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Asset Allocation, Market Timing, Security Selection, and the Limits of Liquidity

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Abstract

We assess and analyze the three components of active management (asset allocation, market timing and security selection) in the performance of pension funds. Security selection explains most of the differences in pension fund returns. Large pension funds in our sample on average provide value to their clients after accounting for all investment-related costs, both before and after risk-adjusting: we find an annual alpha of 17 basis points from changes in asset allocation, 27 basis points from market timing, and 45 basis points from security selection. All three active management components exhibit significant liquidity limitations, which are important in all asset classes, including equity and fixed income. Security selection outperformance is largely driven by momentum trading. Accounting for momentum reduces the security selection alpha by about 72 basis points and offsets most of the positive risk-adjusted returns from market timing and asset allocation changes. Larger funds realize economies of scale in their relatively small allocation to private asset classes, like private equity and real estate. However, in equity and fixed income markets they experience substantial liquidity-related *dis*economies of scale.

JEL Classifications: G11; G23.

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1. Introduction

Can large, sophisticated investors beat the market? And if so, what investment skills are most prevalent? Can investors outperform by periodically changing asset allocation target weights, by deviating from those in market timing trades, or by selecting securities within asset classes? Do asset allocation and market timing work best using actively managed strategies at higher costs or using a cheaper, passive approach? Are there better opportunities in some asset classes relative to others? What works best: investing internally or using external managers? Finally, are there (dis)economies of scale and liquidity limitations in the answers to these questions? In this paper, we try to address these questions by investigating a unique database of the largest U.S. and Canadian pension funds.

These questions are particularly relevant given the significant aggregate resources devoted to active investing on the one hand (see e.g. French (2008)), and the growing popularity of index funds and index-tracking ETFs on the other hand (see e.g. Cremers and Petajisto (2009) and Cremers, Ferreira, Matos, and Starks (2011)). Such questions have been most intensively investigated in the mutual fund literature. For example, Malkiel (1995), Gruber (1996) and Chan, Chen, and Lakonishok (2002) find that, on average, mutual funds underperform the market by about the amount of expenses charged to investors. More recent studies document evidence that at least some subset of mutual fund managers may have skill. For example, Kacperczyk, Sialm, and Zheng (2008) find that funds that focus on particular industries may outperform, and Cremers and Petajisto (2009) find that funds with high Active Share, i.e., funds whose holdings differ most significantly from those in their benchmark, tend to outperform their index net of all expenses and costs. Kosowski, Timmermann, Wermers and White (2006) find not only that a sizable subgroup of mutual fund managers exhibits stock-picking skills that more than cover their costs, but also that the superior alphas of these managers persist.

Pension funds are large and important investors, playing a vital role in financial markets and influencing general welfare. They are among the largest institutional investors and can influence asset prices and market liquidity through their asset allocation decisions (Allen (2001)). Being responsible for the income of retirees, a poor investment performance of pension funds can not only reduce the wealth and consumption of current and future retirees, but also increase tax burdens if public pension funds fail to meet liabilities (Novy-Marx and Rauh (2011)). The largest defined benefit pension funds are relatively unconstrained, and are able and willing to invest across many different public asset classes (such as equities and fixed income) and private assets (like real estate, private equity and hedge funds), using both active and passive strategies and employing both internal and external investment managers. The long-term liability structure enables pension funds to also invest in the domain of longer-term illiquid assets, in which their vast average size provides significant bargaining power. This makes pension fund performance a particularly rich environment for research, allowing an in-depth analysis of all three components of (strategic) portfolio management and of the extent to which all three contribute to performance: asset allocation, market timing and security selection.

Pension funds face an environment that is different from mutual funds. For example, mutual funds are typically much smaller than the pension funds in our sample, and generally have significant constraints in investing across different (alternative) asset classes. Further, incentives differ substantially. Mutual funds with the best performance receive large cash inflows (see e.g. Sirri and Tufano (1998)). As mutual fund manager pay depends on the size of the assets under management and the relative performance compared to the benchmark, this can create substantial incentives for mutual fund managers to engage in active management or chase short-term performance. However, pension funds' inflows do not depend on performance, but on actuarial and demographic factors, e.g. pension fund maturity or the composition of younger and older workers contributing to and relying on the fund.

We are the first paper, to our knowledge, to provide a comprehensive overview of pension funds' asset allocation, market timing and security selection decisions over two decades, documenting how those decisions relate to their cost structure and their performance.[1] We can do so through access to the unique CEM dataset, comprised of a total of 774 U.S. and Canadian defined benefit pension funds for the period 1990-2008.[2] This database includes details on each fund's target and actual asset allocation decisions, the self-declared benchmarks for each asset class, and the precise cost structure and performance for all separate asset classes and their benchmarks.

In defined benefit (henceforth, DB) pension funds, plan sponsors have two main investment responsibilities.[3] The first involves allocating assets across various asset classes and choosing between active versus passive, and internal versus external management. The second responsibility is to choose and subsequently monitor investment managers. Recent research has focused mainly on the second responsibility, specifically measuring the performance of managers that are hired or fired by plan sponsors (see Goyal and Wahal (2008) and Blake, Timmermann, Tonks and Wermers (2010)). This research design does not allow direct analysis of the total performance of pension funds, since account managers are often hired by more than one pension fund and pension funds typically employ more than one manager. Specifically, this previous literature does not investigate how asset allocation decisions and plan-level choices among managers relate to pension fund characteristics and performance, and typically focuses primarily on equity investments. In this paper, we consider both

[1] A closely related paper is Blake, Lehmann and Timmermann (1999), who investigate the asset allocation and performance of U.K. pension funds throughout the sample period 1986-1994. Their data includes all U.K. funds that maintained the same single, externally appointed fund management group throughout the period. Our data incorporates not only external mandates, but also internal mandates across a more detailed list of asset classes. Another related paper is Brown, Garlappi and Tiu (2010), who consider endowment funds. Endowment funds are similar to pension funds because they also invest simultaneously in equity, fixed income and alternative asset classes. However, the amount of assets under management of pension funds is substantially larger. According to Brown et al. (2010), from 1989-2005, endowment funds had on average $ 287 million under management, while the mean holdings of U.S. pension funds in our sample is $ 9,559 million.

[2] CEM Benchmarking Inc. (henceforth, CEM) provides services to a larger universe of pension funds, but the U.S. and Canadian samples are by far the largest. Moreover, these funds are based in a similar regulatory environment. Funds in both countries on average have comparable asset allocations: 50%-60% in equities, 30-40% in fixed income and 10% in alternative asset classes.

[3] We focus on defined benefit (DB) funds only. In this context, the pension fund's Board makes the asset allocation decisions and is responsible for the eventual performance. In defined contribution (DC) funds, plan sponsors select the menu of available investment options, while each plan member individually is responsible for the actual asset allocation decision. Thus, asset allocation outcomes within DC funds belong more to the literature on individual investors' decision making. Moreover, DC funds usually do not include alternative asset classes in the menu, whereas the alternative asset classes constitute a significant part of the portfolio of a typical DB fund.

responsibilities of plan sponsors, asset allocation policy and its relation to overall pension fund performance measured at the *total fund level* (i.e., not at the mandate or manager level). The overall pension fund performance incorporates the performance in equity, fixed income and alternative asset classes such as real estate, private equity and hedge funds. Pension funds in our sample have both internal and external managers, and combine both active and passive strategies.

Our main findings are seven-fold, collectively suggesting strong evidence for the ability of the pension funds in our sample to outperform, though subject to significant liquidity limitations. First, we document the asset allocation decisions and cost structures of large U.S. and Canadian pension funds. Pension funds make similar asset allocation decisions, with a typical pension fund in our sample investing around 55% of the assets in equity, 35% in fixed income and 10% in different alternative asset classes, and only limited cross-sectional dispersion. Equity and fixed income holdings mainly consist of domestic assets, with international diversification increasing over time.[4] Real estate is the most important alternative asset class in both countries, accounting for 4% of U.S. and 3% of Canadian funds' total assets under management, with 77% (64%) of the pension funds in U.S. (Canada) investing in real estate over the 1990-2008 period. More than 80% of the assets of the pension funds in our database are invested in active mandates and this pattern persists in all asset classes and across time. This helps explain the large cross-sectional differences in returns across pension funds. Only 15% of assets are managed internally, mostly by the largest funds.

Although U.S. funds are on average larger than Canadian funds, this does not result in lower costs. The total investment costs of U.S. pension funds are on average 35.25 basis points per year, whereas Canadian funds exhibit costs of 25.65 basis points. This is somewhat surprising, because in general we find strong evidence of economies of scale in costs, with larger funds having lower costs per dollar invested.[5] The costs difference could imply that Canadian funds are better governed or that especially the larger U.S. funds have a potential to further reduce their investment costs by more strongly exercising negotiation power.

Investment costs are stable during the first half of our sample, but continuously increase after 1999. This trend is largely due to the higher allocation to alternative assets, especially hedge funds, which have much higher costs. In 2008, the average cost of U.S. funds was 49.72 basis points per year, while Canadian funds paid 33.92 basis points for their investments. Over the entire period, the most expensive asset class is private equity (average cost of 280 basis points per year[6]), while the least expensive classes are fixed income and cash (14-19 basis points).

[4] U.S. (Canadian) funds' investments in domestic equity represented 89% (74%) of total equity holdings in 1990, while in 2008 their share reduced to 64% (43%), with most of the shift going into global equity funds.

[5] Even though larger funds have more negotiation power and can capitalize on economies of scale, our findings indicate that Canadian funds have lower costs on the fund level, but also separately in all major asset classes. The difference in costs is also not due to more passive or internal management among Canadian funds, because pension funds in both countries manage on average around 80% of their assets actively and externally (see also Bikker, Steenbeek and Torracchi (2010)).

[6] This estimation understates the actual costs of investing in private equity (see Phalipou (2009) for a detailed analysis of private equity fees). It captures the management fees, but the performance fees are subtracted directly from the returns. Nevertheless, in the calculation of private equity net returns both management and performance fees are deducted.

Second, we decompose pension fund returns in three components (asset allocation, market timing and security selection). The first component, asset allocation, is calculated in two ways. When comparing the importance of asset allocation, market timing and security selection for explaining net performance variability, we define the asset allocation return component as a deviation in the strategic (target) asset allocation policy from the average asset allocation policy of all funds in one year. We do so in order to conform as closely as possible to Xiong, Ibbotson, Idzorek and Chen (2010). When we evaluate pension fund performance, asset allocation return is calculated using the changes over time in each fund's *ex-ante* declared 'target' asset allocation weights times the self-declared benchmark returns of the different asset classes. For each separate asset class within each fund, we observe the self-declared benchmark as well as the return on these benchmarks. Asset allocation performance evaluation thus compares the performance of the change in target weights over last year, relative to not changing last year's target weights. The second component is market timing (or tactical asset allocation), defined as the difference between target and actual (realized) weights. Market timing thus captures the performance related to overweighting or underweighting particular asset classes, relative to the target weights in that year.[7] The third and last component is security selection, corresponding to benchmark-adjusted net returns or the difference between realized net returns and benchmark returns for a given asset class. This component captures the returns due to picking securities and timing industries and styles within an asset class. All three components are measured after accounting for all investment costs.

Net performance variability comes mainly from security selection: 45-55% in the U.S. and 48-58% in Canada. Asset allocation decisions explain only 35-41% of the return differences in the U.S. and even less in Canada (25-34%), with the balance attributed to market timing.[8]

Third, we document that pension funds are, on average, able to beat the market or their self-declared benchmarks, both before and after risk-adjusting for equity market, size, value, liquidity and fixed income market factors. Interestingly, they can do so in all three components of active management. Pension funds show skill with respect to setting asset allocation target weights (17 basis point annual alpha), the timing of asset allocation decisions (27 b.p. annual alpha), and derive an even larger positive alpha resulting from security selection decisions (45 b.p. per year).

Fourth, we offer particular interpretations of the security selection results. For U.S. funds, the positive alpha from security selection, 28 basis points per year (marginally significant only with a z-statistic of

[7] For instance, if a fund's strategic weight for U.S. equity is 60%, but the realized weight is 65% (and say for U.S. fixed income the strategic weight is 40% and the realized weight is 35%), the market timing components for U.S. equity (fixed income) equals +5% (-5%), multiplied by the relevant benchmark return. The main difference between asset allocation and market timing is horizon. Asset allocation target weights change less frequently: many fund-years observations show no change in asset allocation. Market timing is shorter-term oriented, with very few funds having no difference between the target and the actual weights in any given year.

[8] Xiong, Ibbotson, Izdorek and Chen (2010) decompose the returns of mutual funds in a similar fashion. Their results show that differences in asset allocation policy and active portfolio management are equally important for mutual funds. Relative to mutual funds, pension funds have a considerably greater opportunity to invest in multiple asset classes and to change investment allocations strategically. Most mutual funds are limited to invest in either equity or fixed income, and 'balanced' mutual funds typically only include equity and fixed income investments but no alternative asset classes. Therefore, *ex ante* the asset allocation policy would seem to be more important for pension funds than mutual funds, such that our results are surprising.

1.70) is fully driven by momentum. The momentum factor captures the difference in returns between a portfolio of stocks with high prior one-year returns (winners) and a portfolio of stock with low prior returns (losers). Adding the momentum factor to the risk-adjusting model, U.S. funds security selection performance turns negative at -107 basis points a year, indicating that momentum strategies deliver about 135 basis points a year.

Canadian funds exhibit a security selection alpha of 83 basis points per year (z-statistic of 2.98), all of which we cannot ascribe to active management nor to momentum but rather to the "Nortel" effect.[9] Adjusting for the "Nortel" effect, the security selection component of Canadian funds equals -4 basis points per year (or -21 basis points a year controlling for the momentum factor, though neither is significant).[10]

Blake, Lehmann and Timmermann (1999) find that the cross-sectional return variation among U.K. pension funds in the period 1986-1994 is also dominated by the security selection component. However, contrary to our findings their results indicate negative returns from market timing, attributed to negative timing returns within foreign equity (see also Timmermann and Blake (2005)). The security selection returns of U.K. funds are positive, but not always significant. One important difference in the construction of the market timing return component is that we have access to the strategic asset allocation weights and self-determined benchmarks, whereas Blake, Lehmann and Timmermann (1999) use one benchmark index per asset class as a return proxy for all pension funds and estimate the strategic weights based on the trend in realized weights. Another difference is that we look not only at the external mandates, but also at the internal mandates across all asset classes. Moreover, we do not require that a single external manager is employed during the entire sample period.

Fifth, in the last step of our analysis, we relate the risk-adjusted returns (on a total fund or asset class level) for the changes in asset allocation, market timing and security selection components to the total size and liquidity of the funds' holdings, the size and liquidity of the investments in a particular asset class, the investment costs and the investment style. The investment style reflects whether assets are managed internally or externally, and whether the assets are managed passively or actively.

The relationship between asset size and performance is not uniform and depends on the asset class and investment style. Larger funds realize economies of scale in alternative asset classes, especially real

[9] The "Nortel Effect" refers to the fact that in July 2000 Nortel Company constituted 36% of the S&P/TSX Composite index. Nortel's return was 69% from January to July 2000, but the overall return for the year 2000 was -33.8%. The volatile returns on Nortel created significant differences between returns on the TSE300 Composite Index (7.4% in 2000) and the capped version of the same index (19.1% in 2000). In other years, there are only minor differences between the two versions of TSE index. The investment decisions of Canadian funds concerning Nortel resulted in a substantial outperformance of the domestic equity benchmark in 2000. Following the index in 2000 was dangerous, because a portfolio with 36% invested in one company cannot qualify for 'diversified investing', as it is exposed to substantial idiosyncratic risk.

[10] The question of whether momentum is a priced risk factor (or can be explained by risk) is clearly debatable. However, most literature suggests that it cannot be explained by exposure to systematic risk factors (see e.g. Jegadeesh and Titman (1993, 2001), Lee and Swaminathan (2000), Cooper, Gutierrez and Hameed (2004) and Cremers and Pareek (2011)). Even the papers arguing for a risk-based interpretation acknowledge that momentum cannot be mostly or completely explained by risk (see e.g. Grundy and Martin (2001) and Lu and Zhang (2008)).

estate, but experience *dis*economies of scale in public equity and fixed income markets. These diseconomies of scale are mainly driven by liquidity constraints. Internal management is associated with improved security selection performance.

Higher costs are generally related to lower performance, but only after controlling for momentum. Further, the impact of investment costs on performance varies between asset classes. For instance, the negative relationship on the total fund level is mainly driven by the negative relationship between costs and performance in equity and alternative assets. Particularly in private equity and real estate portfolios, investment costs have a strong negative effect on net returns. We find some evidence that asset allocation performance is best achieved using passive rather than active management, which is related to liquidity as well, as passive investing generally means more liquidity.

Sixth, all three components of active management exhibit liquidity limitations, which seem quite important even for asset classes such as equity and fixed income. Shifts in the strategic asset allocation towards more illiquid assets hurt the performance of larger funds relative to smaller funds. Similarly, smaller funds can more effectively do market timing without distorting market prices. Finally, the security selection performance of larger funds seems particularly constrained by liquidity, with significant economic effects: increasing liquidity by lowering the liquidity beta by 10 percentage points is associated with an improvement of the alpha of funds at the 75^{th} size percentile by 15 basis points per year more than the improvement of the alpha of a fund at the median size percentile.

Seventh and finally, we document strong performance persistence for both market timing and security selection using annual quintile rankings. Funds are more likely to end up in a better performing quintile next year, if they also do so this year, and they are more likely to perform worse in the ranking next year if they performed relatively poorly this year.

The empirical conclusions are not likely to be influenced by a self-reporting bias. Results from a Cox proportional hazard model show that the database does not seem to suffer from this bias with respect to costs and returns, though larger funds are more likely to survive in the CEM database. The database is most inclusive for Canada: CEM covers approximately 30-40% of the total assets managed by U.S. DB pension funds and 80-90% by Canadian funds. Further, sample selection and survivor issues appear *ex-ante* to be greater for the U.S. sample (due to lower coverage). The general consistency of results across both countries strengthens our conclusion that the database does not suffer from self-reporting biases related to performance.

Our finding that smaller fund or mandate size results in better security selection returns in equity were already documented for this same sample in Bauer, Cremers and Frehen (2010), who exclusively study the performance of the domestic equity portfolios of U.S. pension funds only. It is also similar to findings of Lakonishok, Shleifer and Vishny (1992), who showed that equally-weighted equity returns of funds are higher than value-weighted returns in the period 1983-1989. In addition to costs advantages, increased scale can be expected to have a positive impact on the level of expertise in the selection and monitoring of investment managers. However, *dis*economies of scale related to organization and liquidity problems have been found among mutual funds (Chen, Hong, Huang and

Kubik (2004)), among private equity companies (Lopez-de-Silanes, Phalippou and Gottschalg (2010)) and among hedge funds (Fung, Hsieh, Naik and Ramadorai (2008)). Our results point mostly towards larger funds being constrained by liquidity. In doing so, we borrow the methodology and again confirm the results in Bauer, Cremers and Frehen (2010) for domestic equities of U.S. funds, but in our paper give those also at the total fund level, for Canadian funds as well as for asset classes other than U.S. equities.

Our results partially contradict the existence of economies of scale in pension fund management as discussed in Dyck and Pomorski (2011). The difference in results can largely be explained by a difference in methodology: we analyze not only the non-risk-adjusted returns, but we also risk-adjust fund performance for factor returns, investigate the importance of momentum and control for fund fixed effects.[11] Dyck and Pomorski (2011) do not risk-adjust returns and focus on specifications without fund fixed effects and without controlling for momentum.[12] In our view, risk-adjustment is critical for performance evaluation and merely benchmark-adjusting is insufficient, as is borne out by our results.[13] At the fund level, for example, we find that evidence that larger U.S. funds do better than smaller U.S. funds (see e.g. Dyck and Pomorski (2011)) disappears once we risk-adjust returns. Evidence that larger Canadian funds do better than smaller Canadian funds can be completely explained by larger Canadian pension funds being more active in pursuing momentum strategies than smaller Canadian pension funds. Specifically, after risk-adjusting, we only find a positive association between alpha and size if we do not control for momentum, and then only for Canadian but not for U.S. pension funds. We generally do not find economies of scale in equity and fixed income, but we confirm Dyck and Pomorski’s finding that larger funds perform better in private equity and especially real estate.

Our results show that large funds that manage most of their assets internally improve their performance compared to peers with similar size but mostly external managers. Dyck and Pomorski (2011) also conclude that internal management improves pension fund performance mainly through cost savings. Internal management can reduce potential agency conflicts from multiple layers (Lakonisok et al. (1992)) and also results in lower investment costs. However, internal management is a realistic option only for larger funds that can devote sufficient resources to establishing an internal asset management department.

The empirical results finally suggest that larger funds can assert more negotiation power in alternative asset classes, which may lead to greater access to the best investment opportunities at lower costs. Larger funds can devote more resources to monitor private equity and real estate investments. The

[11] Robustness of our risk-adjusted results can be checked by comparing Appendix Table A.2 with Table 7.

[12] In Appendix Tables A.7 and A.10 we replicate part of Dyck and Pomorski (2011) findings of economies of scale among pension funds before risk-adjusting.

[13] Additionally, Dyck and Pomorski (2011) transform all returns and holdings of Canadian pension funds in U.S. dollars using the end-of-year exchange rate. We believe that this transformation introduces unnecessary time series variation in Canadian funds’ returns and assets size. Domestic assets constitute the major part of Canadian funds’ portfolio and most of the pension funds hedge the exchange rate risk when investing in international markets. Hence, the returns and holdings of Canadian funds do not fluctuate together with the exchange rate between the U.S. and Canadian dollar.

largest funds even establish internal or "at-arms-length" operating private equity and real estate divisions. The importance of lower cost is especially pronounced among U.S. funds investing in private equity and Canadian pension funds investing in real estate.

The paper proceeds as follows. Section 2 describes the CEM dataset and considers possible self-reporting biases. Section 3 explains the methodology to decompose fund returns into asset allocation, market timing and security selection components, and to measure the importance of each component in explaining the differences in returns between pension funds. Section 4 describes the methodology employed to measure the fund (and asset class) risk-adjusted performance and its relation to fund characteristics, and presents the empirical results. Section 5 briefly discusses the persistence in pension fund performance. Concluding comments are provided in section 6.

2. Characteristics of the CEM database

CEM Benchmarking Incorporated (henceforth CEM) collects Canadian and U.S. defined benefit pension fund data through yearly questionnaires.[14] The CEM database contains detailed information on pension fund holdings, costs, benchmarks and returns on the fund level and per asset class. Table 1 illustrates the time trend in the number of funds reporting to CEM. In the period 1990–2008, a total of 774 U.S. and Canadian pension funds have reported to CEM. The number of funds reporting is lower in the first three years of the database formation, but afterwards it is stable over time. The main motive for pension funds to enter the database is to benchmark their costs against peers based on total fund size and total holdings in particular asset classes. Funds sometimes decide to stop submitting the questionnaires to CEM for various reasons, such as termination of the service due to costs savings, mergers, acquisitions and bankruptcies of the underlying corporations etc. As reporting to CEM is voluntary, the data is potentially vulnerable to self-reporting bias. Bauer, Cremers and Frehen (2010) address the self-reporting bias by matching the CEM data with the Compustat SFAS data and testing whether the decision to stop reporting is related to the overall fund performance. Their results indicate that there is no evidence of a self-reporting bias related to performance in the exiting and entering years.

Here, we address the self-reporting problem by constructing a Cox proportional hazard model. We test whether the decision of a particular pension fund to exit the database is related to its returns, its costs or its size. The event of interest is the decision of the pension funds not to report to CEM in a given year. In the Cox hazard model, we treat each fund re-entry as a new fund, which explains why the number of units in Table 2 (column 1) is higher than the total number of funds presented in Table 1 (column 2). The results in Table 2 indicate that fund size ("log(Size)") has the strongest effect on the fund's exit rate. Size in this case refers to the total holdings (asset under management) by the pension fund. For example, a hazard ratio of 0.7483 (-6.81) means that an increase by one unit in log(size)

[14] Other papers studying pension fund performance using the CEM database are French (2008), Bauer, Cremers and Frehen (2010) and Dyck and Pomorski (2011). The CEM database also includes information of pension funds in Europe and Australia, and includes both defined benefit and defined contribution plans.

leads to a decrease of 25.17% (100% - 74.83% = 25.17%) in the exit rate (see first row in panel A). Panels B and C show that the results from the Cox proportional hazard model for all funds are consistent with the findings in the U.S. and Canadian subsamples.

Overall, Table 2 shows that smaller funds are more likely to exit the CEM database. This is consistent with the idea that specialized benchmarking services provided by CEM are more relevant and cost-effective for larger funds. Further, we relate the fund exit rate to pension fund net returns, benchmark returns and benchmark-adjusted returns. Net returns are obtained after subtracting total costs from gross returns. Benchmark returns are calculated using the benchmarks reported by pension funds for every asset class in which they invest. Every year, CEM asks funds to report the exact definition of the benchmark they employ, as well as the return on that benchmark for every asset class in which a fund has holdings. We specify benchmark-adjusted net returns as gross fund returns minus costs, and minus benchmark returns. In panel B (U.S. funds only), the positive hazard ratios on net returns and benchmark returns indicate that funds are more likely to stop reporting in years that financial markets perform well. For instance, the hazard ratio of 1.0220 (t-statistic of 1.86) on net returns in panel B indicates that a one-percentage point increase in net returns increases the exit rate by 2.20%. Hazard ratios of benchmark-adjusted net returns are always insignificant, so we can conclude that exit events are not related to funds underperforming or outperforming their benchmark.[15] Hence, we find no evidence that the CEM database suffers from self-reporting bias related to performance.

Total costs are somewhat negatively related to the exit rate of U.S. funds. The hazard ratio of 0.9915 (t-statistic of -1.76) in Panel B indicates that an increase in costs by one basis point results in 0.85% decrease in the exit rate. Funds with higher costs may benefit more from the cooperation with CEM, because the company is specialized in advising on costs. Overall, the self-reporting tests suggest that CEM suits better the interests of larger funds, but the dropping rate is not related to benchmark-adjusted performance and only marginally to the cost level.

Funds included in the CEM database cover a substantial share of the pension fund assets under management and market capitalization in the U.S. and Canada. For example, Canadian pension funds' holdings in Canadian equity represent approximately 11.8% of the total market capitalization of Toronto Stock Exchange (TSX) in 2008. Over the 1990-2008 period, Canadian funds included in the CEM database account for approximately 80-90% of the asset under management by Canadian pension funds. U.S. funds in the same time period comprised around 30-40% of the asset under management by U.S. pension funds. In 2008, the holdings in U.S. equity of U.S. pension funds included in the CEM universe represent 6.5% of the market capitalization of the NYSE, NASDAQ and AMEX and their fixed income holdings are equal to about 2% of the total outstanding U.S. bond market debt in 2008.

The U.S. funds in our sample are significantly larger than the Canadian funds (see Table 3). The average and 75% percentile of fund size equal 9.6 billion USD and 8.1 billion USD for U.S. funds,

[15] In Appendix Table A.11 we sort the funds into five quintiles based on their market timing and security selection returns. The percentage of U.S. and Canadian funds exiting the database is similar across all quintiles, i.e. top performers have very similar exit rates as the worst performers.

respectively, versus 4.4 billion CAD and 2.6 billion CAD for Canadian funds. The positive skewness indicates that the CEM universe consists of several very large and many smaller funds.

We can distinguish the following asset classes, with their average weights for U.S. / Canadian funds, respectively: equity (58% / 54%), fixed income (31% / 38%), cash (2% / 3%), real estate (4% / 3%), private equity (2% / 1%) and other (2% / 1%). Panel A of Figure 1 presents the time trend in the allocation to equity, fixed income, cash, real estate, private equity and other assets among U.S. funds. Panel B presents the same information for Canadian funds. In the period 1990-2000, allocations to equity increase in both countries. The most important alternative asset class for both U.S. and Canadian pension funds is real estate.[16] U.S. funds allocate a higher percentage of their assets to private equity compared to Canadian funds.[17] "Other" presents a heterogeneous category consisting of assets, which separately constitute only a minor part of pension funds holdings. It encompasses the following asset types: tactical asset allocation (TAA) mandates, infrastructure, hedge funds, commodities and natural resources, which has been growing in importance. In 2000, fewer than 3% of funds have hedge fund investments, while 43% of U.S. funds and 27% of Canadian funds do in 2008 (hedge fund investments in 2008 represent 3.33% of total assets for the U.S. and 1.65% of total assets in Canada).

To summarize, pension funds seem to display large degrees of herding in the asset allocation decisions. A typical pension fund in our sample invests around 55% of the assets in equity, 35% in fixed income and 10% in different alternative asset classes, with only limited cross-sectional dispersion. This is consistent with the observation of Lucas and Zeldes (2009). Using a sample of U.S. public pension funds, they show that variation in the equity share in the funds' portfolios is not explained by the percentage of active participants, differences in funding ratios and other variables suggested by theory to be relevant for asset allocation policy.

Bauer, Cremers and Frehen (2010) document a negative relationship between fund size and costs for investing in U.S. equities. This negative relationship is robust to the investment style, i.e. it is not driven by the higher proportion of passive and internal investments among larger funds. Larger funds are able to negotiate lower fees for external mandates and organize more cost-efficient internal mandates. Considering the total fund level here, the negative relationship between fund size and costs exists within both Canada and the U.S. However, Canadian funds have significantly lower costs than U.S. funds, even though they are much smaller. Panel B of Table 3 demonstrates that Canadian funds have lower costs across all asset classes, except "other". The higher costs of Canadian funds in the "other" category are largely due to the higher allocation to infrastructure (which is relatively expensive). Apparently, Canadian pension funds are able to negotiate lower fees for investing in equity, fixed income, cash, real estate and private equity. On a total fund level, pension funds from Canada paid on average 25.65 basis points, whereas U.S. funds spent around 35.25 basis points for

[16] The real estate category includes assets invested in direct real estate holdings, segregated real estate holdings, real estate limited partnerships and real estate investment trusts (REITs).

[17] Private equity includes venture capital, LBO and energy partnerships, as well as equity or fixed income investments in turnarounds, start-ups, mezzanine, and distress financing.

investing in the same asset classes (in the 1990-2008 period). This cost difference is not driven by a higher allocation to passive mandates, which are by construction cheaper than active mandates. Surprisingly, U.S. funds even have a slightly higher allocation to passive and thus less expensive mandates in equity than Canadian funds (27.18% versus 15.67%). Furthermore, the difference is present in every year and is not due to outliers, as indicated by lower 25th percentile and 75th percentile cost values for Canadian funds in Table 3.

Figures 2 and 3 plot the time variation in asset allocation within equity, fixed income and alternative asset classes of U.S. and Canadian Funds. Panel A in both figures shows that pension funds invest the majority of their equity holdings in domestic stock markets, with international diversification increasing over time. For instance, U.S. funds invested 89.47% of their total equity holdings in U.S. markets in 1990, while this percentage decreased to 64.23% in 2008. The same trend can be noticed among Canadian funds in Figure 3 (Panel A). The allocation to Canadian equity decreases from 73.84% in 1990 to 42.53% in 2008.

In both countries, the decrease in domestic equity is reallocated to either an EAFE mandate, capturing about 18% and 22% of the equity holdings of U.S. and Canadian funds respectively, or a global equity mandate.[18] For example, the allocation to these global mandates is 14.67% in 2008 for U.S. funds.

Panel B in Figures 2 and 3 plots the time variation of allocation to various fixed income asset classes. The focus on domestic investments is even more striking here. In 1990, U.S. funds held 96.64% of their fixed income investments in the U.S. market (and 99.36% for Canada), with only very limited international diversification since then. For instance, the allocations to EAFE, Emerging Markets and Global fixed income mandates remain low and stable over the 1990–2008 period for both U.S. and Canadian funds (less than 8% combined).

Overall, the asset allocation policy of pension funds in equity is similar to the policy of endowment funds described in Brown, Garlappi and Tiu (2010). However, pension funds allocate a higher proportion of their assets to fixed income securities than endowments (20-25%). Furthermore, the most important alternative asset class category for endowments is hedge funds, whereas pension funds focus more on real estate and private equity investments.

3. Decomposing pension fund returns

In addition to realized (actual) asset allocation weights, CEM also provides information on the pension fund target policy weights, which are determined by the pension funds' Boards. The changes in policy weights from year *t-1* to year *t* show how pension fund strategic allocations evolve over time. Table 4 shows that U.S. funds modified their strategic allocation by adding more private equity and other alternative assets at the expense of fixed income and cash. Canadian funds also reduced the target weights for fixed income and cash, but increased mainly the equity target weights. The realized (or actual) weights vary around the target asset allocation weights. Table 4 further presents information on

[18] EAFE mandates refer to equity investments in Europe, Australasia and Far East (developed countries). Most global mandates use the ACWxUS ("All countries in the World excluding US") benchmark.

the differences between the reported target weights and realized (actual) weights, which are close to zero on average, but with (averaged across time) cross-sectional standard deviations of 1.5% - 5.5%.

To estimate and compare the importance of the asset allocation, market timing and security selection, we follow the methodology of Xiong, Ibbotson, Idzorek and Chen (2010) and Brown, Garlappi and Tiu (2010). A fund's total return can be decomposed into four components: (1) the average policy return, (2) the asset allocation policy return in excess of the average policy return, (3) market timing and (4) security selection or active management returns. The total fund return is the weighted return on all assets, in which one fund has holdings, net of all expenses and fees.

Our measure of the average policy return, PR_t, is the average of the equally-weighted policy return for a given year of all the funds in the database. The policy return for every fund is calculated using the target policy weights in a given year times the benchmark returns.

$$PR_t = \frac{\sum_{i=1}^{N}\sum_{j=1}^{M} w_{i,j,t}^{AA} r_{i,j,t}^{BM}}{N_t}$$

where $w_{i,j,t}^{AA}$ is the policy weight of fund *i* for asset class *j* in year *t*, $r_{i,j,t}^{BM}$ is the benchmark return on asset class *j* for fund *i* in period *t*, and N_t represents the number of funds in year *t*.

Xiong, Ibbotson, Idzorek and Chen (2010) argue that overall market movements dominate the time-series analysis of total returns in time series regressions, accounting for about 80-90% of the total return variation and obscuring the contributions of asset allocation, market timing and security selection. Cross-sectional regressions naturally remove the influence of market movements, essentially resulting in the same analysis as using excess market returns (see Xiong et al. (2010)). In our methodology, market movements are captured by the average policy return (PR_t).

Following Brown, Garlappi and Tiu (2010), we decompose the total returns of pension funds in excess of the average policy return (or in excess of the market) into three components: (1) asset allocation, (2) market timing and (3) security selection. Formally, let $R_{i,t}$ be the realized return on fund i at the end of year *t*, $w_{i,j,t}$ the actual realized weight of fund i in asset class $j = 1, \ldots, M$ and year *t*, and $r_{i,j,t}$ the realized net return on the asset class *j* for the year *t* by fund *i*, then

$$\begin{aligned} R_{i,t} - PR_t &= \sum_{j=1}^{M}\left(w_{i,j,t}^{AA} r_{i,j,t}^{BM} - PR_t\right) + \sum_{j=1}^{M}\left(w_{i,j,t} - w_{i,j,t}^{AA}\right) r_{i,j,t}^{BM} + \sum_{j=1}^{M} w_{i,j,t}\left(r_{i,j,t} - r_{i,j,t}^{BM}\right) \\ &\equiv R_{i,t}^{AA} + R_{i,t}^{MT} + R_{i,t}^{SS}. \end{aligned}$$

The first component, $R_{i,t}^{AA}$, indicates the return from the asset allocation policy in excess of the average policy return. $R_{i,t}^{MT}$ captures market timing, estimated as returns due to the difference between actual realized weights and target asset allocation weights in different asset classes. The last component, $R_{i,t}^{SS}$, measures returns from security selection, estimated as the difference between the realized net returns and the benchmark returns. Hence, the security selection component is equivalent to benchmark-adjusted net returns and accounts for all returns that are not attributable to policy decisions or timing decisions. The market timing term will account for returns due to changes in the weights *between* asset classes, not *within* a mandate. For instance, it will capture returns due to a higher allocation to equity at the expense of bonds, or returns due to a higher allocation to domestic equity instead of an EAFE mandate. However, the market timing component will not capture returns due to overweighting particular industry sectors within the U.S. equity mandate.

Related to our measure of market timing, pension fund Boards in practice usually determine not only the target asset allocation mix, but also the range in which these weights can fluctuate (bandwidths). For example, a pension fund board can decide that their policy weight to equity is 60% of assets under management, with a range of 57% to 63%. If the allocation to equity goes below 57% or above 63%, the fund will rebalance its portfolio in order to restore the strategic asset allocation mix. Thus, the differences between realized and target weights can result from market movements and active rebalancing decisions of investment managers. The market timing component will capture both causes.

Table 5 summarizes the decomposition of the variation in total net return in excess of the average policy return ($R_{i,t} - PR_t$), in terms of the average R-squared. It shows the average contribution of each component to the variation in the difference between the total net return and the average policy return. This table reports time-series and cross-sectional R-squared summary statistics on the fund level, incorporating all assets. Panel A displays summary statistics from the cross-sectional distribution of R-squared statistics obtained from performing the following regression for each pension fund over time:

$$R_{i,t} - PR_t = \alpha_i + \beta_i R_{i,t}^k + \varepsilon_{i,t}\ , \qquad i = 1, \dots, N$$

where $R_{i,t}$ is the net return of pension fund *i* at time *t*, and PR_t is the average of equally weighted policy return for year *t*. $R_{i,t}^k$ can refer to the asset allocation return component $R_{i,t}^{AA}$, the market timing component $R_{i,t}^{MT}$ or the security selection component $R_{i,t}^{SS}$.

The second part of Table 5 reports summary statistics from the time-series distribution of R-squared from the 19 (1990–2008) cross-sectional regressions:

$$R_{i,t} - PR_t = \alpha_i + \beta_i R_{i,t}^k + \varepsilon_{i,t}\ , \qquad t = 1, \dots, T$$

where $k = AA, MT, SS$. At least five data points per fund are required to run each time-series or cross-sectional regression. Hence, in the regressions on all funds we include 348 funds, of which 217 are U.S. funds and 131 Canadian. Our results are robust to using cutoff thresholds with more or less than five data points (see appendix Table A.1 for results using at least 4, 7 and 9 data points).

We first consider the results for the "All Funds" universe. The asset allocation policy has the highest explanatory power, accounting for 51% (cross-sectional) to 60% (time series) of the variation in returns between funds. We expected these results, since U.S. and Canadian funds have very different asset allocation policies, as presented in Figures 2 and 3. U.S. and Canadian funds hold the majority of their assets in domestic equity and domestic fixed income mandates.[19] This explains the high explanatory power of the asset allocation decision. Table 5 further shows that the security selection

[19] For instance, Canadian funds invest on average 57% of their total equity holdings in the Canadian market. U.S. funds do not have a separate "Canadian equity" asset class.

component accounts for 32-34% of the variations in excess policy return. Finally, the market timing component explains 5-18% of the return differences between all funds.

We explicitly analyze the single-country subsamples because the results for the all funds universe are mainly driven by the strong home bias in both countries. When U.S. and Canadian pension funds are analyzed separately, results are different. Security selection now has the highest explanatory power, accounting for 45-55% of the variation in excess policy returns in the U.S. and 48-58% in Canada. The explanatory power of the market timing component remains around 4-18% in both countries. The asset allocation decision explains only 35-41% of the return differences of U.S. funds and even less in Canada: 25-34%. These findings are in line with the research on mutual funds by Ibbotson and Kaplan (2000), who find that the asset allocation policy has a cross-sectional R-squared of around 40%. Brown, Garlappi and Tiu (2010) have even more pronounced results and find that the security selection component is responsible for most (74.69%) of the cross-sectional variation in endowment returns. The research on U.K. pension funds by Blake, Lehmann and Timmermann (1999) finds fairly low probabilities of individual fund asset allocations remaining above or below the industry average weight each year, also implying possible herding behavior.

Asset allocation has higher explanatory power within the U.S. as compared to Canada, partly because U.S. funds have more specific benchmarks and lower aggregation levels within equity investments. First, U.S. funds can choose different benchmarks for domestic equity (e.g. Russell 3000, S&P 500, Russell 2000 and Wilshire 5000), whereas the vast majority of Canadian funds use the S&P/TSE300 as their benchmark. Second, the CEM reporting structure allows U.S. funds to report large and small cap domestic equity investments separately (which is not available for Canadian funds).

As pension funds are relatively unconstrained and can invest in all asset classes, it may be surprising that security selection has a higher explanatory power than asset allocation. These results are driven mainly by two causes. First, while U.S. and Canadian funds have an opportunity to choose from multiple asset classes, most of them end up with a conventional asset allocation mix. The typical pension fund in our sample invest between 55-60% of the asset in equity, 30-35% in fixed income and around 10% in alternative assets, with a substantial proportion of the equity and fixed income assets held in domestic markets. Second, U.S. and Canadian funds employ a large degree of active management. During the 1990–2008 period, Canadian and U.S. funds held on average 84% and 73% of their equity holdings in actively managed mandates, respectively (with a similar picture for fixed income, (81% and 85%, respectively)). Active management can lead to substantial differences in returns between pension funds. Ibbotson and Kaplan (2000) present consistent evidence that active management decreases the cross-sectional R-squared of the asset allocation components of mutual funds.

4. Pension Fund Characteristics and Performance

In this section, we discuss whether asset allocation, market timing and security selection decisions result in outperformance or underperformance of pension funds. To evaluate pension fund performance, we employ two different methodologies: the Swamy (1970) random coefficient model as well as Fama-MacBeth (1973) regressions.

4.1 Methodology

To estimate and evaluate the asset allocation skills of pension funds, we look at the yearly changes in pension fund strategic asset allocations.[20] The returns due to such changes are estimated as the difference between pension fund *i* policy (i.e., target) weights for asset class *j* in year *t* compared to year *t-1* multiplied with the benchmark return of that asset class at time *t*:

$$R_{i,t}^{CAA} = \sum_{j=1}^{M} \left(w_{i,j,t}^{AA} - w_{i,j,t-1}^{AA}\right) r_{i,j,t}^{BM}$$

We define market timing returns of fund i in year t ($R_{i,t}^{MT}$) as the pension fund return due to a deviation from strategic asset allocation policy:

$$R_{i,t}^{MT} = \sum_{j=1}^{M} \left(w_{i,j,t} - w_{i,j,t}^{AA}\right) r_{i,j,t}^{BM}$$

Following the previous section, our security selection return component ($R_{i,t}^{SS}$) of fund i in year t represents benchmark-adjusted net returns, i.e. returns that are due to deviation from self-declared benchmarks within the particular asset class:

$$R_{i,t}^{SS} = \sum_{j=1}^{M} w_{i,j,t}\left(r_{i,j,t} - r_{i,j,t}^{BM}\right)$$

We can characterize our random coefficient risk-adjusting model in the following way:

$$R_{i,t}^{k} = \alpha_i + \beta_i F_t + \varepsilon_{i,t}$$

where $k = CAA, MT, SS$. We assume that α_i and β_i are drawn independently from distributions with constant means and variances. F_t stands for year t factor returns. In order to risk-adjust the pension fund performance in all asset classes, we use the following factors: MKT (excess market return), SMB (small-minus-big), HML (high-minus-low), FIMKT (fixed income excess market return) and LIQ (traded liquidity factor). We add also MOM, (momentum factor) to the risk-adjusting model to control for returns on momentum trading strategies.

An important advantage of the random coefficient model is that it allows for heteroskedasticity and fund-specific betas, while being more robust to outliers than the standard Fama-MacBeth approach. As

[20] This return component, which measures the returns due to changes in strategic asset allocation policy over time, is different from the asset allocation component used in the decomposition of fund returns (Section 3). In this section, we look at the outcome of active decisions made by the pension fund to modify the strategic asset allocation policy in year *t* compared to year *t-1*. In the previous, we analyzed the return differences among funds, which can be attributed to the deviation in asset allocation policy from the average asset allocation policy of all funds in one year. Hence, the asset allocation component constructed to measure this deviation has a zero mean and cannot be used to measure return outcomes. The market timing and security selection components are constructed in the same way in sections 3 and 4.

Swamy (1970) explains, the random coefficient model is similar to a generalized least squares approach that puts less weight on the return series of funds that are more volatile.

In addition, we are also interested in the relation between certain pension fund characteristics and risk-adjusted performance. Particularly, we would like to see whether characteristics like asset size, costs and investment style have a systematic impact on performance. These relations are tested using Fama-MacBeth (1973) regressions on risk-adjusted asset allocation, security selection and market timing components. In the first step, we perform a time-series regression on each fund's returns with an appropriate factor model. We run these regressions for every fund that has at least one more observation than coefficients to be estimated. Our findings do not change when we include only funds with at least 2, 3 or 4 more observations than coefficients (see Appendix Table A.2). Second, we run Fama-MacBeth regressions on alphas plus residuals retrieved in the risk-adjusting step, correcting standard errors for autocorrelation and heteroskedasticity using the Newey-West procedure.

For U.S. pension funds, we use MKT, SMB, HML, MOM from Kenneth French's website, plus fixed income and liquidity factors. To calculate fixed income excess returns (FIMKT), we use the returns on U.S. Broad Investment-Grade Bond Index (US BIG) from City Group.[21] The traded liquidity factor is from Pastor and Stambaugh (2003). In the analysis of Canadian pension fund returns, we use the same factors, but calculated using the Canadian stock and fixed income markets. Stock excess returns (MKT) are calculated using the returns on the S&P TSX Index. SMB, HML and MOM factors for Canadian stock market were provided to us by Eun, Lai, de Roon and Zhang (2010). These factor loadings are calculated using the returns on more than 1,000 Canadian companies. We use the DEX Universe Bond Index, which is designed to be a broad measure of the Canadian investment-grade fixed income market, as a proxy for the Canadian fixed income market return.[22]

4.2 Risk-adjusted Performance of Pension Funds

This subsection shows performance evaluation results of U.S. and Canadian pension funds. We start with analyzing performance on a fund level and then look separately at performance in equity, fixed income, real estate and private equity. Our focus is on the changes in asset allocation, market timing and security selection return components as explained previously.

4.2.1 Performance at the pension fund level

Table 6 provides summary statistics of benchmark-adjusted asset allocation, market timing and security selection returns, showing that U.S. and Canadian pension funds beat their benchmarks using

[21] The US BIG Index is composed of the following securities: treasuries (excluding inflation-indexed securities and STRIPS); agencies (excluding callable zeros and bonds callable less than one year from issue date); mortgage pass-throughs; asset-backeds; supranationals; credit (excluding bonds callable less than one year from issue date); Yankees, globals, and securities issued under Rule 144A with registration rights.

[22] In the DEX index there are four main credit or borrower categories: bonds issued by the Government of Canada (including Crown Corporations), Provincial bonds (including provincially guaranteed securities), Municipal Bonds, and Corporate Bonds.

all three components. For every variable we run a random coefficient regression with only a constant. Changes in the asset allocation policy produce 8 basis points (z-statistic of 2.20) return per year for U.S. funds, whereas Canadian funds exhibit a return of 4 basis points, which is not significant (z-statistic of 1.20). Market timing delivers about 28 basis points (z-statistic of 7.55) return per year to U.S. funds and 26 basis points (z-statistic of 7.10) to Canadian funds. Additionally, U.S. (Canadian) funds obtain 19 (28) basis points per year by security selection (z-statistics of 2.20 and 2.76, respectively).

We estimate a random coefficient model to assess whether the outperformance remains after risk-adjusting. This is also important because benchmarks are generally chosen (and reported) by the funds themselves, such that funds could potentially choose benchmarks that are relatively easy to beat. The standard model we employ included five factors, namely the standard three Fama-French factors (market, size and value) augmented with the Pastor-Stambaugh (2003) traded liquidity factor and the excess return on a fixed income market index. We compare results using this baseline 5-factor model with using a 6-factor model that also includes a momentum factor. The momentum factor captures the difference in returns between a portfolio of stocks with high prior one-year returns (winners) and a portfolio of stock with low prior returns (losers). We do not consider the momentum factor as a priced risk factor, but rather include the momentum factor to understand its importance for the performance (attribution) of the funds in our sample. However, the question whether momentum is a priced risk factor (or can be explained by systematic risk) is clearly debatable, and it is straightforward to re-interpret our results under the assumption that momentum is priced (in which case funds would not get any credit on a risk-adjusted basis for successfully pursuing momentum strategies). Most of the literature, however, suggests that momentum cannot be explained by exposure to systematic risk factors (see e.g. Jegadeesh and Titman (1993, 2001), Lee and Swaminathan (2000), Cooper, Gutierrez and Hameed (2004) and Cremers and Pareek (2011)). Even papers arguing for a risk-based interpretation acknowledge that momentum cannot be mostly or completely explained by risk (see e.g. Grundy and Martin (2001) and Lu and Zhang (2008)).

Results in Table 7 show the annual alpha and beta coefficients on these factors, plus the root mean squared error (RMSE) of the residuals. After risk-adjusting, the changes in asset allocation policy deliver a positive alpha of 16 basis points per year (z-statistic of 2.72). This positive alpha is mainly due to the performance of U.S. funds, which obtain an asset allocation alpha of 22 basis points (z-statistic of 2.77), while the asset allocation alpha of Canadian funds is positive but insignificant. Inclusion of the momentum factor increases the estimated asset allocation alpha of U.S. funds by about 14 basis points to 35 basis points per year (z-statistic of 2.20). This suggests that changes in target weights are not made in order to capture momentum.

In Panel B, using all funds together, we find that after risk-adjusting market timing still delivers a positive alpha of 27 basis points per year (z-statistic of 5.68). For U.S. funds only, the results indicate even larger abnormal returns: 29 basis points (z-statistic of 5.08). Our results indicate that Canadian funds deliver market timing abnormal returns of 24 basis points per year (z-statistic of 2.88).[23] Adding the momentum factor to the market-timing risk-adjustment model does not change our conclusion.

The beta coefficients indicate that pension funds, on average, do not systematically overweight a particular style. There is an economically small positive (but statistically significant) coefficient on the SMB factor that is driven by U.S. funds, but all other coefficients are statistically indistinguishable from zero. These results confirm the findings in Table 4, as the time averages of the mean differences for all asset classes are close to zero. However, Table 4 shows that pension funds' actual weights fluctuate substantially around reported policy weights. The results in Panel B of Table 7 show that these fluctuations covary positively with benchmark returns, evidenced by the positive coefficient of the constant, indicating market timing skill.[24]

Panel C of Table 7 shows the random coefficient model results for security selection (i.e., benchmark-adjusted net returns). After risk-adjusting, security selection delivers a positive alpha of 45 basis points per year (z-statistic of 2.94), or 28 basis points for U.S. funds (z-statistic of 1.70, p-value of 0.091) and 83 basis points in our Canadian subsample. The positive security selection alpha of U.S. funds is fully driven by momentum. Once we add the momentum factor, U.S. funds' performance becomes negative: -107 basis points per year. This indicates that momentum trading strategies on average deliver around 135 basis points annually. We do not consider momentum as a priced risk factor, because most of the literature concludes that it cannot be captured by exposure to systematic risk factors. However, momentum is a well-known trading strategy and pension funds should seem to be able to implement it with relatively low investment costs. The large negative alpha after controlling for momentum returns indicates the failures of other active management strategies. Only part of this negative alpha can be attributed to investment costs.

The security selection abnormal return of Canadian funds is not sensitive to inclusion of the momentum factor. The alpha equals 89 basis points (z-statistic of 2.94), even when we control for momentum. However, when analyzing the performance of Canadian funds, it is critical to control for the so-called "Nortel effect". For this reason we include a year 2000 dummy variable. In this year, the Nortel company dominated the S&P/TSX Composite index. As of July 26 (2000), when Nortel was trading at $124.50 a share on the TSX, it represented 36.5% of the TSE 300 index (http://www.cbc.ca/news/background/nortel/stock.html). The "Nortel effect" made it virtually impossible for a manager with a diversified Canadian equity portfolio to beat the benchmark index when Nortel's stock was outperforming the overall market. Following the index was also dangerous, because a portfolio with 36.5% invested in one company cannot qualify for diversified passive investing and is exposed to substantial idiosyncratic risk. However, later in the autumn of 2000, the

[23] When analyzing the performance of Canadian funds, we run a random coefficient model with and without the traded liquidity factor of Pastor and Stambaugh (2003), because this factor is based on U.S. stock market data. The inclusion of liquidity factor did not influence the estimated alphas in Tables 7 and 8. We used the traded liquidity factor to proxy for liquidity risk, which is considered as a highly relevant risk for large institutional investors like pension funds.

[24] Our results are robust to including only pension funds with a higher number of observations per fund in the regressions as presented by the robustness checks in Appendix Table A.2.

Nortel stock price started decreasing, dragging also the Canadian stock index down. The overall return of Nortel in 2000 was -33.8%, but until July that year Nortel had a positive return of 69%. The large negative returns on the Nortel stock created a substantial difference between the return on TSE Composite Index (7.4% in 2000) and the capped version of the same index (19.1% in 2000).

The abnormal returns of 89 basis points per year of Canadian funds disappear once we control for the "Nortel effect"**.** After adjusting for 'Nortel effect' Canadian funds produce an alpha of -21 basis points (z-statistic of -0.97). This shows that Canadian funds beat significantly the S&P/TSX Composite index in 2000 due to the underweighting of Nortel in their portfolios (or good timing). The large impact of the "Nortel effect" on the overall fund performance can be expected, because Canadian pension funds' domestic equity holdings were 33% in 2000. As abnormal returns of Canadian funds disappear once we control for the year 2000, we can conclude that Canadian pension funds cannot consistently produce abnormal returns, but their "lucky" (or constrained) investment decisions around the "Nortel effect" resulted in returns significantly higher than the TSX benchmark returns.[25]

Overall, our paper provides evidence that pension funds obtain a positive alpha of 17 basis points from changes in strategic asset allocation and 27 basis points from market timing asset allocation decisions. Security selection produces an even larger alpha of 45 basis points per year, which is robust to controlling for risks related to equity market, size, value, liquidity and fixed income market factors. For U.S. funds, any outperformance in security selection seems completely due to funds pursuing momentum strategies. For Canadian funds, the outperformance is due to the "Nortel" effect. The alpha for benchmark-adjusted net returns of all funds is -62 basis points per year, once we control for both momentum and the "Nortel effect" (z-statistic of -4.02). A large part of this negative return can be attributed to investment costs. The negative alpha from security selection among U.S. funds after controlling for momentum outweighs the positive risk-adjusted returns from changes in asset allocation and market timing. The negative, but insignificant, security selection alpha of Canadian funds after removing the "Nortel effect" also offsets most of the positive returns from market timing and asset allocation changes.

4.2.2 Performance in separate asset classes

Table 6 presents the summary statistics of pension funds asset allocation, market timing and security selection returns on an asset class level. Changes in the strategic asset allocation policy within equity produce small returns indistinguishable from zero. Before risk-adjusting, U.S. pension funds can beat their equity benchmarks by about 22 basis points (z-statistic of 5.98) per year using market timing and by an additional 19 basis points using security selection (z-statistic of 1.83 and p-value of 0.067). Results for Canadian funds are 17 and 43 basis points respectively. Canadian funds appear to be especially successful in their domestic equity investments: 64 basis points.

[25] Our results are robust to including only pension funds with a higher number of observations per fund in the regressions as presented by the robustness checks in Appendix Table A.2.

Within fixed income, U.S. funds seem to perform better than Canadian funds. Funds in both countries experience high variation in private equity and real estate performance, which follows from the substantially higher standard deviations, compared to equity and fixed income. As previously discussed, hedge funds become especially popular at the end of our period. Pension funds' returns in hedge funds are volatile and on average negative: -182 basis points (z-statistic of -1.85) in the U.S. and -227 basis points (z-statistic of -1.89) in Canada.[26] In line with our results, Dichev and Yu (2011) also find that the returns of hedge fund investors over 1980-2008 period are reliably lower that the returns of broad-based indexes like the S&P500 and only marginally higher than risk-free rates of return.

Risk-adjusted performance results for separate asset classes are presented in Table 8. In Panels A and B we show results for all funds, in Panels C and D for U.S. funds only and in Panels E and F for Canadian funds. The first column shows the results for changes in asset allocation within equity (AA-E), presenting alphas and root mean square errors of the random coefficient model using MKT, SMB, HML and LIQ factors. In Panels B, D and F we add the momentum factor to the risk-adjusting model.

Consistent with our findings in Table 6, changes in the asset allocation policy within equity do not deliver positive and significant alpha. Adding momentum does not influence the results. This suggests that our result (see Panel A of Table 7) that changes in asset allocation policy over time produced about 16 basis points alpha on the fund level, are not due to changes in the strategic allocation within equity, but are rather due to changes in policy weights across broader asset classes over time. For example, U.S. funds on average increased their policy allocation to private equity and other alternative assets at the expense of fixed income and cash.

The second column of Table 8 shows the market timing results within equity (MT-E), which can be measured only when funds invest in at least two categories within equity.[27] Results in the MT-E column confirm the findings in Table 7 Panel B that pension funds can create abnormal returns from timing their allocation decisions, obtaining around 14 basis points (z-statistic of 3.72). Controlling for the momentum factor, the alphas from market timing within equity are somewhat higher. As the market timing results at the fund level produced about 27 basis points alpha per year, this implies that a large part of this abnormal return is due to timing the performance across various equity classes, rather than timing the performance across broader asset classes (such as moving from equity to fixed income or real estate).

In line with our findings in Table 7, U.S. pension funds on average demonstrate security selection skills within equity (see column SS-E). The alpha from random coefficient regressions on equity

[26] These are the most frequently reported benchmarks by US and Canadian funds: U.S. equity – S&P500, Russell 1000, Russell 2000 and Russell 3000; Canadian equity – TSE300; U.S. fixed income – Citi Group US Big Index and Barclays US Aggregate; Canadian fixed income – DEX Universe Bond; Real estate – NCREIF, RCPI and NAREIT; Private equity – Wilshire 5000, Cambridge Private Equity, Venture Economics and custom benchmarks; Hedge funds – CSFB Tremont, HFRI Indices and custom benchmarks.

[27] For example, based on the strategic policy a pension fund should invest in 50% in Canadian equity, 30% in U.S. equity and 20% in EAFE equity. If the actual allocation percentages are different from the above-mentioned policy weights, that fund will generate returns from market timing within equity, measured as the difference between actual and policy weights times the benchmark returns. However, it does not capture returns from overweighting certain industries within Canadian equity mandate.

benchmark-adjusted net returns is equal to 38 basis points (z-statistic of 1.93). However, when we also control for the momentum factor, the alpha from security selection within equity turns negative to -72 basis points. Canadian funds exhibit a high security selection alpha before controlling for the “Nortel effect” (see Appendix Table A.3), but after controlling for the year 2000 and momentum, they obtain a large positive alpha in domestic equity of 90 basis points (z-statistic of 2.68). However, their overall return from security selection is still negative due to the poor performance in international equity.

Following Blake, Elton and Gruber (1993), Elton, Gruber and Blake (1995) and Cici and Gibson (2010), we risk-adjust the performance of fixed income assets using the following factors: MKT (equity market), FIMKT (fixed income market), HY (high yield) and OPTION (option-like characteristics of mortgage securities). Specifically, HY is the return difference of the Merrill Lynch High Yield and Government index for U.S. funds (or return difference between DEX BBB Universe and DEX Government Universe Index for Canadian funds). OPTION is estimated as the return difference of the US BIG (Canadian DEX) Mortgage Index and US BIG (Canadian DEX) Government Index.

Results in column AA-FI indicate that changes in the strategic allocation policy do not deliver abnormal returns for U.S. or Canadian funds. Further, column MT-FI presents the alphas obtained from market timing within fixed income assets. Results for all funds together as well as separately for U.S. and Canadian funds indicate that pension funds are not able to generate abnormal returns from timing their allocations between various fixed income categories. Moreover, security selection results in the column SS-FI show that U.S. and Canadian funds are not able to generate alphas from active management within fixed income assets. Alphas are also very close to zero when we look at the pension fund performance in domestic fixed income assets. Importantly, alphas disappear only after controlling for the high yield spread and option elements in fixed income returns. Our findings for pension fund performance are in line with Cici and Gibson (2010), who consider corporate-bond mutual funds.

Finally, we consider pension fund performance in private equity and real estate, the alternative asset classes with the highest number of observations. We again risk-adjust using market, size, value, and liquidity factors. The only adjustment is that we proxy for the equity market return using the excess returns on the Nasdaq index in the private equity regressions. This provides a better fit and thus is more representative for private equity investments.[28] Results in Table 8 indicate that private equity delivers a large positive alpha of 443 basis points per year (z-statistic of 3.07) on a risk-adjusted basis. After controlling for momentum, the alpha from private equity is considerable smaller and equal to 120 basis points per year, and no longer statistically different from zero. The results for real estate indicate a large negative alpha of about 1% a year, which is significant when combining U.S. and

[28] If we risk-adjust the security selection returns in private equity using the standard market return (CRSP data), we obtain significant alpha of 293 basis points (604 basis points without momentum). Table 8 shows that this alpha is lower (without controlling for momentum) or not present when we use the Nasdaq index as a proxy for excess market return.

Canadian funds. Real estate returns are not sensitive to adding a momentum factor to the risk-adjusting model.

4.3 Relation between Pension Fund Characteristics and Performance

In this section, we relate the risk-adjusted asset allocation, market timing and security selection alphas to certain characteristics of pension funds using Fama-MacBeth regressions. Specifically, we examine whether differences in performance are associated with fund size, mandate (or asset class) size, liquidity, investment costs and investment style (referring to whether assets are managed internally or externally, and passively or actively). Fund size reflects the total size of the pension fund holdings, which is a sum of holdings in all asset classes, while mandate size reflects the size of the holdings in a particular mandate, like fixed income. The analysis again is first conducted on a fund level and later by asset class.

4.3.1 Fund Level

Tables 9, 10 and 11 present the results for the asset allocation, market timing and the security selection component, respectively. Panel A of each table presents results when we risk-adjust using a five factor model that includes MKT, SMB, HML, LIQ and FIMKT in the first step of the Fama-MacBeth regressions. In Panel B thereof these tables, we add momentum to the five factor risk-adjusting model.

The asset allocation performance regressions with only a constant (Model 1 in Table 9) serve as a robustness check of the results in Panel A of Table 7. They confirm our previous finding that pension funds generate abnormal returns of 18 basis points per year from changes in the strategic asset allocation. Our results also confirm that this abnormal return is higher for U.S. funds, 25 basis points (t-statistic of 6.53), and lower for Canadian funds (8 basis points with a t-statistic of 2.29).

Fund size is slightly positively related to abnormal returns from changes in asset allocation policy. More importantly, the interaction between fund size and the fund's liquidity beta (i.e. the exposure to the Pastor-Stambaugh traded liquidity factor) is negative and highly significant. Using all funds, the interaction coefficient equals -1.68 (t-statistic of -18.04) in Model 3 of Table 10. Economically, this coefficient means that increasing liquidity by lowering the liquidity beta by 10 percentage points, would be associated with an improvement of the alpha of funds at the 75th size percentile by 19 basis points per year (= -0.1 x -1.6760 x (ln[5769]-ln[1896]) more than the improvement of the alpha of a fund at the median size percentile. This finding implies that larger funds face significant liquidity limitations when redesigning their strategic asset allocation. Rapid shifts in the strategic asset allocation towards more illiquid assets hurt the performance of larger funds relative to smaller funds.

Table 10 considers the relation between market timing returns and pension fund characteristics. The results with only a constant (Model 1 in Table 10) confirm our findings from Panel B of Table 7. They confirm our previous finding that pension funds generate abnormal returns of 28-31 basis points per year from market timing. Our results also confirm that this abnormal return is slightly higher for U.S.

funds, 30 basis points (t-statistic of 5.04), and lower, but still significant, for Canadian funds (25 basis points with a t-statistic of 5.20).

U.S. funds with higher costs are better at market timing. E.g., (in Panel B Model 4) the coefficient on total costs of 0.55 (t-statistic of 3.27) means that a one standard deviation increase in the total costs of U.S. funds (0.19) is associated with a 10 basis points per year higher return from market timing (0.19 * 0.55). In general, a positive coefficient on total costs implies that pension funds that obtain higher returns from market timing pay more for the flexibility to rebalance more frequently. Canadian funds do not show any association between market timing and costs. Therefore, the results are consistent with Canadian funds allowing for less flexibility to rebalance frequently, resulting in lower overall costs but lower market timing performance.

Fund size by itself does not seem related to the market timing abilities of pension funds. However, the interaction between fund size and the fund's liquidity beta is negative and highly significant. For the all funds universe the interaction coefficient equals -1.38 in Model 3 of Table 10. Economically, this coefficient means that increasing liquidity by lowering the liquidity beta by 10 percentage points, would be associated with an improvement of the alpha of funds at the 75th size percentile by 15 basis points per year (= -0.1 x -1.3778 x (ln[5769]-ln[1896]) more than the improvement of the alpha of a fund at the median size percentile.

Further, our results (in Appendix Table A.4) with the momentum factor included show that especially a high involvement in external management (%Ext) reduces market timing. External mandates usually include commitment periods and redemption fees, which make the rebalancing less attractive. Additional robustness checks confirm that size of the assets managed externally is negatively associated with market timing returns.[29]

Overall, our results imply that smaller funds can rebalance their positions easily, without distorting market prices. Managing larger holdings externally reduces the market timing returns because of liquidity effects.

In Table 11, we consider the same fund characteristics for security selection (benchmark-adjusted net returns). Again, regressions with a constant only (Model 1) serve as a robustness check of alphas presented in Table 7, indicating again that U.S. funds on average display security selection skills, with average outperformance here estimated to be 49 basis points per year (t-statistic of 2.17; before adjusting for momentum, see Panel A). At the fund level, U.S. fund security selection performance is unrelated to fund size before controlling for momentum. However, if we control for momentum, we find that benchmark-adjusted returns become positively related to fund size. This suggests that it is

[29] In Appendix Tables A.4 and A.5 as a further robustness check we also look directly at the log of fund holdings invested in one style. For example SizeAct represents log of assets managed actively. This calculation of log styles' asset size is subject to arbitrary correction of the values when style holdings are equal to zero i.e. when no assets are managed in the particular style. We replace these results with ln(0.05), which will be the lowest value in every style. When we use these logs of style holdings in the regressions of Appendix Table A.4 our findings remain the same as in Table 10. In Tables 10 and 11 we do not include jointly in a regression the percentage and amount of assets managed with particular style due to high correlations. For example, the correlation between %Ext and SizeInt is -78% and the correlation between %Act and SizePas equals -69%.

especially smaller U.S. pension funds that are pursuing momentum strategies. As momentum can explain any evidence of outperformance of security selection for U.S., this could further explain the results in Bauer, Cremers and Frehen (2010) that small funds have particularly good equity performance.[30] In Canada, contrary to the U.S., larger funds follow more momentum strategies. Hence, economies of scale disappear once we control for momentum returns.

The security selection performance of larger funds seems particularly constrained by liquidity, as evidenced by the large, negative coefficients on the interaction between fund size and the liquidity beta. The interaction coefficient equals -1.3154 for the all funds universe in Model 3 of Table 11. Economically, this coefficient means that increasing liquidity by lowering the liquidity beta by 10 percentage points, would be associated with an improvement of the alpha of funds at the 75th size percentile by 15 basis points per year (= -0.1 x -1.3154 x (ln[5769]-ln[1896]) more than the improvement of the alpha of a fund at the median size percentile. Moreover, the magnitude of this interaction term decreases by half once we control for momentum (see Models 3 and 5). This shows that larger funds cannot engage as much as smaller funds in momentum trading due to liquidity constraints.

For Canadian funds, we consistently control for the "Nortel effect", which is especially important for smaller Canadian pension funds and thus matters greatly when considering the association of fund size with performance[31]. Once we control for the year 2000 outperformance of Canadian funds, the size effect becomes positive if we do not control for momentum. However, after controlling for momentum, size is no longer significant, suggesting that in Canada, larger funds are more actively involved in momentum strategies. If we look at Model 2 before controlling for momentum, one standard deviation increase in log size of Canadian funds improves their abnormal return by 10 basis points (0.0694 * 1.4686).

In Models 4 and 5, we further relate the total investment costs to security selection performance. For U.S. funds, before controlling for momentum, its coefficient is positive but insignificant (see Model 5 in Panel A; a coefficient of 0.49 with a t-statistic of 0.75), but it becomes negative and strongly significant after controlling for momentum (see Panel B; coefficient of -1.23 with a t-statistic of 2.45). This suggests that funds pursuing momentum strategies have higher costs that more than compensate with higher performance of these same strategies. Canadian funds show no significance for investment costs, and consistently with earlier results, adjusting for momentum does not matter.

In Model 6 of Table 11 and Appendix Table A.5, we analyze the association between security selection performance and the percentage of assets managed in active and external mandates. We first consider U.S. funds. In Model 6, the coefficient on the percentage of actively managed assets is

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[30] These results are confirmed when forming three different samples based on the size of the assets under management. All three groups have, on average, positive security selection performance after risk-adjusting but before controlling for momentum (28 basis points per year for the smallest and 23 basis points for the largest third of U.S. pension funds). After controlling for momentum, all 3 groups have negative alpha, especially the smaller funds (-171 basis points per year for the smallest third and -92 basis points per year for the largest third of U.S. funds). Results are available upon request.

[31] See Appendix Table A.6 for results without controlling for "Nortel effect"

positive but insignificant before adjusting for momentum, and becomes negative and significant (coefficient of -0.50 with a t-statistic of 1.68 or a p-value of 0.093) after adjusting for momentum. Likewise, the coefficient on the percentage of externally managed assets is only negative and significant after again adjusting for momentum. Both of these results can be explained by momentum being (obviously) an active strategy, and one that is apparently more pursued by external managers rather than by managers investing funds internally. Second, for Canadian funds, both coefficients are negative and generally statistically significant, indicating that funds with more passive and with more internal management perform better.

The result that active and external mandates are related to lower performance for U.S. funds (after controlling for momentum) can be explained by liquidity constraints faced by larger funds. Once we control for the interaction between size and the liquidity beta in Model 4 of Appendix Table A.5 Panel D, both become insignificant. This is consistent with liquidity constraints being most important for actively managed mandates and for assets managed externally. However, liquidity constraints fail to explain the negative association between active and external management for Canadian funds.[32]

4.3.2 Asset Class Level

We also look at the influence of pension fund characteristics on performance on a lower level of aggregation, or how size, liquidity, costs and investment style relate to the performance in equity, fixed income, private equity and real estate. Table 12 shows the results for pension fund performance in equity, using the 4-factor equity model without momentum in Panel A and adding momentum in Panel B[33]. We focus on the market timing and security selection returns within equity, as our previous findings showed that asset allocation returns due to changes in equity policy weights were indistinguishable from zero.

Results from Model 1 with a constant confirm the previous findings from Table 8. U.S. pension funds on average generate positive and significant alpha from both market timing across equities and security selection within equities. U.S. small cap performance is particularly large and positive (confirming Bauer, Cremers and Frehen (2010)). Canadian funds again perform especially well in security selection of domestic equities.

As equity represents on average 54%-58% of the total pension fund holdings, the results in Table 12 will naturally resemble the results in Tables 10 and 11 at the fund level. For equities, size is strongly negatively related to performance for both U.S. and Canadian funds (see Model 2 in Panel A). This is largely related to liquidity constraints (see Model 3 in Panel A). For U.S. funds, the pursuit of momentum strategies explains (see Panel B) the direct effect of asset size, but not of the liquidity-size interaction. Cost levels are actually positively related to the security selection of U.S. funds for their domestic equity and small cap equity investments (see Model 4 in Panel A), which can again be

[32] When we use these logs of style holdings in the regressions of Appendix Table A.5 our findings remain the same as in Table 11. Greater internal management is related to improved performance.
[33] Appendix Table A.8 presents the results for U.S. and Canadian funds together and the results without controlling for “Nortel effect”.

explained by momentum (see Model 4 in Panel B). Much of the higher costs of small cap equity investing can thus be explained by funds' pursuit of momentum, which seems an investment strategy bearing higher investment costs than other active strategies.

In line with our findings on the fund level, after controlling for momentum, the percentage of equity holdings managed internally is positively associated with security selection and market timing in equity, especially among U.S. funds (see Model 5 in Panel B). One standard deviation increase in the percentage of equity holdings managed externally by U.S. pension fund reduces their security selection performance by 49 basis points (0.2435 * (-2.0167)). The only exception is the performance of U.S. funds in small cap mandates. We still observe a positive relationship, which is due to the better performance of smaller funds in small cap mandates. One explanation is that smaller funds engage less in internal management and another potential explanation is that investing in small cap stocks requires more expertise that cannot be easily internally acquired.

Further, there is no significant relationship between the percentage of actively managed equity holdings and the performance of U.S. pension funds. Among Canadian funds, the percentage of active management is negatively related to performance, which implies that managing equity more passively reduces their underperformance in equity (see Model 5 in Panel B). One standard deviation increase in the percentage of equity assets managed actively by Canadian funds increases the underperformance by 18 basis points (0.2221 * (-0.8217)).

Pension fund performance in fixed income assets is analyzed in Table 13.[34] In line with Table 8, pension funds do not obtain positive alphas from market timing or security selection within fixed income. After risk-adjusting for the 4-factor fixed income model, their alphas are close to zero and not statistically significant (see Model 1). The size of the fixed income holdings leads to differences in performance among U.S. funds (See Model 2 in Panel A). Similar to equity results, smaller funds display better security selection skills, but the economic magnitude is smaller. A one standard deviation increase in the log of fixed income holdings leads to an 18 basis points (1.51 * (-0.1168)) decrease in risk-adjusted returns from security selection. Somewhat surprising, investment costs are positively related to performance in fixed income (see Model 3). This result is mainly driven by better performance of smaller mandates, which bear higher costs, and is also economically relatively small. A one standard deviation increase in fixed income investment costs of U.S. funds improves their performance by nine basis points (0.11 * 0.7888). The investment style variables %ActFI and %ExtFI also have a marginal impact on security selection and market timing returns, but the economic effect is less than 10 basis points for a one standard deviation change. Compared to equity, the influence of pension fund characteristics has a much lower effect on the fixed income performance.

Finally, in Table 14 we look at the performance in the two most important alternative asset classes: real estate and private equity. In the first step, risk-adjusting is done using the 4-factor model with Fama-French factors augmented with liquidity. In the private equity analysis, we use the excess returns of the Nasdaq index as a proxy for the market return. In Panels B and D, we add the

[34] Appendix Table A.9 shows the results for U.S. and Canadian funds together.

momentum factor to the model. Model 1 in Panels A and B confirms our findings in Table 8 that U.S. and Canadian funds generate significant and positive alphas in private equity before controlling for momentum. Afterwards, the alpha is insignificant and close to zero. Results in Model 1 also indicate that pension funds tend to have negative alphas from real estate.

In Panel B, the results also show that funds with larger holdings perform better in private equity. This effect is strongest among Canadian pension funds. A one standard deviation increase in the log of private equity holdings of Canadian pension funds leads to 600 basis points (2.6341 * 2.3) higher abnormal return (see Model 3 in Panel B). Similarly, Canadian funds with large holdings in real estate also realize economies of scale. A one standard deviation increase in the log of their real estate holdings leads to 158 basis points (0.8294 * 1.9) higher abnormal return (see Model 3 in Panel D). The economic magnitude of the other coefficients is also large. The performance of larger funds in alternative assets is again constrained by liquidity, as evidenced by the large, negative coefficients on the interaction between mandate size and the liquidity beta (see Model 4).

Our results show that larger funds can assert more bargaining power in private deals in private equity, infrastructure and real estate.[35] Larger funds can devote more resources to monitor closer their external counterparts in these investment vehicles. The largest funds even establish internal (or at-arms-length") private equity and real estate divisions, which is a good long-term approach if you are large enough. The negotiation power of funds that invest large amounts in private equity or real estate can be seen in the coefficients on investment costs (see Models 5 and 6). Costs are negatively related to abnormal returns from private equity and real estate and the effects are especially pronounced among U.S. funds investing in private equity and Canadian pension funds investing in real estate.

These economies of scale in private equity and real estate investments (as well as the negative relation between costs and performance) are not driven by funds that recently started investing in these asset classes. Controlling for 'new investors' in these asset classes with less experience and possibly worse opportunities, the coefficients on size, costs and liquidity interaction term remain unchanged (results are not reported). Our results are also robust to not risk-adjusting in the first step, but rather directly regressing the net benchmark-adjusted private equity and real estate returns on characteristics.

Overall, the previous discussion shows that the relationship between size and performance is not uniform. Large funds experience diseconomies of scale in more standardized asset classes, like domestic equity and fixed income, but manage to recover by economies of scale in alternative asset classes.

[35] Lopez-de-Silanes, Phalippou and Gottschalg (2010) identify strong diseconomies of scale among private equity firms. Our findings do not contradict the observed diseconomies of scale in the private equity industry. First, pension funds holdings in private equity can be compared to the value of investments held in parallel by private equity firms. The median holding of pension funds would fall in the second smallest decile in Lopez-de Silanes et al. (2010) sorting of private equity firms, based on value of investment held in parallel. Second, pension funds have an option to invest in multiple private equity companies if they are concerned about diseconomies of scale. Third, we look at returns on investments in private equity after subtracting costs, and private equity is the most expensive asset class in pension fund portfolio.

5. Persistence in Pension Fund Performance

Previous sections showed that pension funds obtain positive returns from market timing and security selection, some of which remain significant even after risk-adjusting. A relevant follow-up question is whether there is persistence in pension fund performance. To answer this question we split pension funds into five quintiles based on their market timing on security selection performance (after costs). We run an ordered logit model, where the dependent variable is the quintile ranking based on the performance in year *t+1* and the main independent variable is the quintile ranking in year *t*. Marginal effects from the ordered logit model for every outcome (quintile ranking) are presented in Table 15. Results for the U.S. are in Panels A and B, and for Canada in Panels C and D. Market timing performance is considered in Panels A and C, and security selection in Panels B and D.

Results indicate that funds are more likely to end up in a better performing quintile next year, if they belong to a better performing quintile already this year. Pension funds are also more likely to be ranked among the worst performers next year, if they performed relatively poorly this year. The persistence is observed among both U.S. and Canadian funds and in both market timing and security selection returns. For example, looking at U.S. funds market timing returns (Panel A), an increase in the quintile ranking from 3 to 4 reduces the probability of ranking among the worst performers in year t+1 by 3.8%. Results in Models 2, 3 and 4 show that the marginal effects of last year's ranking remain even after controlling for fund size, costs, and the percentage of assets managed actively and externally.

In Appendix Table A.11 we present the actual transition matrixes. The percentage of funds repeating as best performers is in all cases higher than the percentage of best performers of last year ending in one of the four lower quintiles this year. The same holds for the worst performing funds. We also look at the returns in year *t+1* of funds ranked in the lowest and highest quintile in year *t*. Funds ranked in the top quintile have higher average returns in the following year than the funds ranked in the bottom quintile. Results from the t-test suggest that the difference in next year's returns is significant for U.S. funds' market timing and security selection returns and for Canadian funds' security selection returns.

These persistence tests are performed directly on the benchmark-adjusted market timing and security selection returns. As we only have access to annual data, we cannot use the risk-adjusted performance in these estimations. Hence, we do not test whether pension funds can persistently deliver abnormal returns, or estimate the effect of liquidity constraints on persistence. Nevertheless, these results show that certain pension funds are persistently better in outperforming their benchmarks using market timing and security selection.

6. Conclusion

We analyze the asset allocation policy and performance of U.S. and Canadian defined benefit pension funds. We provide a detailed overview of the time trends in pension fund allocations to multiple asset classes and the investment costs of pension funds. There is a substantial home bias in pension fund allocations to equity and fixed income that goes down over time. Real estate is the most important alternative asset class for pension funds and accounts for 3-4% of their total holdings, whereas private equity is by far the most expensive asset category with mean annual expenses of 280 basis points.

We decompose differences between pension fund returns into asset allocation policy, market timing and security selection returns. We find that pension funds manage approximately 80% of their total assets in an active way, which creates substantial differences in their returns. Even though pension funds have the opportunity to invest in multiple asset classes, the majority of them follow a standard asset allocation policy. This ‘herding’ in asset allocation together with high levels of active management explains why security selection accounts for more than 50% of the variation in excess returns of both U.S. and Canadian pension funds.

Pension funds are able to beat their benchmarks before and after risk-adjusting. Changes in asset allocation policy result in positive abnormal returns of 17 basis points per year, which is mainly observed among U.S. funds. These abnormal returns are due to pension funds changing their asset allocation policy across broader asset classes over time, not to changes within equity or fixed income. This suggests that when modifying their strategic asset allocations, especially larger funds face significant liquidity limitations.

Market timing delivers a positive alpha of 27 basis points per year. This abnormal return is larger among smaller funds, funds with greater internal management and funds with higher investment costs. In general, market timing returns depend on the flexibility to rebalance and liquidity constraints. About half of the alpha comes from market timing within different equity styles (such as domestic versus international stocks, and large versus small cap stocks). This suggests that funds that try to stay as close as possible their strategic asset allocation policy may miss market timing opportunities. If fund managers have market timing skills, as our results indicate, letting the actual weights deviate from the strategic weights and not rebalancing back immediately can in fact improve performance, in line with Sharpe’s (2010) idea of an ‘adaptive asset allocation policy.’

Security selection delivers an even higher alpha of 45 basis points, where the outperformance among U.S. funds is driven by the momentum factor and that of Canadian funds can be fully explained by the “Nortel effect” in the year 2000. Once we control for these two factors, security selection delivers a negative alpha of -62 basis points per year. For U.S. funds, we find that costs have a strong negative effect on performance after controlling for momentum. This implies that the momentum strategy bears higher costs than other active strategies. Further, we find that the security selection performance of larger funds is particularly constrained by liquidity.

The relation between size and performance is not uniform and depends on the asset class and investment style. Larger pension funds experience diseconomies of scale in equity and fixed income (mainly due to liquidity limitations), but they realize their economies of scale in alternative asset classes, especially in real estate. Larger funds can assert more negotiation power in alternative asset classes, which enables them to access better investment opportunities at lower costs. Our results also show that funds that manage most of their assets internally improve their performance compared to peers with mostly external mandates, potentially due to fewer agency conflicts and lower investment costs.

Lastly, we find persistence in pension funds’ ability to deliver higher market timing and security selection returns. Funds belonging to the best performing quintile this year are more likely to remain among the best performers in the following year.

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Table 1: Number of funds

This table displays the number of U.S. and Canadian pension funds in the CEM database in the sample period 1990-2008. We also display the number of funds entering and exiting the database in a given year. The Total row shows the total number of funds reporting at least one year to the CEM.

Year	Total			U.S.			Canada		
	# Funds	# Enter	# Exit	# Funds	# Enter	# Exit	# Funds	# Enter	# Exit
1990	104	104	0	51	51	0	53	53	0
1991	124	58	38	63	39	27	61	19	11
1992	164	69	29	83	38	18	81	31	11
1993	220	90	34	134	70	19	86	20	15
1994	266	92	46	168	68	34	98	24	12
1995	294	83	55	192	62	38	102	21	17
1996	290	57	61	185	36	43	105	21	18
1997	265	37	62	168	29	46	97	8	16
1998	278	47	34	174	37	31	104	10	3
1999	292	56	42	182	40	32	110	16	10
2000	270	38	60	165	23	40	105	15	20
2001	276	46	40	177	36	24	99	10	16
2002	254	30	52	156	15	36	98	15	16
2003	254	39	39	158	27	25	96	12	14
2004	262	43	35	166	25	17	96	18	18
2005	262	36	36	155	15	26	107	21	10
2006	247	31	46	146	18	27	101	13	19
2007	311	102	38	215	88	19	96	14	19
2008	290	46	67	204	36	47	86	10	20
Total	774			534			240		

Table 2: Cox proportional hazard model and self-reporting bias

This table presents the results of a survival analysis using the Cox proportional hazard model. The event of interest is the decision of the pension funds not to report to CEM in a given year. We treat each fund re-entry as a new fund which explains why the # Units is higher than the # Funds presented in Table 1. # Exit Events presents the number of observations when pension funds decided not to report to CEM again. # Obs. presents the total number of observations in the database. Independent variables included in the model are Net returns in percentage points, Benchmark-adjusted net returns in percentage points, Total Costs in basis points and Log(Size) – logarithm of the asset under management. In this table the hazard ratios for each independent variable are reported together with their corresponding z-statistics in parentheses. Panel A presents the results for all funds, while in Panels B and C we split the sample on U.S. and Canadian funds. All regressions use robust standard errors clustered by year.

Interpretation of the hazard ratios in Panel A:
Net returns: 1 percentage point increase in the Net returns increases the rate of dropping out from the CEM Database by 2.22%. Total costs: when the total costs increase by 1 basis point, the dropping rate decreases by (100% - 99.5%) = 0.5%. Log(Size): when the log(size) increase by 1 unit, the dropping rate decreases by (100% - 74.83%) = 25.17%.

# Units	# Exit Events	# Obs.	Net returns	Benchmark returns	Benchmark-adj net returns	Total Costs	Log(Size)
Panel A: All Funds							
1078	787	4643	1.0222			0.9950	0.7483
			(1.81)			(-1.03)	(-6.81)
1078	787	4643			1.0060	0.9953	0.7549
					(0.44)	(-1.04)	(-6.89)
1078	787	4643		1.0274	1.0049	0.9951	0.7470
				(1.70)	(0.44)	(-1.04)	(-6.85)
Panel B: U.S.							
736	532	2910	1.0220			0.9915	0.7339
			(1.86)			(-1.76)	(-7.50)
736	532	2910			1.0120	0.9924	0.7514
					(0.78)	(-1.60)	(-5.50)
736	532	2910		1.0274	1.0076	0.9915	0.7294
				(1.70)	(0.54)	(-1.79)	(-7.91)
Panel C: Canada							
342	255	1733	1.0209			0.9925	0.6670
			(1.20)			(-1.31)	(-7.63)
342	255	1733			0.9790	0.9907	0.6588
					(-0.93)	(-1.41)	(-7.62)
342	255	1733		1.0245	0.9904	0.9924	0.6702
				(1.30)	(-0.38)	(-1.32)	(-7.44)

Table 3: Fund size, asset allocation and costs summary statistics

Panel A presents the size and percentage allocation summary statistics. Funds Size is reported in million USD for U.S. funds and in million CAD for Canadian funds. Domestic E presents the percentage allocation to domestic equity from total holdings, whereas Domestic FI displays the percentage allocation to domestic fixed income from total holdings. Other category incorporates the remaining alternative asset classes: tactical asset allocation, infrastructure, hedge funds, commodities and natural resources. Panel B presents the costs summary statistics. Total costs row presents the total fund costs in basis points. The costs are also reported separately for equity, domestic equity, fixed income, domestic fixed income, cash, real estate, private equity and other alternative assets (tactical asset allocation, infrastructure, hedge funds, commodities and natural resources). For every variable the time series averages of cross-sectional means, 25th percentile and 75th percentile values for the period 1990–2008 are presented.

	U.S.			Canada		
	25th perc.	Mean	75th perc.	25th perc.	Mean	75th perc.
Panel A: Asset under Management (Holdings) summary statistics						
Fund Size	1234.55	9559.66	8109.81	496.55	4347.84	2557.39
Equity	52.68%	58.42%	65.60%	49.81%	54.04%	59.10%
Domestic E	38.46%	44.84%	51.78%	25.50%	30.49%	35.83%
Fixed Income	24.03%	31.08%	36.51%	32.70%	37.64%	42.32%
Domestic FI	19.96%	26.99%	33.46%	27.09%	32.50%	40.20%
Cash	0.21%	1.94%	2.56%	0.70%	3.44%	4.76%
Real Estate	0.34%	3.97%	6.36%	0.19%	2.94%	4.93%
Private Equity	0.00%	2.38%	3.87%	0.00%	0.77%	0.73%
Other	0.00%	2.21%	1.15%	0.00%	1.17%	0.30%
Panel B: Costs summary statistics in basis points						
Total Costs	23.04	35.25	46.03	17.06	25.65	30.92
Equity	20.06	32.92	44.39	19.55	29.18	35.39
Domestic E	16.19	29.41	40.74	13.71	22.37	27.77
Fixed Income	10.86	19.30	25.67	7.22	14.08	19.85
Domestic FI	9.38	17.99	24.41	6.87	13.82	20.02
Cash	3.48	28.27	17.82	4.39	13.35	15.94
Real Estate	53.97	89.14	106.35	24.27	54.03	74.52
Private Equity	138.25	283.81	292.84	73.53	273.93	313.32
Other	36.16	95.27	113.38	64.49	105.37	138.75

Table 4: Strategic policy weights vs. Actual weights

This table presents the strategic policy weights of the pension funds and the realized policy weights. Column Policy weight presents the time series averages of cross-sectional mean strategic policy weights (target weights) for different asset classes for the period 1990–2008. Column Actual weight presents the time series averages of cross-sectional mean realized weights for different asset classes for the period 1990–2008. Mean column of $Actual_t$ – $Policy_t$ displays the time series averages of cross-sectional mean differences between the actual weights and strategic policy weights, whereas the StDev column presents the time series average of cross-sectional standard deviations of the mean differences between the actual (realized) weights and strategic (target) weights. Mean column of $Policy_t$ – $Policy_{t-1}$ displays the time series averages of cross-sectional mean differences between the strategic policy weights in year *t* and the strategic policy weights in the previous year *t-1*, whereas the StDev column presents the time series average of cross-sectional standard deviations of the differences between the strategic policy weights from year *t* and year *t-1*.

	Policy weight	Actual weight	$Actual_t$ – $Policy_t$		$Policy_t$ – $Policy_{t-1}$	
			Mean	StDev	Mean	StDev
Panel A: U.S.						
Equity	58.30%	58.42%	0.11%	5.45%	0.02%	4.50%
Fixed Income	31.44%	31.08%	-0.36%	4.96%	-0.33%	4.36%
Cash	1.19%	1.94%	0.75%	2.32%	-0.13%	1.39%
Real estate	4.62%	3.97%	-0.65%	2.05%	-0.06%	1.62%
Private Equity	2.91%	2.38%	-0.52%	2.26%	0.22%	1.66%
Other	1.54%	2.21%	0.66%	3.67%	0.27%	2.25%
Panel B: Canada						
Equity	53.86%	54.04%	0.18%	4.74%	0.49%	3.45%
Fixed Income	38.66%	37.64%	-1.02%	4.56%	-0.29%	3.78%
Cash	2.61%	3.44%	0.82%	3.11%	-0.26%	1.74%
Real estate	3.31%	2.94%	-0.37%	1.96%	-0.01%	1.52%
Private Equity	0.70%	0.77%	0.07%	1.42%	0.02%	0.98%
Other	0.86%	1.17%	0.31%	2.48%	0.05%	1.64%

Table 5: Time-series and cross-sectional return variation

This table reports the time-series and cross-sectional summary statistics on a fund level, incorporating all assets. Panel A displays the summary statistics from the cross-sectional distribution of R-squared statistics obtained from performing the following regression for each pension fund over time:

$$R_{i,t} - PR_t = \alpha_i + b_i R_{i,t}^k + \varepsilon_{i,t}\ , \quad i = 1, \dots, n$$

where $R_{i,t}$ is the net return of pension fund *i* at time *t* and PR_t is the average of equally weighted policy return for year *t*. $R_{i,t}^k$ refers to asset allocation return component $R_{i,t}^{AA}$, the market timing component $R_{i,t}^{MT}$ and the security selection component $R_{i,t}^{SS}$. The three different return components are defined in section 3. Panel B reports the summary statistics from the time-series distribution of R-squared statistics from the 19 (1990–2008) cross-sectional regressions:

$$R_{i,t} - PR_t = \alpha_i + b_i R_{i,t}^k + \varepsilon_{i,t}\ , \quad t = 1, \dots, T$$

where $k = AA, MT, SS$. At least five data points per fund are required to run each time-series or cross-sectional regression. Hence, in the regressions on all funds we include 348 funds, of which 217 are U.S. funds and 131 Canadian funds. Appendix Table A.1 presents the results for other cutoff points – at least 4, 7 or 9 observations per fund.

	All Funds			U.S.			Canada		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Panel A: Time-series R-squared values									
Asset Allocation policy	59.63	66.30	28.60	41.78	38.51	29.76	33.76	31.20	28.22
Market Timing	17.82	9.45	21.06	18.35	9.73	21.78	17.62	9.31	22.34
Security Selection	33.59	28.60	25.95	54.69	56.36	28.06	58.20	65.62	28.63
Panel B: Cross-sectional R-squared values									
Asset Allocation policy	51.13	51.54	22.41	35.07	35.49	18.32	24.72	21.15	14.69
Market Timing	4.52	2.01	5.11	4.06	3.50	3.66	7.22	4.19	10.65
Security Selection	32.35	28.80	21.88	44.62	43.26	19.82	48.25	46.48	19.98

Table 6: Return components summary statistics

This table presents the asset allocation, market timing and security selection return components summary statistics. For every variable we run a random coefficient model only with a constant. In the Mean column the value of this constant is shown, while z-stat column presents the corresponding z-statistics. AA All Assets, MT All Assets and SS All Assets rows present the asset allocation, market timing and security selection returns on a fund level. We also report these three return components separately for equity (AA Equity, MT Equity and SS Equity) and fixed income investments (AA Fixed Income, MT Fixed Income and SS Fixed Income). For equity and fixed income assets the summary statistics for domestic investments are also included (SS Domestic Equity and SS Domestic Fixed Income). For private equity and real estate we present only the security selection returns (SS Private Equity and SS Real Estate). SS Hedge Funds summary statistics are based on shorter time period (2000-2008). The number of funds considered for these summary statistics corresponds to the number of funds included in the regressions in Tables 7 and 8.

	U.S. funds only		Canadian Funds only	
	Mean	z-stat	Mean	z-stat
AA All Assets	0.0839	(2.20)	0.0429	(1.20)
MT All Assets	0.2770	(7.55)	0.2640	(7.10)
SS All Assets	0.1913	(2.20)	0.2846	(2.76)
AA Equity	-0.0362	(-1.16)	-0.0564	(-1.18)
MT Equity	0.2209	(5.98)	0.1700	(4.92)
SS Equity	0.1856	(1.83)	0.4272	(2.70)
SS Domestic Equity	0.0184	(0.16)	0.6415	(2.97)
AA Fixed Income	0.0217	(0.87)	0.0028	(0.17)
MT Fixed Income	0.0211	(0.83)	-0.0098	(-0.58)
SS Fixed Income	0.0952	(1.16)	-0.1060	(-1.59)
SS Domestic Fixed Income	0.1343	(1.55)	-0.1092	(-1.48)
SS Private Equity	0.5715	(0.57)	-1.1263	(-0.65)
SS Real Estate	-0.3201	(-0.98)	0.3417	(0.70)
SS Hedge Funds (2000-2008)	-1.8248	(-1.85)	-2.2731	(-1.89)

Table 7: Risk-adjusted performance per return components in all asset classes on a fund level

This table reports the net risk-adjusted performance at the fund level for all assets using a random coefficients model. The following factors are included in the regressions: MKT, SMB and HML are the Fama-French factor returns, MOM – momentum factor, LIQ – Pastor and Stambaugh (2003) traded liquidity factor, FIMKT – fixed income excess market return. Dummy Y2000 is a dummy variable for year 2000 (Nortel effect). In Panel A the dependent variable is the return due to changes in asset allocation policy, which is calculated as the return due to changes in the strategic asset allocation weights in year *t* compared to year *t-1* multiplied with the benchmark return $R_{i,t}^{CAA} = \sum_{j=1}^{N}(w_{i,j,t}^{AA} - w_{i,j,t-1}^{AA}) r_{i,j,t}^{BM}$. In Panel B the dependent variable is the market timing component of fund returns $R_{i,t}^{MT} = \sum_{j=1}^{N}(w_{i,j,t} - w_{i,j,t}^{AA}) r_{i,j,t}^{BM}$, where $w_{i,j,t}^{AA}$ is the policy weight for fund *i* for asset class *j* and year *t*, $w_{i,j,t}$ is the actual realized weight for fund *i* for asset class *j* and year *t* and $r_{i,j,t}^{BM}$ is the benchmark return for fund *i* for the asset class *j* and period *t*. In Panel C we use the security selection component of fund returns as dependent variable $R_{i,t}^{SS} = \sum_{j=1}^{N} w_{i,j,t}(r_{i,j,t} - r_{i,j,t}^{BM})$, where $r_{i,j,t}$ is the realized net return on the asset class *j* for the year *t* by fund *i*. We report the annual alpha (Cons.) and betas with corresponding z-statistics in parentheses. RMSE is the root mean square error.

	# Funds # Obs.	Cons.	MKT	SMB	HML	MOM	FIMKT	LIQ	Dummy Y2000	RMSE
*Panel A: Changes in Asset Allocation return component: (Year t weights – Year t-1 weights) * Benchmark returns*										
All Funds	203	0.1662	-0.0078	0.0020	-0.0087		0.0096	-0.0028		12.0981
	2585	(2.72)	(-3.06)	(0.78)	(-3.55)		(1.04)	(-0.79)		
All Funds	203	0.2402	-0.0088	0.0007	-0.0106	-0.0026	0.0100	-0.0050		12.1071
	2585	(2.27)	(-2.45)	(0.27)	(-3.06)	(-0.77)	(1.16)	(-1.34)		
U.S.	120	0.2181	-0.0091	0.0045	-0.0103		0.0123	-0.0064		13.3716
	1492	(2.77)	(-2.41)	(1.11)	(-3.00)		(0.92)	(-1.51)		
U.S.	120	0.3468	-0.0120	0.0027	-0.0145	-0.0061	0.0150	-0.0083		13.3903
	1492	(2.20)	(-2.12)	(0.67)	(-2.68)	(-1.10)	(1.20)	(-1.75)		
Canada	83	0.0787	-0.0057	-0.0008	-0.0070		0.0090	0.0028		10.1814
	1093	(0.81)	(-1.93)	(-0.29)	(-2.08)		(0.76)	(0.46)		
Canada	83	0.0986	-0.0042	-0.0012	-0.0057	0.0015	0.0047	-0.0001		10.1773
	1093	(1.11)	(-1.34)	(-0.46)	(-1.75)	(0.55)	(0.41)	(-0.02)		
*Panel B: Market Timing return component: (Actual weights – Policy weights) * Benchmark returns*										
All Funds	256	0.2666	-0.0045	0.0059	-0.0047		0.0061	0.0010		12.0239
	3341	(5.68)	(-1.52)	(2.66)	(-1.92)		(0.87)	(0.21)		
All Funds	256	0.2747	-0.0044	0.0046	-0.0045	-0.0005	0.0052	0.0006		12.0321
	3341	(4.14)	(-1.33)	(2.05)	(-1.54)	(-0.18)	(0.64)	(0.13)		
U.S.	152	0.2867	-0.0051	0.0084	-0.0050		0.0132	-0.0013		13.2756
	1949	(5.08)	(-1.59)	(2.45)	(-1.80)		(1.47)	(-0.35)		
U.S.	152	0.3254	-0.0066	0.0061	-0.0058	-0.0046	0.0150	0.0001		13.2943
	1949	(3.22)	(-1.62)	(1.67)	(-1.65)	(-1.08)	(1.35)	(0.03)		
Canada	104	0.2357	-0.0032	0.0029	-0.0053		-0.0024	0.0046		10.0658
	1392	(2.88)	(-0.57)	(1.33)	(-1.18)		(-0.21)	(0.45)		
Canada	104	0.2343	-0.0011	0.0021	-0.0038	0.0036	-0.0078	0.0001		10.0595
	1392	(3.23)	(-0.19)	(1.12)	(-0.75)	(1.30)	(-0.70)	(0.01)		
*Panel C: Security Selection return component: Actual weights * (Realized net return – Benchmark return)*										
All Funds	253	0.4461	0.0089	0.0121	0.0338		-0.0675	-0.0179		11.9592
	3276	(2.94)	(1.65)	(2.11)	(5.08)		(-3.70)	(-2.14)		
All Funds	253	-0.2711	0.0237	0.0382	0.0598	0.0581	-0.1202	-0.0198		11.9115
	3276	(-1.35)	(3.42)	(4.98)	(8.22)	(5.22)	(-5.66)	(-1.92)		
All Funds	223	-0.0549	0.0081	0.0190	0.0121		-0.0380	0.0091	2.9992	12.0064
	3036	(-0.48)	(1.83)	(3.59)	(2.14)		(-2.48)	(1.38)	(9.06)	
All Funds	223	-0.6249	0.0225	0.0374	0.0403	0.0516	-0.0867	-0.0026	2.5755	11.9470
	3036	(-4.02)	(4.17)	(6.20)	(5.89)	(6.77)	(-5.34)	(-0.37)	(7.89)	
U.S.	152	0.2837	0.0085	0.0303	0.0219		-0.0819	-0.0086		13.1562
	1937	(1.70)	(1.18)	(3.43)	(2.71)		(-3.46)	(-1.01)		
U.S.	152	-1.0677	0.0369	0.0768	0.0653	0.1056	-0.1643	-0.0153		13.1211
	1937	(-4.45)	(3.71)	(6.79)	(6.84)	(6.29)	(-5.74)	(-1.16)		
Canada	101	0.8327	0.0077	-0.0120	0.0532		-0.0609	-0.0359		10.2089
	1339	(2.98)	(0.94)	(-2.66)	(4.87)		(-2.10)	(-2.21)		
Canada	101	0.8939	0.0053	-0.0128	0.0554	-0.0053	-0.0617	-0.0293		10.2672
	1339	(2.94)	(0.64)	(-2.58)	(4.90)	(-0.71)	(-2.01)	(-1.75)		
Canada	88	-0.0441	0.0004	-0.0008	0.0338		-0.0024	0.0108	3.2943	10.2724
	1235	(-0.23)	(0.05)	(-0.19)	(4.16)		(-0.11)	(0.88)	(6.71)	
Canada	88	-0.2103	0.0055	-0.0010	0.0397	0.0205	-0.0283	-0.0037	3.8044	10.2994
	1235	(-0.97)	(0.77)	(-0.22)	(4.72)	(2.66)	(-1.26)	(-0.29)	(7.46)	

Table 8: Risk adjusted returns per asset class

This table reports the net risk-adjusted performance at the asset class level using a random coefficients model. The asset allocation (AA), market timing (MT) and security selection (SS) return components within Equity are risk-adjusted using the following factors: MKT, SMB and HML – the Fama-French factor returns, LIQ – Pastor and Stambaugh (2003) traded liquidity factor and year dummy 2000 for all funds and Canadian funds (Panels A, B, E and F). In Panels B, D and F we also add MOM – momentum factor to the model. Domestic equity SS column displays the security selection returns (benchmark adjusted net returns) of U.S. Funds mandates in U.S. equity and Canadian Funds mandates in Canadian equity. Within fixed income asset allocation (AA-FI), market timing (MT-FI) and security selection (SS-FI) return components are risk-adjusted using the following factors: FIMKT – fixed income excess return, HY – high yield spread, OPTION – option-like characteristics of mortgage securities returns and MKT – equity excess return. Domestic fixed income SS-DFI column displays the security selection (benchmark adjusted net returns) for U.S. Funds mandates in U.S. fixed income and Canadian Funds mandates in Canadian fixed income. Private equity security selection returns (benchmark-adjusted returns) are regressed on excess returns of NASDAQ index and SMB, HML and LIQ factors. Real Estate security selection returns (benchmark-adjusted returns) are regressed on MKT, SMB, HML and LIQ factors. In panels B, D, and F we also add MOM – momentum factor to the private equity and real estate regressions. The table shows the alpha, its corresponding z-statistic and the root mean square error (RMSE) from all regressions.
AA: (Policy weight year t – Policy weight year t-1) * Benchmark returns
MT: (Actual weights – Policy weights) * Benchmark returns
SS: Actual weights * (Realized net return – Benchmark return)

	Equity			Domestic Equity	Fixed Income			Domestic Fixed Inc.	Private Equity	Real Estate
	AA-E	MT-E	SS-E	SS-DE	AA-FI	MT-FI	SS-FI	SS-DFI	SS-PE	SS-RE
Panel A: All Funds without adjusting for momentum										
# Funds	230	256	252	249	261	232	318	298	122	186
# Obs.	2765	3287	3225	3188	2960	2814	3662	3346	1396	2165
Alpha	-0.0350	0.1435	-0.0351	0.1212	0.0167	-0.0030	-0.0296	0.0063	4.4332	-0.8219
	(-0.70)	(3.72)	(-0.27)	(0.78)	(0.59)	(-0.11)	(-0.35)	(0.07)	(3.07)	(-2.07)
RMSE	12.1816	11.9577	12.3004	12.6749	12.0843	12.3910	11.7636	11.6572	16.3668	11.7609
Panel B: All Funds with adjusting for momentum										
# Funds	230	256	252	249					122	186
# Obs.	2765	3287	3225	3188					1396	2165
Alpha	-0.0278	0.2139	-0.8027	-0.2522					1.2005	-0.9999
	(-0.20)	(3.79)	(-4.52)	(-1.25)					(0.55)	(-1.92)
RMSE	12.1982	11.9629	12.2779	12.6499					16.6544	11.7929
Panel C: U.S. without adjusting for momentum										
# Funds	138	176	176	175	157	160	200	186	93	123
# Obs.	1609	2095	2078	2060	1732	1861	2231	2069	1067	1418
Alpha	-0.0692	0.1328	0.3839	0.1193	0.0368	0.0045	-0.0248	0.0258	4.7015	-0.7838
	(-1.22)	(3.05)	(1.93)	(0.48)	(0.92)	(0.12)	(-0.24)	(0.25)	(2.77)	(-1.67)
RMSE	13.3890	13.1782	13.6732	13.7768	13.2500	13.3155	12.5052	12.2935	16.3342	(12.5887)
Panel D: U.S. with adjusting for momentum										
# Funds	138	176	176	175					93	123
# Obs.	1609	2095	2078	2060					1067	1418
Alpha	-0.0695	0.2278	-0.7208	-0.5358					0.3555	-1.1112
	(-0.32)	(3.27)	(-2.70)	(-1.91)					(0.18)	(-1.62)
RMSE	13.4234	13.2064	13.5800	13.7611					17.0062	12.7525
Panel E: Canada without adjusting for momentum										
# Funds	92	104	104	99	104	72	118	112	29	63
# Obs.	1156	1360	1343	1303	1228	953	1431	1277	329	747
Alpha	0.0286	0.1076	0.0146	1.0421	-0.0127	-0.0184	-0.0776	-0.0680	3.0452	-1.1128
	(0.31)	(1.77)	(0.06)	(3.52)	(-0.32)	(-0.72)	(-0.53)	(-0.42)	(1.10)	(-1.50)
RMSE	10.2902	10.0612	10.4133	11.3180	10.1723	10.2641	10.2490	10.2432	16.9253	9.7527
Panel F: Canada with adjusting for momentum										
# Funds	92	104	104	99					29	63
# Obs.	1156	1360	1343	1303					329	747
Alpha	0.0387	0.1817	-0.5360	0.8997					2.1098	-0.9872
	(0.31)	(1.89)	(-2.07)	(2.68)					(0.31)	(-1.25)
RMSE	10.2933	10.0654	10.4291	11.3896					17.3202	9.6920

Table 9: Pension fund characteristics and total asset allocation (AA) returns

In the first step we regress the total asset allocation returns on a five factor model that includes the MKT, SMB, HML, LIQ and FIMKT. In Panels B and D we also add the momentum factor to the five factor model. We run these regressions for every fund that has at least 8 observations, which results in 203 Funds (2585 observations) in All funds models, 120 U.S. Funds (1492 observations) and 83 Canadian funds (1093 observations). In the second step we augment the alphas retrieved from the first step with the error terms of the first step and run Fama-MacBeth regressions and correct for autocorrelation and heteroskedasticity (using Newey-West with three lags). We include the following characteristics: LogSize – log of average pension fund holdings in a given year, %Act – percentage of all holdings invested in active mandates, %Ext – percentage of all holdings invested in external mandates and Costs – total fund costs. SizeLiq is an interaction term of the log fund size with the first step fund-specific loading on the liquidity factor. In parentheses we report the t-statistics for every coefficient.

	Model 1	**Model 2**		**Model 3**			**Model 4**		**Model 5**				**Model 6**		
	Cons	Cons	LogSize	Cons	LogSize	SizeLiq	Cons	Costs	Cons	LogSize	SizeLiq	Costs	Cons	%Act	%Ext
Panel A: without adjusting for momentum in the first step															
All Funds	0.1761	-0.3986	0.0704	0.1445	-0.0022	-1.6760	0.1026	0.2219	0.0503	0.0023	-1.6745	0.1849	0.4762	-0.4263	0.0634
	(7.27)	(-3.16)	(4.75)	(2.15)	(-0.37)	(-18.04)	(2.57)	(1.20)	(0.78)	(0.51)	(-18.53)	(1.02)	(5.86)	(-7.28)	(0.65)
U.S.	0.2461	-0.4773	0.0834	0.1693	-0.0049	-1.6679	0.1924	0.1406	-0.0919	0.0122	-1.6818	0.3204	0.2363	0.0895	-0.0593
	(6.53)	(-1.94)	(3.00)	(0.92)	(-0.27)	(-13.68)	(4.34)	(0.63)	(-0.80)	(1.06)	(-14.69)	(1.72)	(2.74)	(0.67)	(-0.37)
Can	0.0807	-0.0392	0.0168	0.1440	-0.0022	-1.5619	0.0552	0.1050	0.0499	0.0086	-1.5904	0.1362	0.9857	-1.0882	0.0122
	(2.29)	(-0.38)	(1.16)	(2.10)	(-0.24)	(-18.46)	(0.99)	(0.47)	(0.35)	(0.59)	(-20.76)	(0.48)	(6.28)	(-6.84)	(0.13)
Panel B: with adjusting for momentum in the first step															
All Funds	0.2699	0.0426	0.0273	0.6274	-0.0587	-2.0494	0.1490	0.3980	0.5532	-0.0548	-2.0515	0.1514	0.6433	-0.6950	0.2278
	(11.37)	(0.33)	(1.81)	(4.30)	(-3.13)	(-7.45)	(3.26)	(3.23)	(2.20)	(-2.20)	(-7.40)	(0.67)	(7.36)	(-7.84)	(5.81)
U.S.	0.4112	0.6751	-0.0323	1.3945	-0.1490	-2.9698	0.3724	0.0807	1.6763	-0.1699	-2.9912	-0.3859	0.4732	-0.3227	0.2179
	(10.56)	(1.91)	(-0.84)	(4.32)	(-3.73)	(-9.52)	(4.49)	(0.39)	(3.05)	(-3.10)	(-9.89)	(-1.09)	(3.89)	(-2.09)	(3.08)
Can	0.0766	0.0878	-0.0012	0.1466	-0.0098	-0.3621	-0.0022	0.3654	-0.0233	0.0052	-0.3808	0.3220	1.0052	-1.1353	0.0319
	(2.31)	(0.93)	(-0.10)	(1.40)	(-0.72)	(-2.16)	(-0.05)	(1.55)	(-0.18)	(0.35)	(-2.33)	(1.49)	(5.80)	(-6.29)	(0.42)

Table 10: Pension fund characteristics and total market timing (MT) returns

In the first step we regress the total market timing returns on a five factor model that includes the MKT, SMB, HML, LIQ and FIMKT. In Panels B and D we also add the momentum factor to the five factor model. We run these regressions for every fund that has at least 8 observations, which results in 256 Funds (3297 observations) in All funds models, 152 U.S. Funds (1937 observations) and 104 Canadian funds (1360 observations). In the second step we augment the alphas retrieved from the first step with the error terms of the first step and run Fama-MacBeth regressions and correct for autocorrelation and heteroskedasticity (using Newey-West with three lags). We include the following characteristics: LogSize – log of average pension fund holdings in a given year, %Act – percentage of all holdings invested in active mandates, %Ext – percentage of all holdings invested in external mandates and Costs – total fund costs. SizeLiq is an interaction term of the log fund size with the first step fund-specific loading on the liquidity factor. In parentheses we report the t-statistics for every coefficient.

	Model 1	**Model 2**		**Model 3**			**Model 4**		**Model 5**				**Model 6**		
	Cons	Cons	LogSize	Cons	LogSize	SizeLiq	Cons	Costs	Cons	LogSize	SizeLiq	Costs	Cons	%Act	%Ext
Panel A: without adjusting for momentum in the first step															
All Funds	0.2757	0.3300	-0.0072	0.4403	-0.0193	-1.2403	0.1691	0.3731	0.3488	-0.0141	-1.2555	0.1774	0.1932	0.1094	-0.0025
	(5.67)	(5.18)	(-0.77)	(6.43)	(-2.12)	(-11.74)	(2.67)	(3.52)	(3.26)	(-1.75)	(-12.08)	(1.04)	(1.80)	(0.95)	(-0.03)
U.S.	0.3030	0.7421	-0.0532	0.6380	-0.0423	-1.3776	0.0766	0.7193	0.4030	-0.0255	-1.3658	0.3009	-0.0260	0.2240	0.1901
	(5.04)	(5.19)	(-3.00)	(4.65)	(-2.62)	(-10.35)	(1.19)	(5.11)	(4.59)	(-2.32)	(-10.16)	(1.97)	(-0.37)	(2.96)	(2.11)
Can	0.2534	0.1262	0.0177	0.2354	0.0083	-1.5065	0.3769	-0.5356	0.6362	-0.0284	-1.5447	-0.7229	0.3331	0.1017	-0.1963
	(5.20)	(1.23)	(1.79)	(2.14)	(0.68)	(-14.73)	(3.04)	(-1.56)	(1.26)	(-0.62)	(-16.78)	(-1.01)	(2.07)	(0.61)	(-2.82)
Panel B: with adjusting for momentum in the first step															
All Funds	0.3051	0.2789	0.0030	0.2126	0.0110	-1.3778	0.2107	0.3580	-0.0607	0.0289	-1.3897	0.5230	0.4578	-0.0817	-0.0940
	(6.22)	(3.11)	(0.33)	(2.02)	(1.13)	(-7.20)	(5.53)	(2.82)	(-1.03)	(4.53)	(-7.27)	(3.00)	(4.13)	(-0.67)	(-0.93)
U.S.	0.3500	0.4177	-0.0091	0.4126	-0.0012	-2.0574	0.1798	0.5493	0.0712	0.0266	-2.0510	0.4056	0.4957	-0.0473	-0.1193
	(4.92)	(1.87)	(-0.45)	(1.52)	(-0.05)	(-8.06)	(3.08)	(3.27)	(0.56)	(1.84)	(-7.72)	(1.67)	(3.96)	(-0.33)	(-1.16)
Can	0.2268	0.5345	-0.0422	0.7466	-0.0782	-1.2438	0.2983	-0.2907	1.0401	-0.1114	-1.3149	-0.3923	0.2260	0.1414	-0.1380
	(4.91)	(3.40)	(-2.17)	(5.27)	(-4.52)	(-14.86)	(2.74)	(-1.16)	(1.93)	(-2.10)	(-12.53)	(-0.57)	(1.75)	(1.37)	(-1.14)

Table 11: Pension fund characteristics and security selection (SS) returns

In the first step we regress the total security selection returns on a five factor model that includes the MKT, SMB, HML, LIQ and FIMKT. In Panels B and D we also add the momentum factor to the five factor model. The regressions for all funds and Canada contain also year dummy 2000. We run these regressions for every fund that has at least 8 observations (9 observations if we include year dummy 2000 in the first step), which results in 224 Funds (3044 observations) in All funds models, 152 U.S. Funds (1937 observations) and 88 Canadian funds (1235 observations). In the second step we augment the alphas retrieved from the first step with the error terms of the first step and run Fama-MacBeth regressions and correct for autocorrelation and heteroskedasticity (using Newey-West with three lags). We include the following characteristics: LogSize – log of average pension fund holdings in a given year, %Act – percentage of all holdings invested in active mandates, %Ext – percentage invested in external mandates and Costs – total fund costs. SizeLiq is an interaction term of the log fund size with the first step fund-specific loading on the liquidity factor. In parentheses we report the t-statistics for every coefficient.

	Model 1	**Model 2**		**Model 3**			**Model 4**		**Model 5**				**Model 6**		
	Cons	Cons	LogSize	Cons	LogSize	SizeLiq	Cons	Costs	Cons	LogSize	SizeLiq	Costs	Cons	%Act	%Ext
Panel A: without adjusting for momentum in the first step															
All Funds	0.0446	-0.4409	0.0619	-0.4692	0.0780	-1.3154	-0.0549	0.3720	-0.4216	0.0722	-1.3159	-0.0365	0.5325	-0.2068	-0.3753
	(0.37)	(-2.27)	(2.72)	(-2.54)	(3.59)	(-11.90)	(-0.55)	(2.11)	(-1.73)	(2.80)	(-11.11)	(-0.16)	(2.91)	(-0.74)	(-2.65)
U.S.	0.4897	0.5503	-0.0075	0.1931	0.0150	-1.5839	0.2362	0.8779	-0.1352	0.0351	-1.5357	0.4853	0.2124	0.0493	0.3085
	(2.17)	(2.26)	(-0.54)	(1.37)	(0.79)	(-7.13)	(1.75)	(1.43)	(-0.24)	(0.67)	(-6.57)	(0.75)	(0.94)	(0.14)	(0.91)
Can	-0.0806	-0.5814	0.0694	-0.7227	0.1119	-1.1716	-0.0154	-0.2387	-0.3578	0.0940	-1.2051	-0.8926	1.0618	-0.5560	-0.8258
	(-0.69)	(-3.08)	(4.66)	(-4.85)	(6.99)	(-19.65)	(-0.16)	(-0.38)	(-0.78)	(1.94)	(-20.13)	(-0.93)	(6.77)	(-3.72)	(-4.56)
Panel B: with adjusting for momentum in the first step															
All Funds	-0.6290	-0.3396	-0.0359	-0.2648	-0.0429	-0.7724	-0.3862	-0.8768	0.5026	-0.0929	-0.8389	-1.4371	0.0092	0.0055	-0.7727
	(-8.01)	(-1.55)	(-1.54)	(-1.05)	(-1.69)	(-4.31)	(-5.80)	(-3.32)	(1.87)	(-3.39)	(-4.98)	(-3.07)	(0.03)	(0.02)	(-4.44)
U.S.	-0.9907	-2.8922	0.2266	-2.5915	0.1841	-0.6865	-0.4687	-1.5846	-1.4949	0.1009	-0.6787	-1.2332	0.1265	-0.4975	-0.8184
	(-6.67)	(-8.47)	(7.03)	(-5.70)	(3.86)	(-2.38)	(-3.52)	(-3.97)	(-2.51)	(1.95)	(-2.30)	(-2.45)	(0.33)	(-1.68)	(-3.09)
Can	-0.3191	-0.5704	0.0319	-0.5519	0.0332	-0.6600	-0.3954	0.5661	-0.9398	0.0852	-0.7190	0.5725	0.5566	-0.3273	-0.7064
	(-3.68)	(-1.63)	(0.72)	(-1.66)	(0.78)	(-9.79)	(-1.83)	(0.42)	(-0.98)	(1.00)	(-5.84)	(0.25)	(2.52)	(-1.56)	(-2.36)

Table 12: Equity – pension fund characteristics and performance

In the first step we regress the equity security selection (SS) (net benchmark-adjusted returns) or market timing (MT) return component on a four factor model that includes the MKT, SMB, HML and LIQ. We run these regressions for every fund that has at least 7 observations. For Canadian funds we also add year dummy 2000 to the factor model and run regressions for every fund with at least 8 observation in that case. In Panel B we also add MOM – momentum factor to the model. In the second step we augment the alphas retrieved from the first step with the error terms of the first step and run Fama-MacBeth regressions and correct for autocorrelation and heteroskedasticity (using Newey-West with three lags). The following characteristics are included in the Fama-MacBeth regressions: LogMand – log of the total equity holdings, Costs – costs for investing in equity, %ActE – percentage in active mandates and %ExtE – percentage in external mandates from the equity holdings. For U.S. Small Cap %ActE and %ExtE are estimated based on assets in U.S. small cap equity. Mand_Liq is an interaction term of the log mandate size with the first step fund-specific loading on the liquidity factor. The first column # Funds and # Obs. present the number of funds and the number of observations included in the analysis. In parentheses we report the t-statistics for every coefficient.

	# Funds	**Model 1**	**Model 2**		**Model 3**			**Model 4**		**Model 5**		
	# Obs.	Cons.	Cons.	LogMand	Cons	LogMand	Mand_Liq	Cons	Costs	Cons	%ActE	%ExtE
Panel A: without adjusting for momentum in the first step												
U.S. Equity SS	176	0.5654	2.4441	-0.2371	0.0817	0.0133	-1.7477	0.5699	0.1340	-0.7303	2.2447	-0.3921
	2078	(2.35)	(4.93)	(-5.63)	(0.12)	(0.15)	(-9.99)	(1.30)	(0.09)	(-1.08)	(1.50)	(-0.65)
U.S. Equity MT	175	0.1915	0.2064	-0.0009	0.3743	-0.0228	-0.8289	0.2452	-0.1736	0.2423	0.1115	-0.1540
	2068	(3.07)	(0.92)	(-0.04)	(1.66)	(-1.01)	(-6.81)	(2.74)	(-0.91)	(4.47)	(0.96)	(-3.08)
U.S. Domestic Equity	175	0.4858	4.2150	-0.4812	1.8326	-0.2074	-1.5540	0.0453	1.7296	-0.4851	1.3535	0.0103
SS	2060	(2.07)	(2.90)	(-2.95)	(1.27)	(-1.30)	(-8.13)	(0.25)	(2.75)	(-1.92)	(2.37)	(0.04)
U.S. Domestic Equity	86	1.3725	5.7826	-0.5618	4.7260	-0.4694	-1.5829	0.3697	2.3301	-0.8160	0.8983	1.6867
Small Cap SS	857	(2.51)	(3.19)	(-3.11)	(2.53)	(-2.42)	(-7.28)	(0.66)	(2.67)	(-1.06)	(1.81)	(2.50)
Canada Equity SS	104	0.0071	0.5491	-0.0876	0.7146	-0.1111	-1.0443	0.3872	-1.3147	0.9023	-0.4663	-0.5470
	1343	(0.04)	(1.58)	(-2.16)	(2.10)	(-2.89)	(-9.13)	(2.04)	(-1.88)	(2.03)	(-1.37)	(-1.56)
Canada Equity MT	111	0.1218	0.3455	-0.0351	0.4060	-0.0408	-1.1187	0.1337	-0.0598	0.0605	0.0337	0.0432
	1392	(2.08)	(2.74)	(-2.87)	(3.66)	(-2.87)	(-3.45)	(4.36)	(-0.32)	(1.12)	(0.21)	(0.32)
Canada Domestic Equity	99	0.9736	1.7593	-0.1404	1.5886	-0.1026	-1.5368	1.1965	-0.8869	0.9888	0.2840	-0.2820
SS	1303	(4.93)	(4.07)	(-1.81)	(4.18)	(-1.78)	(-11.75)	(3.15)	(-0.58)	(1.79)	(1.58)	(-0.64)
Panel B: with adjusting for momentum in the first step												
U.S. Equity SS	176	-0.7573	-0.5634	-0.0230	-2.4983	0.1918	-1.6017	0.1148	-2.8050	-0.1141	1.5036	-2.0167
	2078	(-4.80)	(-1.01)	(-0.39)	(-1.76)	(1.07)	(-5.26)	(0.26)	(-1.92)	(-0.13)	(0.83)	(-2.62)
U.S. Equity MT	175	0.3063	0.4538	-0.0168	0.6680	-0.0444	-0.8693	0.3250	-0.0595	0.4704	0.0104	-0.1963
	2068	(5.12)	(1.13)	(-0.38)	(1.51)	(-0.89)	(-4.11)	(3.06)	(-0.28)	(4.95)	(0.08)	(-3.73)
U.S. Domestic Equity	175	-0.5537	0.8706	-0.1779	-0.0969	-0.0730	-1.3649	-0.0588	-1.8839	0.0830	0.9044	-1.5932
SS	2060	(-2.95)	(0.56)	(-1.00)	(-0.07)	(-0.50)	(-6.20)	(-0.30)	(-4.88)	(0.19)	(0.89)	(-3.92)
U.S. Domestic Equity	86	-0.6947	5.4173	-0.7898	4.2499	-0.7432	-2.5245	-1.0779	1.0083	-2.1444	0.3825	1.3608
Small Cap SS	857	(-1.36)	(2.42)	(-3.13)	(2.11)	(-3.34)	(-8.43)	(-1.83)	(1.09)	(-2.96)	(0.66)	(2.23)
Canada Equity SS	104	-0.6444	0.2164	-0.1365	0.3217	-0.1423	-1.2704	-0.4268	-0.5952	0.2755	-0.8217	-0.2271
	1343	(-4.17)	(0.65)	(-4.07)	(1.15)	(-10.86)	(-2.43)	(-1.76)	(-0.44)	(0.83)	(-2.21)	(-0.85)
Canada Equity MT	111	0.1896	0.5538	-0.0575	0.5494	-0.0574	0.0481	0.1325	0.2176	-0.0662	0.2897	0.0323
	1392	(4.71)	(5.17)	(-4.63)	(5.10)	(-4.92)	(0.41)	(3.82)	(1.88)	(-0.82)	(2.29)	(0.28)
Canada Domestic Equity	99	0.8132	1.8665	-0.1831	1.2671	-0.0167	-1.9786	0.8556	0.2598	0.5801	0.2739	0.0216
SS	1303	(4.10)	(7.29)	(-4.21)	(2.15)	(-0.14)	(-2.94)	(1.71)	(0.12)	(0.91)	(0.90)	(0.06)

Table 13: Fixed income – pension fund characteristics and performance

In the first step we regress the fixed income security selection (SS) (net benchmark-adjusted returns) or market timing (MT) return component on a four factor model that includes the FIMKT, MKT, OPTION and HY. We run these regressions for every fund that has at least 6 observations. In the second step we augment the alphas retrieved from the first step with the error terms of the first step and run Fama-MacBeth regressions and correct for autocorrelation and heteroskedasticity (using Newey-West with three lags). The following characteristics are included in the Fama-MacBeth regressions: LogMand – logarithm of the total fixed income holdings, Costs – costs for investing in Fixed Income, %ActFI – percentage in active mandates from the fixed income holdings and %ExtFI – percentage in external mandates from the fixed income holdings. The first column # Funds and # Obs. present the number of funds (cross-sectional units) and the number of observations included in the analysis. Panel A presents the results for U.S. funds only, while Panel B shows the results for Canadian funds. In parentheses we report the t-statistics for every coefficient. Market timing component within fixed income requires that the fund invests in at least two types of fixed income (for example: Canadian fixed income and EAFE fixed income). In that case there can be a difference in weights within the fixed income, which will lead to return component that is due to the difference from actual and strategic weights.

		Model 1	**Model 2**		**Model 3**		**Model 4**		
	# Funds # Obs.	Cons.	Cons.	LogMand	Cons	Costs	Cons	%ActFI	%ExtFI
Panel A: U.S.									
FI SS	200	0.0389	0.8504	-0.1168	-0.0856	0.7888	-0.1895	0.1169	0.1719
	2231	(0.33)	(1.95)	(-2.25)	(-0.66)	(1.78)	(-0.98)	(0.41)	(1.69)
FI MT	160	0.0299	-0.1094	0.0186	0.0270	0.0251	-0.0186	0.1262	-0.0721
	1861	(1.93)	(-1.49)	(1.75)	(0.85)	(0.23)	(-0.58)	(2.37)	(-2.27)
Domestic FI SS	186	-0.0350	0.2183	-0.0374	-0.1792	0.9794	0.1109	-0.0582	-0.1025
	2069	(-0.31)	(1.41)	(-1.51)	(-1.70)	(2.37)	(0.59)	(-0.22)	(-1.15)
Panel B: Canada									
FI SS	118	-0.0073	0.1310	-0.0203	-0.2122	1.7752	-0.2157	0.2031	0.0633
	1430	(-0.09)	(0.59)	(-0.60)	(-2.29)	(1.34)	(-0.95)	(0.88)	(0.46)
FI MT	72	-0.0149	0.0044	-0.0028	-0.0449	0.2404	-0.0082	-0.0387	0.0391
	953	(-1.59)	(0.09)	(-0.44)	(-1.94)	(1.09)	(-0.32)	(-1.24)	(1.80)
Domestic FI SS	112	0.0275	0.1366	-0.0159	-0.2358	2.4104	-0.1499	0.1864	0.0299
	1277	(0.33)	(0.55)	(-0.40)	(-1.75)	(1.56)	(-0.56)	(0.70)	(0.18)

Table 14: Private equity and real estate – pension fund characteristics and performance

In Panel A in the first step we regress the private equity security selection (SS) return component (net benchmark-adjusted returns) on a four factor model that includes the Nasdaq excess returns, SMB, HML and LIQ. In Panel C in the first step we regress the real estate security selection (SS) return component (net benchmark-adjusted returns) on a four factor model that includes the MKT, SMB, HML and LIQ. In Panels B and D we add the momentum factor to the risk-adjusting models. We run these regressions for every fund that has at least 7 observations. In the second step we augment the alphas retrieved from the first step with the error terms of the first step and run Fama-MacBeth regressions and correct for autocorrelation and heteroskedasticity (using Newey-West with three lags). The following characteristics are included in the Fama-MacBeth regressions: LogSize – logarithm of total fund holdings, LogMand – logarithm of the total private equity holdings in Panels A and B (real estate holdings in panels C and D) and Costs – costs for investing in private equity in Panels A and B (real estate in panels C and D). Mand_Liq is an interaction term of the log mandate size with the first step fund-specific loading on the liquidity factor. The first column # Funds and # Obs. present the number of funds (cross-sectional units) and the number of observations included in the analysis. In parentheses we report the t-statistics for every coefficient.

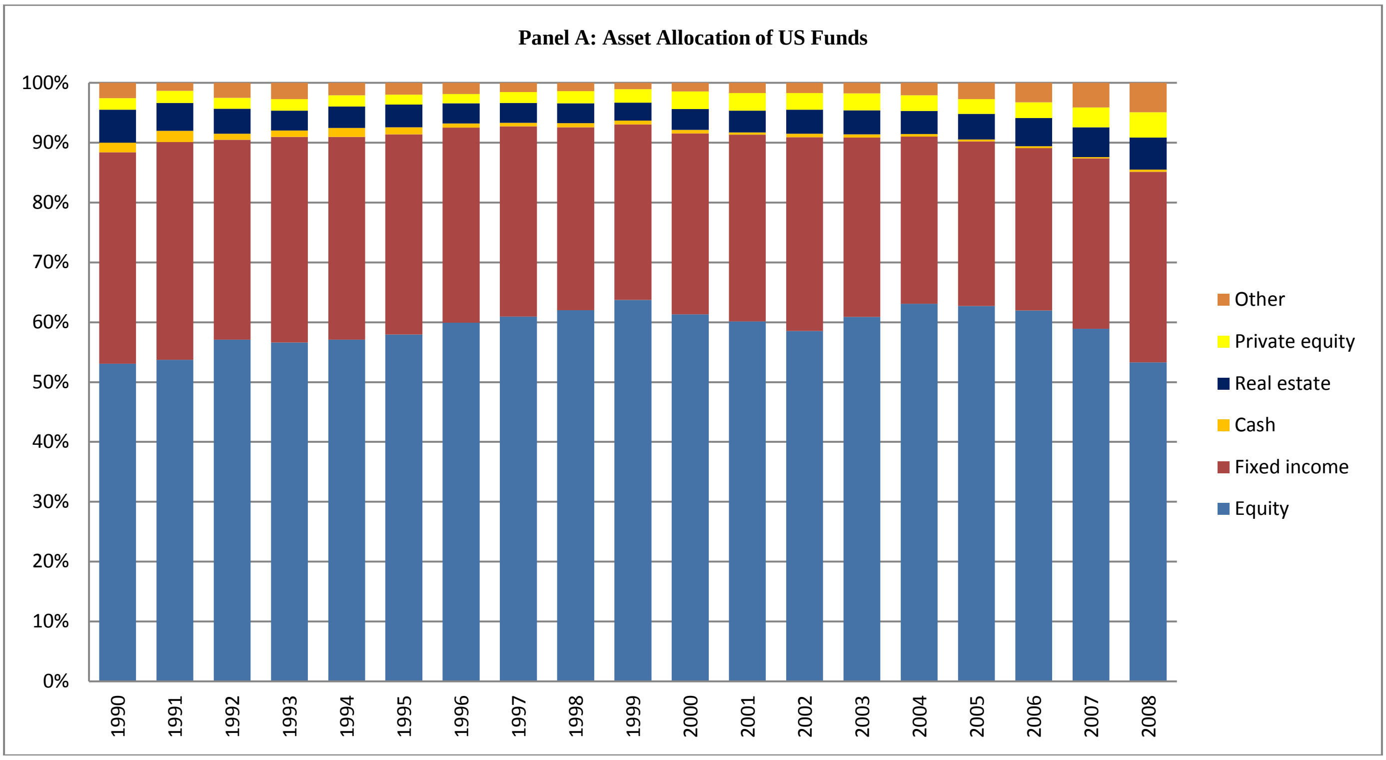
		Model 1	**Model 2**		**Model 3**		**Model 4**			**Model 5**		**Model 6**			
	# Funds / # Obs.	Cons	Cons	LogSize	Cons	LogMand	Cons	LogMand	Mand_Liq	Cons	Costs	Cons	LogMand	Costs	Mand_Liq
Panel A: Private Equity without adjusting for momentum in the first step															
All Funds	122	5.8101	5.0884	0.0611	3.5332	0.4725	2.3750	0.2183	-1.7564	9.0040	-1.4698	8.0795	-0.2012	-1.6384	-1.8337
	1396	(3.95)	(2.54)	(0.17)	(2.63)	(1.62)	(1.83)	(0.82)	(-3.99)	(6.79)	(-3.64)	(5.48)	(-0.76)	(-4.07)	(-4.37)
U.S.	93	6.1515	7.0347	-0.1109	6.5277	0.0280	4.1774	-0.2585	-1.9778	9.3953	-1.4858	11.1325	-0.8485	-1.6499	-2.0799
	1067	(3.08)	(5.90)	(-0.35)	(2.20)	(0.06)	(1.83)	(-0.60)	(-4.58)	(4.72)	(-4.50)	(3.52)	(-1.72)	(-3.90)	(-5.33)
Canada	29	4.2622	3.4799	0.0762	0.9543	0.7390	-0.4966	1.3415	-1.7133	6.8633	-0.7525	6.2493	0.5258	-1.7362	-1.8370
	329	(3.95)	(1.10)	(0.24)	(0.32)	(1.47)	(-0.15)	(2.15)	(-2.75)	(8.52)	(-1.11)	(1.38)	(0.52)	(-1.34)	(-3.26)
Panel B: Private Equity with adjusting for momentum in the first step															
All Funds	122	0.2651	-2.9278	0.3794	-5.2398	1.2232	-6.1797	1.1267	-0.9992	3.7754	-1.5634	-1.4167	0.8347	-1.3957	-1.0438
	1396	(0.23)	(-0.74)	(0.87)	(-2.06)	(2.70)	(-2.88)	(2.55)	(-4.42)	(2.05)	(-2.05)	(-0.36)	(1.49)	(-1.60)	(-5.99)
U.S.	93	-0.0922	-2.2576	0.2420	-5.3424	1.1284	-6.9459	1.1898	-0.4735	4.2204	-1.9956	0.2279	0.7200	-2.0881	-0.6507
	1067	(-0.06)	(-0.51)	(0.57)	(-1.26)	(1.72)	(-1.57)	(1.56)	(-1.12)	(2.89)	(-2.65)	(0.05)	(0.87)	(-2.01)	(-1.83)
Canada	29	0.7791	-16.6292	2.2014	-8.7594	2.6341	-11.2415	3.7131	-3.9379	1.7892	1.0724	-12.8786	3.9975	2.1789	-3.7712
	329	(0.58)	(-1.67)	(2.02)	(-1.96)	(2.84)	(-2.70)	(3.50)	(-3.45)	(0.42)	(0.56)	(-1.66)	(2.77)	(1.10)	(-3.44)
Panel C: Real Estate without adjusting for momentum in the first step															
All Funds	186	-0.4792	-3.3492	0.3466	-2.5550	0.4186	-2.9497	0.6177	-1.6864	-0.0520	-0.5438	-2.1954	0.5730	-0.6981	-1.7049
	2164	(-1.67)	(-4.71)	(3.40)	(-6.92)	(5.35)	`(-10.61)	(9.87)	(-9.07)	(-0.07)	(-0.90)	(-3.44)	(9.06)	(-1.22)	(-9.98)
U.S.	123	-0.5368	-1.6259	0.1092	-2.3244	0.3172	-0.5302	0.1989	-2.0259	-0.6678	0.2531	-0.5751	0.2382	-0.3218	-1.9584
	1417	(-2.13)	(-0.73)	(0.39)	(-3.36)	(2.32)	(-0.25)	(0.65)	(-4.45)	(-0.71)	(0.27)	(-0.50)	(1.10)	(-0.46)	(-4.96)
Canada	63	-0.3418	-5.3507	0.6814	-3.7462	0.8111	-4.1493	0.8752	0.5426	1.0701	-2.9169	-2.3892	0.8733	-2.1019	-1.8626
	747	(-0.74)	(-2.69)	(3.04)	(-4.42)	(5.15)	(-4.84)	(3.96)	(0.20)	(1.16)	(-3.22)	(-1.96)	(5.42)	(-2.14)	(-3.35)
Panel D: Real Estate with adjusting for momentum in the first step															
All Funds	186	-0.2247	-4.1452	0.4744	-2.0854	0.3842	-2.3570	0.5036	-1.0573	0.4718	-0.9234	-1.2741	0.4343	-0.9964	-1.0772
	2164	(-0.88)	(-4.75)	(3.63)	(-5.11)	(4.11)	(-5.30)	(5.13)	(-5.28)	(0.73)	(-1.42)	(-1.46)	(3.95)	(-1.43)	(-5.40)
U.S.	123	-0.2407	-3.3706	0.3458	-1.1593	0.1680	-0.1555	0.1267	-1.4852	0.0174	-0.2413	-0.7276	0.2293	-0.3387	-1.3347
	1417	(-1.10)	(-1.35)	(1.18)	(-3.32)	(1.98)	(-0.10)	(0.57)	(-4.81)	(0.02)	(-0.23)	(-0.67)	(1.90)	(-0.26)	(-6.43)
Canada	63	-0.1493	-4.6605	0.6202	-3.5700	0.8294	-3.9280	1.1430	-1.8786	1.4210	-3.1841	-1.9369	0.7664	-2.3011	-0.6796
	747	(-0.33)	(-2.56)	(2.84)	(-4.73)	(6.03)	(-4.80)	(4.76)	(-1.62)	(2.20)	(-4.03)	(-2.15)	(5.17)	(-2.62)	(-1.63)

Table 15: Persistence in pension fund performance

This table presents the marginal effects after an ordered logit model. The dependent variable is the quintile ranking based on returns in year *t+1* with 1 being lowest quintile ranking and 5 being the quintile with highest returns. The LY ranking independent variable is the quintile ranking in the previous year *t*. We also include the following variables: LogSize – log of average pension fund holdings in a given year, Costs – total fund costs, %Act – percentage of all holdings invested in active mandates and %Ext – percentage invested in external mandates. The marginal effects are estimated at the median values. In the ordered logit model we also add year dummy variables and cluster the standard errors by funds. Panel A presents the marginal effects for U.S. funds market timing returns, Panel B – U.S. funds security selection returns, Panel C – Canadian funds market timing returns and Panel D – Canadian funds security selection returns. The marginal effects are presented with their corresponding z-statistic in the parentheses.

Ranking	**Model 1**	**Model 2**		**Model 3**		**Model 4**		
	LY ranking	LY ranking	Logsize	LY ranking	Costs	LY ranking	%Act	%Ext
Panel A: U.S. Funds Market Timing Returns								
1	-0.0383	-0.0376	0.0073	-0.0373	-0.0909	-0.0364	-0.0048	-0.0538
	(-3.87)	(-3.86)	(1.22)	(-3.80)	(-2.31)	(-3.65)	(-0.14)	(-1.87)
2	-0.0099	-0.0100	0.0020	-0.0102	-0.0248	-0.0112	-0.0015	-0.0166
	(-1.37)	(-1.43)	(0.96)	(-1.47)	(-1.22)	(-1.69)	(-0.14)	(-1.13)
3	0.0077	0.0074	-0.0014	0.0073	0.0177	0.0063	0.0008	0.0094
	(1.15)	(1.11)	(-0.83)	(1.08)	(1.05)	(0.90)	(0.14)	(0.91)
4	0.0185	0.0183	-0.0036	0.0183	0.0445	0.0182	0.0024	0.0269
	(5.92)	(5.87)	(-1.26)	(5.78)	(2.45)	(5.59)	(0.14)	(1.88)
5	0.0219	0.0219	-0.0043	0.0220	0.0535	0.0230	0.0030	0.0340
	(3.15)	(3.16)	(-1.20)	(3.18)	(1.93)	(3.22)	(0.14)	(1.49)
Panel B: U.S. Funds Security Selection Returns								
1	-0.0218	-0.0204	-0.0236	-0.0193	0.0324	-0.0196	0.0456	0.0790
	(-2.96)	(-2.86)	(-3.03)	(-3.10)	(0.79)	(-3.05)	(1.33)	(2.46)
2	-0.0071	-0.0061	-0.0070	-0.0090	0.0152	-0.0078	0.0181	0.0314
	(-1.48)	(-1.30)	(-1.39)	(-3.19)	(0.81)	(-2.70)	(1.35)	(2.33)
3	0.0034	0.0038	0.0044	0.0009	-0.0015	0.0022	-0.0051	-0.0088
	(0.72)	(0.88)	(0.86)	(0.29)	(-0.27)	(0.74)	(-0.64)	(-0.72)
4	0.0110	0.0102	0.0118	0.0105	-0.0176	0.0104	-0.0242	-0.0419
	(3.71)	(3.47)	(4.16)	(3.33)	(-0.80)	(3.38)	(-1.37)	(-2.60)
5	0.0144	0.0125	0.0145	0.0169	-0.0285	0.0148	-0.0345	-0.0597
	(2.30)	(2.19)	(2.54)	(3.34)	(-0.82)	(3.09)	(-1.39)	(-2.61)
Panel C: Canadian Funds Market Timing Returns								
1	-0.0243	-0.0200	0.0051	-0.0231	-0.1316	-0.0191	-0.0552	-0.0209
	(-3.70)	(-3.46)	(1.07)	(-3.49)	(-1.55)	(-3.33)	(-1.75)	(-1.07)
2	-0.0099	-0.0116	0.0030	-0.0097	-0.0551	-0.0118	-0.0340	-0.0129
	(-2.79)	(-3.34)	(1.07)	(-2.74)	(-1.42)	(-3.49)	(-1.70)	(-0.99)
3	0.0017	-0.0023	0.0006	0.0015	0.0084	-0.0031	-0.0088	-0.0033
	(0.56)	(-0.56)	(0.52)	(0.49)	(0.47)	(-0.75)	(-0.70)	(-0.56)
4	0.0124	0.0102	-0.0026	0.0119	0.0677	0.0096	0.0278	0.0105
	(3.88)	(3.01)	(-1.02)	(3.67)	(1.53)	(2.68)	(1.60)	(1.05)
5	0.0200	0.0237	-0.0061	0.0194	0.1105	0.0243	0.0703	0.0266
	(3.23)	(3.03)	(-1.08)	(3.07)	(1.50)	(3.09)	(1.67)	(0.98)
Panel D: Canadian Funds Security Selection Returns								
1	-0.0398	-0.0374	-0.0132	-0.0429	0.0341	-0.0399	-0.0187	0.0896
	(-5.29)	(-5.00)	(-2.36)	(-4.12)	(0.32)	(-5.35)	(-0.42)	(2.72)
2	-0.0181	-0.0182	-0.0064	-0.0160	0.0127	-0.0157	-0.0073	0.0352
	(-4.29)	(-4.61)	(-2.15)	(-2.18)	(0.33)	(-3.58)	(-0.42)	(2.53)
3	0.0013	0.0002	0.0001	0.0046	-0.0037	0.0038	0.0018	-0.0085
	(0.25)	(0.05)	(0.05)	(0.50)	(-0.27)	(0.77)	(0.37)	(-0.75)
4	0.0210	0.0199	0.0070	0.0220	-0.0174	0.0208	0.0097	-0.0467
	(4.97)	(4.56)	(2.34)	(5.21)	(-0.32)	(5.37)	(0.42)	(-2.84)
5	0.0356	0.0355	0.0125	0.0323	-0.0256	0.0310	0.0145	-0.0696
	(5.09)	(5.18)	(2.10)	(3.14)	(-0.33)	(4.90)	(0.42)	(-2.70)

Figure 1: Asset allocation of U.S. and Canadian funds



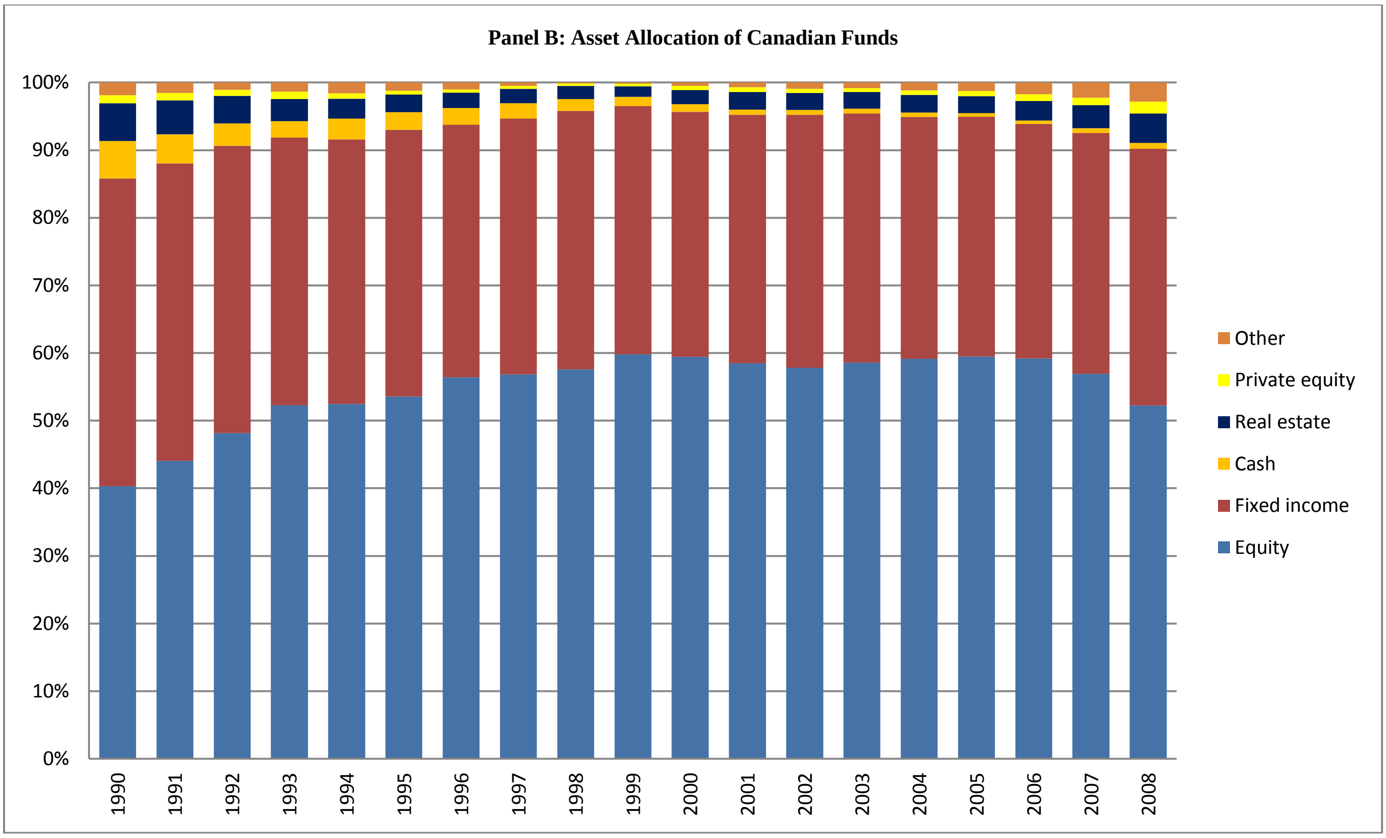


Figure 2: Asset allocation of U.S. funds within equity, fixed income and alternatives

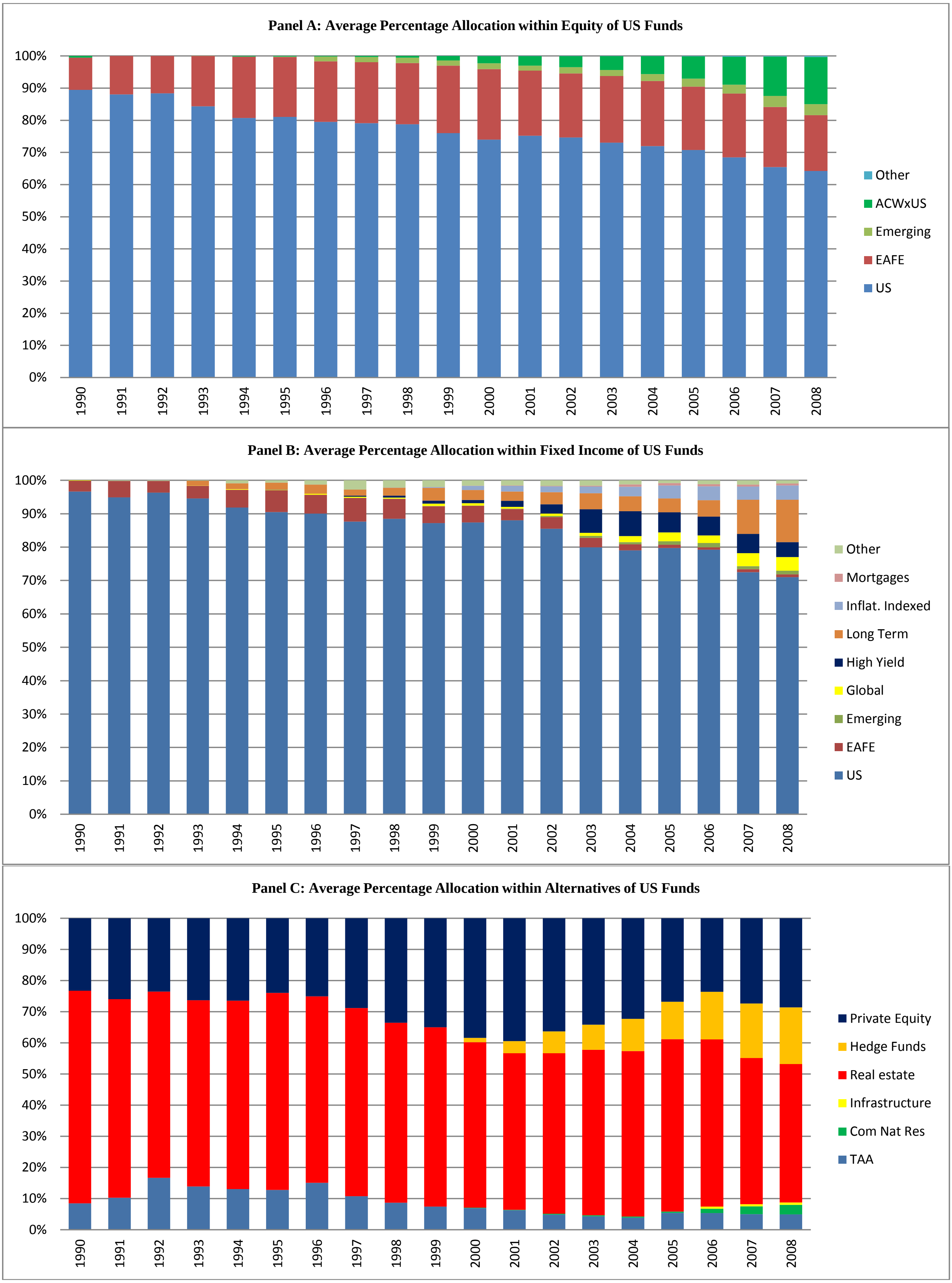
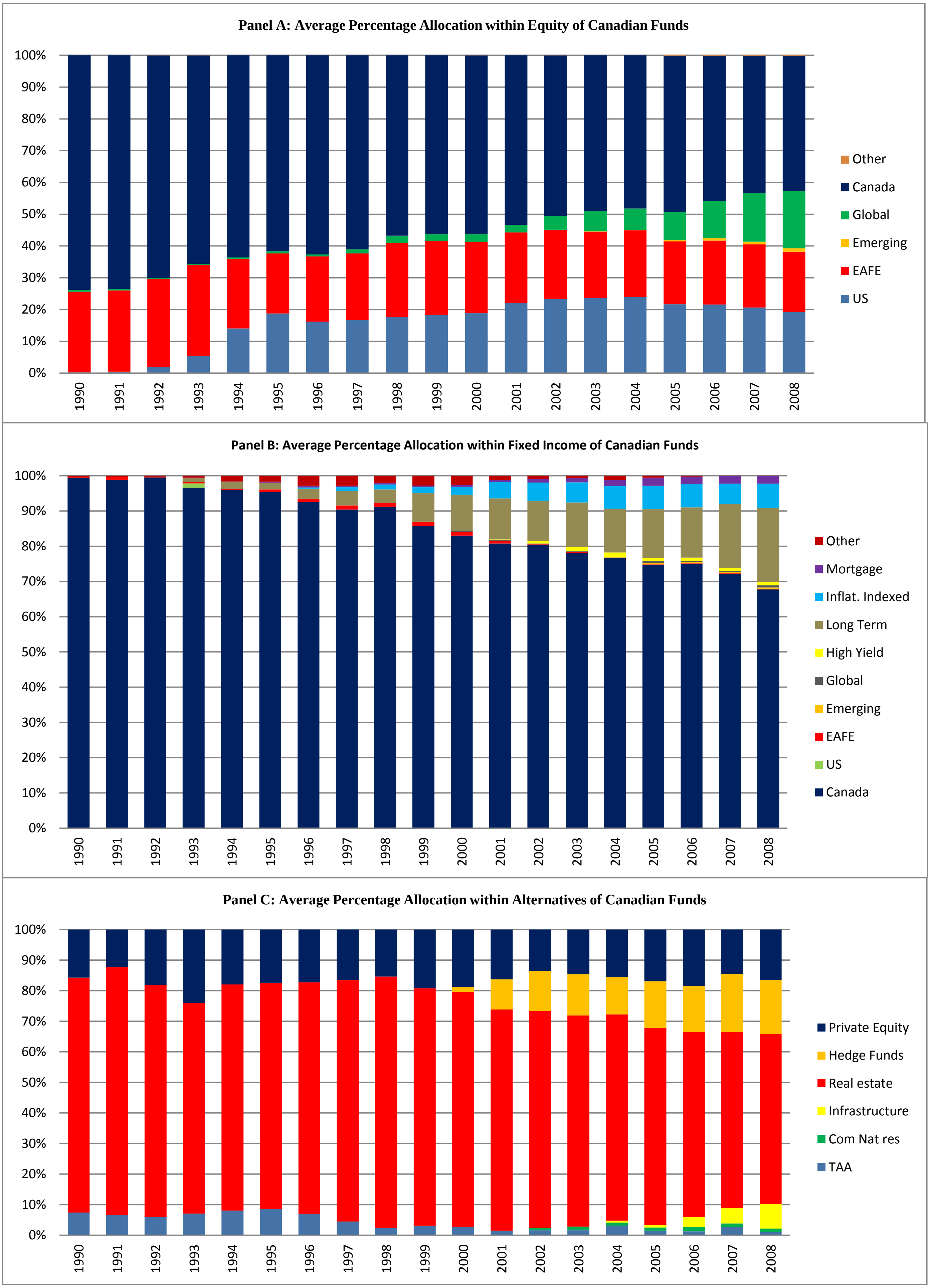


Figure 3: Asset allocation of Canadian funds within equity, fixed income and alternatives



Appendix Table A.1: Time-series and cross-sectional return variation (related to Table 5)

This table reports the time-series and cross-sectional summary statistics on a fund level, incorporating all assets. Panel A displays the summary statistics from the cross-sectional distribution of R-squared statistics obtained from performing the following regression for each pension fund over time:

$$R_{i,t} - PR_t = \alpha_i + b_i R_{i,t}^k + \varepsilon_{i,t}\ , \quad i = 1, \ldots, n$$

where $R_{i,t}$ is the net return of pension fund *i* at time *t* and PR_t is the average of equally weighted policy return for year *t*. $R_{i,t}^k$ refers to asset allocation return component $R_{i,t}^{AA}$, the market timing component $R_{i,t}^{MT}$ and the security selection component $R_{i,t}^{SS}$. The three different return components are defined in section 3. Panel B reports the summary statistics from the time-series distribution of R-squared statistics from the 19 (1990–2008) cross-sectional regressions:

$$R_{i,t} - PR_t = \alpha_i + b_i R_{i,t}^k + \varepsilon_{i,t}\ , \quad t = 1, \ldots, T$$

where $k = AA, MT, SS$. At least four, seven or nine data points per fund are required to run each time-series or cross-sectional regression. In table 5 we required at least five data points per fund.

Table 5 with at least 4 data points per fund:

	All Funds			U.S.			Canada		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Panel A: Time-series R-squared values									
Asset Allocation policy	60.04	67.02	28.94	42.23	39.49	30.19	35.29	31.71	28.85
Market Timing	21.25	10.37	24.77	21.57	11.42	24.30	20.14	10.37	24.84
Security Selection	34.18	28.88	26.61	55.34	57.44	28.89	59.39	66.64	29.11
Panel B: Cross-sectional R-squared values									
Asset Allocation policy	50.92	52.77	21.87	35.18	35.80	16.75	23.99	20.78	13.49
Market Timing	4.53	2.49	4.97	4.16	3.77	3.48	7.62	4.23	10.67
Security Selection	33.11	37.29	21.66	45.59	46.12	18.70	48.81	46.65	19.78

Table 5 with at least 7 data points per fund:

	All Funds			U.S.			Canada		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Panel A: Time-series R-squared values									
Asset Allocation policy	59.09	63.46	27.54	40.03	37.59	29.14	32.22	27.75	27.34
Market Timing	14.41	7.13	17.74	15.72	8.71	19.36	12.45	5.18	15.37
Security Selection	33.69	30.04	24.98	54.54	55.78	27.89	57.82	66.50	28.02
Panel B: Cross-sectional R-squared values									
Asset Allocation policy	52.13	57.15	22.72	36.11	32.88	18.98	24.74	28.12	13.57
Market Timing	4.31	2.09	5.07	4.10	3.53	4.09	7.54	4.28	10.23
Security Selection	32.23	31.95	21.84	44.44	45.67	19.76	47.70	46.77	18.45

Table 5 with at least 9 data points per fund:

	All Funds			U.S.			Canada		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Panel A: Time-series R-squared values									
Asset Allocation policy	59.27	61.14	26.25	40.43	37.85	29.39	30.56	27.93	26.65
Market Timing	11.69	5.83	15.13	12.12	7.41	14.55	10.69	5.11	13.30
Security Selection	32.58	28.60	23.66	51.33	53.70	27.01	59.17	66.64	26.64
Panel B: Cross-sectional R-squared values									
Asset Allocation policy	54.47	61.89	22.81	39.93	37.80	19.72	25.38	25.91	13.23
Market Timing	4.16	1.67	5.05	3.84	3.06	3.86	7.69	3.48	11.72
Security Selection	31.56	30.93	22.42	42.47	41.71	20.33	48.72	48.31	18.80

Appendix Table A.2: Risk-adjusted performance per return components in all asset classes on a fund level (related to Table 7)

Robustness check – every fund included in the regressions below has at least 13 observations.

This table reports the net risk-adjusted performance at the fund level for all assets using a random coefficients. The following factors are included in the regressions: MKT, SMB and HML are the Fama-French factor returns, MOM – momentum factor, LIQ – Pastor and Stambaugh (2003) traded liquidity factor, FIMKT – fixed income excess market return. Dummy Y2000 is a dummy variable for year 2000 (Nortel effect). In Panel A the dependent variable is the return due to changes in asset allocation policy, which is calculated as the return due to changes in the strategic asset allocation weights in year *t* compared to year *t-1* multiplied with the benchmark return $R_{i,t}^{CAA} = \sum_{j=1}^{N}(w_{i,j,t}^{AA} - w_{i,j,t-1}^{AA})r_{i,j,t}^{BM}$. In Panel B the dependent variable is the market timing component of fund returns $R_{i,t}^{MT} = \sum_{j=1}^{N}(w_{i,j,t} - w_{i,j,t}^{AA})r_{i,j,t}^{BM}$, where $w_{i,j,t}^{AA}$ is the policy weight for fund *i* for asset class *j* and year *t*, $w_{i,j,t}$ is the actual realized weight for fund *i* for asset class *j* and year *t* and $r_{i,j,t}^{BM}$ is the benchmark return for fund *i* for the asset class *j* and period *t*. In Panel C we use the security selection component of fund returns as dependent variable $R_{i,t}^{SS} = \sum_{j=1}^{N} w_{i,j,t}(r_{i,j,t} - r_{i,j,t}^{BM})$, where $r_{i,j,t}$ is the realized net return on the asset class *j* for the year *t* by fund *i*. We report the annual alpha (Cons.) and betas with corresponding z-statistics in parentheses. RMSE is the root mean square error.

	# Funds # Obs.	Cons.	MKT	SMB	HML	MOM	FIMKT	LIQ	Dummy Y2000	RMSE
*Panel A: Changes in Asset Allocation return component: (Year t weights – Year t-1 weights) * Benchmark returns*										
All Funds	107	0.1901	-0.0089	0.0025	-0.0085		0.0063	-0.0045		12.0859
	1630	(3.13)	(-3.44)	(1.04)	(-3.75)		(0.88)	(-1.19)		
All Funds	107	0.2047	-0.0084	0.0021	-0.0089	0.0003	0.0057	-0.0061		12.0819
	1630	(2.70)	(-2.83)	(0.82)	(-3.31)	(0.10)	(0.75)	(-1.46)		
U.S.	60	0.2814	-0.0102	0.0056	-0.0108		0.0063	-0.0112		13.4111
	896	(3.61)	(-2.88)	(1.45)	(-3.64)		(0.59)	(-2.51)		
U.S.	60	0.3306	-0.0106	0.0046	-0.0129	-0.0030	0.0088	-0.0116		13.4086
	896	(2.96)	(-2.47)	(1.11)	(-3.21)	(-0.65)	(0.78)	(-2.53)		
Canada	47	0.0709	-0.0082	-0.0001	-0.0081		0.0102	0.0044		10.3304
	734	(0.76)	(-2.13)	(-0.03)	(-2.28)		(1.07)	(0.73)		
Canada	47	0.0719	-0.0069	-0.0006	-0.0068	0.0022	0.0066	0.0013		10.3348
	734	(0.73)	(-1.70)	(-0.23)	(-1.93)	(0.72)	(0.66)	(0.18)		
*Panel B: Market Timing return component: (Actual weights – Policy weights) * Benchmark returns*										
All Funds	139	0.2515	-0.0028	0.0031	-0.0044		0.0084	0.0006		11.9486
	2196	(4.88)	(-1.18)	(1.28)	(-2.10)		(1.38)	(0.18)		
All Funds	139	0.2504	-0.0027	0.0025	-0.0041	0.0001	0.0089	0.0002		11.9543
	2196	(3.83)	(-1.05)	(0.95)	(-1.75)	(0.02)	(1.34)	(0.01)		
U.S.	81	0.2097	-0.0020	0.0060	-0.0052		0.0219	0.0020		13.1378
	1253	(3.19)	(-0.61)	(1.53)	(-1.79)		(2.78)	(0.50)		
U.S.	81	0.2291	-0.0027	0.0049	-0.0053	-0.0020	0.0246	0.0022		13.1516
	1253	(2.34)	(-0.78)	(1.12)	(-1.51)	(-0.47)	(2.73)	(0.54)		
Canada	58	0.3182	-0.0038	0.0003	-0.0029		-0.0076	-0.0011		10.2145
	943	(3.76)	(-1.11)	(0.17)	(-0.96)		(-0.81)	(-0.23)		
Canada	58	0.3044	-0.0025	-0.0000	-0.0022	0.0025	-0.0103	-0.0047		10.2123
	943	(3.66)	(-0.64)	(-0.01)	(-0.75)	(0.87)	(-1.11)	(-0.84)		
*Panel C: Security Selection return component: Actual weights * (Realized net return – Benchmark return)*										
All Funds	139	-0.0313	0.0112	0.0182	0.0112		-0.0296	0.0055	3.0524	11.8948
	2166	(-0.27)	(2.43)	(3.03)	(1.76)		(-2.08)	(0.82)	(8.15)	
All Funds	139	-0.5922	0.0234	0.0327	0.0334	0.0463	-0.0749	-0.0037	2.7448	11.8615
	2166	(-4.63)	(4.94)	(5.38)	(5.19)	(7.14)	(-4.58)	(-0.57)	(6.94)	
U.S.	81	0.2238	0.0135	0.0278	0.0212		-0.0637	-0.0094		12.9975
	1245	(1.38)	(2.13)	(2.87)	(2.52)		(-2.82)	(-1.18)		
U.S.	81	-0.8830	0.0368	0.0625	0.0591	0.0790	-0.1352	-0.0078		12.9551
	1245	(-4.66)	(5.46)	(6.62)	(6.60)	(8.29)	(-5.64)	(-1.04)		
Canada	58	-0.0347	0.0014	0.0006	0.0297		-0.0060	0.0077	3.2666	10.2986
	921	(-0.19)	(0.21)	(0.13)	(3.20)		(-0.30)	(0.66)	(6.36)	
Canada	58	-0.3472	0.0077	0.0031	0.0308	0.0235	-0.0212	-0.0068	3.9086	10.2801
	921	(-1.84)	(1.17)	(0.65)	(3.38)	(3.43)	(-1.06)	(-0.55)	(7.10)	

Appendix Table A.3: Risk adjusted returns per asset class (related to Table 8)

This table reports the net risk-adjusted performance in equity using a random coefficients model. Market timing (MT-E) and Security selection returns (SS-E) within Equity are risk-adjusted using the following factors: MKT, SMB and HML are the Fama-French factor returns, MOM – momentum factor, LIQ – Pastor and Stambaugh (2003) traded liquidity factor. Compared to Table 8 we do not control for year dummy 2000 ("Nortel effect"). Domestic equity SS-DE column displays the security selection (net benchmark-adjusted returns) for U.S. Funds mandates in U.S. equity and Canadian Funds mandates in Canadian equity. The table shows the alpha, its corresponding z-statistic and the root mean square error (RMSE) from all regressions.

MT: (Actual weights – Policy weights) * Benchmark returns
SS: Actual weights * (Realized net return – Benchmark return)

	Equity		Domestic Equity
	MT-E	SS-E	SS-DE
Panel A: All Funds without Year dummy 2000			
# Funds	287	287	285
# Obs.	3504	3470	3440
Alpha	0.2079	-0.1793	0.5261
	(4.12)	(-0.89)	(2.11)
RMSE	12.0470	12.0894	12.5198
Panel B: Canada without Year dummy 2000			
# Funds	111	111	110
# Obs.	1409	1392	1380
Alpha	0.1808	0.8014	2.5456
	(2.54)	(2.83)	(6.60)
RMSE	10.1103	10.2763	11.1858

Appendix Table A.4: Pension fund characteristics and total market timing (MT) returns (related to Table 10)

In the first step we regress the total market timing returns on a five factor that includes the MKT, SMB, HML, LIQ and FIMKT. In Panels B and D we also add the momentum factor to the risk-adjusting model. We run these regressions for every fund that has at least 8 observations, which results in 256 Funds (3297 observations) in All funds models, 152 U.S. Funds (1937 observations) and 104 Canadian funds (1360 observations). In the second step we augment the alphas retrieved from the first step with the error terms of the first step and run a Fama-MacBeth regressions and correct for autocorrelation and heteroskedasticity (using Newey-West with three lags). We include the following characteristics: SizeAct – log of total holdings in all active mandates, SizePas – log of total holdings in all passive mandates, SizeExt – log of total holdings in all external mandates, SizeInt – log of total holdings in all internal mandates, LogSize – log of average pension fund holdings in a given year, %Act – percentage of all holdings invested in active mandates, %Ext – percentage of all holdings invested in external mandates and Costs – total fund costs. SizeLiq is an interaction term of the log fund size with the first step fund-specific loading on the liquidity factor. In parentheses we report the t-statistics for every coefficient.

	Model 1			**Model 2**		
	Cons.	SizeAct	SizePas	Cons.	SizeExt	SizeInt
Panel A: without momentum factor in the first step						
All Funds	0.2505	0.0059	-0.0048	0.2833	0.0003	-0.0006
	(4.96)	(0.75)	(-1.81)	(4.37)	(0.03)	(-0.13)
U.S.	0.5326	-0.0257	-0.0055	0.4253	-0.0120	-0.0112
	(5.37)	(-1.94)	(-1.36)	(7.25)	(-1.27)	(-1.97)
Canada	0.1526	0.0209	-0.0104	0.4520	-0.0399	0.0157
	(1.43)	(1.88)	(-1.31)	(1.56)	(-0.91)	(2.30)
Panel B: with momentum factor in the first step						
All Funds	0.3184	-0.0037	0.0046	0.4236	-0.0140	0.0006
	(3.11)	(-0.37)	(0.90)	(7.16)	(-1.47)	(0.09)
U.S.	0.3868	-0.0090	0.0052	0.5290	-0.0217	0.0003
	(2.25)	(-0.71)	(0.92)	(5.97)	(-2.53)	(0.03)
Canada	0.4918	-0.0311	-0.0109	0.8732	-0.0982	0.0065
	(3.41)	(-1.88)	(-1.34)	(2.54)	(-2.05)	(0.89)

	Model 3					**Model 4**					
	Cons	LogSize	Costs	%Act	%Ext	Cons	LogSize	SizeLiq	Costs	%Act	%Ext
Panel C: without adjusting for momentum in the first step											
All Funds	0.3069	-0.0061	0.4067	-0.0091	-0.1043	0.4054	-0.0202	-1.2572	0.1855	0.0846	-0.0898
	(2.74)	(-1.38)	(3.37)	(-0.07)	(-1.85)	(2.14)	(-2.03)	(-12.22)	(1.19)	(0.94)	(-1.59)
U.S.	0.2126	-0.0145	0.5884	0.0162	0.0170	0.4048	-0.0258	-1.3631	0.3012	0.0731	-0.0568
	(1.14)	(-0.89)	(3.46)	(0.12)	(0.19)	(4.11)	(-2.30)	(-10.07)	(1.75)	(0.97)	(-1.11)
Canada	1.0166	-0.0782	-0.7932	0.1631	-0.2737	0.8018	-0.0705	-1.5137	-0.7988	0.2796	-0.1516
	(1.19)	(-0.98)	(-1.23)	(0.84)	(-1.73)	(0.87)	(-0.82)	(-15.60)	(-1.17)	(1.77)	(-0.83)
Panel D: with adjusting for momentum in the first step											
All Funds	0.5620	-0.0054	0.5641	-0.2030	-0.2334	0.1931	0.0146	-1.3897	0.5969	-0.0278	-0.1614
	(6.05)	(-0.96)	(4.19)	(-1.51)	(-2.77)	(1.28)	(1.77)	(-7.46)	(3.05)	(-0.28)	(-3.13)
U.S.	0.6117	0.0028	1.0418	-0.3590	-0.3909	0.5115	0.0057	-2.0635	0.6782	0.0186	-0.4203
	(3.36)	(0.19)	(5.47)	(-2.21)	(-6.47)	(2.81)	(0.34)	(-7.97)	(2.08)	(0.28)	(-8.05)
Canada	1.5300	-0.1406	-0.7330	0.1719	-0.3910	1.2224	-0.1561	-1.2775	-0.4630	0.4126	-0.2638
	(2.40)	(-1.96)	(-1.17)	(1.33)	(-2.41)	(1.80)	(-2.15)	(-15.24)	(-0.65)	(3.93)	(-2.21)

Appendix Table A.5: Pension fund characteristics and total security selection (SS) returns (related to Table 11)

In the first step we regress the total security selection returns on a five factor that includes the MKT, SMB, HML, LIQ and FIMKT. In Panels B and D we also add the momentum factor to the risk-adjusting model. The regressions for all funds and Canada contain also year dummy 2000. We run these regressions for every fund that has at least 8 observations (9 observations if we include year dummy 2000 in the first step), which results in 224 Funds (3044 observations) in All funds models, 152 U.S. Funds (1937 observations) and 88 Canadian funds (1235 observations). In the second step we augment the alphas retrieved from the first step with the error terms of the first step and run a Fama-MacBeth regressions and correct for autocorrelation and heteroskedasticity (using Newey-West with three lags). We include the following characteristics: SizeAct – log of total holdings in all active mandates, SizePas – log of total holdings in all passive mandates, SizeExt – log of total holdings in all external mandates, SizeInt – log of total holdings in all internal mandates, LogSize – log of average pension fund holdings in a given year, %Act – percentage of all holdings invested in active mandates, %Ext – percentage of all holdings invested in external mandates and Costs – total fund costs. SizeLiq is an interaction term of the log fund size with the first step fund-specific loading on the liquidity factor. In parentheses we report the t-statistics for every coefficient.

	Model 1			**Model 2**		
	Cons.	SizeAct	SizePas	Cons.	SizeExt	SizeInt
Panel A: without momentum factor in the first step						
All Funds	-0.1933	0.0248	0.0156	-0.0187	0.0032	0.0334
	(-1.24)	(1.22)	(1.32)	(-0.17)	(0.17)	(8.12)
U.S.	0.5771	-0.0186	0.0125	0.6239	-0.0148	0.0118
	(2.01)	(-0.53)	(0.79)	(3.49)	(-0.45)	(0.88)
Canada	-0.3653	0.0436	0.0113	0.5385	-0.1049	0.0623
	(-2.10)	(3.62)	(0.68)	(1.93)	(-2.14)	(9.98)
Panel B: with momentum factor in the first step						
All Funds	-0.2919	-0.0303	-0.0226	0.1067	-0.1062	0.0493
	(-2.09)	(-1.59)	(-1.85)	(0.34)	(-3.47)	(5.51)
U.S.	-2.3509	0.1568	0.0168	-1.3441	0.0357	0.0602
	(-8.36)	(3.58)	(0.96)	(-4.70)	(1.35)	(6.76)
Canada	-0.4154	0.0161	0.0011	0.5481	-0.1337	0.0257
	(-1.25)	(0.36)	(0.08)	(3.79)	(-10.12)	(1.58)

	Model 3					**Model 4**					
	Cons	LogSize	Costs	%Act	%Ext	Cons	LogSize	SizeLiq	Costs	%Act	%Ext
Panel C: without adjusting for momentum in the first step											
All Funds	0.2028	0.0409	0.9546	-0.3952	-0.4862	0.4096	0.0316	-1.3285	0.3037	-0.1510	-0.5589
	(0.54)	(1.30)	(3.60)	(-1.52)	(-2.76)	(1.01)	(1.06)	(-11.52)	(1.67)	(-0.51)	(-3.55)
U.S.	-0.4544	0.0630	0.7544	-0.0348	0.3237	-0.2556	0.0386	-1.4938	0.0712	0.0349	0.2844
	(-0.62)	(1.09)	(0.66)	(-0.06)	(0.80)	(-0.36)	(0.68)	(-5.48)	(0.06)	(0.06)	(0.68)
Canada	1.2482	-0.0179	1.0275	-0.6387	-1.0275	1.7419	-0.0425	-1.2132	-0.2710	-0.4181	-1.0729
	(1.38)	(-0.21)	(1.06)	(-4.08)	(-4.10)	(1.99)	(-0.48)	(-18.26)	(-0.28)	(-1.54)	(-4.64)
Panel D: with adjusting for momentum in the first step											
All Funds	1.4511	-0.1308	-0.5096	-0.1606	-0.9257	1.6887	-0.1540	-0.8496	-0.9246	-0.0482	-0.9492
	(3.86)	(-5.62)	(-1.58)	(-0.73)	(-3.65)	(5.10)	(-6.06)	(-5.13)	(-2.02)	(-0.23)	(-3.91)
U.S.	-2.0231	0.1642	-1.1994	0.2196	-0.0800	-1.5784	0.1000	-0.6423	-1.6881	0.3766	0.0071
	(-2.58)	(3.91)	(-1.52)	(0.41)	(-0.18)	(-2.31)	(1.94)	(-2.08)	(-1.73)	(0.82)	(0.02)
Canada	0.4655	-0.0032	1.9715	-0.3471	-0.9923	0.8593	-0.0242	-0.6976	1.1510	-0.4823	-0.8883
	(0.40)	(-0.03)	(0.97)	(-1.86)	(-3.42)	(0.76)	(-0.24)	(-5.22)	(0.50)	(-2.74)	(-4.52)

Appendix Table A.6: Pension fund characteristics and security selection (SS) returns (related to Table 11)

In this table we do not control for “Nortel effect” and it can be compared with Table 11 and Appendix Table A.5

In the first step we regress the total security selection (net benchmark-adjusted) returns on a six factor model that includes the MKT, SMB, HML, MOM, LIQ and FIMKT. We run these regressions for every fund that has at least 8 observations, which results in 256 Funds (3297 observations) in Panel A, and 104 Funds (1360 observations) in Panel B. In the second step we augment the alphas retrieved from the first step with the error terms of the first step and run a Fama-MacBeth regressions and correct for autocorrelation and heteroskedasticity (using Newey-West with three lags). We include the following characteristics: Log(Size) – log of average pension fund holdings in a given year, %Act – percentage of all holdings invested in active mandates, %Ext – percentage of all holdings invested in External Mandates and Costs – total fund costs. We also include four other size-related variables: SizeAct – log of total holdings in all active mandates, SizePas – log of total holdings in all passive mandates, SizeExt – log of total holdings in all external mandates and SizeInt – log of total holdings in all internal mandates. SizeLiq is an interaction term of the log fund size with the first step fund-specific loading on the liquidity factor. Panel A presents the results for both U.S. and Canadian funds, while in Panel B we show the results of Canadian funds only. In parentheses we report the t-statistics for every coefficient.

Cons.	Log(Size)	SizeLiq	Costs	%Act	%Ext	SizeAct	SizePas	SizeExt	SizeInt
Panel A: All Funds									
-0.1213									
(-0.90)									
1.9874	-0.2648								
(3.22)	(-4.38)								
1.6149	-0.2400	-1.0931							
(3.17)	(-4.67)	(-4.08)							
2.1123								-0.2997	0.0507
(2.75)								(-3.70)	(3.23)
1.5523						-0.1869	-0.0590		
(2.45)						(-2.92)	(-4.62)		
0.6335			-2.5326						
(3.32)			(-13.67)						
3.5599	-0.3544	-1.1474	-3.7664						
(5.07)	(-5.67)	(-4.33)	(-5.37)						
0.0142				0.9779	-1.1034				
(0.03)				(2.79)	(-3.30)				
4.3207	-0.4133		-3.2000	1.0467	-1.2516				
(4.10)	(-5.33)		(-5.67)	(3.98)	(-2.67)				
3.8806	-0.3918	-1.1317	-3.5442	1.0038	-1.0277				
(5.24)	(-6.18)	(-4.42)	(-4.65)	(4.83)	(-3.25)				
Panel B: Canada									
1.0898									
(5.30)									
3.4071	-0.3161								
(3.88)	(-3.84)								
2.5959	-0.2452	-1.0734							
(3.79)	(-3.86)	(-4.60)							
5.0383								-0.5614	0.0137
(3.90)								(-3.68)	(0.44)
2.8109						-0.2042	-0.0813		
(4.03)						(-4.68)	(-2.50)		
1.1131			0.1260						
(3.26)			(0.14)						
2.7897	-0.2409	-1.1476	-0.7368						
(2.12)	(-1.97)	(-4.54)	(-0.43)						
0.5803				1.4269	-0.7636				
(1.03)				(2.62)	(-1.55)				
5.8969	-0.5463		0.4446	1.3343	-2.2656				
(2.59)	(-2.56)		(0.30)	(2.51)	(-2.75)				
4.3427	-0.4208	-1.0919	-0.4270	1.1763	-1.4614				
(3.11)	(-2.61)	(-4.51)	(-0.22)	(1.89)	(-3.20)				

Appendix Table A.7: Replication of Dyck and Pomorski (2011)

This table can be compared with Table 3 of Dyck and Pomorski (February 2011). The dependent variable is the overall fund net benchmark-adjusted return in year *t* (security selection return component on a fund level). The main independent variable is the log of year t-1 fund size. Regressions are estimated over the pooled sample of U.S. and Canadian funds (All) or on a single-country level and, where indicated, we use also year fixed effects. Corporate is a dummy variable, which is equal to 1 if the pension fund is classified as corporate and 0 otherwise.

	U.S.	U.S.	U.S.	Canada	All
Log of end of year t-1 plan size	0.1083	0.0895	0.1071	0.0683	0.0864
	(2.28)	(1.97)	(2.31)	(1.50)	(2.65)
Corporate plan dummy			0.2681	0.1791	0.2210
			(1.98)	(1.38)	(2.22)
Observations	2175	2175	2175	1393	3568
R-squared	0.0024	0.1436	0.1451	0.2360	0.1184
Year FE	NO	YES	YES	YES	YES
Plan FE	NO	NO	NO	NO	NO

Appendix Table A.8: Equity – pension fund characteristics and performance (related to Table 12)

In the first step we regress the equity security selection (SS) (net benchmark-adjusted returns) or market timing (MT) return component on a four factor model that includes the MKT, SMB, HML and LIQ. We run these regressions for every fund that has at least 7 observations. For Canadian funds here we do not add year dummy 2000 to the factor model. In Panel B we also add MOM – momentum factor to the model. In the second step we augment the alphas retrieved from the first step with the error terms of the first step and run Fama-MacBeth regressions and correct for autocorrelation and heteroskedasticity (using Newey-West with three lags). The following characteristics are included in the Fama-MacBeth regressions: LogMand – log of the total equity holdings, Costs – costs for investing in equity, %ActE – percentage in active mandates and %ExtE – percentage in external mandates from the equity holdings. For U.S. Small Cap %ActE and %ExtE are estimated based on assets in U.S. small cap equity. Mand_Liq is an interaction term of the log mandate size with the first step fund-specific loading on the liquidity factor. The first column # Funds and # Obs. present the number of funds and the number of observations included in the analysis. In parentheses we report the t-statistics for every coefficient.

	# Funds	**Model 1**	**Model 2**		**Model 3**			**Model 4**		**Model 5**		
	# Obs.	Cons.	Cons.	LogMand	Cons.	LogMand	Mand_Liq	Cons.	Costs	Cons	%ActE	%ExtE
Panel A: without momentum												
All Funds Equity SS no	287	0.7378	2.8938	-0.2860	1.4645	-0.1500	-1.4554	0.7354	0.0155	-0.2881	1.7303	-0.3595
year dummy	3470	(3.13)	(3.32)	(-3.25)	(2.47)	(-2.42)	(-7.80)	(3.04)	(0.02)	(-0.51)	(1.94)	(-2.03)
All Funds Equity SS	256	0.0810	0.3844	-0.0403	0.4016	-0.0459	-1.3731	0.4838	-1.4226	0.2935	0.2968	-0.5280
with year dum 2000	3253	(0.54)	(1.15)	(-0.93)	(1.03)	(-0.92)	(-6.29)	(2.28)	(-2.94)	(0.46)	(0.33)	(-4.56)
All Funds Equity MT	286	0.1677	0.1018	0.0100	0.2089	-0.0056	-0.8762	0.1702	-0.0157	0.2758	-0.0833	-0.0451
	3460	(4.47)	(0.77)	(0.55)	(1.76)	(-0.38)	(-8.06)	(5.72)	(-0.12)	(2.70)	(-0.53)	(-0.65)
All Funds Dom Equity	285	1.1968	5.1669	-0.5678	3.1238	-0.3375	-1.6681	1.0809	0.5095	-0.4036	2.3776	-0.1734
SS no year dummy	3440	(5.05)	(5.59)	(-5.56)	(5.62)	(-5.10)	(-10.56)	(7.36)	(1.02)	(-2.21)	(4.59)	(-0.80)
All Funds Dom Equity	249	0.3868	2.0369	-0.2363	1.7037	-0.1759	-1.5594	0.5906	-0.7431	0.1701	0.6684	-0.2976
SS with year dum 2000	3188	(2.80)	(7.17)	(-5.81)	(5.11)	(-3.83)	(-16.39)	(4.63)	(-0.68)	(0.84)	(10.08)	(-0.84)
Canada Equity SS no	111	1.0465	3.3224	-0.3371	2.2739	-0.2464	-1.0236	0.9354	0.4015	0.6857	1.1070	-0.5555
year dummy	1392	(3.23)	(2.94)	(-3.13)	(2.82)	(-3.42)	(-4.32)	(3.07)	(0.50)	(1.97)	(1.42)	(-2.07)
Canada Domestic Equity	110	2.2977	5.2507	-0.4948	3.7043	-0.3599	-1.5373	1.9023	2.0259	0.5231	2.1597	-0.0342
SS no year dummy	1380	(5.80)	(5.78)	(-6.08)	(6.20)	(-5.61)	(-4.99)	(4.13)	(2.29)	(1.30)	(2.90)	(-0.10)
Panel B: with momentum												
All Funds Equity SS no	287	-0.0670	2.6897	-0.3715	2.2219	-0.3393	-1.2818	0.5079	-2.0017	-0.3972	1.8779	-1.3026
year dummy	3470	(-0.39)	(3.58)	(-4.74)	(3.18)	(-4.52)	(-7.20)	(2.20)	(-3.34)	(-0.56)	(1.86)	(-3.92)
All Funds Equity SS	256	-0.7136	-0.2734	-0.0587	-0.1468	-0.0862	-1.2407	-0.0635	-2.3063	0.0054	0.4219	-1.2306
with year dum 2000	3253	(-6.45)	(-0.72)	(-1.27)	(-0.32)	(-1.45)	(-2.14)	(-0.44)	(-5.20)	(0.01)	(0.42)	(-5.79)
All Funds Equity MT	286	0.2605	0.2049	0.0089	0.3180	-0.0072	-0.5979	0.2067	0.1766	0.3787	-0.0505	-0.0814
	3460	(6.73)	(1.69)	(0.53)	(2.74)	(-0.49)	(-4.89)	(5.75)	(1.42)	(4.48)	(-0.35)	(-1.21)
All Funds Dom Equity	285	0.7160	5.3794	-0.6701	4.6192	-0.5892	-1.4591	1.3096	-2.4780	-0.6156	2.9185	-1.0083
SS no year dummy	3440	(3.73)	(6.86)	(-7.45)	(6.50)	(-6.81)	(-9.20)	(7.33)	(-6.48)	(-2.27)	(5.83)	(-3.35)
All Funds Dom Equity	249	0.0388	1.8743	-0.2618	1.7425	-0.2360	-1.0654	0.4781	-0.0171	-0.1149	1.1207	-0.8102
SS with year dum 2000	3188	(0.32)	(4.66)	(-5.11)	(3.75)	(-3.90)	(-3.39)	(2.51)	(-1.42)	(-0.41)	(4.50)	(-3.02)
Canada Equity SS no	111	1.0020	3.8010	-0.4181	3.5830	-0.3978	-0.9111	0.8032	0.8055	0.4479	1.2443	-0.4447
year dummy	1392	(3.06)	(3.40)	(-4.11)	(3.26)	(-3.81)	(-2.41)	(2.47)	(0.76)	(1.86)	(1.48)	(-1.95)
Canada Domestic Equity	110	2.6351	6.0636	-0.5734	5.0945	-0.4183	-1.7546	2.0425	3.1911	0.5872	2.2755	0.1875
SS no year dummy	1380	(6.90)	(6.32)	(-6.70)	(4.40)	(-2.76)	(-4.19)	(4.32)	(2.35)	(1.83)	(2.95)	(0.52)

Appendix Table A.9: Fixed income – pension fund characteristics and performance (related to Table 13)

In the first step we regress the fixed income security selection (SS) (net benchmark-adjusted returns) or market timing (MT) return component on a four factor model that includes the FIMKT, MKT, OPTION and HY. We run these regressions for every fund that has at least 6 observations. In the second step we augment the alphas retrieved from the first step with the error terms of the first step and run Fama-MacBeth regressions and correct for autocorrelation and heteroskedasticity (using Newey-West with three lags). The following characteristics are included in the Fama-MacBeth regressions: LogMand – logarithm of the total fixed income holdings, Costs – costs for investing in Fixed Income, %ActFI – percentage in active mandates from the fixed income holdings and %ExtFI – percentage in external mandates from the fixed income holdings. The first column # Funds and # Obs. present the number of funds (cross-sectional units) and the number of observations included in the analysis. This table presents results of the joint analysis of U.S. and Canadian funds. In parentheses we report the t-statistics for every coefficient. Market timing component within fixed income requires that the fund invests in at least two types of fixed income (for example: Canadian fixed income and EAFE fixed income). In that case there can be a difference in weights within the fixed income, which will lead to return component that is due to the difference from actual and strategic weights.

		Model 1	**Model 2**		**Model 3**		**Model 4**		
	# Funds # Obs.	Cons.	Cons.	LogMand	Cons.	Costs	Cons.	%ActFI	%ExtFI
FI SS	318	0.0221	0.4382	-0.0629	-0.1076	0.8411	-0.1909	0.1591	0.0916
	3661	(0.26)	(4.43)	(-6.77)	(-1.24)	(2.44)	(-2.03)	(1.01)	(2.08)
FI MT	232	0.0012	-0.0357	0.0051	-0.0171	0.1120	-0.0612	0.1000	-0.0250
	2814	(0.11)	(-1.01)	(0.83)	(-0.73)	(1.06)	(-2.18)	(2.56)	(-1.40)
Domestic FI SS	298	-0.0102	0.2162	-0.0344	-0.1603	1.0433	0.0532	0.0046	-0.0890
	3346	(-0.11)	(1.50)	(-1.64)	(-2.41)	(4.57)	(0.43)	(0.02)	(-0.92)

Appendix Table A.10: Comparison with Dyck and Pomorski (2011)

This table can be compared with Table 7 Panel B of Dyck and Pomorski (February 2011). The dependent variable is the net benchmark-adjusted return on private equity, real estate, hedge funds, equity, U.S. equity or fixed income. The coefficient presented refers to log of year t-1 holdings in the give asset class. Regressions are estimated over the pooled sample of U.S. and Canadian funds and, where indicated, we use also year or plan fixed effects. In model 2 we also add corporate dummy, which is equal to 1 if the pension fund is classified as corporate and 0 otherwise.

	(1)	(2)	(3)
Private Equity	1.5226	1.5703	1.0361
	(4.64)	(4.79)	(1.53)
Real Estate	0.5232	0.5471	0.1852
	(5.91)	(6.10)	(0.86)
Hedge Funds	0.1790	0.1713	-3.2489
	(0.53)	(0.51)	(-2.53)
Equity	-0.0214	-0.0088	0.2327
	(-0.54)	(-0.22)	(2.16)
U.S. Equity	-0.0184	-0.0121	-0.0537
	(-0.34)	(-0.22)	(-0.39)
Fixed Income	0.0609	0.0561	0.0091
	(2.98)	(2.67)	(0.17)
Corporate Dummy	NO	YES	NO
Year FE	YES	YES	YES
Plan FE	NO	NO	YES

Appendix Table A.11: Persistence in pension fund performance

In Panels A and C funds are placed into quintiles based on their market timing returns. In Panels B and D U.S. and Canadian funds are placed into quintiles based on their security selection (net benchmark-adjusted) returns. High row or column represents the quintile with the highest market timing return. Percentages represent the probability that a fund which was ranked in one of the 5 quintiles in year *t* ends up in one of the quintiles in year *t+1* or exits the database. Exit column presents the percentage of funds exiting the CEM database in year *t+1*. Return in *t+1* columns present the market timing or security selection returns in year *t+1* of the top and bottom quintiles, which are formed in year *t*. Test Diff column is a t-statistic of the difference in returns between the low and high quintile.

Panel A: U.S. Funds Market Timing Returns

		Year *t+1* ranking						Return in *t+1*		Test
		Low	2	3	4	High	Exit	Low	High	Diff
	Low	**23.49%**	16.78%	11.74%	13.26%	11.07%	23.66%	0.0506	0.3073	2.79
Year *t*	2	14.77%	**18.17%**	17.15%	11.71%	10.87%	27.33%			
ranking	3	12.95%	16.35%	**19.76%**	15.33%	10.56%	25.04%			
	4	10.87%	15.62%	14.60%	**19.86%**	13.58%	25.47%			
	High	17.21%	9.64%	11.02%	14.11%	**21.51%**	26.51%			

Panel B: U.S. Funds Security Selection Returns

		Year *t+1* ranking						Return in *t+1*		Test
		Low	2	3	4	High	Exit	Low	High	Diff
	Low	**20.54%**	12.56%	13.41%	14.94%	12.56%	25.98%	-0.0912	0.6156	2.90
Year *t*	2	13.01%	**15.92%**	16.44%	15.75%	10.96%	27.91%			
ranking	3	11.74%	17.27%	**16.93%**	16.23%	13.47%	24.35%			
	4	12.50%	15.58%	17.64%	**16.78%**	14.55%	22.95%			
	High	14.63%	12.02%	12.37%	14.46%	**20.38%**	26.13%			

Panel C: Canadian Funds Market Timing Returns

		Year *t+1* ranking						Return in *t+1*		Test
		Low	2	3	4	High	Exit	Low	High	Diff
	Low	**22.68%**	17.49%	14.48%	13.39%	12.57%	19.40%	0.1434	0.2794	1.46
Year *t*	2	17.93%	**17.65%**	16.25%	14.29%	13.73%	20.17%			
ranking	3	11.90%	17.00%	**22.66%**	17.00%	12.75%	18.70%			
	4	14.37%	15.21%	16.34%	**18.87%**	17.18%	18.03%			
	High	18.29%	12.00%	11.43%	16.57%	**19.43%**	22.29%			

Panel D: Canadian Funds Security Selection Returns

		Year *t+1* ranking						Return in *t+1*		Test
		Low	2	3	4	High	Exit	Low	High	Diff
	Low	**20.85%**	19.44%	12.68%	11.27%	13.24%	22.54%	0.0227	0.9041	3.42
Year *t*	2	21.39%	**13.87%**	20.23%	14.45%	10.98%	19.08%			
ranking	3	16.09%	19.25%	**17.82%**	17.24%	10.63%	18.97%			
	4	11.85%	17.05%	15.90%	**19.08%**	17.34%	18.79%			
	High	14.20%	8.58%	12.43%	18.64%	**24.85%**	21.30%			