in Panel B of Table 3. Cross-sectional regression naturally already removes the influence of market movements.

Again benchmark selection supersedes asset allocation policy in explaining returns net of market movements.

[insert Table 4 here]

6. Analysis of pension fund portfolio returns and changes in the strategic asset allocation

Pension funds gradually change their strategic asset allocation over time. This is shown in Figure 2 and Table 1a. Pension funds have multiple reasons for doing so. For instance because their liability structure changes, or their return and risk expectations of the different asset classes change. Changing the strategic asset allocation is also an active decision impacting returns. In this section we estimate the impact from this active investment decision on returns, first as such and then with adjustment for risk.

6.1 *Returns from actively changing strategic asset allocation*

An active change in the strategic asset allocation is defined as a quarter-on-quarter change in a strategic weight (w^{AA}).[10] Following Andonov *et al.* (2012), we estimate and evaluate the return implications from these active decisions made by the pension fund to modify the strategic asset allocation policy over time as follows:

$$R_{i,t}^{\Delta AA} = \sum_{j=1}^{M} (w_{i,j,t}^{AA} - w_{i,j,t-1}^{AA}) r_{i,j,t}^{PB} \quad (9)$$

This return component measures the return due to *changes* in strategic asset allocation policy *over time*, which is different from the asset allocation component used in the decomposition of pension fund returns (Eqs. (2) and (6)). As ee focus on the effect of *changes* in strategic asset allocation policy, following Andonov *et al*. (2012), we do not address the effect of benchmark selection in this analysis and only use the returns on the proprietary benchmarks. We do, as Andonov *et al.* (2012) do, however address the other active decisions made by the pension

[10] Pension funds typically reassess the strategic asset allocation every three years. However, we observe more frequent changes in strategic portfolio weights. There are at least two reasons for this. First, a large change in the strategic asset allocation may take several quarters or even years to implement. Pension funds may report in such a case gradual changes in the strategic asset allocation. Second, pension funds may have a dynamic asset allocation strategy in which strategic weights automatically follow some state-variables.

funds to deviate from benchmark returns: market timing and security selection. These are identical to their respective components in Eqs. (2) and (6):

$$R_{i,t}^{MT} = \sum_{j=1}^{M}(w_{i,j,t} - w_{i,j,t}^{AA})r_{i,j,t}^{PB} \tag{10}$$

$$R_{i,t}^{SS} = \sum_{j=1}^{M} w_{i,j,t}(r_{i,j,t} - r_{i,j,t}^{PB}) \tag{11}$$

Following Andonov *et al.* (2012), we run a random coefficient model with a constant only for the three active return management components as defined in Eqs. (9), (10) and (11). Table 5 shows the constants and the corresponding z-statistic in parentheses. Changes in strategic asset allocation policy produce an additional 0.013 basis points return per quarter.[11] However, in 46 percent of observations pension funds did not change their strategic allocation policy from one quarter to the other. This means that $R^{\Delta AA} = 0$, the dependent variable in the regression, is zero in those cases. If we run the regression for strategic asset allocation changes excluding zero changes, we get an estimate of 0.039 basis points return per quarter which is borderline significant at 10 percent. This is equivalent to 0.156 basis points per year and therefore economically insignificant. Market timing delivers a statistical significant 0.089 basis points per quarter, but also the economic impact is negligible. Security selection does not yield a statistically significant return.

[insert Table 5 here]

6.2 *Risk adjusted returns from changing strategic asset allocation*

The performance measures in Table 5 do not adjust for risk. Therefore, we follow Andonov *et al.* (2012) by also presenting random coefficient model estimates that include multiple factors to assess whether the performance remains after risk adjusting. The model is:

$$R_{i,t}^{k} = a_i + \sum_{f=1}^{5}\beta_{i,f} F_{t,f} + \varepsilon_{i,t} \tag{12}$$

[11] The number of pension funds drops to 413 due to the transformation as in Eq. (9).

where $k = \Delta AA$, MT, SS, and the dependent variables are as defined by Eqs. (9), (10) and (11), respectively. F_f stands for quarterly factor returns (f = 1, …, 5). In order to risk-adjust the pension fund portfolio performance, we use the following five global Fama-French (2015) factors: MKT-RF (the return on the value-weighted market portfolio minus the risk-free return), SMB (the return on a diversified portfolio of small stocks minus the return on a diversified portfolio of big stocks), HML (the difference between the returns on diversified portfolios of high and low book-to-market stocks), RMW (the difference between the returns on diversified portfolios of stocks with robust and weak profitability) and CMA (the difference between the returns on diversified portfolios of the stocks of low and high investment firms). Andonov *et al.* (2012) use the random coefficient model because it has as an important advantage that it allows for heteroscedasticity and pension fund-specific betas, while being more robust to outliers than the standard Fama-MacBeth approach. As Swamy (1970) explains, the random coefficient model is similar to a generalized least squares model that puts less weight on the return series that are more volatile.

Results in Table 6 show the quarterly alpha (i.e., the constant) and beta coefficients on these factors. After risk-adjusting, the changes in asset allocation policy deliver a positive alpha of 0.016 basis point per quarter, and 0.048 if we exclude zero change observations. These outcomes do not differ much from the results before risk adjustment and are economically insignificant.[12] Note however that the betas of the five factors are insignificant for this return component.

Market timing after risk-adjusting delivers a positive alpha of 0.11 basis point, also more or less the same as before. Notice however that market timing has a positive loading on the SMB and CMA factors and a negative loading on the market and HML factors. All four factors are statistically significant. Security selection again does not yield a statistically significant return. Contrary to market timing, security selection has a positive factor loading on the market and a negative on CMA.

[insert Table 6 here]

[12] The numbers of observations and pension funds are lower than before risk-adjusting, as the number of panels that are too small for random coefficients regression increases.

7. Robustness check

In Section 4 we explain how we clean the data for possible reporting errors and omissions based on comparing asset class returns with portfolio returns. As a consequence we prudently drop 18 percent of the quarterly observations from the data. We cannot determine with certainty however that these are true reporting errors and omissions. Possibly, different treatments of currency and other derivatives overlays in reporting may cause differences between reported and calculated portfolio returns. As a robustness check we therefore run all our regressions using the full sample. The findings in this case are overall comparable to those in the main analysis.[13] The last two rows in Table 2 show the mean total returns and standard deviations for the full sample. Based on this, the strategic asset allocation explains 87 percent of actual returns, benchmark selection 5, timing 9 and selection 5 percent respectively. Hence, asset allocation remains the main driver of returns. Obviously, standard errors are larger in this case as the 'outliers' are included. If we assess the drivers of cross-sectional return variation we see that benchmark selection is still key. Based on the full sample, asset allocation explains on average 9.6 percent of the cross-sectional variation in pension fund returns. Benchmark selection explains 25.7 percent, timing contributes 15.0 percent and security selection 25.2 percent. These numbers can be compared to Table 4, Panel B.

8. Conclusion

Based on mandatory reporting of Dutch pension funds, we analyze the four key decisions that drive their investment returns: asset allocation, benchmark selection, market timing and security selection. Benchmark selection is innovative to the literature and reflects decisions on the investment universe of a pension fund. A pension fund with a specific investment universe uses a proprietary benchmark instead of a standard benchmark for return evaluation. Our key findings are as follows.

Return decomposition. In a panel regression, taking time series and cross sectional effects together, on average the strategic asset allocation decision comprises 82 percent of total return. The contribution of benchmark selection to total return is on average positive and determine 8 percent of total returns. Benchmark selection is more important than timing and security

[13] Tables are available upon request.

selection. However, it is also fair to say that benchmark selection contributed negatively to the overall return in half of the years in the sample.

Contributions to return variation. When we focus on times series and cross sectional effects separately, the results are different. Over time, asset allocation explains 39 percent of the variation of pension funds' returns, whereas benchmark selection, timing and selection explain 11, 9 and 16 percent, respectively. Across pension funds, benchmark selection explains 33 percent of cross sectional returns, whereas asset allocation explains only 19 percent. Selecting the investment universe therefore matters in comparing returns between pension funds.

Contributions to return variation net of market movements. After correcting for market movements, benchmark selection explains 35 percent of the time variation of returns. Benchmark selection is in this case more important than the asset allocation decision.

Returns from actively changing strategic asset allocation. Changing the strategic asset allocation policy over time produces an additional 0.013 basis points return per quarter. Or 0.039 basis points additional return per quarter if we consider only those pension funds changing their strategic asset allocation. This effect is economically insignificant.

Risk adjusted returns from actively changing strategic asset allocation. After risk-adjustment, the changes in the strategic asset allocation deliver a positive alpha of 0.016 basis point per quarter, and 0.048 when dropping excluding zero change observations. Again an economically insignificant effect.

Furthermore, we find that market timing delivers a positive alpha of 0.11 basis point per quarter. Market timing has a positive loading on the SMB and CMA factors and a negative loading on the market and HML factors. All these four are statistically significant. Security selection on the other hand does not produce additional returns but has a positive factor loading on the market and a negative on CMA.

Which investment decision - asset allocation, benchmark selection, market timing or security selection - is most important? The answer is not straightforward and depends on the framing of the question. In this paper we are the first to show that benchmark selection matters. The choice of a proprietary benchmark reflects a pension funds investment universe. We show that this investment decision matters significantly in explaining return differences between pension funds.

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Appendix. A closer look at returns from market timing

Timing involves an active decision to over or underweight a specific asset class relative to the strategic asset allocation. Earning additional returns from market timing is difficult. This is because timing decisions typically have a low frequency and predicting market movements is particularly difficult. We already mentioned that the overall mean return from timing across pension funds and time is 0.10 percent (Table 2). To see whether pension funds returns differ in success between overweight versus underweight decisions, we split the return from timing into the return from overweight and the return from underweight decisions (Table A1). The average return across pension funds and time of overweighting asset classes is 0.11 percent per quarter. This compares to an average return of -0.02 percent of underweighting asset classes. Apparently pension funds are more successful when deciding to overweight a certain asset class.

[insert Table A1 here]

Figure 1. Dependencies of the variables in Equation (2).

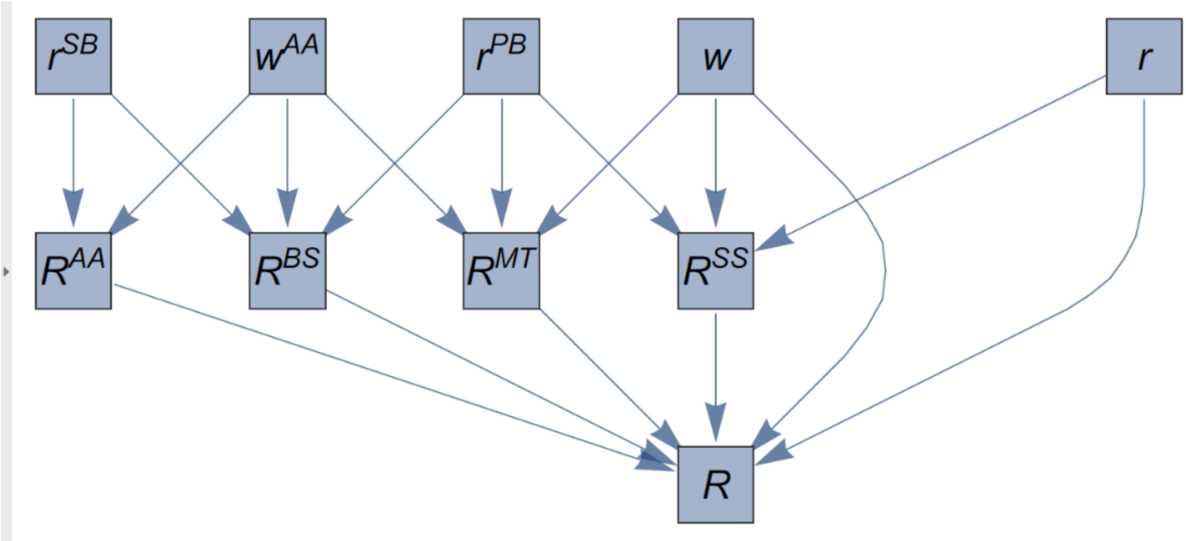
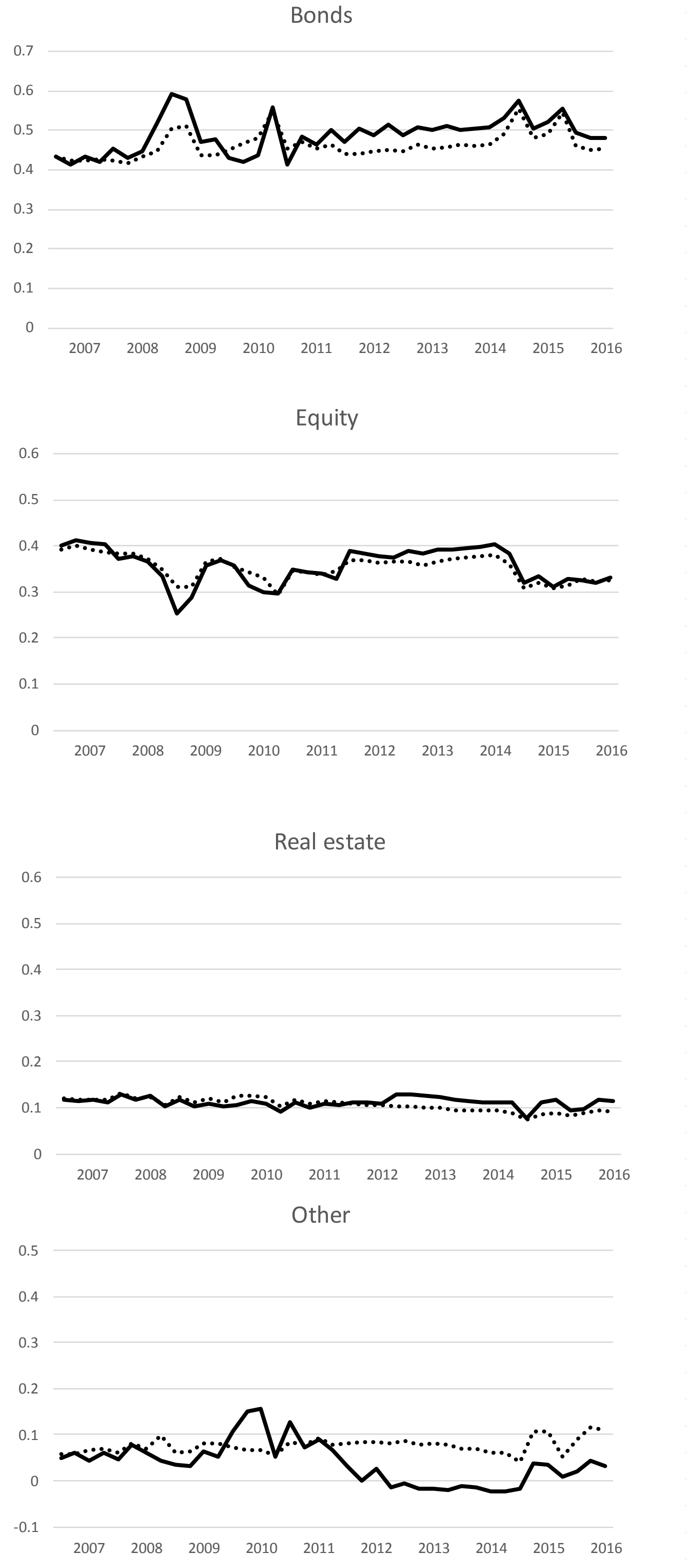


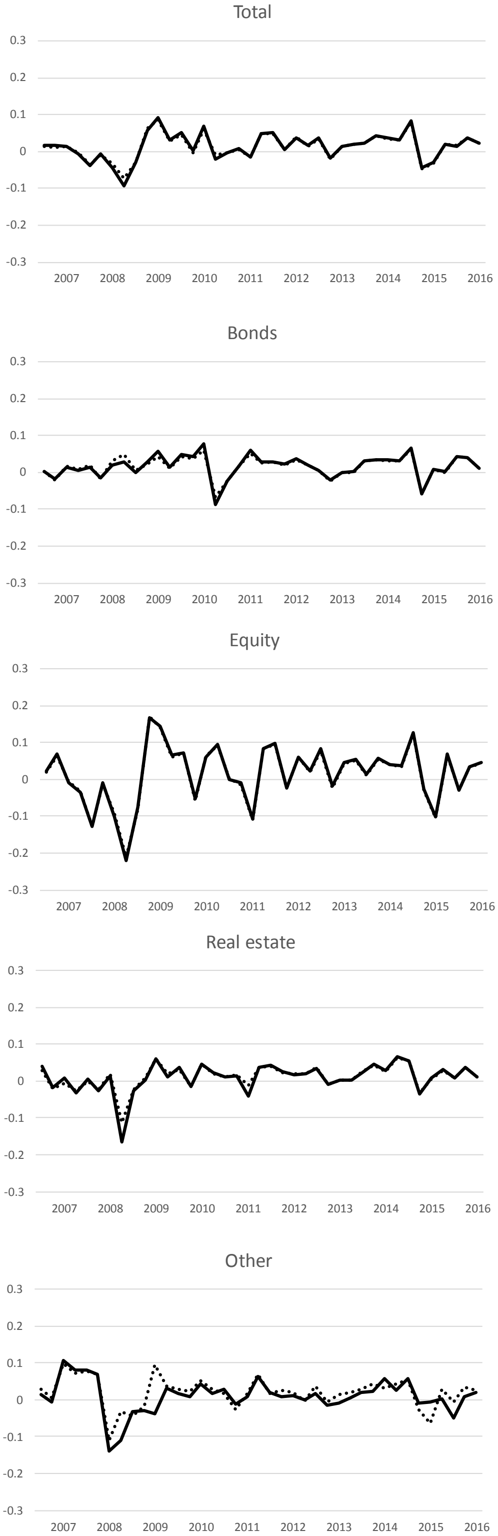
Figure 1 shows how the realised total portfolio return R is determined by the four investment decisions (subscripts are supressed for ease of exposition). R^{AA} is the portfolio return from asset allocation policy based on the standard benchmark return r^{SB} and the strategic asset allocation w^{AA}. R^{BS} is the additional portfolio return from benchmark selection. This additional return is a function of the proprietary benchmark return r^{PB} minus the standard benchmark return and the strategic asset allocation. The additional return from market timing R^{MT}, is a function of the proprietary benchmark return and the deviation of actual asset allocation w from strategic asset allocation w^{AA}. Finally, the additional return from security selection R^{SS} is determined by the actual allocation w and the actual return r.

Figure 2. Average quarterly strategic and actual asset allocation



Note: Weighted averages for 455 pension funds. Bold line is actual, dotted line is strategic. Averages are weighted by total assets under management.

Figure 3. Average quarterly realised returns and returns from asset allocation policy, by asset class



Note: Weighted averages for 455 pension funds. Bold line is actual realised returns, dotted line is return from asset allocation policy. Averages are weighted by total assets under management.

TABLES

Table 1a. Variation in asset allocation across pension funds and time

Asset class	Strategic weights	Actual weights
Bonds	0.159	0.175
Equity	0.124	0.128
Real estate	0.059	0.057
Other	0.078	0.114

Note: The table shows the standard deviations across both pension funds and time of strategic and actual allocation weights, respectively, for bonds, equities, real estate and other investments

Table 1b. Summary statistics of the difference between proprietary and standard benchmarks

Asset class	Bonds	Stocks	Real estate
Mean	0.0033	-0.0013	-0.0144
Median	0.0049	0.0038	-0.0168
Std	0.0398	0.0293	0.0929
N	9,374	9,374	9,374

Note: The table shows mean, median and standard deviation between the quarterly returns on the reported proprietary benchmarks and standard benchmarks. For bonds we use the JPM Global Government Bond Index, for equities the MSCI World Index and for real estate GPR 250 Index. All benchmark returns are total returns in euros. N is the number of observations.

Table 2. Return decomposition

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Realised return	Asset allocation policy	Bench-mark policy	Timing	Selection	Policy contri-bution	Number of obs.	Number of Pension funds
Year		R	R^{AA}	R^{BS}	R^{MT}	R^{SS}	$R-R^{AA}$		
2007	Mean	0.0034	-0.0026	0.0056	0.0008	-0.0004	0.0003	1,223	381
	Std	0.0142	0.0126	0.0117	0.0031	0.0078	0.0083		
2008	Mean	-0.0233	-0.0192	-0.0037	0.0044	-0.0047	-0.0003	982	350
	Std	0.0284	0.0428	0.0337	0.0095	0.0167	0.0185		
2009	Mean	0.0310	0.0192	0.0090	-0.0004	0.0030	0.0026	1,157	364
	Std	0.0469	0.0390	0.0219	0.0138	0.0178	0.0140		
2010	Mean	0.0291	0.0388	-0.0144	0.0010	0.0036	0.0046	1,008	325
	Std	0.0414	0.0321	0.0531	0.0047	0.0196	0.0196		
2011	Mean	0.0131	0.0125	-0.0017	0.0005	0.0018	0.0023	1,000	324
	Std	0.0342	0.0389	0.0278	0.0051	0.0173	0.0181		
2012	Mean	0.0295	0.0136	0.0148	0.0004	0.0006	0.0011	1,055	312
	Std	0.0220	0.0261	0.0334	0.0035	0.0089	0.0098		
2013	Mean	0.0120	0.0030	0.0082	0.0006	0.0001	0.0007	1,028	286
	Std	0.0215	0.0257	0.0146	0.0035	0.0053	0.0062		
2014	Mean	0.0350	0.0386	-0.0047	0.0013	-0.0001	0.0011	910	266
	Std	0.0157	0.0115	0.0158	0.0039	0.0068	0.0076		
2015	Mean	0.0051	0.0165	-0.0126	0.0005	0.0007	0.0012	550	188
	Std	0.0185	0.0577	0.0211	0.0042	0.0104	0.0111		
2016	Mean	0.0218	0.0173	0.0051	0.0001	-0.0007	-0.0006	461	177
	Std	0.0151	0.0238	0.0202	0.0033	0.0064	0.0071		
Total	Mean	0.0158	0.0130	0.0013	0.0010	0.0005	0.0015	9,374	455
	Std	0.0356	0.0368	0.0297	0.0069	0.0134	0.0133		
Total'	*Mean*	*0.0161*	*0.0140*	*0.0008*	*0.0014*	*0.0008*	*0.0026*	*12,230*	*480*
	Std	*0.0928*	*0.0390*	*0.0368*	*0.0123*	*0.0791*	*0.00258*		

Note: The table reports the summary statistics for pension funds' mean realised returns (Mean) and standard deviations of returns (Std). Both are measured across time and pension funds. Following Eq. (2) the successive columns show the average realised portfolio return R, the return contribution from asset allocation policy R^{AA} based on standard benchmarks, the average return contribution from benchmark selection R^{BM} based on proprietary benchmark returns, the average return contribution from market timing R^{MT} and the average return contribution from security selection R^{SS}. The contribution of policy is given by the difference between the active return and passive return $R-R^{AA}$ based on standard benchmark returns. All these numbers are averaged over 4 quarters and the number of pension funds in that year excluding possible reporting errors and omissions. The last two rows (*Total'*) show the mean total returns and standard deviation using the full sample.

Table 3. Contributions to return variation

Panel A. Time series R^2 values

	Asset allocation	Benchmark selection	Market timing	Security selection
Mean	0.394	0.111	0.094	0.159
Median	0.393	0.072	0.033	0.082
25th percentile	0.223	-0.010	-0.023	-0.010
75th percentile	0.556	0.196	0.175	0.270
Standard deviation	0.230	0.154	0.156	0.221
Number of observations (i.e., pension funds)	344	344	344	344

Panel B. Cross sectional R^2 values

	Asset allocation	Benchmark selection	Market timing	Security selection
Mean	0.188	0.333	0.049	0.108
Median	0.155	0.319	0.018	0.089
25th percentile	0.058	0.210	0.005	0.032
75th percentile	0.280	0.438	0.082	0.166
Standard deviation	0.159	0.196	0.064	0.092
Number of observations (i.e., quarters)	39	39	39	39

Note: This table shows the distribution of R^2 for the time series regression in Eq. (3) in Panel A and for the cross-sectional regression in Eq. (4) in Panel B. Panel A shows the return variation contribution over time and Panel B the return variation contribution across pension funds.

Table 4. Contributions to return variation net of market movements
Time series R^2 values

	Asset allocation	Benchmark selection	Market timing	Security selection
Mean	0.226	0.353	0.102	0.150
Median	0.167	0.342	0.039	0.065
25th percentile	0.016	0.094	-0.025	-0.015
75th percentile	0.388	0.576	0.194	0.262
Standard deviation	0.244	0.282	0.172	0.223
Number of observations (i.e., pension funds)	344	344	344	344

Note: This table shows the distribution of R^2 for the time series regression in Eq. (7) in excess of the market. The distribution of R^2 for the cross-sectional regression in Eq. (8) in excess of the market is identical to Panel B of Table 3 as the cross-sectional regression already removes the influence of market movements.

Table 5. Returns from actively changing strategic asset allocation

	Constant	Number of obs.	Number of pension funds
Change in Asset Allocation	0.00013** (2.43)	7,619	413
Change in Asset Allocation, Non-zero changes only	0.00039* (2.00)	3,020	311
Market timing	0.00089*** (7.77)	9,356	437
Security selection	0.00022 (1.07)	9,356	437

Note: Random coefficient estimates of the constants for the change in asset allocation, market timing and security selection. ***, **, * denote significance at the 1%, 5%, 10% level.

Table 6. Risk adjusted returns from actively changing strategic asset allocation

	Return component:			
	Change in Asset Allocation	Change in Asset Allocation, non-zero changes only	Market timing	Security selection
Constant (alpha)	0.00016*** (2.59)	0.00048*** (2.94)	0.00105*** (7.96)	-0.00010 (0.36)
Risk factors:				
MKT-RF	-0.00011 (0.07)	-0.00033 (0.11)	-0.01467*** (6.16)	0.01551*** (3.30)
SMB	0.00258 (1.42)	0.00671 (1.01)	0.01474*** (3.66)	0.00050 (0.06)
HML	-0.00221 (0.59)	-0.00437 (0.63)	-0.01934*** (2.63)	0.01193 (0.93)
RMW	-0.00227 (0.98)	-0.00700 (1.27)	-0.00498 (1.34)	0.01414* (1.81)
CMA	0.00188 (0.44)	0.00111 (0.12)	0.01807*** (2.74)	-0.03995*** (3.45)
Number of obs.	7,335	2,495	9,135	9,135
Number of pension funds	342	172	380	380
Wald test	3.74	3.96	64.40***	35.57***

Note: Random coefficient estimates of the constant (alpha) when adjusting for five risk factors. The five Fama-French (2015) factors are: MKT-RF (excess market return), SMB (small-minus-big), HML (high-minus-low), RMW (robust-minus-weak profitability) and CMA (low-minus-high investment). *z*-values in parentheses. ***, **,* denote their significance at the 1%, 5%, 10% level.

Table A1. Decomposition of quarterly pension fund returns from market timing into under and overweight decisions

		(1)	(2)	(3)	(4)	(5)
Year		R^{MT}	R^{MT+}	R^{MT-}	Obs.	Pension funds
2007	Mean	0.0008	0.0007	0.0001	1,223	381
	Std	0.0031	0.0022	0.0019		
2008	Mean	0.0044	0.0002	0.0042	982	350
	Std	0.0095	0.0048	0.0070		
2009	Mean	-0.0004	0.0011	-0.0015	1,157	364
	Std	0.0138	0.0123	0.0078		
2010	Mean	0.0010	0.0017	-0.0007	1,008	325
	Std	0.0047	0.0031	0.0039		
2011	Mean	0.0005	0.0007	-0.0001	1,000	324
	Std	0.0051	0.0032	0.0035		
2012	Mean	0.0004	0.0016	-0.0011	1,055	312
	Std	0.0035	0.0033	0.0027		
2013	Mean	0.0006	0.0010	-0.0003	1,028	286
	Std	0.0035	0.0029	0.0025		
2014	Mean	0.0013	0.0025	-0.0012	910	266
	Std	0.0039	0.0041	0.0024		
2015	Mean	0.0005	0.0006	-0.0001	550	188
	Std	0.0042	0.0040	0.0036		
2016	Mean	0.0001	0.0013	-0.0012	461	177
	Std	0.0033	0.0027	0.0022		
Total	Mean	0.0010	0.0011	-0.0002	9,374	455
	Std	0.0069	0.0054	0.0046		

Note: The table reports the summary statistics as of Table 2 for the average return contribution from market timing R^{MT}, split into the return from overweight and the return from underweight decisions.

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