Do pension funds manage cash efficiently?

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Abstract

Using unexplored data on Swiss pension funds, we study whether pension funds manage their cash efficiently. While a share of cash is held to meet certain operational and investment needs, the remaining is accumulated from past activity and slowly invested. Most of the variation observed in pension fund cash holdings is, however, attributable to pension fund-specific time-invariant factors rather than to differences in pension funds' needs. We estimate that pension funds with excessive cash holdings hold an average of 8.4% of total assets in excess cash. Investing this excess cash in a representative portfolio of assets could translate into an additional expected annual return of 30 basis points. Furthermore, we show that pension funds in a deccumulation phase, as well as large pension funds, are more efficient in managing their cash and that the introduction of negative interest rates by the Swiss National Bank triggered a systematic reduction in pension fund cash holdings.

Keywords: Pension funds, Cash holdings, Performance, Switzerland

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1. Introduction

Retirement-income systems around the world face similar challenges. Rising life expectancy means that pension funds must distribute benefits longer, and an unfavorable financial environment of low interest rates implies lower returns on accumulated capital. These together translate into pension funds' assets growing much slower than their liabilities, threatening the goal of providing adequate retirement income. To ensure that the overall pension system is sustainable, pension funds should revise critical aspects, such as contributions, benefits, and investment management. While both contributions and benefits often depend on regulatory policies, pension funds have wide discretion on asset allocation decisions, a key determinant of investment performance. The main goal of this project is to uncover the forces that shape cash allocation decisions, which has important implications for investment performance and, to our knowledge, has been relatively neglected in existing studies. To this end, we focus on the following question: why pension funds hold cash and whether some could be reinvested in assets with higher expected returns. We evaluate this question using a unique dataset that covers over 1'800 pension funds founded in Switzerland and spans over a decade. This dataset includes a large amount of information for every pension fund; thus, it is ideal to study cross-sectional and time series factors.[1]

Our question is grounded on the observation that there is large variation across pension funds and across countries in the amount held in cash. For example in Switzerland, over the period 2006-2018, pension funds have been persistently holding an average of 7.0% of their investments in cash, although, we observe large within country cross-sectional differences. Pension funds in other countries such as Australia, Spain or Austria also hold significant average cash balances. In contrast, in other countries such as the U.S., Canada, or Netherlands, with developed retirement-income systems, pension funds have cash to total investments averages closer to 2.5%.[2] While holding large cash balances provides pension funds with extra layers of liquidity and with the option to grasp investment opportunities, it involves bearing significant opportunity costs as well as direct costs after the decision of the Swiss National Bank (SNB) to introduce negative interest rates in 2015. Thus managing cash efficiently and keeping only necessary cash reserves is important and can contribute to enhanced returns. To address our question, we study pension fund cash holdings and their likely determinants to understand how much cash pension funds should hold without jeopardizing performance. We evaluate whether their cash holdings are driven primarily by their operational and investment needs as well as whether there is a share of cash holdings that could be reallocated to earn higher

[1] We provide a brief description of the institutional setting in Switzerland in Appendix A.1. For a more detailed analysis, see Queisser and Vittas (2000), Gerber and Weber (2007), and Bütler (2014).

[2] Cash refers to both cash holdings and cash equivalents. Cash allocations are computed using aggregated data provided by the OECD, Funded Pension Statistics. The 2.5% refers to average cash over total investments held by pension funds located in the Netherlands, Canada, and the U.S. High cash holdings in Switzerland is not an isolated case. There are other countries holding also high levels of cash such as Australia, Austria or Spain (see, e.g. OECD, 2019).

returns. In the end, we aim to assess the potential that pension funds may have to increase their performance given a particular institutional setting.

To start with, we develop a static model of cash holdings based on pension funds' operational and investment needs. The first reason for pension funds to keep cash is to comply with upcoming operations. We hypothesize that pension funds with larger expected outflows from their daily business should hold more cash. This is because selling assets to meet these outflows in case of cash shortages could bring significant transactional costs at the expense of performance. Considering though that some of these outflows can be met with pension funds' inflows, we expect pension funds with higher positive net cash flows to have lower cash holdings. Hedging activities can also require cash holdings as pension funds need to fulfill collateral requirements or provide for the settlement of hedging programs when the value of their derivative contracts falls. Thus, we expect pension funds with greater hedging activities to hold more cash as a cushion against such cash transfers. There are also some investment reasons for holding cash. Pension funds may also keep cash because either the opportunity cost of holding cash rather than long term bonds with similar risk is low or they expect investment opportunities to arise in the future.

Our results suggest that pension funds' cash policies only partially reflect operational and investment needs. While a share of cash is held to cushion against expected outflows from their operating and hedging activities and to meet investment needs, the remaining is accumulated from current operations and slowly reinvested. Further, we find that contemporaneous inflows are not considered to meet outflow needs and reduce cash holdings. Some pension fund cash policies differ from this general pattern. We find that cash holdings of pension funds in deccumulation phase (having negative net cash flows) respond, to a greater extent, to their operational needs and, thus, they seem to be more cautious in managing their cash. Large pension funds hold lower levels of cash, which is consistent with the evidence that size matters for efficient investment management (see, e.g., Davis and De Haan, 2012; Ammann and Ehmann, 2017; Andonov, Bauer, and Cremers, 2012). We further examine if pension funds became more efficient in managing their cash after the imposition of negative interest rates by the SNB in 2015. This event introduced an explicit cost in holding cash that should have triggered pension funds to be more careful with their cash policies. Indeed, we find that the decision of the SNB induced a systematic reduction of cash holdings of about 1% since 2015.

One implication of the static model is that part of pension funds' cash holdings may result from a passive accumulation of certain cash flows in cash. At this point, we ask to what extent pension funds accumulate cash and how much time they take to reinvest this liquidity. To answer these questions, we explore the dynamics of pension funds' cash holdings, and we perform several tests. Our findings show that pension funds need up to four years to invest previously retained cash flows. We examine if our results are driven by policies of smoothing investments over time and we find that such cases are rather rare. We can, therefore,

conclude that pension funds seem to slowly adjust their cash according to their needs and this slow adjustment is most likely due to delayed action.

Although operational and investment needs can explain to some extent why pension funds hold cash, there is a large variation in the amount of cash held among pension funds that does not seem to be captured by the differences in these needs. Additional analysis reveals that most explanatory power comes from a permanent component that is unrelated to operational and investment needs. We find that time-invariant pension fund-specific factors appear to be the most important drivers of pension fund cash holdings. These unobserved factors could be, for example, differences in technologies, managerial behaviour, competence in financial matters and/or organizational set ups. Thus, even in a setting of institutional investors, investor characteristics play a central role. This finding provides an important research avenue for future work.

Finally, we evaluate how much cash is held in excess of what operational and investment needs would justify. To estimate the amount of excess cash, we construct three different measures and we obtain that, pension funds with excessive cash holdings, hold on average, 8.4% of total assets in excessive cash. In some cases, the amount of excess cash can be, therefore, substantial with consequences for pension funds' performance. When we examine the performance foregone by holding excessive cash, we estimate that investing excessive cash in a representative combination of bonds, equities and real estate could bring an expected annual return of 30.0 basis points.

Our study contributes to the literature exploring the factors that shape pension fund asset allocations. While existing studies mostly examine the choice between bonds and stocks, we are the first, to our knowledge, to study the drivers of cash holdings. Because holding too much cash has significant embedded costs, keeping only necessary cash balances can improve pension fund performance.

We further contribute to the discussions on how pension funds can improve the efficiency of their investment management under the current challenges. Cash holdings represent a significant portion of assets to which pension funds do not seem to have devoted yet enough attention. This is especially evident in the context of Swiss pension funds which have persistently been holding significant amounts of cash in their balance sheets, sacrificing potential performance. Understanding what determines cash holdings should provide pension funds with some guidance on how much cash to hold without compromising either their liabilities or their performance.

Finally, after adjusting our models to the particularities of each institutional environments, we believe that similar predictions may apply and our analysis can be extended to other jurisdictions, for example, where pension funds keep on average substantial investment assets in cash, such as Australia, Austria or Spain (see, e.g. OECD, 2019). Global demographic and economic trends necessitate pension funds around the world to optimize, among other things, their investment management practices with the goal to mitigate the adverse effects these trends have on their performance and funding capacity. Our study shows that

optimizing cash policies is already a step towards that goal. This holds not only for Swiss pension funds, but also for pension funds in other countries with similar levels of cash given that the factors we identify as drivers of pension fund cash holdings are not likely to differ much across institutional environments. For that reason, we believe that our findings can be generalized beyond the Swiss context after accounting for certain institutional differences.

This paper is organized as follows: Section 2 outlines the theoretical reasons as to why pension funds should hold cash. Section 3 portrays the characteristics of the dataset and presents pension funds' cash flows and their association with cash. Section 4 describes the model and provides univariate tests and results for the association of cash with pension funds' operational and investment needs. Section 5 explores the dynamics of cash. Section 6 defines and describes cash held beyond operational and investments reasons and Section 7 estimates the consequences on performance of holding excessive cash. Section 8 briefly concludes.

2. Related literature and hypotheses development

The main goal of this study is to understand what drives pension fund allocation of cash and to evaluate whether there is room to enhance performance. To date, the empirical literature on pension fund asset allocation focuses on the interplay between bonds and equities and identifies pension fund-specific, institutional, and sponsoring firm-specific factors to be associated with such allocations. The most common view in the literature is that pension fund asset allocation should, first, reflect the riskiness of pension liabilities and their exposure to interest rate and inflation risk (see, e.g., Hoevenaars, Molenaar, Schotman, and Steenkamp, 2008; Jondeau and Rockinger, 2014) and, second, be in accordance with pension fund risk capacity and its funding status (see, e.g., Sundaresan and Zapatero, 1997; Lucas and Zeldes, 2006, 2009; Rauh, 2009; Weller and Wenger, 2009). However, institutional frictions that allow for a higher discretion in setting liability discount rates (see, e.g., Pennacchi and Rastad, 2011; Mohan and Zhang, 2014; Andonov, Bauer, and Cremers, 2017) or that are related to the sponsoring firms having control over pension assets (see, e.g., Cocco and Volpin, 2007; Phan and Hedge, 2013), weaken the view that asset allocation reflects liabilities risk and pension fund risk-capacity. Our aim is to go beyond bonds and equities and to study the role of cash holdings in pension funds' asset allocation and performance.

Current studies provide a limited understanding of the role of cash holdings in pension fund asset management and, at most, only include some basic statistics on how much cash pension funds hold (see, e.g., Petersen, 1995; Gerber and Weber, 2007; Mohan and Zhang, 2014; Andonov and Rauh, 2020; Boubaker, Gounopoulos, Nguyen, and Paltalidis, 2018). This is probably due to theoretical predictions that cash has a limited role in a long-term portfolio choice. According to Campbell and Viceira (2002), asset-only long-term investing implies that long-term bonds or inflation-indexed bonds, in the presence of

inflation risk, dominate the choice of holding cash due to the reinvestment risk inherent in cash. In the context of asset-liability investing, Jondeau and Rockinger (2014) show that a liability-hedging portfolio should hold no cash if pension fund asset allocation is driven by the riskiness of pension liabilities due to the low and negative correlation of cash with the growth of pension fund liabilities. However, these studies do not consider the benefits that cash conveys as a liquidity provider. Broeders, Jansen, and Werker (2020) propose that pension funds should also consider liquidity risk. They argue that pension funds should hold sufficient cash to fulfill short-term pension payments and operating costs. The more immediate these payments are, the higher the need for liquidity and, therefore, the higher the amount of cash to be held. This renders operational needs the main driver of pension funds' cash holding behavior, suggesting a role for holding cash.

In this study, we reconcile theoretical predictions with the empirical observation that pension funds do hold, in some cases, substantial amounts of cash.[3] We aim to understand why pension funds hold cash and whether some could be reinvested in assets with higher expected investment returns. To address these questions, we investigate the reasons that justify cash holdings and we estimate if there is any surplus that should be reinvested to enhance performance. The study of these questions represents a substantial contribution to the limited, virtually absent, empirical studies on pension cash holdings. An exception is Bregnard and Salva (2019) who show that well governed pension funds that have comprehensive investment policies in place tend to hold lower levels of cash. Our study provides a more comprehensive analysis of the true forces shaping cash holdings to better understand what actually matters for a pension fund in the decision to hold cash.

To approach these questions, we borrow from the literature on corporate and mutual fund liquidity. Although firms and mutual funds have different incentives to hold cash compared to pension funds, there are still some similarities. Keynes (1936) and Opler, Pinkowitz, Stulz, and Williamson (1999) show that firms keep cash to meet operating needs when raising external funds is costly. Similarly, Yan (2006) and Simutin (2014) suggest that mutual funds hold cash to adhere to their operational and investment needs when transaction costs from liquidating assets are high. Following the same line of reasoning, we view operational needs as the main reason for pension funds to hold cash. These needs entail meeting on-going outflows, such as regular and lump-sum benefits, administrative, management and insurance expenses as well as accumulated savings when employees leave the fund. If cash is insufficient to cover these outflows, pension funds are obliged to sell a fraction of their assets. Selling assets can be costly for two reasons. First, pension funds may be forced to sell at depressed prices if market conditions are unfavorable and second, they may incur significant transaction costs if their liquid assets are not sufficient. Even if neither of these is the case, pension funds may not be able to sell immediately because the sale must be first approved by

[3] For example, in Switzerland, while pension funds in the lowest decile hold 1.7% of total assets in cash, those in the highest hold 16.7%.

the Board of Trustees in their scheduled meeting. Such delays in the process of asset liquidation can put a significant burden on the capacity to make payments when they become due and amplify the role of cash. As pension funds with larger expected outflows are likely to fall into larger cash shortages, they may need to sell more assets to raise cash and eventually face higher costs. To avoid such costs, we argue that pension funds with large expected outflows should hold more cash.

However, some of these outflows can be offset by pension funds' inflows. Such inflows include contributions, accumulated savings from new employees joining the pension fund and investment income.[4] As using inflows to cover outflows reduces the amount of cash needed, we should expect pension funds that anticipate large and positive net cash flows to hold less cash. Following this reasoning, we motivate our first hypothesis:

H1: The higher (lower) the expected net cash flows (outflows), the lower the amount of cash held, all else equal.

Pension funds should also ensure sufficient liquidity to adhere to their hedging commitments as suggested by Broeders, Jansen, and Werker (2020). If pension funds experience adverse movements against their positions in derivative contracts, they need to settle hedging programs with cash. To provide a back up for such cash transfers, we expect those with on-going derivative contracts to hold more cash than those with no hedging activity.[5] We, therefore, propose the following hypothesis:

H2: Pension funds that use derivative contracts for hedging purposes should hold more cash, all else equal.

So far, we consider operational needs as the main factor to drive the need for cash. This also agrees with what the law stipulates for Swiss pension funds in that they need to keep sufficient liquidity to comply with on-going operations (LPP, art. 71). Yet, we identify some investment reasons for holding cash. First, cash can be an intended investment when its opportunity cost is low, or the foregone returns associated with it are low or even absent. That is, when yield curves are flat or downward-sloping, cash can be considered a substitute for long-term high-credit-quality bonds. Conversely, with upward-sloping yield curves, the choice of long-term assets with similar credit quality that entail lower reinvestment risk should dominate cash. This leads us to our third hypothesis:

H3: If cash is held as a substitute for long-term high-credit quality bonds, the steeper is the yield curve the lower is the amount of cash.

[4] These cash flows refer to the institutional and legal environment of Switzerland and may be different in other institutional settings.
[5] Cash could also be justified when there is a need to hedge against inflation (see, e.g., Hoevenaars, Molenaar, Schotman, and Steenkamp, 2008); Jondeau and Rockinger, 2014). However, given the low levels of inflation in Switzerland and the non-mandatory pension indexation, we argue that inflation-hedging is unlikely to drive pension fund cash holdings.

Pension funds may also hold cash if the goal is to pursue anticipated investment opportunities. For example, they may retain some cash if they expect capital calls from private equity or infrastructure funds or if they intend to profit from market downturns and compressed prices. We, therefore, expect pension funds that plan to invest over the coming year to hold more cash. With this argument, we articulate the following additional hypothesis:

H4: If cash is held in view of future investments, we should observe an increase in investments made with cash.

3. Data and descriptive statistics

To start with, we obtain data from the Swiss Federal Statistical Office (FSO) for the complete universe of pension funds founded in Switzerland. This data has been largely unexplored in academic research. The FSO database provides a detailed overview of pension fund income statements and balance sheets as well as structural, administrative, and financial characteristics. Having this unique dataset at hand allows us to obtain a large amount of information for every pension fund over a decade and to have a large cross-section of institutions, so we can study the questions proposed while controlling for potential confounding effects.

For this study, we use individual variables related to regular activities, asset allocations, cash holdings, and idiosyncratic characteristics for the period 2005-2018. To hold the legal environment constant in our analysis, we exclude pension funds that offer only super-obligatory benefits because they are not subject to the same legal rules. We also exclude pension funds that reinsure all risks (actuarial and investment risks) with insurance companies and do not manage pension assets themselves. Finally, we drop pension funds when they are in the process of full liquidation and/or in the year when they first enter the sample because in these cases, asset allocations do not reflect pension funds' fundamentals. Our final dataset includes an average of 1,523 pension funds across years and 21,326 pension fund-year observations. Appendix A.2 details the construction of our sample.

To complement pension fund data, we also collect monthly yields for Swiss government bonds of different maturities from Thomson Reuters. In addition, we use expected equity premiums in Dimson, Marsh, and Staunton (2011-2018) estimated from a long history of world equity returns relative to U.S long-term bonds and treasury bills. Finally, we follow Andonov and Rauh (2020) and use institutional investors' expectations of long-term excess returns for four asset classes as provided by the U.S Governmental Accounting Standards Board Statement (GASB) 67.

3.1. Sample description

Panel A, Table I displays some general aggregated characteristics of our final sample. As of 2018, pension funds collectively manage CHF 848 billion of total assets growing at a compound annual growth

rate (CAGR) of 3.6% since 2005 for 3.8 million members. According to Panel B, Table I, out of these pension funds, 94% are private, 68% are multi-employer, 46% are semi-autonomous of type 1, and 94% provide defined contributions (DC) plans.[6] The fraction of pension funds belonging to each administrative type remains quite stable over the previous years.[7]

Panel A, Table II provides a pooled description of our dataset and shows that it is largely dominated by small pension funds while there are also a few large ones. The average pension fund manages CHF 430 million of total assets for more than 2,000 beneficiaries. We, also, observe that average total contributions are higher than average total benefits (CHF 24 million vs CHF 17 million) but grow at a slower pace (2% vs 6%). This is due to the number of pensioners growing faster than that of active employees as baby-boomers reach retirement. Furthermore, private and fully capitalized public pension funds are, on average, adequately funded with a funding ratio of 112% and 104.6%, respectively. The average partially capitalized public pension fund though displays a funding ratio of 90.2%.[8] Panel B, Table II further shows that 64% (52%) of the pension funds can use their contributions (total inflows) to cover their benefits (total outflows) and those tend to keep more (less) cash.

The upper graph of Figure II illustrates how the asset allocation of Swiss pension funds has evolved over time. We observe that since 2008, pension funds have increased the risk of their portfolio by investing more in equities and real estate and less in cash and bonds, possibly triggered by decreasing interest rates after the financial crisis. The decrease in cash is more pronounced since 2015 coinciding with the introduction of negative interest rates in Switzerland. As shown in the lower graph of Figure II, this event triggered a decrease in the cross-sectional variation of cash and, therefore, a systematic decline in cash holdings. This means that pension funds jointly adjusted their cash holdings downward and appear to have transferred part of it to alternative investments and real estate. Panel A, Table III shows that pension funds in our sample allocate on average 9% of total assets on cash, 35% on bonds, 28% on stocks, 18% on real estate and 4% on alternative investments and are largely within the legal investment limits.[9] Finally, the correlations among different asset classes in Panel B, Table III indicate that cash tends to be a substitute to the rest of the asset classes and mainly to bonds and stocks.

[6] Appendix A.1 provides a detailed description of the different organizational forms of Swiss pension funds. Note that semi-autonomous pension funds of type 1 cover only old-age benefits and reinsure death and invalidity benefits with insurance companies. Also, note that in Switzerland, DC plans are like "cash balance plans" as they have embedded minimum mandatory guarantees. Cash balance plans are considered as defined benefits under international accounting standards and, thus, the distinction between defined benefit (DB) plans and DC plans is insignificant.

[7] These statistics are different from FSO statistics as of 2018 due to the way we select our sample.

[8] Partially capitalized public pension funds are public pension funds with state guarantees that may be underfunded and are required to submit an investment plan to the supervisory authorities that aims at reaching a funding ratio of 80% by 2054 (LPP, art. 72c).

[9] These proportions do not add up to 100% because we scale by total assets which apart from pension fund investments, include other accrual and receivable accounts. The average proportion of total assets held in cash by pension funds in our sample is also different from the average proportion estimated with the annual data retrieved from the OECD database (9% vs 7%) for two reasons. First, OECD data refers to annual aggregate amounts and not averages and second, cash holdings calculated with OECD data are scaled by total investments and not by total assets.

3.2. Descriptive statistics of pension fund cash flows and different measures of cash

In Table IV, we examine the distribution of pension fund cash flows and their relationship with cash. In terms of magnitude, total contributions are the most important cash flows as they represent 6.5% of total assets, out of which 5.6% refers to contributions regularly received by employees and employers. This is followed by exit vested benefits (5.0%), total benefits (3.5%), entry vested benefits (3.3%) and investment income (3.1%). We note that investment income is the only non-pure cash flow variable as it includes unrealized investment gains and losses. Given that we cannot separate realized investment income from valuation adjustments, we specially track this variable and perform various robustness tests on our analysis.

In aggregate, pension funds' inflows amount to an average of 12.9% of total assets whereas their outflows equal 9.9%.[10] Given that pension funds can use their inflows to cover their outflows, we net their cash flows by activity. We observe that net cash flows from pension funds' regular activities, that of receiving employee and employer contributions and paying annuity benefits (regular net contributions), represent 3.3% of total assets. However, in the 5th percentile, employee and employer contributions are insufficient to cover annuity benefits. Net cash flows from vesting activities are on average negative, which implies that employees leaving the pension fund are barely replaced or are replaced by younger ones. Netting at a more aggregate level shows that pension funds' net total cash flows represent 3.0% of total assets. Excluding investment income though, reduces net total cash flows to -0.01%.[11]

In terms of relevance, Table IV shows that, contemporaneously, most cash flows display a significant and positive association with the cash-to-total assets allocation. Apart from annuity benefits and investment income, we observe that all other types of inflows and outflows are positively correlated with cash. Netting respective cash flows shows that the association of regular net contributions with cash is particularly relevant while that of aggregated net cash flows with cash is economically less important. Aggregating at a higher level assumes that all cash flows are equally important in pension funds' decision making; however, their size and their relationship with cash indicates that this is less likely to be the case.

To sum up, this preliminary analysis shows that regular net contributions are the most important cash flow associated with cash holdings in terms of magnitude and relevance. While individual outflows display the expected relation with cash, regular net contributions and individual inflows appear to contradict our predictions as pension funds with higher values for these variables hold more cash.

After exploring the relation of pension funds' cash flows with cash, we build different measures to better understand the amount of cash held with respect to cash flows. Table V summarizes our cash measures

[10] Total inflows include total contributions, entry vested benefits and investment income. Total outflows include total benefits, exit vested benefits and total expenses (administrative, investment and insurance expenses).

[11] We exclude investment income because first, it includes unrealized gains and losses that do not correspond to cash flows and second, it is usually directly reinvested according to discussions we had with different pension providers.

for the years 2005 and 2018 and shows that pension fund cash holdings have decreased over time. For example, as of 2005, pension funds held on average 9.2% of total assets in cash and with the cash at hand, without considering contributions, they could cover 89 months of benefits and 17 months of total outflows. Netting contributions shows that pension funds in a deccumulation phase (benefits are higher than contributions) could cover 185 months of residual benefits. In 2018, pension funds decreased cash holdings to an average of 8.0% of total assets and with the cash at hand, without contributions, they could cover 49 months of benefits and 13 months of total outflows. Then netting contributions, they could cover 183 months of residual benefits. This analysis shows that while cash is lower in 2018 than it was in 2005, there is still a substantial amount held.

4. Determinants of cash holdings

This section, describes the methodology we follow to test the hypotheses highlighted in Section 2 on how operational and investment needs relate to pension fund cash holdings, and details the results we obtain.

4.1. Base model

To evaluate hypotheses H1 to H4, we regress cash as a percentage of total assets on variables that proxy for operational and investment reasons to hold cash. For that, we propose the following baseline model:

$$\begin{aligned} Cash_{i,t} = \beta_0 + \beta_1 NetCF_{i,t+1} + \beta_2 EnVB_{i,t+1} + \beta_3 (ExVB + LS)_{i,t+1} + \beta_4 Texp_{i,t+1} + \\ \beta_5 Derivatives_{i,t} + \beta_6 NewInv_{i,t+1} + \beta_7 YC_t + \Gamma' X_{i,t} + \eta_t + \varepsilon_{i,t} \end{aligned} \quad (1)$$

where, subscripts refer to pension fund *i* and year *t*, respectively. *Cash* refers to holdings of cash and cash equivalents scaled by total assets and includes bank deposits and investments in money market securities. In our data, total assets excludes assets managed by insurance companies.

To test H1, we include a set of variables all scaled by total assets. Specifically, we include *NetCF* that refers to employee and employer contributions minus benefits in the form of annuities. We choose net cash flows from pension funds' regular activity because our previous analysis shows that, aggregating net cash flows at a higher level weakens the relation with cash holdings, so we allow various flows to have different sensitivities in the model. We further include *EnVB* that refers to entry vested benefits and represents retirement savings from new employees joining the fund, and any premiums paid by the beneficiary to recover retirement assets from home ownership or divorce withdrawals. *ExVB* is exit vested benefits and includes termination benefits, home ownership and divorce withdrawals and *LS* is benefits paid in the form of lump-sums. We also add *Texp* that refers to the sum of administration and investment expenses as well as insurance premiums. We include all these cash flows separately rather than netting them out because, as indicated in the subsection 3.2, pension funds appear to pay more attention to the sign of these cash flows

rather than on the net amounts. With our specification, we allow pension funds to place different weights on distinct cash flows depending on their sign and regularity of occurrence. Subscript *t+1* indicates expected cash flows a period ahead that are scaled by total assets at *t* to eliminate the effect of changes in asset valuations. To proxy for the various expected cash flows we use actual cash flows at *t+1*. We note that most cash flows in pension funds are highly predictable.

Under H1, we expect β_1 and β_2 coefficients to be negative as pension funds with positive and large regular net cash flows and higher entry vested benefits need less cash. Also, our hypothesis predicts that β_3 and β_4 coefficients should be positive as pension funds with large outflows should hold more cash to cushion against liquidity shortfalls.

For H2, we use *Derivatives* as a proxy for liquidity needs from hedging commitments. This is a dummy variable that takes the value of 1 if the pension fund has derivative contracts and zero, otherwise. If those who hedge need more cash, we expect the coefficient β_5 to be positive.

To examine H3 and H4, we use the last set of variables that proxy for investment reasons to hold cash. *NewInv* proxies for next-year investments made with current cash. It is defined as the overall change in pension funds' investments from *t* to *t+1* less the investments made with net total cash flows received at *t+1*. More precisely, *NewInv* is the residual of the regression of the change in pension funds' investments from *t* to *t+1* on net total cash flows at *t+1*. If cash is held to pursue anticipated investment opportunities, H4 predicts a positive sign for β_6 coefficient. *YC* proxies for the slope of the yield curve and is the spread between 1-year and 30-year Swiss government bonds. According to H3, β_7 should be negative.

To ensure that pension funds are truly comparable, we further include *X*, a set of control variables capturing pension fund-level characteristics. We also add calendar year fixed effects η to isolate the across pension fund variation and account for economic trends driving cash allocations. Finally, given the panel structure of the sample and to account for persistence in both cash holdings and our variables of interest, we use clustered standard errors at the pension fund level.

The set of controls that we consider is as follows:

LnTA is the natural logarithm of total assets to control for the size effect. We expect larger funds to hold less cash either because they are considered to be more sophisticated investors (see, e.g., Davis and De Haan, 2012; Ammann and Ehmann, 2017; Andonov, Bauer, and Cremers, 2012), or because they are more likely to benefit from economies of scale and face lower liquidity needs.

Coverage is the coverage ratio, also called funding ratio (assets over liabilities). Underfunded funds are required by law to undertake specific measures to resolve underfunding, which includes following more conservative investment policies.

4.2. Univariate tests

Having defined the variables of interest that proxy for operational and investment needs, we first perform some univariate analysis. Table VI evaluates cash holdings for pension funds with low and high operational and investment needs and provides univariate tests. For each variable, we split pension funds into two groups. One group includes pension funds with the variable lower than the median and the other group includes the rest. To proxy for operational needs, we use pension fund next-year cash flows and whether they have derivative contracts running. Pension funds that anticipate higher regular net contributions and entry vested benefits appear to retain more cash (10.4% vs 7.3% and 9.4% vs 8.5%). More cash is also held by those with higher lump-sum and exit vested benefits as well as higher total expenses in the coming year (9.8% vs 7.9% and 10.5% vs 7.2%). However, those with derivative contracts tend to keep lower cash (8.1% vs 9.1%). We further observe that current operating activity associates closely with cash and in a similar way with future activity. Univariate t-tests show that all these differences are statistically significant. For investments needs, our analysis shows that pension funds hold more cash when they plan to invest over the next year (10.0% vs 7.7%) and when the yield spread shrinks (9.1% vs 8.8%). Taken together, the univariate analysis suggests that pension funds tend to hold more cash the higher their cash flows and the larger their investment needs.

4.3. Regression results

Table VII reports coefficients, standard errors and significance tests for time fixed-effects regressions of cash on variables representing operational and investment needs. In column (1), we examine whether pension funds hold cash in anticipation of next-year activity. We observe that higher upcoming lump-sum benefits, exit vested benefits and total expenses are associated with higher cash holdings. Consistent with our hypothesis, this indicates that pension funds keep liquidity to meet next period outflows. Also, in line with our predictions, they hold less cash when entry vested benefits are expected to be large. The positive coefficient on expected regular net contributions, though, suggests that pension funds tend to hoard cash even if they anticipate positive net cash flows from their regular activity. This implies that cash balances do not fully mirror operational needs but may partially result from a passive accumulation of cash flows from current operations or delayed investment. To examine this, in column (2), we add current cash flows and show that cash is positively associated with current net and individual inflows. A share of cash may, therefore, be accumulated at least in the short run. We provide a more detailed analysis in the next section. In specification (3), we add controls and we draw similar conclusions. Once we control for size, liquidity needs from pension funds' hedging activities become significant. Pension funds with derivative contracts hold 1.2% of total assets more in cash than those without derivatives.

So far, we have excluded investment income from pension fund operating needs because, it includes unrealized gains and losses and is frequently directly reinvested within the same asset class that generates it. Adding it in column (4) shows that pension funds expecting higher investment income tend to hold less cash. However, this result should be taken with caution because it may be affected by reverse causality. Investment income may be higher due to lower cash holdings to begin with. To avoid potential biases in our estimates, we exclude investment income from our subsequent analysis. Including it, though, does not alter our results.

With regards to investment reasons to hold cash, in column (5), we observe a positive and statistically significant coefficient on new investment. This means that pension funds keep cash balances, or delay investing their cash to the next year. This interpretation may mask two effects. Pension funds may delay investment either because they expect investment opportunities to arise or because they need some time to invest their cash flows. In unreported tests, we investigate whether investment opportunities have a bearing on explaining cash. Specifically, we examine if the exposure to private equity leads to higher cash holdings in anticipation of capital calls, but we do not find any evidence. In the next section, we further examine how long it takes for transitory increases of cash to be reinvested. Finally, in the last column, we add the yield curve as a determinant of cash while we exclude time fixed effects. We see that pension funds hold less cash when their opportunity cost is high, and the term spread widens.

In Table VIII, we evaluate whether cash policies depend on particular circumstances. In the first two columns, we use specification (5) of Table VII and we split our sample into pension funds in an accumulation phase (positive regular net contributions) and in a deccumulation phase (negative regular net contributions), respectively. Column (2) shows that, in contrast to their counterparts in column (1), pension funds in a deccumulation phase show greater sensitivities of key operational outflows to the level of cash. Also, the coefficient on regular net contributions indicates that pension funds with low contributions and high benefits hold lower levels of cash.

In the two subsequent columns of Table VIII, we split our sample into small and large pension funds as a rough proxy for more efficient processes or management capacity. We observe that large pension funds show greater sensitivities of operational and investment proxies to the level of cash, indicating that cash policies respond more to their needs. Although regular net contributions are still positively associated with cash, their magnitude and significance decreases showing that cash holdings respond less to current period net inflows. This evidence suggests that large pension funds are, on average, more reactive in investing their cash flows. They also cushion more against high expected outflows and hold significantly more cash when they have derivative contracts. In addition, the variable new investments loads higher for large pension funds. This means that the cash they hold is reinvested at a faster rate. These findings are consistent with

the evidence of size being indicative of superior sophistication (see, e.g., Davis and De Haan, 2012; Ammann and Ehmann, 2017; Andonov, Bauer, and Cremers, 2012).

Lastly, we evaluate how pension funds reacted to the decision of the SNB, in January 2015, to introduce negative interest rates as this event introduced an explicit cost to holding cash. Column (5) shows that in 2015, pension funds decreased their cash holdings by 1.2% and this reduction persists three years later. This evidence indicates that cash holdings were not tied to operational and investment needs and that pension funds were holding more cash than was needed. Thus, the introduction of negative interest rates brought some discipline to pension funds' cash management.

To sum up, while a share of cash is held to satisfy operational and investment needs, the rest is more likely accumulated from current operations and slowly deployed. In the next section, we analyse the dynamics of cash.

5. Dynamics of cash holdings

This section explores the dynamic behaviour of pension fund cash holdings to understand to what extent, and for how long they accumulate cash. We also aim to understand if, apart from operational and investment needs, there are other unobservable cross-sectional differences among pension funds that may explain persistent effects of cash.

5.1. Accumulation of cash holdings

A prominent implication of our analysis is that pension funds do not timely invest a share of their cash flows, accumulating them instead in cash. We explore this observation further using three sets of tests. First, we examine how much of pension funds' past activity is still kept in cash. Second, we evaluate how long it takes for pension funds to invest their cash holdings. Finally, we employ a partial adjustment model to estimate the speed at which pension funds adjust their cash towards a target level.

Panel A, Table IX presents parameter estimates and standard errors from estimating these three models. For columns (1) and (2), the idea is that the effect of some past cash flows persists in the future. That is, the current level of cash may partly include previous cash flows not yet invested. As cash is a function of pension funds' cash flows, its lags could have a dynamic interpretation and indicate the rate at which the effects of prior cash flows persist. Column (1) includes the first lag of cash along with the determinants of cash we introduced in the previous section and reveals some interesting features. The estimated magnitude of lagged cash indicates that an important share of current cash results from previous cash levels, in the sense that pension funds tend to only gradually update their cash. The increase in the R-squared from 11% in specification (6), Table VII to 60% when we add lagged cash suggests that lagged cash captures a significant missing factor that explains a substantial portion of the variation in cash holdings. Given that lagged cash

indirectly controls for time-invariant characteristics that may drive pension fund cash holdings, the missing factor likely refers to an unobservable pension fund-specific component. Even in the presence of that component, the majority of previously identified time-varying operational and investment variables are still significant in explaining cash.[12] In other words, while pension funds set cash levels to partly respond to fluctuations in certain determinants of cash holdings, cash holdings are highly driven by idiosyncratic differences among pension funds. We examine the importance of the permanent component driving pension fund cash holdings in more detail in the next subsection. Column (2) introduces additional lags of cash and shows how long the effect of past cash flows lasts. We find that pension funds tend to keep a share of their cash flows in cash until four years after they incurred them.

Column (3) presents our second test that evaluates the rate at which pension funds deploy their cash. New investments correspond to cumulated investments made with cash over the next years. The rate is stronger a year ahead and decreases thereafter but it is still significant four years later. These results verify our previous conclusion and suggest that it takes over four years for pension funds to deploy their cash.

Finally, in column (4) we further confirm our findings by estimating by how much pension funds adjust towards a target level of cash every year. For that, we follow Lemmon, Roberts, and Zender (2008) and use the following autoregressive model of cash holdings:

$$\Delta Cash_{i,t} = a + \lambda(\widehat{Cash_{i,t}} - Cash_{i,t-1}) + \varepsilon_{i,t} \qquad (2)$$

where subscripts refer to pension fund *i* and year *t*, respectively. *ΔCash* is the change in cash from *t-1* to *t*. $\widehat{Cash}$ is the predicted target level of cash estimated using equation (1). The parameter λ is the speed of adjustment and measures the fraction of the difference between last year's cash and this year's target cash pension funds cover each year. We obtain the result that pension funds tend to close 26% of this gap every year. This implies that they take up to four years to scale back their cash holdings and invest previously retained cash flows.

In sum, these findings suggest that pension funds delay adjusting their cash holdings to keep up with their needs, accumulating a part of it. However, there are instances where accumulating cash flows is not necessarily problematic. For example, if a pension fund receives a large one-off inflow from a large wave of new employees joining the pension fund, it may reasonably decide to smooth out the investment of this inflow over time especially if market prices are high. To explore how pension funds react when they experience sudden increases in their cash, we divide them into quartiles based on our measure of cash. We only focus on those that enter the highest quartile for the first time each year and we provide the fraction of pension funds that remain in that quartile for the five subsequent years. Panel B, Table IX shows that more

[12] Factors such as regular net contributions and total expenses get insignificant as they are quite persistent over time and their effect is reasonably absorbed by lagged cash.

than 50% of the pension funds within the highest quartile of cash do not belong in this category after one year. This could indicate that most pension funds invest one-off inflows already the year after. However, some of those in the highest quartile for more than one year remain in that quartile for quite some time; others spread investment over at least two years. Our results show that for the majority of pension funds, accumulation of cash is the result of delayed action.

Until now, we have uncovered that cash policies respond to some extent to pension funds' operational and investment needs, that there is some cash accumulation that it is slowly deployed and that a time invariant pension specific factor critically defines cash levels. Thus, time-series fluctuations in pension funds' needs do not appear to be responsible for most of the variation observed in cash holdings. The question that arises naturally at this stage is, to what extent cross-sectional unobserved differences among pension funds justify the unexplained variation in cash holdings. In the next subsection, we attempt to shed more light on this perspective.

5.2. Persistence in cash holdings

Our previous analysis reveals that prior cash levels are important in explaining current cash holdings. While this is partly due to pension funds slowly deploying their cash flows, it also indicates that there may be time-invariant factors that lead some pension funds to persistently hold more cash than others. To disentangle these two effects and focus on the second one, we go further back into the past and we examine whether initial levels of cash have a bearing on explaining current cash holdings. If current cash holdings are closely related to the initial levels of cash, this relation would be less likely to be driven by the effect such a past activity has on current cash. Conversely, it would signify that there is a permanent pension fund-specific component that triggers persistent differences in the cash held among pension funds. To investigate that, we regress current cash holdings on initial cash. Initial cash is cash held during the first year pension funds appear in our sample.[13] Specification (1) in Panel A, Table X shows that pension funds with high cash to start with continue to hold high cash in the future. Initial cash alone explains almost 25% of the variation in cash holdings. In the subsequent columns, we add our time-varying operational and investment variables and we see that their coefficients are consistent with our previous evidence. The introduction of these variables further increases R-squared to 32% but leaves the coefficient of initial cash intact in terms of magnitude and significance, suggesting that historical levels of cash are an important driver of future cash holdings. These results reveal that, a permanent pension fund-specific component is more important in explaining cash, compared to the time-varying operational and investment determinants.

We now turn to quantify the impact of that permanent component. To start with, we compute the within- and between-pension fund variation of cash. We obtain that the within variation is 6.3% while the between

[13] To avoid estimating an identity specification, we exclude the first observation for each pension fund.

variation is 9.0%. This indicates that cash holdings vary almost 43% more across pension funds than within pension funds. To estimate how much of the discrepancy in cash is attributable to each factor, we follow Lemmon, Roberts, and Zender (2008) and we perform an analysis of covariance. Panel B, Table X displays the results of variance decompositions for different specifications using Type III partial sum of squares. We normalize each column to sum to one by dividing the partial sum of squares of each factor by the total sum of squares of the factors included in each model. The last row of the table displays the R-squared of each model.

In the first two columns, pension fund and time fixed effects, explain 100% of the fraction in the sum of squares, respectively, as they are the only factors included in each model. Pension fund fixed effects capture 57% of the variation in cash holdings (column (1)) as opposed to the time fixed effects that capture only 1% (column (2)). We can, therefore, conclude that differences in cash holdings are largely due to permanent pension fund-specific factors, suggesting some persistence in pension funds' cash. This is further verified by the third column, where our model includes both pension fund and time fixed effects. Column (4) shows that a similar specification with the one presented in specification (5), Table VII, where we include all time-varying factors with year fixed effects, yields an R-squared of almost 10%. This is by far smaller compared to the explanatory power of pension fund fixed effects alone (R-squared = 57% in column (1)). Previously identified time-varying factors are, thus, relatively weak in explaining discrepancies in cash holdings when compared to time-invariant factors. Nevertheless, operating needs that have to do with pension funds' regular activity (regular net contributions) and overall management (upcoming total expenses) as well as investment needs (new investments and year fixed effects) account for most of the explanatory capacity of this model. Upcoming outflows, such as lump-sum and exit vested benefits, have a smaller explanatory power. This is surprising as these outflows are an important dimension along which institutional environments differ and could explain to a large extent why Swiss pension funds hold more cash compared to those in other countries. Still, we find that even an institutional setting, that is more demanding in terms of liquidity needs, justifies very little of the cash held. In the last column, we add pension fund fixed effects to the model of column (4). We obtain that this specification explains 65% of the variation in cash holdings, and pension fund fixed effects are responsible for the largest part of the explained variation.

These findings suggest that most of the variation in cash holdings is due to cross-sectional unobserved differences among pension funds rather than to time-series changes in the determinants of cash. This is not to say that time-varying operational and investment determinants are irrelevant in determining cash. On the contrary, their explanatory capacity appears to be only partially driven by cross-sectional variations. This is because while they explain 10% of the variation in cash holdings when included alone (column (4)), they improve by 8% the explanatory power if added to a model with pension fund fixed effects (65% in column (5) vs 57% in column (1)). This means that permanent pension fund-specific factors do not remove the

informativeness of time-varying factors, however, they matter more than anything else in understanding why pension funds hold cash. These unobserved factors could be, for example, differences in technologies, managerial behaviour, competence in financial matters and/or organizational set ups. Identifying these factors would require additional analysis that is beyond the scope of this study.

6. Cash beyond operational and investment needs

Our findings so far suggest that only a share of the observed cash is in accordance with pension funds' operational and investment needs while the remaining can, thus, be considered excessive. The question we aim to answer at this point is whether pension funds hold excess cash and, if they do, how much?

To compute excess cash, we follow Opler, Pinkowitz, Stulz, and Williamson (1999), Dittmar and Mahrt-Smith (2007), and Fresard and Salva (2010) and we define excess cash as the difference between the amount of cash actually held by a pension fund and the predicted normal amount of cash:

$$Xcash_{i,t} = Cash_{i,t} - \widehat{Cash}_{i,t} \tag{3}$$

where subscripts refer to pension fund *i* and year *t*, respectively. *XCash* is the excess cash as a proportion of total assets and *Cash* is the actual cash over total assets. $\widehat{Cash}$ is the predicted level of cash and refers to the amount of cash a pension fund should hold if the goal was only to cover operational and investment needs. To predict that amount of cash and eventually estimate excess cash, we follow different approaches.

First, we estimate the model in regression (5), Table VII. Then to predict cash we consider only those coefficients that are consistent with our hypotheses and we exclude fixed effects. Because we are interested in estimating the normal level of cash justified by operational and investment needs, we do not account for coefficients that may capture other reasons why pension funds hold cash. Then we define excess cash as in equation (3).

Our second approach defines excess cash as the residual of the same regression with pension fund fixed effects. According to our previous analysis, there is a time invariant unobservable pension fund-specific effect and ignoring it may bias regression coefficients. Again, we then estimate the normal level of cash using regression coefficients that are in line with our predictions but excluding fixed effects.

Finally, we provide a model-free definition of excess cash. According to Panel B, Table V, almost 25% of the pension funds in our sample hold approximately 2% of total assets in cash with which they can cover up to three months of total outflows. We assume that 2% is closer to the amount of cash that pension funds should hold to meet their operational needs. We therefore compute the normal level of cash for each pension as the amount of cash needed to cover three months of upcoming outflows. To this amount, we add 1% for

pension funds that have derivative contracts to mitigate for outflows that may arise from these contracts.[14] This amount is further increased by 1% to account for investment purposes to hold cash. Excess cash is, then, computed as the difference of actual cash and this normal level of cash.

Table XI presents our estimates of excess cash as well as their distribution and that of the elements used for their computation according to equation (3). For our model-based measures, we report only excess cash estimates for pension funds having positive excess cash. Pension funds with positive excess cash have on average 8.6%-8.9% of excessive cash holdings. The estimate is 7.6% for our model-free estimate. We note that model-based estimates implicitly assume that, on average, no excess cash is held in the population of pension funds. If we think that reasonable levels of cash are below the population averages, then we are likely underestimating the amount of excess cash held by some pension funds. All our measures lead to similar estimates, are highly correlated (almost 99%), and display a right-skewed distribution indicating that there are pension funds holding significant amounts of excess cash. In unreported tests, we estimate excess cash with alternative models and assumptions and all lead to very similar conclusions.

7. The cost of excessive cash holdings

In this section, we evaluate the performance that pension funds forego by keeping cash in excess of their operational and investment needs. To do so, we assume that excess cash is, instead, invested in a combination of bonds and equities, or in a combination of bonds, equities, and real estate. First, we hypothesize a standard allocation of 60/40 bonds/equities. For pension funds with positive excess cash, we apply these weights on the proportion of total assets held as excess cash and on expected equity and bond excess return benchmarks. Our first benchmark relies on Dimson, Marsh, and Staunton (2011-2018) and uses long-term geometric averages, in real terms, of equity and bond returns in excess of treasury bills. We focus on average estimates over 100 years as they provide superior estimators of expected returns.

As a second benchmark, we use institutional investors' expectations on returns of four asset classes as provided by U.S GASB 67. We assume that the excess cash is invested in four asset classes, namely bonds, domestic and international equities and real estate, rather than in a combination of bonds and equities only. We assume a 40% investment in bonds and 20% in each of the other assets. We apply these weights on the proportion of excess cash and on the expected returns of these four assets in excess of the return on cash and cash equivalents (which according GASB 67, is zero). Panel A, Table XII presents the return benchmarks we use for this analysis.

In Panel B, Table XII we show descriptive statistics for the forgone performance pension funds suffer from keeping excess cash rather than investing it in more profitable assets. On average, pension funds with

[14] This is in line with what we obtain in our base model in column (6), Table VII, where pension funds that have derivative contracts appear to hold almost 1% more cash.

excess cash could expect to earn between 17 to 32 basis points, depending on the definition of excess cash, the weights on asset classes and the benchmark for expected excess returns. The forgone performance is also higher, about 30 basis points, under a richer diversification that allows for investments in real estate and both international and domestic equities.[15] We can interpret these foregone gains as minimum values since they could be higher if, excess cash is also invested in alternatives or only in higher yielding assets, to the extent this is compatible with pension funds' risk capacity.[16]

Our analysis shows that performance can be undermined by the way cash is managed, a fact that should evoke pension funds' attention given the current economic and demographic reality in which maintaining healthy funding ratios and achieving required rate of returns is a real challenge. The optimization of cash holdings could be seen as a contributor to additional performance and to the goal of providing adequate retirement income.

8. Conclusion

We study to what extent operational and investment needs explain pension fund cash holdings. In particular, we evaluate why Swiss pension funds hold so much cash and whether there is a share of this cash held that could be reinvested to assets with higher expected returns. We find that while a portion of cash is held to satisfy operating and investment needs, the remaining is accumulated from current and previous activity. Pension funds do not actively invest their cash flows, taking up to four years to reinvest them. Operational and investment needs appear rather weak in explaining differences in cash holdings among pension funds. We find that these differences are to a large extent attributable to time-invariant factors that are likely associated with pension funds' internal organization and management. There are, therefore, other factors, more pension fund-specific, that may explain why some pension funds tend to always hold more cash than others or to be less reactive in managing their cash. Accounting or not for time-invariant factors in our base model or even using a model-free definition to estimate the normal level of cash pension funds should hold, our findings show that some pension funds hold excessive cash balances. For those, 8.4% of cash, on average, is held in excess of what operational and investment needs would dictate, and this comes at the expense of performance. If pension funds would invest their excess cash in more profitable assets, they could expect to gain an additional annual return of about 30 basis points.

[15] According to the annual survey of Swisscanto, Dändliker, Deplazes, and Konrad (2020), an additional return of 60 basis points, on average, could secure pensions and compensate for the reduction of conversion rates under discussion in political circles. The estimated additional performance pension funds could have gained by investing their excess cash is, therefore, of important significance for the system.

[16] Given the positive skewness of performance cost, we go further and we focus on the pension funds belonging to the highest quartile of performance cost. In unreported results, we obtain that the average performance cost for these pension funds reaches 44 to 87 basis points.

We, further, show that pension funds in a deccumulation phase as well as large pension funds are likely to engage in a more efficient cash management. Finally, we find that the introduction of negative interest rates by the SNB in 2015 triggered a systematic reduction of cash holdings bringing some discipline to how pension funds manage their cash.

Our study shows that a substantial amount of the cash pension funds hold does not mirror their needs and can be considered as excessive. Holding more cash than necessary can hurt investment performance given the foregone returns from holding investment assets in cash. To avoid that, pension funds should, therefore, devote closer scrutiny on their cash policies. While we focus on the Swiss context, we believe that our conclusions can be meaningful for pension funds in other countries as our models can easily be adapted to other institutional environments.

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Table I
Sample general characteristics

This table presents general and administrative characteristics of Swiss pension funds for the period 2005-2018. **Panel A** shows the evolution of general characteristics over time. All variables are aggregated across pension funds each year. *Number of PFs* is the number of pension funds. *Total assets* is the total assets held excluding insurance assets. *Contributions* is the amount of total contributions received and *Benefits* is the amount of total benefits paid by pension funds. *Beneficiaries* is the number of active employees and retirees. *Employees* is the number of active employees contributing to the pension fund and *Retirees* is the number of retirees. **Panel B** provides information on pension funds' legal and administrative form. *Public* equals one if the pension fund is founded by a public institution and zero, otherwise (=*Private*). *Public-partial cap.* equals one if the pension is founded by a public institution that operates under partial capitalization and zero, otherwise (=*Public-full cap.) Single-employer* equals one for single-employer funds and zero, otherwise (=*Multi-employer*). *Collective* equals one if the pension fund is multi-employer and maintains separate accounts and rules for the pension schemes of participating employers and zero, otherwise. *Common* equals one if the pension fund is multi-employer and runs one scheme with similar rules and accounts for participating employers. A*utonomous* equals one if the pension fund covers all risks itself and zero, otherwise. A*utonomous (stop-loss)* equals one if the pension fund covers all risks itself but is supported by "stop-loss" contracts with insurance companies and zero, otherwise. *Semi-autonomous type 1* equals one if the pension fund covers old-age risks itself but transfers the risks of death and disability to insurance companies and zero, otherwise. *Semi-autonomous type 2* equals one if the pension fund accumulates retirement savings but transfers all risk to insurance companies and zero, otherwise. *DB, DC* and *Mixed DB, DC* are indicator variables for the plan type and equal one for defined-benefit, defined-contributions and mixed plans, respectively, and zero, otherwise.

Panel A: General sample characteristics

Year	Number of PFs	Total assets (CHF mio)	Contributions (CHF mio)	Benefits (CHF mio)	Beneficiaries	Employees	Retirees
2005	1,825	513,492	25,495	20,104	2,655,445	2,245,566	409,879
2006	1,753	549,264	27,113	21,468	2,775,853	2,346,962	428,891
2007	1,741	578,758	32,490	22,936	2,960,514	2,509,338	451,176
2008	1,718	514,368	32,952	24,015	3,107,972	2,634,725	473,247
2009	1,692	573,085	33,958	24,915	3,138,530	2,645,883	492,647
2010	1,648	595,464	35,924	25,687	3,194,992	2,683,249	511,743
2011	1,584	602,136	36,102	26,414	3,290,785	2,757,731	533,054
2012	1,509	645,009	36,406	27,427	3,324,150	2,772,378	551,772
2013	1,436	650,352	37,046	25,885	3,199,420	2,672,647	526,773
2014	1,365	707,135	40,717	26,740	3,277,618	2,726,678	550,940
2015	1,325	759,421	43,261	29,168	3,518,377	2,905,096	613,281
2016	1,282	792,595	43,371	29,893	3,565,295	2,935,658	629,637
2017	1,228	860,848	44,775	31,028	3,683,244	3,031,650	651,594
2018	1,220	847,976	46,883	32,303	3,809,494	3,133,948	675,546

Panel B: Number of pension funds by administrative type by year

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total number of PFs	1,825	1,753	1,741	1,718	1,692	1,648	1,584	1,509	1,436	1,365	1,325	1,282	1,228	1,220
Public	97	93	92	93	91	88	88	86	76	71	72	72	70	70
Public-Partial cap.	76	72	71	71	68	64	64	63	54	34	30	32	31	31
Public-Full cap.	21	21	21	22	23	24	24	23	22	37	42	40	39	39
Private	1,728	1,660	1,649	1,625	1,601	1,560	1,496	1,423	1,360	1,294	1,253	1,210	1,158	1,150
Single-employer	783	728	705	682	677	637	588	546	499	461	441	408	387	395
Multi-employer	1,042	1,025	1,036	1,036	1,015	1,011	996	963	937	904	884	874	841	825
Collective	71	71	71	72	71	73	74	73	74	75	83	85	81	81
Common	92	91	92	92	92	92	90	88	85	84	90	97	100	100
Autonomous	394	385	392	391	384	376	371	361	344	322	305	293	270	263
Autonomous (stop-loss)	477	472	460	455	444	417	397	367	350	328	318	303	287	273
Semi-autonomous type 1	596	583	598	591	603	605	585	574	550	542	547	539	543	565
Semi-autonomous type 2	358	313	291	281	261	250	231	207	192	173	155	147	128	119
DC	1,410	1,391	1,410	1,405	1,396	1,405	1,362	1,307	1,265	1,232	1,213	1,181	1,140	1,144
DB	238	216	192	172	162	138	122	102	84	61	51	43	37	30
Mix (DC, DB)	31	31	33	33	35	42	38	39	37	30	26	23	23	22

Table II
Descriptive statistics

Panel A reports summary statistics of key variables of our sample for the period 2005-2018. *Total assets* (*investments*) is the total assets (investments) held by the pension fund (in CHF mio). *Retirement savings* is the savings capital accumulated by the pension fund for active employees and pensioners (in CHF mio). *Total contributions* is the amount of total contributions received by the pension fund (in CHF mio). *Total benefits* is the amount of total benefits paid by the pension fund (in CHF mio). *Beneficiaries* is the number of active employees and retirees. *Employees* is the number of active employees contributing to the pension fund and *Retirees* is the number of retirees. *Beneficiaries ratio* equals active employees over retirees and is equal to zero if the number of active employees is zero and equal to its max when the number of retirees is zero. *Funding ratio* refers to pension assets over pension liabilities as reported by the pension fund and is expressed in percentage. *Public partial cap. (Public full cap.)* refers to pension funds founded by a public institution that operate under partial (full) capitalization and is expressed in percentage. Missing cells marked with (-) refers to percentile estimates that our data provider requires not to disclose. *Total assets (total contributions, total benefits) CAGR* is the cumulative average growth rate of total assets (total contributions, total benefits) from the first year each pension fund appears in our sample to the last and is expressed in percentage. **Panel B** presents the number of pension funds with more (less) total contributions than total benefits and with more (less) inflows than outflows as well as the percentage of total assets these pension funds hold in cash. *Inflows* includes total contributions, entry vested benefits and investment income and O*utflows* includes total benefits, exit vested benefits, investment, administrative and insurance expenses.

Panel A: Summary statistics

	Obs.	Mean	St.Dev	p5	p25	Median	p75	p95
Total assets (CHF mio)	21,326	430.92	1,797.95	4.25	22.42	62.36	190.14	1,630.47
Total investments (CHF mio)	21,326	406.86	1,709.41	3.32	20.34	58.83	181.48	1,511.79
Retirement savings (CHF mio)	21,326	391.30	1,658.58	3.22	17.63	51.59	160.49	1,466.01
Total contributions (CHF mio)	21,326	24.22	92.46	0.24	1.26	3.49	11.13	99.48
Total benefits (CHF mio)	21,326	17.26	80.34	0.04	0.61	1.97	6.51	61.21
Beneficiaries	21,326	2,133.63	8,404.84	25.00	128.00	321.00	957.00	8,539.00
Employees	21,326	1,781.93	7,276.76	21.00	107.00	266.00	794.00	7,157.00
Retirees	21,326	351.69	1,598.72	0.00	10.00	38.00	141.00	1,246.00
Beneficiaries ratio	21,326	152.46	573.79	1.50	3.47	7.20	18.43	2,569.00
Funding ratio (%)	21,326	111.18	23.14	91.70	103.00	109.60	117.00	133.60
Public partial cap. (%)	761	90.21	17.69	-	-	93.30	-	-
Public full cap. (%)	398	104.57	8.52	-	-	104.20	-	-
Private (%)	20,167	112.10	23.12	93.90	103.70	110.00	117.40	134.30
Total assets CAGR (%)	21,326	3.65	5.14	-3.09	1.15	3.26	5.94	10.82
Total contributions CAGR (%)	21,326	2.44	7.83	-6.59	-0.03	2.75	5.44	10.85
Total benefits CAGR (%)	20,524	6.15	13.04	-5.26	1.37	4.47	9.04	24.63

Panel B: Pension funds in accumulation and deccumulation phase

	Obs.	Number of PFs	Cash (in %)
Total contributions > Total benefits	16,221	1,847	9.55
Inflows > Outflows	15,397	1,971	8.84
Total contributions < Total benefits	5,088	1,050	7.06
Inflows < Outflows	5,926	1,833	9.24

Table III
Pension fund asset allocation

This table presents information on pension fund asset allocation for the period 2005-2018. **Panel A** provides descriptive statistics of asset allocations. *Cash* refers to cash and cash equivalents (CHF and foreign currency). *Bonds* is the total investments in Swiss and foreign bonds as well as in foreign currency bonds. *Stocks* is the total investments in Swiss and foreign stocks. *Real estate* is the total investments in Swiss and foreign direct and indirect real estate. *Alternatives* is investments in hedge funds, private equity, commodities, infrastructures, insurance-linked securities and others. All variables are computed in % of total assets and are expressed in percentage. Total assets do not include assets managed by insurance companies. **Panel B** provides pair-wise correlations of the different asset classes using Bonferroni correction.

Panel A: Summary statistics of asset allocation

	Obs.	Mean	St.Dev	p5	p25	Median	p75	p95
Cash	21,326	8.95	10.12	1.10	3.33	6.15	10.75	25.66
Bonds	21,326	34.84	14.85	7.18	25.50	35.61	45.23	57.51
Stocks	21,326	27.57	10.45	8.50	21.95	27.90	33.69	44.01
Real estate	21,326	18.38	13.21	0.00	9.28	16.77	25.50	42.47
Alternatives	21,326	3.66	5.68	0.00	0.00	1.30	5.61	13.73

Panel B: Correlation between asset allocations

	Cash	Bonds	Stocks	Real estate	Alternatives
Cash	1.00				
Bonds	-0.30*	1.00			
Stocks	-0.29*	0.05*	1.00		
Real estate	-0.16*	-0.49*	-0.23*	1.00	
Alternatives	-0.08*	-0.15*	-0.02*	-0.06*	1.00

Table IV
Descriptive statistics of pension fund cash flows

This table provides summary statistics for pension fund cash flows and their association with cash. *Total contributions* includes employee, employer and other contributions received by the pension fund. *Regular contributions* includes employee and employer contributions. *Irregular contributions* is total contributions less regular contributions. *Total benefits* includes benefits paid in the form of annuities and lump-sums to benefit recipients. *Annuities* is benefits paid in the form of annuities every year and *Lump-sums* is benefits paid in the form of capital. *Entry vested benefits* includes termination benefits transferred by new employees joining the fund and any premiums paid to recover retirement assets from home ownership or divorce withdrawals. *Exit vested benefits* is termination benefits and early withdrawals for home ownership and divorce. *Investment income* is income from investments and includes realized and unrealized gains and losses. *Total expenses* refers to the sum of investment, administrative and insurance expenses. *Investment* (*Administrative*) *expenses* includes expenses related to the investment management (administration) of the pension fund. *Insurance expenses* is insurance premiums paid to the Guarantee Fund and to insurance companies if the pension fund is has some reinsurance. *Inflows* includes total contributions, entry vested benefits and investment income. *Inflows (ex. inv.inc)* is inflows less investment income. *Outflows* includes total benefits, exit vested benefits, investment, administrative and insurance expenses. *Net contributions* is total contributions minus total benefits. *Regular net contributions* is regular contributions minus annuities. *Net vested benefits (Net cash flows)* is entry vested benefits (inflows) minus exit vested benefits (outflows). *Net cash flows (ex. inv.inc)* is inflows less investment income minus outflows. All variables are computed in % of total assets and are expressed in percentage. Total assets do not include assets managed by insurance companies. In the last column, β represents the slope estimate of an OLS univariate regression of cash on the respective variable.

	Obs.	Mean	St.Dev	p5	p25	Median	p75	p95	β
Total contributions (a)	21,326	6.51	3.87	2.22	4.13	5.74	8.02	13.05	0.45***
Regular contributions (b)	21,326	5.59	3.00	1.88	3.67	5.04	6.99	10.80	0.59***
Irregular contributions	21,326	0.92	2.11	0.00	0.07	0.31	0.92	3.62	0.32***
Total benefits (c)	21,326	3.54	3.33	0.45	2.06	3.19	4.39	7.25	-0.17***
Annuities (d)	21,326	2.28	1.64	0.20	1.12	2.00	3.17	5.08	-1.03***
Lump-sums	21,326	1.26	3.09	0.00	0.05	0.55	1.41	4.65	0.09***
Entry vested benefits (e)	21,326	3.29	4.74	0.08	1.05	2.14	3.99	9.49	0.22***
Exit vested benefits (f)	21,326	5.00	7.36	0.41	1.89	3.39	5.94	13.98	0.13***
Investment income (g)	21,326	3.13	6.56	-11.08	1.01	4.13	7.17	10.67	-0.11***
Total expenses (h)	21,326	1.41	1.29	0.22	0.54	1.10	1.93	3.47	1.53***
Investment expenses	21,326	0.38	0.55	0.01	0.15	0.31	0.52	0.93	-0.13
Admin. expenses	21,326	0.27	0.32	0.02	0.11	0.19	0.33	0.72	4.98***
Insurance expenses	21,326	0.76	0.97	0.00	0.02	0.43	1.20	2.51	2.20***
Inflows (i=a+e+g)	21,326	12.93	9.26	-0.53	8.59	12.87	17.10	25.78	0.08***
Inflows (ex. inv.inc) (j=a+e)	21,326	9.80	7.20	3.01	5.76	8.25	11.97	20.93	0.23***
Outflows (k=c+f+h)	21,326	9.95	8.60	4.09	6.24	8.12	11.26	21.03	0.10***
Net contributions (a-b)	21,326	2.97	5.32	-3.21	0.11	2.46	5.34	11.12	0.31***
Regular net contributions (b-d)	21,326	3.32	3.93	-2.28	0.68	3.04	5.59	9.85	0.53***
Net vested benefits (e-f)	21,326	-1.71	7.37	-9.12	-2.64	-0.87	0.13	3.26	-0.03***
Net cash flows (i-k)	21,326	2.98	10.81	-13.77	-0.68	4.09	8.20	14.67	-0.00
Net cash flows (ex. inv.inc) (j-k)	21,326	-0.1	8.84	-9.11	-2.62	-0.01	2.69	8.79	0.05***

Table V
Description of cash holdings

This table presents descriptive statistics for different definitions of cash holdings for 2005 in **Panel A** and for 2018 in **Panel B**. *Cash/Total assets* (*Cash/Total investments*) is cash and cash equivalents over total assets (investments) and is expressed in percentage. Total assets do not include assets managed by insurance companies. *Cash/Total benefits*12* (*Cash/Outflows*12*) is cash and cash equivalents over total benefits (outflows) times 12, which represents how many months of benefits (outflows) the pension fund can cover with its cash. *Outflows* includes total benefits, exit vested benefits, investment, administrative and insurance expenses. *Cash/Net contributions*12* is cash and cash equivalents over net contributions times 12 if net contributions are negative. It represents how many months of residual benefits the pension fund can cover with its cash. *Net contributions* is total contributions minus total benefits. *Cash/Net cash flows*12* is cash and cash equivalents over net total cash flows times 12 if net total cash flows are negative. This represents how many months of residual outflows the pension fund can cover with its cash. *Net cash flows (ex. inv.inc)* is total contributions and entry vested benefits minus total benefits, exit vested benefits and investment, administrative and insurance expenses.

Panel A: Cash in 2005

	Obs.	Mean	St.Dev	p5	p25	Median	p75	p95
Cash/Total assets	1,825	9.25	10.93	1.06	3.38	6.02	10.54	28.23
Cash/Total investments	1,820	10.62	13.07	1.27	3.79	6.69	11.86	33.86
Cash/Total benefits*12	1,737	89.19	305.08	2.96	11.67	25.10	57.87	325.83
Cash/Outflows*12	1,825	16.91	37.80	1.27	4.58	8.66	17.24	54.89
Net contributions < 0								
Cash/Net contributions*12	410	185.33	681.36	0.67	13.06	33.79	110.57	589.42
Net cash flows < 0								
Cash/Net cash flows (ex.inv.inc)*12	410	93.60	976.74	0.22	5.65	15.41	36.42	148.48

Panel B: Cash in 2018

	Obs.	Mean	St.Dev	p5	p25	Median	p75	p95
Cash/Total assets	1,220	7.95	10.71	0.87	2.47	5.06	9.32	23.92
Cash/Total investments	1,219	8.92	12.88	0.93	2.66	5.33	9.92	28.47
Cash/ Total benefits*12	1,211	49.43	202.78	2.74	8.04	18.31	39.19	146.96
Cash/Outflows*12	1,220	13.11	26.97	1.27	3.66	7.01	13.81	40.09
Net contributions < 0								
Cash/Net contributions*12	283	183.59	644.85	2.79	12.38	34.85	121.93	553.19
Net cash flows < 0								
Cash/ Net cash flows (ex.inv.inc)*12	283	44.41	138.05	1.50	5.50	14.31	34.32	149.50

Table VI
Univariate tests of cash holdings

This table provides univariate tests of cash holdings for pension funds with low vs high ranking of variables that measure operational and investment needs. Each year, we rank pension funds based on the median of the following variables. *Regular net contributions* is regular contributions minus annuities. *Entry VB* include termination benefits transferred by new employees joining the fund and any premiums paid to recover retirement assets from home ownership or divorce withdrawals. *Exit VB & Lump-sums* is the sum of lump-sum and exit vested benefits and *Total expenses* is the sum of investment, administrative and insurance expenses. These variables are computed in % of total assets and are expressed in percentage. Total assets do not include assets managed by insurance companies. With the subscript *t+1*, we refer to next-year cash flows scaled by total assets at year *t. New investments* is the residual of regressing the change in investments from *t* to *t+1* on net cash flows at *t+1* and represents investments made with cash in *t* over *t+1*. *30y-1y* is the yield spread between the 1-year and 30-year Swiss government bonds. *Derivatives* is a dummy equal to 1 if the pension fund has derivative contracts and zero, otherwise. We provide descriptive statistics of cash holdings for each group, expressed in percentage, and then we test whether there are significant differences between the two groups using a t-test.

	Flow variable < Median Low ranking		Flow variable ≥ Median High ranking		(Low-High)	
	Obs.	Mean cash	Obs.	Mean cash	Difference	t-stat
Anticipated operating activity						
Regular net contributions$_{t+1}$	11,276	7.42	10,050	10.67	-3.25	-23.70
Entry VB $_{t+1}$	11,276	8.45	10,050	9.52	-1.07	-7.75
Exit VB & Lump-sums $_{t+1}$	11,276	7.95	10,050	10.07	-2.12	-15.35
Total expenses $_{t+1}$	11,276	7.29	10,050	10.82	-3.54	-25.90
Current operating activity						
Regular net contributions	10,660	7.22	10,666	10.68	-3.46	-25.30
Entry VB	10,666	8.21	10,660	9.70	-1.49	-10.80
Exit VB & Lump-sums	10,666	8.21	10,660	9.70	-1.49	-10.80
Total expenses	10,666	7.07	10,660	10.84	-3.77	-27.70
Investment activity						
New investments	11,276	7.75	10,050	10.3	-2.56	-18.55
30y-1y	10,815	9.06	10,511	8.84	0.22	1.60

	Variable: No		Variable: Yes		(No-Yes)	
	Obs.	Mean cash	Obs.	Mean cash	Difference	t-stat
Derivatives	18,392	9.10	2,934	8.05	1.05	5.20

Table VII
What drives pension fund cash holdings?

This table presents pooled regressions where *Cash* is regressed on variables that proxy for pension fund operational and investment needs and a set of control variables. *Cash* is the percentage of total assets held in cash and equivalents. *Regular net contributions* is regular contributions minus annuities. *Entry VB* include termination benefits transferred by new employees joining the fund and any premiums paid to recover retirement assets from home ownership or divorce withdrawals. *Exit VB & Lump-sums* is the sum of lump-sum and exit vested benefits and *Total expenses* is the sum of investment, administrative and insurance expenses. *Investment income* is income from investments and includes realized and unrealized gains and losses. These variables are computed in % of total assets. Total assets do not include assets managed by insurance companies. With the subscript *t+1*, we refer to next-year cash flows scaled by total assets at year *t. Derivatives* is a dummy equal to 1 if the pension fund has derivative contracts and zero, otherwise. *New investments* is the residual of regressing the change in investments from *t* to *t+1* on net cash flows at *t+1* and represents investments made with cash over *t+1*. *30y-1y* is the yield spread between 1-year and 30-year Swiss government bonds. Regressions (3)-(6) include a set of control variables. *Total assets (ln)* is the natural logarithm of total assets held by the pension fund and *Funding ratio* refers to pension assets over pension liabilities as report by the pension fund. All estimations include year fixed effects except regression (6). We report robust standard errors clustered at the pension fund level in (.). ***, ** and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

	(1) Cash	(2) Cash	(3) Cash	(4) Cash	(5) Cash	(6) Cash
Regular net contributions $_{t+1}$	0.206***					
	(0.062)					
Regular net contributions		0.314***	0.285***	0.250***	0.237***	0.246***
		(0.055)	(0.050)	(0.047)	(0.049)	(0.048)
Entry VB $_{t+1}$	-0.059**	-0.071***	-0.045***	-0.041***	-0.025*	-0.028*
	(0.027)	(0.017)	(0.016)	(0.015)	(0.015)	(0.015)
Entry VB		0.052*	0.081***	0.071***	0.052**	0.052**
		(0.029)	(0.028)	(0.027)	(0.026)	(0.026)
Exit VB & Lump-sums $_{t+1}$	0.093***	0.080**	0.085***	0.100***	0.101***	0.103***
	(0.033)	(0.031)	(0.028)	(0.025)	(0.024)	(0.024)
Exit VB & Lump-sums		-0.004	-0.012	-0.014	-0.006	-0.004
		(0.020)	(0.020)	(0.021)	(0.020)	(0.020)
Total expenses $_{t+1}$	0.761***	0.688***	0.153	0.282*	0.412**	0.388**
	(0.160)	(0.173)	(0.163)	(0.156)	(0.163)	(0.163)
Derivatives	-0.003	-0.002	0.012***	0.012***	0.012***	0.012***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Investment income $_{t+1}$				-0.255***		
				(0.032)		
New investments					0.162***	0.162***
					(0.011)	(0.011)
30y-1y						-0.003***
						(0.001)
Total assets (ln)			-0.010***	-0.009***	-0.010***	-0.011***
			(0.002)	(0.002)	(0.002)	(0.002)
Funding ratio			-0.011**	-0.011**	-0.013**	-0.017***
			(0.005)	(0.005)	(0.005)	(0.006)
_cons	0.067***	0.064***	0.190***	0.198***	0.191***	0.208***
	(0.004)	(0.004)	(0.022)	(0.022)	(0.022)	(0.022)
Obs.	20106	20106	20106	20106	20106	20106
R-squared	0.054	0.060	0.079	0.086	0.116	0.112
Year FE	YES	YES	YES	YES	YES	NO

Table VIII
When are pension funds more efficient in managing their cash?

Columns (1)-(4) present pooled regressions of sample splits where *Cash* is regressed on variables that proxy for pension fund operational and investment needs and a set of control variables. *Cash* is the percentage of total assets held in cash and equivalents. In column (1) and (2), we split to pension funds in accumulation and deccumulation phase and in column (3) and (4), to small and large pension funds based on median size. In column (5), we add year dummies from 2015 and on. *Regular net contributions* is regular contributions minus annuities. *Entry VB* include termination benefits transferred by new employees joining the fund and any premiums paid to recover retirement assets from home ownership or divorce withdrawals. *Exit VB & Lump-sums* is the sum of lump-sum and exit vested benefits and *Total expenses* is the sum of investment, administrative and insurance expenses. These variables are computed in % of total assets. Total assets do not include assets managed by insurance companies. With the subscript *t+1*, we refer to next-year cash flows scaled by total assets at year *t. Derivatives* is a dummy equal to 1 if the pension fund has derivative contracts and zero, otherwise. *New investments* is the residual of regressing the change in investments from *t* to *t+1* on net cash flows at *t+1* and represents investments made with cash over *t+1*. *2015 (2016, 2017)* is a dummy that equals to one for the year 2015 (2016, 2017) and zero, otherwise. *Total assets (ln)* is the natural logarithm of total assets held by the pension fund and *Funding ratio* refers to pension assets over pension liabilities as report by the pension fund. All estimations include year fixed effects except specification (5). We report robust standard errors clustered at the pension fund level in (.). ***, ** and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

	(1) Accumulation phase	(2) Deccumulation phase	(3) Small funds	(4) Large funds	(5) Cash
Regular net contributions	0.279***	0.164	0.368***	0.121**	0.238***
	(0.070)	(0.125)	(0.079)	(0.052)	(0.049)
Entry VB $_{t+1}$	-0.021	-0.125	-0.037**	-0.044	-0.027*
	(0.016)	(0.077)	(0.016)	(0.038)	(0.015)
Entry VB	0.056**	-0.056	0.045	0.034	0.056**
	(0.027)	(0.127)	(0.033)	(0.039)	(0.026)
Exit VB & Lump-sums $_{t+1}$	0.090***	0.243***	0.079***	0.155***	0.100***
	(0.025)	(0.074)	(0.027)	(0.047)	(0.024)
Exit VB & Lump-sums	-0.007	-0.025	-0.016	0.017	-0.005
	(0.024)	(0.024)	(0.025)	(0.022)	(0.020)
Total expenses $_{t+1}$	0.317*	0.975*	0.508***	0.895***	0.398**
	(0.172)	(0.501)	(0.179)	(0.262)	(0.163)
Derivatives	0.011***	0.014***	-0.001	0.005*	0.012***
	(0.004)	(0.005)	(0.006)	(0.003)	(0.003)
New investments	0.157***	0.181***	0.132***	0.265***	0.162***
	(0.012)	(0.029)	(0.012)	(0.027)	(0.011)
2015					-0.012***
					(0.002)
2016					-0.014***
					(0.002)
2017					-0.010***
					(0.002)
Total assets (ln)	-0.011***	-0.008***			-0.010***
	(0.002)	(0.002)			(0.002)
Funding ratio	-0.019**	-0.004	-0.007	0.015	-0.016***
	(0.009)	(0.005)	(0.006)	(0.012)	(0.006)
_cons	0.206***	0.147***	0.077***	0.034**	0.201***
	(0.028)	(0.036)	(0.009)	(0.014)	(0.022)
Obs.	16351	3755	10050	10056	20106
R-squared	0.103	0.132	0.077	0.114	0.114
Year FE	YES	YES	YES	YES	NO

Table IX
Do pension funds accumulate cash flows in cash?

Columns (1)-(3) in **Panel A** present pooled regressions where *Cash* is regressed on its lags, leads of new investments, variables that proxy for pension fund operational and investment needs and a set of control variables. *Cash* is the percentage of total assets held in cash and equivalents. *New investments* is the residual of regressing the change in investments from *t* to *t+1* on net cash flows at *t+1*. This variable represents investments made with cash over *t+1*. *New investments*$_{t+2}$ is the residual of regressing the change in investments from *t* to *t+2* on net cash flows at *t+1* and net cash flows at *t+2*. This represents investments made with cash over *t+1* and *t+2*, and so on. *Regular net contributions* is regular contributions minus annuities. *Entry VB* include termination benefits transferred by new employees joining the fund and any premiums paid to recover retirement assets from home ownership or divorce withdrawals. *Exit VB & Lump-sums* is the sum of lump-sum and exit vested benefits and *Total expenses* is the sum of investment, administrative and insurance expenses. These variables are computed in % of total assets. Total assets do not include assets managed by insurance companies. With the subscript *t+1*, we refer to next-year cash flows scaled by total assets at year *t*. *Derivatives* is a dummy equal to 1 if the pension fund has derivative contracts and zero, otherwise. *30y-1y* is the yield spread between 1-year and 30-year Swiss government bonds. *Total assets (ln)* is the natural logarithm of total assets held by the pension fund and *Funding ratio* refers to pension assets over pension liabilities as report by the pension fund. In column (4), we estimate the following regression:

$$\Delta Cash_{i,t} = a + \lambda(\widehat{Cash}_{i,t} - Cash_{i,t-1}) + \varepsilon_{i,t}$$

where *ΔCash* is the change in cash from *t-1* to *t*. $\widehat{Cash}$ is the predicted target level of cash estimated using equation (1). The parameter λ is the speed of adjustment and measures the fraction of the difference between last year's cash and this year's target cash pension funds cover each year. **Panel B** presents the transition matrix for pension funds in the highest quartile of cash. Each year, pension funds are divided to quartiles of cash. Pension funds that, each year, appear for the first time in the highest quartile of cash are followed for the five subsequent years. The first two columns show the year and the number of these pension funds. The columns that follow provide the proportion of these pension funds that remain in the highest quartile of cash in the five subsequent years.

Panel A: Cash accumulation

	(1) Cash	(2) Cash	(3) Cash	(4) Δcash
$Cash_{t-1}$	0.751***	0.584***		
	(0.022)	(0.020)		
$Cash_{t-2}$		0.103***		
		(0.022)		
$Cash_{t-3}$		0.090***		
		(0.018)		
$Cash_{t-4}$		0.049***		
		(0.013)		
New investments			0.147***	
			(0.014)	
New investments$_{t+2}$			0.109***	
			(0.019)	
New investments$_{t+3}$			0.069***	
			(0.018)	
New investments$_{t+4}$			0.073**	
			(0.029)	
Speed of adjustment				0.260***
				(0.021)
Regular net contributions	0.034	0.002	0.201***	
	(0.023)	(0.027)	(0.062)	
Entry VB $_{t+1}$	-0.024	-0.005	-0.028	
	(0.016)	(0.022)	(0.030)	
Entry VB	0.056**	0.056*	0.012	
	(0.027)	(0.032)	(0.033)	
Exit VB & Lump-sums $_{t+1}$	0.090***	0.095***	0.094**	

Panel A, Table IX continued.

	(1) Cash	(2) Cash	(3) Cash	(4) Δcash
	(0.023)	(0.029)	(0.045)	
Exit VB & Lump-sums	-0.046*	-0.062**	-0.034	
	(0.028)	(0.031)	(0.029)	
Total expenses $_{t+1}$	-0.083	-0.192	1.011***	
	(0.091)	(0.127)	(0.226)	
Derivatives	0.005***	0.005***	0.010***	
	(0.001)	(0.001)	(0.003)	
30y-1y	-0.013***	-0.006***	-0.003***	
	(0.001)	(0.002)	(0.001)	
Total assets (ln)	-0.004***	-0.004***	-0.007***	
	(0.001)	(0.001)	(0.002)	
Funding ratio	-0.002	-0.002	-0.008	
	(0.003)	(0.002)	(0.005)	
_cons	0.075***	0.060***	0.153***	-0.036***
	(0.009)	(0.009)	(0.025)	(0.003)
Obs.	18085	12514	13716	18085
R-squared	0.591	0.627	0.174	0.141
Year FE	NO	NO	NO	NO

Panel B: Transition matrix for pension funds in the highest quartile of cash

	Number of PFs with first time high cash	Year 1	Year 2	Year 3	Year 4	Year 5
2006	156	46%	21%	13%	12%	9%
2007	134	44%	25%	18%	13%	9%
2008	121	36%	22%	13%	13%	8%
2009	95	37%	26%	19%	13%	7%
2010	70	46%	24%	14%	10%	9%
2011	55	25%	18%	16%	7%	7%
2012	59	46%	27%	20%	12%	12%
2013	46	35%	15%	11%	4%	4%
2014	34	29%	18%	15%	12%	
2015	39	46%	26%	23%		
2016	32	50%	31%			
2017	24	46%				

Table X
How persistent are cash holdings?

Panel A presents pooled regressions where *Cash* is regressed on *Initial cash* and variables that proxy for pension fund operational and investment needs. *Cash* is the percentage of total assets held in cash and equivalents. *Initial cash* is cash held during the first year a pension fund appears in the sample. We drop the first observation for each pension fund to avoid an identity specification. *Regular net contributions* is regular contributions minus annuities. *Entry VB* include termination benefits transferred by new employees joining the fund and any premiums paid to recover retirement assets from home ownership or divorce withdrawals. *Exit VB & Lump-sums* is the sum of lump-sum and exit vested benefits and *Total expenses* is the sum of investment, administrative and insurance expenses. These variables are computed in % of total assets. Total assets do not include assets managed by insurance companies. With the subscript *t+1*, we refer to next-year cash flows scaled by total assets at year *t. Derivatives* is a dummy equal to 1 if the pension fund has derivative contracts and zero, otherwise. *New investments* is the residual of regressing the change in investments from *t* to *t+1* on net cash flows at *t+1* and represents investments made with cash over *t+1*. *30y-1y* is the yield spread between 1-year and 30-year Swiss government bonds. **Panel B** shows a variance decomposition for different models used to determine pension fund cash holdings as well as their R-squared in the last row. We compute Type III partial sum of squares for each factor used in the respective model. We normalize each column to sum to one by dividing the total sum of squares of the all the factors included in the model. Pension fund FE (Year FE) are pension fund (calendar year) fixed effects.

Panel A: The impact of initial cash on current cash holdings

	(1)	(2)	(3)
	cash	cash	cash
Initial cash	0.470***	0.455***	0.453***
	(0.041)	(0.042)	(0.043)
Regular net contributions		0.077*	0.102**
		(0.045)	(0.045)
Entry VB $_{t+1}$		-0.051***	-0.062***
		(0.015)	(0.015)
Entry VB		0.016	0.015
		(0.031)	(0.031)
Exit VB & Lump-sums $_{t+1}$		0.073***	0.077***
		(0.022)	(0.022)
Exit VB & Lump-sums		-0.009	-0.005
		(0.020)	(0.020)
Total expenses $_{t+1}$		0.737***	0.745***
		(0.152)	(0.153)
Derivatives		-0.000	-0.001
		(0.003)	(0.003)
New investments		0.137***	0.138***
		(0.010)	(0.010)
30y-1y			-0.005***
			(0.001)
_cons	0.046***	0.027***	0.035***
	(0.003)	(0.004)	(0.004)
Obs.	19321	18101	18101
R-squared	0.244	0.315	0.306
Year FE	NO	Yes	NO

Panel B: Variance decomposition of pension fund cash holdings

Variable	(1)	(2)	(3)	(4)	(5)
Pension fund FE	1.000		0.987		0.983
Year FE		1.000	0.013	0.112	0.011
Regular net contributions				0.102	0.000
Entry VB				0.001	0.002
Entry VB_{t+1}				0.010	0.000
Exit VB & Lump-sums				0.000	0.000
Exit VB & Lump-sums $_{t+1}$				0.048	0.003
Total expenses $_{t+1}$				0.171	0.001
Derivatives				0.001	0.000
New investments				0.553	0.066
R-squared	0.573	0.011	0.582	0.095	0.654

Table XI
How much of the cash held is excess?

This table presents summary statistics of our three definitions of excess cash over the period 2005-2018. *Actual cash* is the actual cash held. *Estimated normal cash 1* is the cash estimated using specification (5), Table VII considering only coefficients in line with our predictions. *Estimated normal cash 2* is the cash estimated using specification (5), Table VII, including pension fund fixed effects and considering only coefficients in line with our predictions. *Model-free normal* cash is computed as 3/12 times next-year outflows plus 1% (to account for cash needed for investments) plus 1% only for pension funds that have derivative contracts running. *Excess cash* is then the difference of actual cash and the estimated or model-free normal cash. These variables are computed in % of total assets and are expressed in percentage. Total assets do not include assets managed by insurance companies.

	Obs.	Mean	St.Dev	p5	p25	Median	p75	p95
Actual cash	7,915	16.50	12.55	7.08	9.46	12.52	18.51	40.52
Estimated normal cash 1	7,915	7.86	3.10	4.28	6.90	7.87	9.12	11.96
Excess cash 1	7,915	8.64	11.85	0.33	1.86	4.66	10.46	31.00
Actual cash	7,634	16.89	12.62	7.55	9.83	12.86	18.81	41.44
Estimated normal cash 2	7,634	7.92	3.51	3.35	7.34	8.22	9.26	11.68
Excess cash 2	7,634	8.97	12.09	0.34	1.91	4.82	11.00	31.69
Actual cash	14,287	11.13	10.33	3.38	5.36	8.04	12.90	28.89
Model-free normal cash	14,287	3.52	1.36	2.07	2.67	3.23	4.00	5.93
Excess cash 3	14,287	7.61	10.11	0.37	1.98	4.47	9.17	24.83

Table XII
What is the cost of holding excess cash?

Panel A depicts the expected excess return benchmarks we use to compute the cost of excess cash. We use world equity and long-term bond expected excess returns over treasury bills by Dimson et al. (2011-2018) estimated as an average over 100 years. Alternatively, we use institutional investors' expected returns for bonds, domestic and international equities and real estate provided by the U.S Governmental Accounting Standards Board Statement (GASB) 67. **Panel B** presents summary statistics for the cost of holding excessive cash over the period 2005-2018. We apply hypothetical weights (60/40 bonds/equities and 40/20/20/20 bonds/domestic equities/international equities/real estate) on the estimated excess cash and on expected excess return benchmarks to estimate the additional performance pension funds could have attained if excess cash was invested in a combination of other assets. *Cost of excess cash 1-3* corresponds to each of our three definitions of excess cash. Benchmark returns and the cost of excessive cash are expressed in percentage.

Panel A: Expected excess returns by Dimson et al. (2011-2018) and GASB No. 67

	Equity excess return over bills	Bond excess return over bills
Dimson et al. (2011-2018)		
2005	4.2	0.8
2006	4.2	0.8
2007	4.2	0.8
2008	4.2	0.8
2009	4.4	0.7
2010	4.5	0.7
2011	4.4	0.9
2012	4.1	0.8
2013	4.3	0.9
2014	4.3	1.0
2015	4.2	1.0
2016	4.2	1.0
2017	4.3	1.1
GASB No. 67		
Domestic equity	5.4	
International equity	5.5	
Fixed income	1.3	
Real estate	4.5	
Cash	0	

Panel B: The cost of excess cash

	N	Mean	St.Dev	p5	p25	Median	p75	p95
Dimson et al. (2011-2018), historical starting from 1900								
60% Bonds/40% Equities								
Cost of excess cash 1	7,915	0.19	0.26	0.01	0.04	0.10	0.23	0.69
Cost of excess cash 2	7,634	0.20	0.27	0.01	0.04	0.11	0.24	0.71
Cost of excess cash 3	14,287	0.17	0.22	0.01	0.04	0.10	0.20	0.55
GASB No. 67								
40% Bonds/20% Domestic equities/20% International equities/20% Real estate								
Cost of excess cash 1	7,915	0.31	0.43	0.01	0.07	0.17	0.38	1.12
Cost of excess cash 2	7,634	0.32	0.44	0.01	0.07	0.17	0.40	1.14
Cost of excess cash 3	14,287	0.27	0.36	0.01	0.07	0.16	0.33	0.89

Figure I
Cash holdings by country

This figure presents cash holdings of pension funds in Canada, Netherlands, Switzerland, and United states over the period 2006-2018. The data is retrieved from the database of the Organization of Economic Co-operation and Development (OECD) and refers to aggregate allocations on cash and cash equivalents as a percentage of aggregate total investments.

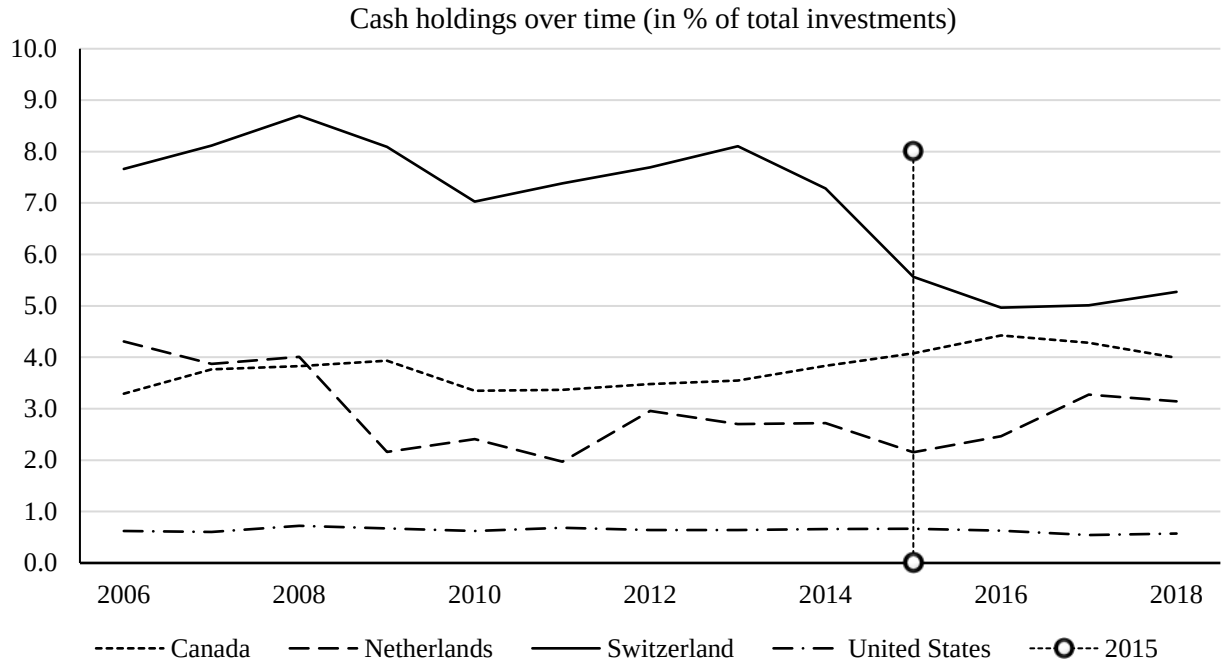
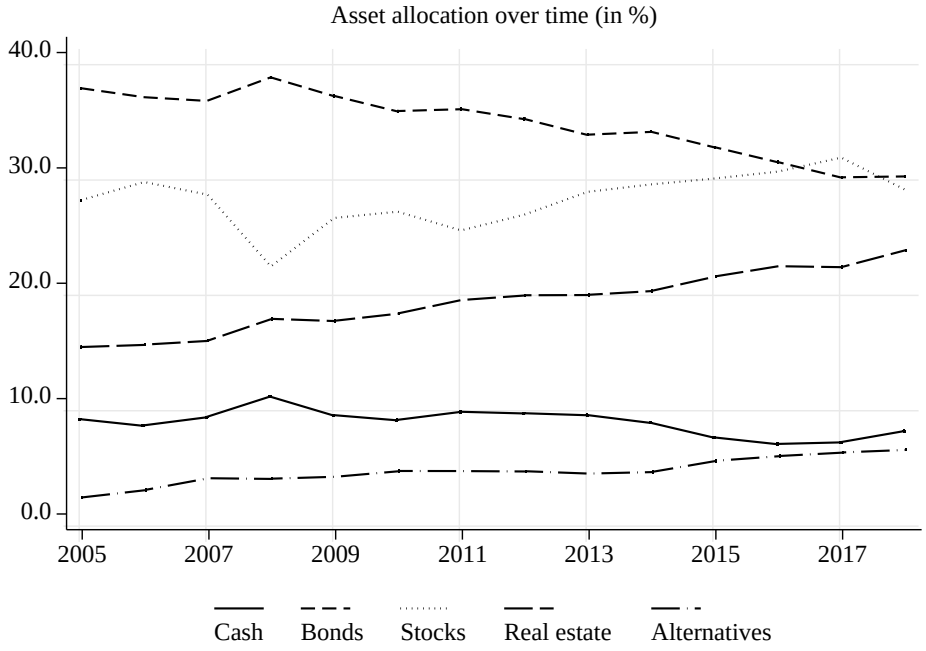
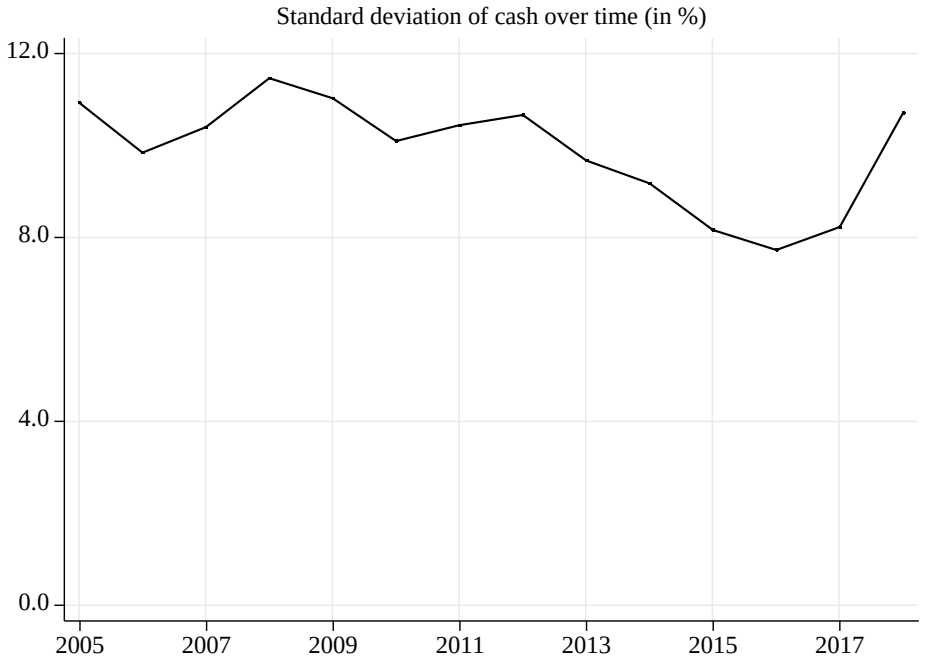


Figure II
Asset allocation and cross-sectional variation over time

The upper graph of this figure shows average asset allocations over time. *Cash* refers to cash and cash equivalents (CHF and foreign currency). *Bonds* is the total investments in Swiss and foreign bonds as well as in foreign currency bonds. *Stocks* is the total investments in Swiss and foreign stocks. *Real estate* is the total investments in Swiss and foreign direct and indirect real estate. *Alternatives* is investments in hedge funds, private equity, commodities, infrastructures, insurance-linked securities and others. The lower graph presents the cross-sectional variation of cash over time. This is computed as the cross-sectional standard deviation of cash holdings each year. All variables are computed in % of total assets and are expressed in percentage**.** Total assets do not include assets managed by insurance companies.





Appendix

Table A.1
The Swiss 2nd pillar

The Swiss occupational pension system, the 2nd Pillar, is based on the Swiss Federal Law on Occupational Retirement, Survivors' and Disability Pension Plans (BVG/LPP). It is mandatory for all employees above a threshold salary in Switzerland and aims at maintaining the standards of living at retirement. Swiss pension funds are financed with contributions paid by both employees and employers. Contribution rates are set by law and increase with the age of the employee. Although the amount of contributions is decided by the pension fund, employers are obliged to pay an amount that is at least equal to the sum of contributions paid by the employees (LPP, art. 66). A member can choose to receive a monthly pension when retired, an annuity, or a partial or full lump-sum payment which should be at least 25% of the accumulated retirement assets. However, the exact amount of the lump-sum as well as the time limit for the notice are on the discretion of the pension fund (LPP, art. 37). Withdrawals of the accumulated pension capital are allowed for housing, self-employment or a permanent departure from Switzerland. In case the employee changes jobs within Switzerland, the accumulated pension capital is transferred directly to the pension fund of the new employer or to a vested benefits account.

Swiss pension funds should remain sufficiently funded to ensure that benefits are secure. The funding ratio measures pension funds' capacity to cover their promises, is calculated based on guidelines set by the law (OPP 2, art. 4 et annexe), and is roughly defined as pension assets over pension liabilities discounted at the technical rate. Technical rates can differ among pension funds but should not exceed the national reference rate set by the Swiss Chamber of Pension Actuaries. Reference rates are computed annually based on the 10-year Swiss government bond yield and the 20-year past performance of a pension fund index. All pension funds must be fully funded with a funding ratio of at least 100% (LPP, art.65). An exception to this rule is public pension funds that can be underfunded if they are supported by the state guarantee and have chosen to operate under partial capitalization (LPP, art.72a).

The mandatory insurance in Switzerland covers annual salaries between CHF 21,150 and CHF 84,600 (LPP art. 8), beyond which the salary is called super-mandatory (or super-obligatory). Every employee with a salary of at least CHF 21,150 is therefore obliged to affiliate to a pension fund. There is also a minimum conversion rate applied on the accumulated pension capital for defined contribution plans that is used to calculate the annual pension that corresponds to each retiree (LPP, art. 14-2). Specific to the context of Switzerland is the annual interest rate applied on the retirement assets of the beneficiaries, which is set by Federal Council at a yearly basis. Although Swiss pension funds are obliged to provide these minimum guarantees for the mandatory part of the insurance, employers are allowed to offer more than that. In fact,

the vast majority of Swiss pension funds offers plans that cover more than these minimums, the so-called enveloping plans. Some pension funds provide plans that cover only the super-mandatory part of the salary (and not the part required by the LPP). Such pension funds are less regulated and operate under their own rules in most of the cases.

With regards to the pension fund governance, the Board of Trustees is the superior governing body with an equal number of employer and employee representatives, which is responsible for all the decisions made on the administration and the investment strategy of the fund. The Board of Trustees can either internalize or externalize the administration and the investment management of the fund by mandating either specialized committees and internal managers or external experts and asset managers.

Swiss pension funds are also strictly constrained on how much they allocate to the different asset classes. In particular, the Ordinance on Occupational Retirement, Survivors' and Disability Pension Plans (BVV2/OPP2) sets the upper limits for the asset categories pension funds invest in. Such asset categories involve equities, real estates, alternative investments and unhedged foreign currencies and their limits correspond to 50%, 30%, 15% and 30%, respectively (OPP2 art. 55).

Pension funds in Switzerland differ based on several organizational forms. First, depending on whether the pension fund is founded by a firm or a public authority, it can be private or public, respectively. Second, pension funds that are set up by one employer are called single-employer, whereas pension funds that serve multiple employers through affiliation contracts are called multi-employer. Multi-employer funds can be either collective or common. Collective ones maintain separate accounts and rules for the pension plans of their affiliated employers while common ones run one scheme that maintains similar accounts and rules. Third, pension funds offer plans that are either defined benefit or defined contribution or a mix of both. The main difference between the two types lies on who bears the investment risk. In defined benefit plans, the benefits to be paid are guaranteed in advance based on the salary evolution, years of service and age of the beneficiaries. As the amount of contributions from both employer and employees as well as the required return on investments is set with the goal to ensure such benefits, the employer is the one bearing the risk. On the other hand, in defined contribution plans, the employer and employee contributions along with the performance of the pension assets defines the benefits to be paid and, therefore, the risk is shifted to the employees. However, in Switzerland, the distinction between the plan types is less relevant due to the minimum mandatory guarantees imposed by the LPP. The minimum interest rate and the minimum conversion rate applied on the retirement capital partially transfers the risk from the employees to the pension fund introducing elements of defined benefit plans into defined contribution plans (see, e.g., Bütler (2014), Bütler and Ruesch (2007), Gerber and Weber (2007), Queisser and Vittas (2000)). Although defined contribution plans are considered like defined benefit plans, the fact that many pension funds pay super-mandatory benefits introduces uncertainty as super-mandatory benefits are not covered by LPP. Fourth,

pension funds differ based on the insurance coverage they use. Autonomous pension funds bear the financial and actuarial risks themselves. Autonomous pension funds with a stop-loss cover all risks but are supported by “stop-loss” or “excess-of-loss” contracts with insurance companies to mitigate against potential losses due to market and economic conditions as well as actuarial events. Semi-autonomous pension funds of type 1 undertake old-age risks but transfer the risks of disability and death to insurance companies. Semi-autonomous pension funds of type 2 accumulate retirement savings to buy pensions from insurance companies when these pensions become due, transferring remaining risks to insurance companies. Fully reinsured pension funds transfer all risks to insurance companies and act as intermediaries between beneficiaries and insurance companies.

Table A.2
Sample construction

	All in	Less only super-obligatory funds	Less fully reinsured funds	Less last year before liquidation	Less years of liquidation process	Less 2018 if in liquidation process	Less first year of entering	Less 2018 if entering on 2017
Total obs.	29, 820	24, 669	22, 689	21, 814	21, 635	21, 528	21, 330	21, 326
Total PFs	3, 006	2, 361	2, 118	2, 042	2, 023	2, 023	2, 009	2, 005
Number of PFs per year								
2005	2, 770	2, 193	1, 937	1, 864	1, 829	1, 825	1, 825	1, 825
2006	2, 669	2, 140	1, 917	1, 844	1, 816	1, 811	1, 753	1, 753
2007	2, 543	2, 061	1, 864	1, 795	1, 772	1, 767	1, 741	1, 741
2008	2, 435	1, 996	1, 823	1, 773	1, 751	1, 744	1, 718	1, 718
2009	2, 351	1, 950	1, 793	1, 739	1, 720	1, 714	1, 692	1, 692
2010	2, 265	1, 897	1, 754	1, 688	1, 673	1, 665	1, 648	1, 648
2011	2, 191	1, 835	1, 703	1, 616	1, 606	1, 600	1, 584	1, 584
2012	2, 073	1, 743	1, 619	1, 530	1, 521	1, 512	1, 509	1, 509
2013	1, 957	1, 648	1, 536	1, 457	1, 451	1, 442	1, 436	1, 436
2014	1, 866	1, 569	1, 463	1, 386	1, 381	1, 374	1, 365	1, 365
2015	1, 782	1, 493	1, 391	1, 343	1, 339	1, 330	1, 325	1, 325
2016	1, 713	1, 440	1, 346	1, 296	1, 293	1, 285	1, 282	1, 282
2017	1, 643	1, 386	1, 300	1, 240	1, 240	1, 232	1, 228	1, 228
2018	1, 562	1, 318	1, 243	1, 243	1, 243	1, 227	1, 224	1, 220

Table A.3
Variable definition

Variable	Definition
Total assets	Total assets in pension funds' balance sheet less insurance assets
Total investments	Total investments as reported in pension fund's balance sheet
Cash	Cash and cash equivalents over total assets. It includes bank deposits and investments in money market securities in Swiss franc and foreign currency
Bonds	Investments in domestic and foreign bonds as well as in foreign currency bonds over total assets
Stocks	Investments in domestic and foreign stocks over total assets
Real estate	Investments in direct and indirect, domestic and foreign real estate over total assets
Alternatives	Sum of private equity, hedge funds, commodities, infrastructures, insurance-linked securities and other alternatives over total assets
Retirement savings	The retirement capital of active employees and retirees
Total contributions	Total contributions received over total assets
Regular contributions	Employee and employer contributions
Irregular contributions	Total contributions minus regular contributions
Total benefits	Total benefits paid over total assets
Annuities	Benefits paid as annuities for retirement, death and invalidity over total assets
Lump-sums	Benefits paid as lump-sums for retirement, death and invalidity over total assets
Entry vested benefits	Entry vested benefits which include termination benefits that refer to the transfer of the new employees' retirement savings within the fund and any premiums paid by the beneficiary to recover the retirement assets from home ownership or divorce withdrawals over total assets
Exit vested benefits	Exit vested benefits which include termination benefits and early withdrawals for home ownership and divorce over total assets. Termination benefits refer to the transfer of the retirement savings of the insured employees to the new employer or to a vested benefits account if employment is terminated. Early withdrawals include the withdrawal of retirement assets to finance principal house ownership or to repay a mortgage (art. 30a-30g, LPP) and, in the case of divorce, the withdrawal of half of the vested benefits accrued by the divorced member to transfer it to the entitled spouse's pension fund or vested benefits account (see, e.g., Code Civil Suisse, Partage de la prévoyance professionnelle en cas de divorce)
Investment income	Income from investments over total assets. It includes income and realized and unrealized gains and losses
Total expenses	The sum of investment, administrative and insurance expenses over total assets
Investment expenses	Expenses related to the investment management over total assets
Administrative expenses	Expenses related to the administration of the pension fund over total assets
Insurance expenses	Insurance premiums paid to the Guarantee Fund, which is obligatory for all Swiss pension funds, and premiums paid to the insurance company if the fund is insured over total assets
Inflows	Total contributions plus entry vested benefits plus investment income over total assets
Inflows (ex. inv.inc.)	Inflows excluding investment income
Outflows	Total benefits plus exit vested benefits plus total expenses over total assets
Net contributions	Total contributions minus total benefits
Regular net contributions	Regular contributions minus annuities
Net vested benefits	Entry vested benefits minus exit vested benefits
Net cash flows	Inflows minus outflows
Net cash flows (ex. inv.inc)	Inflows excluding investment income minus outflows
Cash/Total assets	Cash and cash equivalents over total assets
Cash/Total investments	Cash and cash equivalents over total investments
Cash/Total benefits*12	Cash and cash equivalents over total benefits times 12
Cash/Outflows*12	Cash and cash equivalents over outflows times 12
Cash/Net contributions*12	Cash and cash equivalents over total net contributions times 12

Cash/Net cash flows (ex. inv.inc)*12	Cash and cash equivalents over net cash flows, excluding investment income, times 12
Assets CAGR (%)	Cumulative average growth rate of total assets
Contributions CAGR (%)	Cumulative average growth rate of total contributions
Benefits CAGR (%)	Cumulative average growth rate of total benefits
Entry VB	Entry vested benefits
Exit VB & Lump-sums	The sum of lump-sum and exit vested benefits
Derivatives	A dummy equal to 1 if the pension fund has derivative contracts and zero, otherwise
New investments	The residual of regressing the change in investments from *t* to *t+1* on net cash flows at *t+1* and represents investments made with cash over *t+1*
30y-1y	The yield spread between the 1-year and 30-year Swiss government bonds
Initial cash	Cash held during the first year a pension fund appears in the sample. We drop the first observation for each pension fund to avoid an identity specification.
Actual cash	The actual cash held by the pension fund
Estimated normal cash 1	Cash estimated using specification (5), Table VII considering only coefficients in line with our predictions
Estimated normal cash 2	Cash estimated using specification (5), Table VII, including pension fund fixed effects and considering only coefficients in line with our predictions
Model-free normal cash	Computed as 3/12 times next-year outflows plus 1% (to account for cash needed for investments) plus 1% only for pension funds that have derivative contracts running
Excess cash 1	The difference of actual cash and estimated normal cash 1
Excess cash 2	The difference of actual cash and estimated normal cash 2
Excess cash 3	The difference of actual cash and model-free normal cash
Cost of excess cash	Hypothetical weights applied on the proportion of excess cash and on benchmark expected excess returns
Public	A dummy equal to 1 if the pension fund is founded by a public institution and zero, otherwise
Public-Partial cap.	A dummy equal to 1 if the pension fund is founded by a public institution that operates under partial capitalization and zero, otherwise
Public-Full cap.	A dummy equal to 1 if the pension fund is founded by a public institution that operates under full capitalization and zero, otherwise
Private	A dummy equal to 1 if the pension fund is founded by a private institution and zero, otherwise
Single-employer	A dummy equal to 1 for pension fund with only one affiliated employer and zero, otherwise.
Multi-employer	A dummy equal to 1 for pension fund with multiple affiliated employers and zero, otherwise
Collective	A dummy equal to 1 for pension fund with multiple affiliated employers that maintain separate accounts and rules for the pension schemes of the participating employers and zero, otherwise
Common	A dummy equal to 1 for pension fund with multiple affiliated employers and run one pension scheme with similar rules and accounts for the participating employers and zero, otherwise
Autonomous	A dummy equal to 1 if the pension fund covers actuarial and investment risks itself and zero, otherwise
Autonomous (stop-loss)	A dummy equal to 1 if the pension fund covers actuarial and investment risks itself but is supported by "stop-loss" contracts with insurance companies and zero, otherwise
Semi-autonomous type 1	A dummy equal to 1 if the pension fund covers old age risks itself but transfers the risks of death and disability to insurance companies and zero, otherwise
Semi-autonomous type 2	A dummy equal to 1 if the pension fund accumulates retirement savings but transfers all risk to insurance companies and zero, otherwise
DC	A dummy equal to 1 if the pension fund runs defined-contributions plans and zero, otherwise
DB	A dummy equal to 1 if the pension fund runs defined-benefits plans and zero, otherwise.
Mix (DC, DB)	A dummy equal to 1 if the pension fund runs a mix of defined-contributions and defined-benefits plans and zero, otherwise
Beneficiaries	Number of active employees and retirees
Employees	Number of active employees

Retirees	Number of retirees
Beneficiaries ratio	Ratio of active employees to retirees. It is equal to zero if the number of active employees is zero and equal to the overall maximum if the number of retirees is zero
Funding ratio	The funding ratio as reported by the pension fund according to OPP 2 art. 44 et annexe
Total assets (ln)	Natural logarithm of total assets