Leverage to Meet the Pension Promise

Author: Dr. Serguei Zernov, GRI Special Advisor

GLOBAL RISK INSTITUTE

ABSTRACT

The article discusses use of leverage in the context of defined benefit pension plan investment. It defines the term ***leverage****, discusses how leverage creates value using a simple one-period model and stylized market assumptions, examines risks associated with using leverage and reviews methods and best practices to mitigate and manage these risks. The article describes stylized cases of using leverage in practice of managing pension investments.*

1. INTRODUCTION

The term *leverage* in the context of pension investments is a frequent subject of discussions in boardrooms of pension plans and at investment committees. The topic sometimes escapes offices of investment managers and regulators and finds itself in the press: for example, a title in Financial Post warns the public that *Canada's public pension funds are piling on leverage - and risk, warns Moody's* [Lev, 2017]. The Financial Post article refers to a short note on Bloomberg web site, and the latter refers to a research report published by Moody's, a rating agency [Mercer, 2018]. The original material in the Moody's publication indeed raises questions regarding the potential impact of the current economic environment and the use of leverage on the creditworthiness of Canadian public pension plans, but it is much less alarming than one could think reading the title in the Financial Post.

The objective of this article is to define the term *leverage* as it applies in pension investments, describe uses of leverage, present an argument that for many pension plan managers leverage is essential in order to deliver the pension promise and that leverage, when used correctly, reduces investment risk at the same level of expected returns. We will describe risks associated with the use of leverage and how these risks can be mitigated.

2. DEFINITIONS AND BASIC CONSTRUCTS

Leverage refers to the use of debt to finance assets in business practice. Virtually any company uses leverage in its day-to-day operations or strategic development[1]. Financial analysts look at measures of leverage such as *operating leverage* defined as ratio of company's EBIT by EBIT less fixed costs, or financial leverage defined as firm's total assets by its equity.

The measures of leverage used to analyze companies are not relevant in investment management analysis. We introduce below several quantities that are helpful in the context of this article:

Accounting leverage: total assets divided by net assets (assets minus liabilities)

Notional leverage: total asset plus total liabilities divided by net assets

Economic leverage: amount of market exposure per unit of committed capital usually measured as ratio of volatility of an instrument to volatility of the underlying market or asset class.

1 *This means that buying shares of a company that has debt is an investment in a leveraged asset*

We distinguish the following ways to implement a leveraged asset allocation:

On-balance sheet leverage: achieved by rasing wholesale market liabilities

Off-balance sheet leverage: achieved by using balance sheet of a counter- party (a bank, a broker). Examples of off-balance sheet leverage include traded and OTC derivatives and other financial agreements

REPO agreement: a *repurchase agreement* is a form of collateralised short term borrowing with the collateral most often being government debt securities. The party entering a REPO agreement sells a security to a counterparty (a lender) with the promise to buy it back after a defined period at a defined price (usually next day, but not always). The counterparty to a REPO agreement enters a reverse repurchase agreement (RRP).

We will use the term *embedded leverage* of an investment instrument which is economic leverage that is an integral property of that instrument (for example, a company share has embedded leverage as the business is leveraged, or a stock option has embedded leverage as it is equivalent to a dynamically adjusted portfolio of a loan and a position in the underlying stock.

When an investment manager solves an asset allocation problem (strategic and tactical), she solves for exposure to asset classes (equity, fixed income, commodities, credit and others) or risk factors, and then achieves the desired exposure with the help of different types of leverage.

3. USE OF LEVERAGE AND PREFERENCES OF CANADIAN PENSION INVESTORS

In order to calibrate the asset allocation model that we will present later, we need a view on the risk/return preferences and behaviour of the investors - Canadian pension plans in our case. The risk/return preferences of the pension plans can be inferred from their going concern discount rates. It is reasonable to assume that a funded pension plan will have the target rate of return equal to the discount rate plus the plan's management and administration cost plus allowance for error in estimating liabilities. We will assume that the management and administration cost plus allowance for the error is equal to 0.5%. It is important to emphasize that the valuation of liabilities is very sensitive to the discount rate because of very long duration of the liabilities (often longer than 20 years).

Private defined benefit pension plans must value their liabilities (Defined Benefit Obligations, DBO) in compliance with International Financial Reporting Standards (IFRS) for fiscal years beginning on or after January 1, 2011- the applied standard is IAS 19. Essentially, the DBO must be discounted at the corporate bond rate of quality and duration chosen in compliance with the methodology outlined in IFRS and by CICA (Canadian Institute of Chartered Accountants) and CIA (CanadianInstitute of Actuaries)[2]. These requirements impose a narrow band on the adopted discount rate, and consequently - on the target expected return for these plans.

A survey of private pension plan economic assumptions conducted by Morneau-Shepell in 2017 [Mor, 2017] indicates that 72% of the Canadian plans applied the rate between 3.75% and 4.0% to value their DBO.

Public pension plans in Canada have much more freedom in determining the rate at which they discount their obligations. The discount rates of some of the largest Canadian public pension plans are summarized in the table, based on their recent financial reports[3].

CPPIB	5.9%
OTPP	4.8%
OMERS	6.0%
HOOPP	5.5%
PSP	6.1%
LAPP (AIMCO)	5.5%

Thus, Canadian private pension plans target the rate of return on their investment of approximately 4.5%, while the public pension plans target approximately 6.5%. Pension plans that are in deficit may adopt a higher return

2 *A recent GRI report (see [Shen, 2017]) discusses discounting methodologies in details.*

3 *3.9% real plus our assumption of 2.0% inflation in the case of CPPIB*

target to close the funding gap. We will demonstrate below that plans with a higher expected return and risk appetite benefit more from using leverage and are more likely to employ leveraged strategies.

4. EXAMPLE OF STRATEGIC ASSET ALLOCATION

4.1 CAPITAL MARKETS ASSUMPTIONS.

The expected return of a strategy is defined by a set of capital market assumptions and the strategic asset allocation. In order to determine their capital market assumptions, larger asset owners rely on their internal economics and actuarial teams, while smaller firms work with consultants and investment partners. Economics teams of large for-profit investment managers publish their market assumptions, either for the clients or everyone interested.

We used publicly available data as of the beginning of 2018 as a reference point for the assumptions in our example[4].

A long-term forecast of expected returns and risk for any narrowly defined asset class (developed market equity, emerging market credit, or energy-related commodities) cannot be precise, nor can a forecast of the covariance matrix (or dependency between classes in a broader sense than covariance). However, long-term properties of an asset allocation strategy are known with a higher precision and are driven by just a few macroeconomic factors. In order for these benefit of aggregation to materialize, it is important that the assumptions are rooted in an internally consistent set of views on the economy and capital markets, that asset allocators specify their contingent behaviour, and follow their strategy, not being distracted by short-term events. Good governance plays a crucial role in allowing the organisation to follow course and assure strategy continuity.

The examples that we present in the article are constructed using the Markowitz mean-variance approach. Solutions to mean-variance optimization problems (the asset weights) are sensitive to return assumptions. This is because the solution involves inverting an estimate of the covariance matrix that can be poorly defined. The expected return of the portfolio is stable to small changes in the expected returns of the assets, and the risk of the portfolio can be predicted quite precisely.

In practice, investment managers do not use straightforward mean-variance solutions and rather rely on algorithms that produce portfolios that are stable with respect to small changes in the capital market assumptions. These algorithms may involve regularization of the covariance matrix, Bayesian techniques like the Black- Litterman model [Litterman et al., 2004], or heuristic methods such as different flavours of the risk-parity approach.

Table 1. *Expected annualized asset returns (arithmetic) and volatilities*

	Volatility, %	Exp. return, %
Short-term rate	0	2.0
Commodities	15.0	4.0
Gold	13.0	4.0
Long bonds	5.5	3.5
Equities	13.0	6.0
Infl. linked bonds	8.0	4.0

Table 2. *Expected correlations*

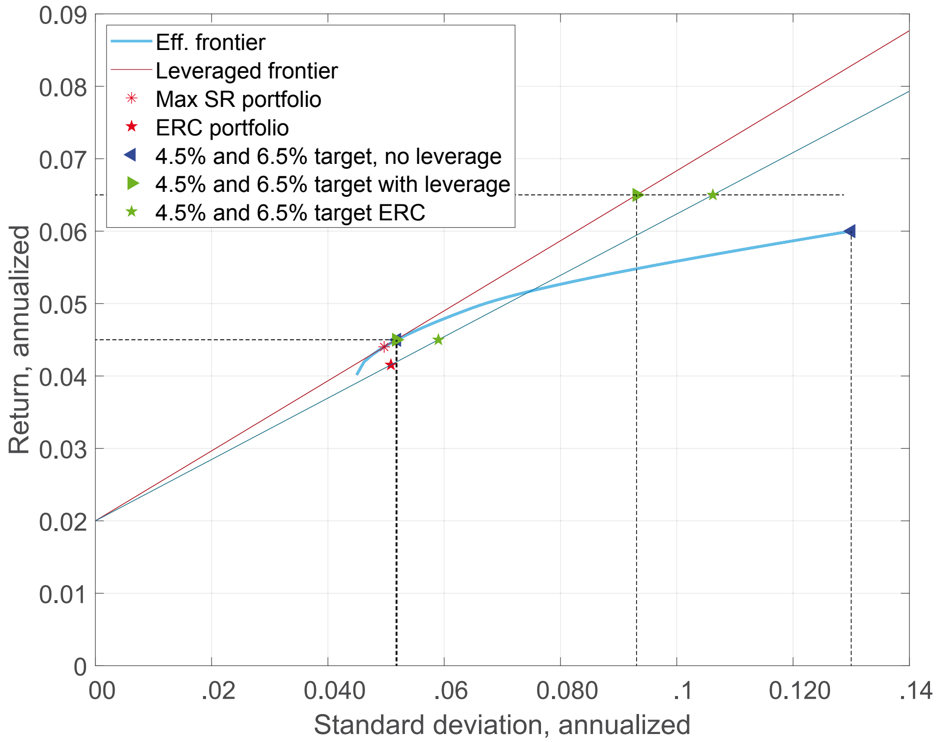
Commodities	1				
Gold	0.15	1			
Long bonds	-0.14	0.35	1		
Equities	0.34	-0.08	0.25	1	
Infl. linked bonds	0.13	0.32	0.80	-0.26	1

We believe that our example employing a simple mean-variance approach is informative for the objective of the paper - evaluating impact of leverage on performance of an asset allocation portfolio calibrated to typical market assumptions. Alternative approaches, such as risk parity or Black-Litterman, would lead to similar conclusions.

Expected asset returns and their standard deviations for the core example are summarized in Table 1 and the correlation matrix in Table 2.

4 *We encourage the reader to study publicly available research by BlackRock [Bla, 2018] or BNY Mellon [Rausch, 2018]*

Figure 1. Efficient frontier: return target objective



4.2. ASSET ALLOCATION WITH A RETURN TARGET.

Given capital markets assumptions in the Section 4.1, the efficient frontier for a fully funded long-only portfolio is shown on Figure 1.

A line connecting the short-term rate with the maximum (long-only) Sharpe ratio portfolio is the efficient frontier for leveraged opportunities (assuming that the cost of borrowing is equal to the cost of lending for the investor). As the graph illustrates, given these specific capital market assumptions, the efficient portfolio for an investor with return target of 4.5% (corporate DB pension in our example) cannot be improved much by using leverage. As far as it concerns the portfolio of our stylized DB public pension plan, it cannot achieve the expected target of 6.5% with a long-only portfolio in the investment universe of the example. The reason why is intuitive: a portfolio invested fully in Equity will have expected return of 6.0% and volatility 13.0% - this is the highest achievable expected return for a portfolio for this universe that is not leveraged.

We also constructed the *equal risk contribution* (ERC) portfolio, one of the strategies known under *risk parity* classification, to illustrate an alternative algorithm[5].

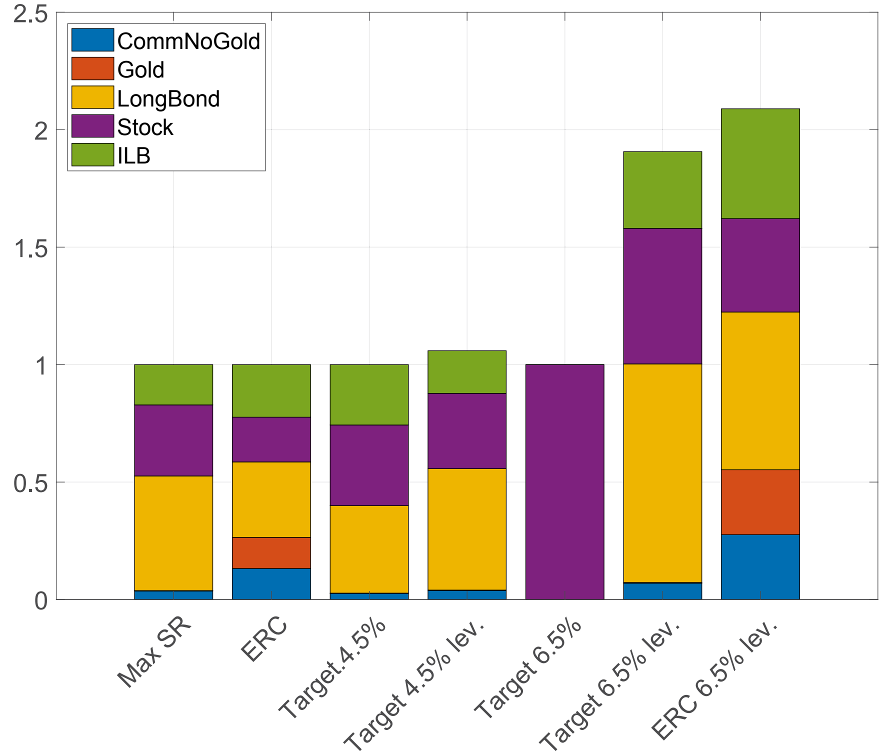
The fully invested ERC portfolio, as well as ERC portfolios leveraged to target 4.5% and 6.5% are shown on Figure 1 as well.

Figure 2 shows the composition of the portfolios discussed above. It is worth noting that the model arrives at the optimal leverage of approximately 2 under the example market assumptions for both the leveraged maximum Sharpe ratio portfolio, and the ERC portfolio targeting 6.5%.

Using assets with embedded leverage. We have just shown that a portfolio manager with access only to the asset classes in this example cannot achieve the target return 6.5% without leveraging the portfolio. What if the manager can invest in an instrument that is a leveraged version of

5 *The ERC portfolio is suboptimal in theoretical mean-variance framework - the leveraged maximum Sharpe Ratio portfolios are optimal by definition. This does not mean that ERC portfolios underperform in practical applications. The important reason is that optimal mean- variance portfolios rely heavily on the accuracy of the market assumptions, which are just forecasts. There are several publications exploring comparative performance of different asset allocation approaches - for example, in [Chaves et al., 2011]*

Figure 2. *Composition of portfolios*



one of the asset classes in the universe - for example, in Equity leveraged 1.5 times? Private equity is an asset with embedded leverage, and pension plans use private equity in their asset allocation. There are studies that argue that a large part of performance of private equity investments can be explained by leveraged public asset classes, such as small-cap equity - see [L'her et al., 2016]. The *Leveraged equity* asset that we constructed has 19.5% volatility and expected return 8.0%, assuming financing at the short-term rate ((1.5(6% − 2%) + 2%)).

Figure 3 shows the resulting efficient frontier and the original frontier. As the figure illustrates, addition of the leveraged asset extends the right end of the frontier and

Figure 3. *Frontier with investment in leveraged equity*

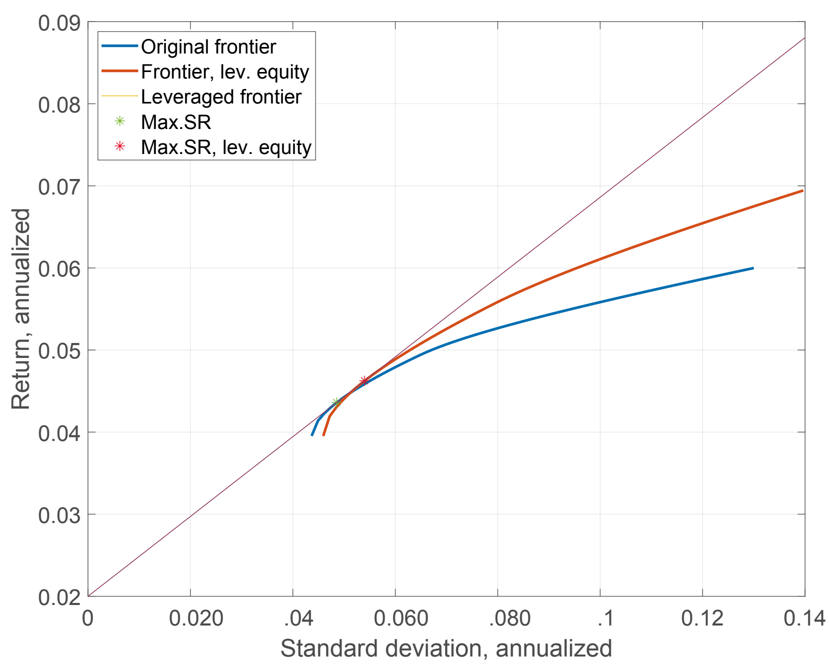
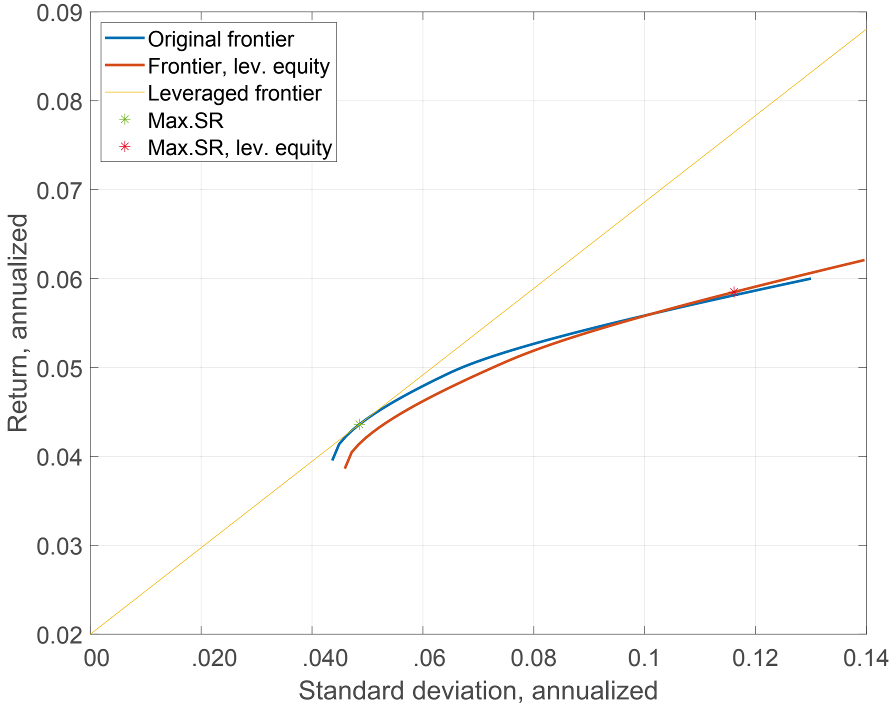


Figure 4. *Frontier with investment in leveraged equity and financing cost of 4.0%*



raises the right part of the frontier. The investor with the return target of 6.5% can achieve her objective without borrowing at the total portfolio level, and the risk-adjusted performance is higher for a range of risk levels. While the rightmost portfolio on the original frontier is invested only in Equity, the portfolio on the new frontier at the same level of return invests in Leveraged Equity and other assets - it is better diversified[6].

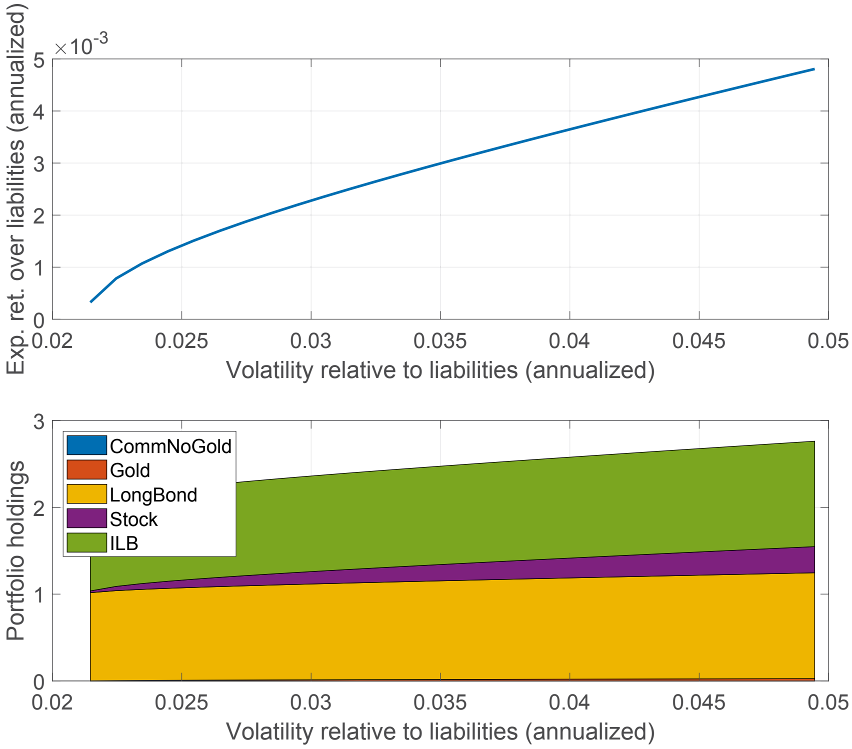
Notice that the maximum Sharpe ratio is the same for the original frontier and the new frontier - their leveraged efficient frontiers coincide and are above both old and new unleveraged frontiers. Thus, provided that expected return of the asset with embedded leverage increases proportionally with leverage, adding a leveraged asset can improve expected risk-adjusted performance of unleveraged portfolios, but theoretically in one-period set-up the improvement is less than what can be achieved by leveraging the total portfolio.

The cost of financing plays an essential role in the performance of an asset with embedded leverage. The cost of financing to leverage the total portfolio is usually low - close to the government short-term rate. Access to cheap financing is achieved either through synthetic leverage (by investing in futures and other derivatives), secured borrowing at the REPO market, or unsecured borrowing for institutions with high credit ratings (public pension plans in Canada enjoy excellent credit ratings). This is not the case for instruments with embedded leverage - for example, [L'her et al., 2016] indicates that the average cost of financing for leveraged buyouts was in excess of 5% in 2014, when short-term rate was essentially zero.

Consider a leveraged equity instrument with the same parameters as described above (1.5 times leverage) but with financing cost of 4%, instead of a 2% short-term rate. The expected return of this instrument will be 7% (1.5 (6% − 4%) + 4%) and the volatility 19.5%. The efficient frontier with this new instrument instead of Equity is almost entirely under the old frontier (see Figure 4) - investing in such an

6 *The frontier shifts because of the constraints - the long-only and the budget. The unconstrained efficient frontier does not change if an asset is added to the universe that is a linear combination of existing assets.*

__Figure 5.__
Efficient frontier relative to liabilities and portfolio holdings



instrument is suboptimal in the practical range of expected risk. In order to be attractive, a leveraged instrument has to overcome this handicap in the cost of financing by generating performance in additions to simply leveraging the underlying asset class.

Another consideration regarding instruments with embedded leverage was presented in [Frazzini and Pedersen, 2012a]. We demonstrated in this paper that an instrument with embedded leverage helps an investor who is constrained to apply leverage to the total portfolio. This creates, according to the authors, additional demand for instruments with embedded leverage and consequently reduces the return - the authors study performance of options and leveraged ETFs.

4.3. ASSET ALLOCATION RELATIVE TO LIABILITIES.

We focus now on a portfolio that is designed to closely follow liability obligations. An investment approach designed to cover current and future liabilities is called *liability-driven investing* (LDI).

We model liabilities as a 50/50% blend of nominal bonds and inflation-linked bonds plus a random error term (we use the instruments as defined in the example earlier). The duration of liabilities of a typical defined pension plan is 20-30 years; fixed income asset classes of the investment universe of the example are calibrated to represent instruments with approximately 10 year durations. It is difficult to find fixed income instruments with very long duration in the market, which is why it is relevant for practitioners to model the yield curve beyond the observable and to use tradeable instruments to replicate long-duration liabilities. See [Shen, 2017] for a detailed discussion. We will leverage the blend of bonds of the universe 2 times to match the duration. The error term in the model of liabilities has annualized volatility 2% and is orthogonal to all universe assets.

The expected return of the liabilities, according to the model, is 5.5% (3.5%+4.0%-2%) and the volatility is 15.2%. The resulting efficient frontier relative to liabilities is shown in Figure 5. As we can see on the bottom chart, the liability matching portfolio is highly leveraged - starting at just over 2 times and increasing as active risk increases. This is not surprising as the liability model has leverage of 2 in terms of the investment universe instruments.

Managers who follow the LDI approach often represent their portfolio as consisting of two components: the liability matching portfolio, and the active portfolio[7]. The liability matching portfolio in the example would consist of 50/50 blend of nominal bonds and ILBs leveraged two times (i.e. liabilities portfolio but without the error term).

Any defined pension plan must invest with its liabilities in mind. The example doesn't have the granularity to discuss in detail the LDI framework and the active portfolio. It is important to notice that the objective of matching liabilities imposes tight constraints on portfolio holdings, and as any constraint, it imposes costs on the performance. Portfolios constructed in the LDI framework are far below the efficient frontier in the absolute returns space and have relatively high volatility - in excess of 13% in the example. Whether the cost of closely matching liability is justified, depends on the preferences of the asset owner.

The conclusion of this section is that following an LDI strategy requires leverage- in practical applications leverage of 3 and above is not unusual.

Case study: HOOPP.

Healthcare of Ontario Pension Plan (HOOPP) is an example of a public defined benefit pension plan that explicitly implements the LDI approach. HOOPP includes in its *liability hedge portfolio* nominal bonds, real return bonds, and real estate, and its *return seeking portfolio* invests in equity, private equity, credit, and active strategies (we rely here on HOOPP's 2017 Financial Report [HOO, 2018].

Balance sheet of HOOPP	
Liabilities, $bln	59.6
Net Assets, $bln	77.8
Total assets, $bln	178.7
Fixed income, $bln	103.2
Real estate, $bln	13.4

We cannot infer exact exposures of the liability portfolio from the report but we can draw approximate conclusions. The firm has over $170bln of assets that can be attributed to the liability-hedging portfolio, and we believe that a larger share of these assets is held to match the liabilities. Thus, the ratio of assets in liability hedging portfolio to liabilities approaches 3 ($170bln by $60bln). The total portfolio of the firm has balance sheet leverage of approximately 2.3 (Total assets ($179bln) by Net Assets, ($78bln)) - this does not account for the leverage through derivatives and investments with embedded leverage.

4.4. VALUE-ADDED THANKS TO LEVERAGE.

Harry Markowitz[8] popularized the expression that *diversification is the only free lunch in investing*, which became an accepted "truth" in academia and industry. In practice, however, diversification is not free. As we saw in the example, a diversified portfolio (maximum Sharpe ratio portfolio) is a low risk and also a low expected return portfolio. As an asset owner has targets expressed as return expectations, rather than in risk-adjusted return expectations, the best diversified portfolio may be not be able to meet the goals. As the asset owner faces fixed costs, their impact on performance is also higher at lower levers of expected returns. Leverage allows the investor to expand the set of possible portfolios and raise the efficient frontier, thus meeting the objectives with a better risk/return trade off. It is not a free lunch but rather an expanded menu of lunch choices.

The examples in this article are based on a simple one-period model that is not directly applicable to practice and uses stylized market assumptions. We also do not conduct sensitivity analysis. However, the market assumptions in the example are realistic and consistent with more advanced studies. The conclusions of the model are also broadly consistent with behaviour and portfolio allocation decisions of actual asset owners.

The example illustrates a significant potential for creating value through leverage for portfolios with a higher return objective. The leveraged portfolio with the return target

7 *The result similar to the portfolio separation theorem with the caveat that the liability matching portfolio in practice is correlated with the active portfolio, albeit the correlation is low.*

8 *Harry Markowitz is a Nobel Prize winner in Economics who pioneered the framework that we use in the examples of this article*

6.5% outperforms the portfolio without leverage at the same risk level by more than 1% (see Figure 1). This is a large margin for a long-term investor. Even if only half of the value is realized, it is still economically significant.

The potential to benefit from using leverage decreases at lower levels of the target return - there is virtually no value created at the expected return level of 4.5% in the example in Section 4.2. This conclusion holds in many practical situations.

Use of leverage by a pension plan gives the members access to financing at a low cost. There are few, if any, investment instruments available to a retail investor that allow such cost-efficient financing: the cheapest sources of retail financing, such as home equity line of credit or secured borrowing on a retail brokerage account, are much more expensive (1.5% REPO rate against in excess of 4.0% in Canada for secured retail lending at the time when this article is written). A typical retail investor does not have the sophistication or sufficient investment capital to access cheap financing by directly investing in derivatives, such as futures. Thus, the ability to execute leveraged strategies is an important source of value creation to members of pension plans. As new National Instruments 81-102 becomes effective, Canadian commercial investment managers are able to offer retail investors funds that invest in derivatives and can use leverage. This reduces advantage of pension plans relative to the commercial competitors that existed due to regulations.

5. ASSET ALLOCATION STRATEGY AND LEVERAGE IN A MULTI-PERIOD CONTEXT

Above we considered one-period (static) examples. While static analysis provides insights into the problem and even allows one to arrive to quantitative conclusions, understanding of portfolio dynamics is absolutely necessary even in the simplest of practical asset allocation strategies. In this article we will list some of the considerations and refer to literature that offers analysis and solutions.

Cost of financing. It is intuitive that an asset allocation strategy that uses leverage depends on the cost of financing. The financing cost is important not on its own, but in relationship to the returns of other assets and how it changes over time.

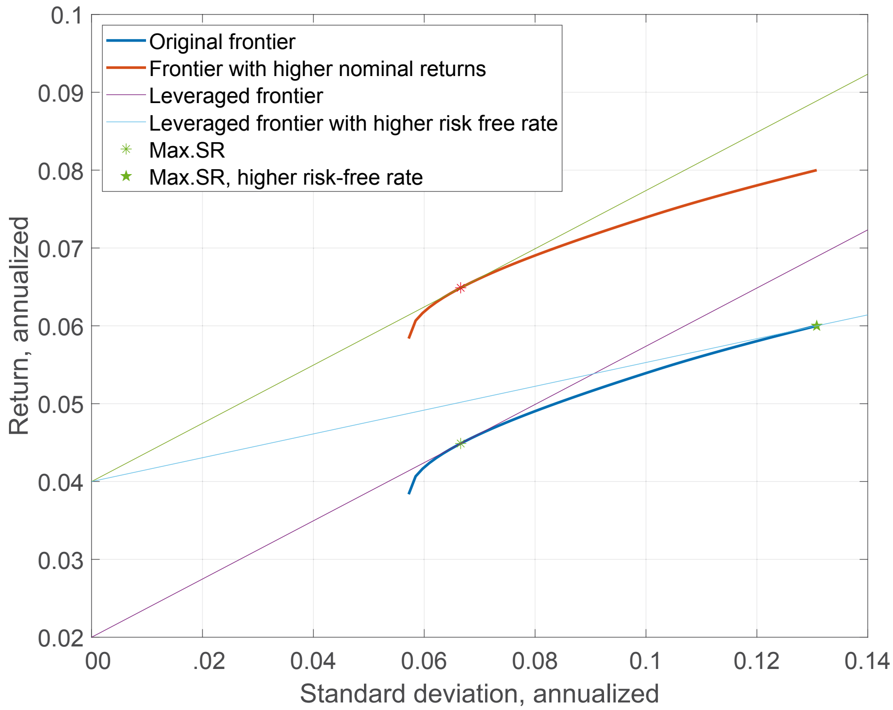
In order to illustrate these points, we once again use a one-period mean-variance framework. All nominal asset returns are influenced by short-term interest rates - asset returns are often defined as premia over the short-term rate. Thus, if all asset returns just shifted with the short-term rate, the problem would be trivial. This is not the case, of course.

Figure 6 shows two efficient frontiers - the lower one corresponds to the base case of the example, and the upper - to the case when the risk free rate and returns of all assets increased by 2% - frontier just shifts up in parallel. Consider the situation when the short-term rate increases but the asset returns do not change. The unleveraged efficient frontier does not move but the maximum Sharpe ratio portfolio moves to the right, and the leveraged frontier changes. In our example an investor with the return target of 6.5% would not benefit from leverage if the cost of financing is increased to 4%.

As the asset allocation strategy is long-term, it should incorporate contingent actions when the financing conditions vary. Variable (stochastic) short-term interest rates introduce problems and opportunities for an asset allocator. Investing in a leveraged asset in dynamic settings is different from investing cash in the same asset in a sense, the use of leverage creates new assets, expands investment universe, and thus creates new investment opportunities.

For example, we demonstrated in Section 4.2 that leveraged strategies tend to allocate a larger share to assets with lower risk, such as fixed income, comparing to an unleveraged strategy with the same expected return. A common discussion question in current market environment (with very low rates by historic standards) is whether it is prudent to allocate a large share of the portfolio to bonds. An investor with a leveraged portfolio thinks not about the dynamics of bond yields over her decision horizon, but rather about what will happens to the yields relative to the cost of financing over the same horizon - returns of (rolled) leveraged bonds do not follow returns of a cash investment in bonds.

Figure 6. Leverage and cost of financing



Transaction costs. Use of leverage means a higher nominal dollar exposure of the portfolio, usually - a higher portfolio turnover as a percent of the net asset value, and higher transaction costs in absolute terms and as a percent of net asset value. While improved performance from using leverage is always qualified as expected, the transaction costs are guaranteed. Thus, careful and strategic planning of portfolio management and execution plays essential role for a leveraged strategy.

Leverage can also help to manage and even to reduce transaction costs. Consider a portfolio that holds liquid and illiquid assets (such as private equity or illiquid bonds). As a result of a change in market conditions the portfolio needs to be rebalanced selling a significant portion of an illiquid asset. If the portfolio manager has derivative instruments at her disposal, such as futures or swaps, and is allowed to use REPO to raise cash, she can adjust the portfolio composition to meet the target asset allocation without the need to immediately dispose of the illiquid asset. This helps to reduce the transaction cost.

Timing of investment decisions, market dynamics, and leverage. The article [M.Anderson et al., 2014] presents a simple two-period example of how the relationship between returns and leverage impacts portfolio performance in the presence of geometric compounding.

Dynamics of leverage in an asset allocation strategy can be driven by:

- *Change in the forecast of the covariance matrix*
- *Change in the short-term interest rate*
- *Change in the net value of the portfolio (for example, if the strategy targets* risk measured in dollars)

Performance of a levered portfolio over time will be driven by, as described in [Anderson et al., 2013]

- *Return of the source portfolio*
- *Magnified return in excess of financing cost*
- *Covariance (or a more complex dynamic relationship) between leverage and excess return*
- *Transaction costs*

Thus, market dynamics interact with investment decisions that involve leverage. It is important that this dynamic interaction is understood when defining an asset allocation strategy, as well as when using leverage tactically - see a discussion of strategic vs. tactical in Appendix B.

6. IMPLEMENTATION OF LEVERAGED ASSET ALLOCATION BY INSTITUTIONAL INVESTORS

6.1. BEST PRACTICES.

From the governance perspective, once the board has formulated investment objectives and risk appetite, and has decided to use leverage to achieve these objectives, a total portfolio approach and a uniform measure of leverage applied across constituent strategies and instruments are essential for the use of leverage to create value. Is it also important to have an integrated process of measuring and managing capital and liquidity risk, as these two risks often impose competing demands on the strategy.

6.2. MISTAKES AND PITFALLS.

Liquidity risk. Leverage imposes demands on liquidity that are different from requirements in an unlevered portfolio. A portfolio manager needs to think strategically and plan for contingent situations when liquidity can dry up, as forced selling of assets may lead to significant losses.

All investments should be ranked from the point of view of their impact on liquidity. At the same time, maintaining liquidity beyond necessary imposes a drag on performance and can nullify any benefits from using leverage, i.e. the manager must have the skills and diligence to walk the fine line.

Implementation shortfall. As we have emphasized above, one-period modelling is not sufficient for evaluating the impact of leverage on strategic asset allocation. First-order approximations that are negligible in one-period analysis sometimes accumulate to have a material impact on performance (usually negative) over a longer time horizon[9].

As far as it concerns transaction costs, we believe that a leveraged strategy should be backtested with tradeable instruments on information sets that are as realistic as possible. The objective of these tests is primarily to see how much the strategy deviates from the theoretical performance and why. Detailed and realistic backtests help to avoid strategies that look good on paper and even in live paper runs but fail to deliver because of unexpected costs.

Finally, leverage can emphasize the impact of geometric compounding and the dependency between returns and volatility. For that reason, it is important to model and backtest a leveraged strategy using a framework that accounts for compounding and timing of cash flows.

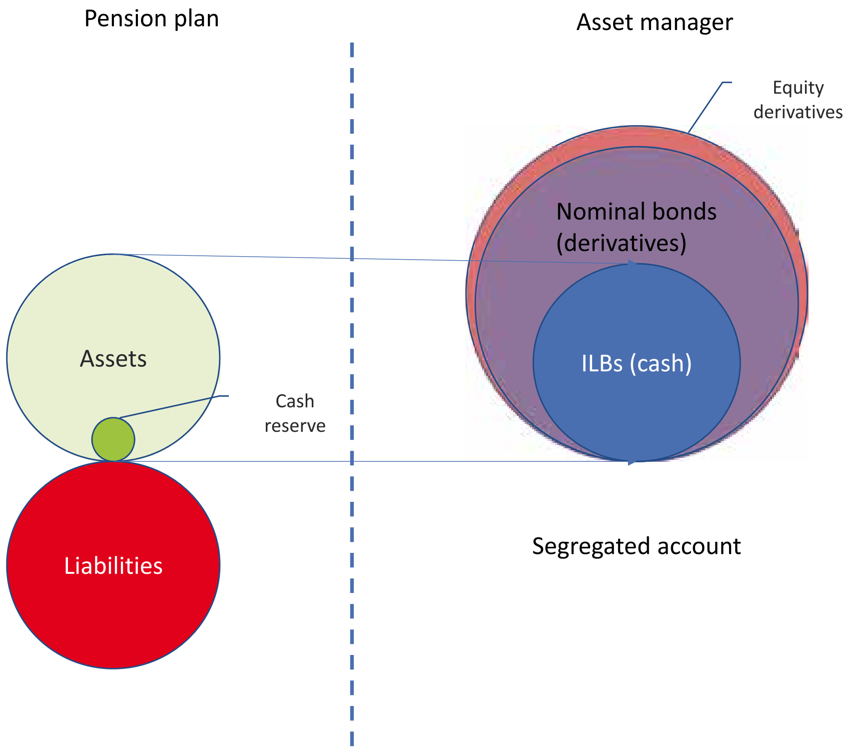
Embedded leverage. We have demonstrated that using instruments with embedded leverage can help to achieve superior investment outcomes when the use of leverage at the portfolio level is constrained. It is crucial, however, that the objective is formulated at the total portfolio level, the instrument with embedded leverage serves to achieve the objective, and the manager has a clear understanding of the exposures of the instrument, what constraints it helps to relax, the instrument's internal cost of financing, liquidity, and performance shortfall. Without that the portfolio manager may arrive to a suboptimal portfolio structure at best, and even suffer losses.

As investors operate in a low-interest rate environment with compressed equity premia, they look for opportunities to generate higher yield. This led to an increasing use of complex illiquid long-term structured financing deals that may offer higher yields and cash flows[10]. These financing arrangements are instruments with embedded leverage. An asset allocator investing in a structured deal should have a clear understanding of how the investment fits into the asset allocation framework at the total portfolio level, including the framework for managing leverage, and what incremental performance it generates at the total portfolio level.

9 *A good example when long-term behavior of a leveraged strategy is different from its short- term behavior are leveraged ETFs - they are almost perfectly correlated with the underlying asset they are designed to replicated, and yet their performance lags the underlying by a very significant margin. These leveraged ETFs perform as they are designed to, just they are not appropriate for investing over a long period of time.*

10 *The instruments in question are equity-linked securities and structured notes, credit-linked securities, leveraged finance, mezzanine finance, project financing, and other arrangements.*

Figure 7. LDI strategy with equity overlay



6.3. EXAMPLES OF USING LEVERAGE IN STRATEGIC ASSET ALLOCATION.

There is a variety of practical ways to implement a leveraged asset allocation. We present stylized examples with progressively increasing complexity and consequently, increasing internal investment expertise and governance.

LDI strategy with equity overlay. Consider a corporate defined benefit pension plan that has $200mln of assets and is fully funded, according to the adopted actuarial assumption. The CFO of the sponsor company and the pension board that she chairs decided to track the liabilities as close as possible with their investment strategy and also generate 0.3 -.4% of additional investment performance in order to cover pension plan administration costs and to have a cushion in case of errors in forecasting liabilities. The liabilities of the plan are partially indexed for inflation and have duration of approximately 20 years.

The Managing Director responsible for managing pension investments consulted the external asset manager, and they adopted market assumptions (asset returns and the covariance matrix). The asset manager suggested the composition of a liability-tracking portfolio consisting of equal exposure to nominal bonds and inflation linked bonds. He advised to add exposure to an international equity index as the performance generating component of the strategy.

The investment manager will use leverage to match the duration of the liabilities with fixed income instruments available on the market. The investment manager invested in a portfolio of international equities using futures with target exposure of 10% of the asset value of the plan. Assuming 6% return on equity, this equity component is expected to generate 0.6% in excess of the liabilities, which covers 0.2% management cost (that includes the adminstration cost, the custodian fees, and the management fee) and provides 0.4% expected excess return for the pension fund. The segregated account managed by the asset manager will likely have leverage of 2 or higher. Figure 7 illustrates this example.

The key risks associated with the strategy are a mismatch of the liability tracking portfolio and a large drawdown in the performance (equity) portfolio. The same strategy can be implemented with the help of an investment bank and total return swaps. Under the latter scenario, the pension plan will have to understand and manage the collateral necessary to maintain derivative positions (under the first implementation scenario the responsibility lies with the asset manager). The swap - based implementation is also exposed to the counterparty risk.

Investment in private equity to improve fund performance. As the performance of the investments of a defined benefit pension plan of a large non-profit organisation lagged expectations in recent years, the plan found itself in a deficit. The situation does not call for an immediate regulatory-mandated action, such a increasing contributions or reducing benefits, but the board is concerned that if investment performance does not improve, the situation may deteriorate. The fund's discount rate for actuarial purposes is 5%, and the board asked the investment team if it would be possible to achieve expected return of 5.5% without increasing the risk level.

The fund is managed by a small professional team consisting of the CIO and four portfolio managers and analysts. The assets are invested in passive strategies and managed internally - the scale of the fund is such that internal management reduces costs, and the board appreciates a higher degree of transparency and control. The pension plan is allowed to invest in nominal bonds, inflation linked bonds, and equity. The plan allocated 50% of its portfolio to equity and 50% of its portfolio to bonds. The SIP&P of the plan does not allow using leverage either through borrowing or derivative instruments - the board believes that they do not have necessary expertise to govern more complex strategies and that the cost of developing such expertise would not be justified.

The CIO suggested to allocate a share of the capital to a private equity fund instead of passively investing in public equities[11]. According to the analysis conducted by the fund's investment team with the help of a consulting company, allocation to private equity will have a higher expected return, will improve portfolio diversification, and lead to a better risk-adjusted performance. The Board supported this course of action.

The pension plan decided to invest in a reputable private equity fund with an excellent performance record. The investment in the private equity fund is expected to outperform two-times leveraged equity by 0.75%, after 2% management fee and 20% performance fee, thanks to the skills of the fund managers.

According to the analysis of the team, the new portfolio will have expected return of 5.5% to meet the board's expectations, at a marginally higher expected risk- 7% in the new strategy against 6.7% of the original strategy. The risk-adjusted performance is expected to increase by more than 10 percent. Approximately 60% of the increase is thanks to better diversification, and the remaining 40% is thanks to the extra return of the private equity fund manager.

While the asset allocation of the original portfolio was 50% equity and 50% nominal bonds, the new portfolio allocates just under 40% to each nominal bonds and inflation-linked bonds, with remaining 25% allocated to leveraged equity (equivalent to 50% equity exposure of the net portfolio value).

The analysis above is illustrated on Figure 8. The efficient frontier of the investment universe is shown on the left side of figure 8. If comparing to Figure 3, the frontier with private equity passes above the leveraged frontier of the original investment set thanks to the expected 0.75% active return of the private equity fund. The asset allocation in terms of capital and exposures is shown on the right side of Figure 8.

Using an asset with embedded leverage improves diversification and risk-adjusted performance in this example, as the embedded leverage helps to relax binding constraints.

The largest risk associated with this investment strategy is that the private equity investment does not deliver expected performance.

11 *This is a stylized example designed to illustrate the principle. Actual exposure created by a private equity investment is more complex than simply leveraged equity and depends on the specific nature of investments. However, studies show that private equity can be modeled with liquid traded instruments quite precisely - see [Stafford, 2016], for example. There are indices and commercial ETFs launched to track private equity returns based on the ideas described in the paper.*

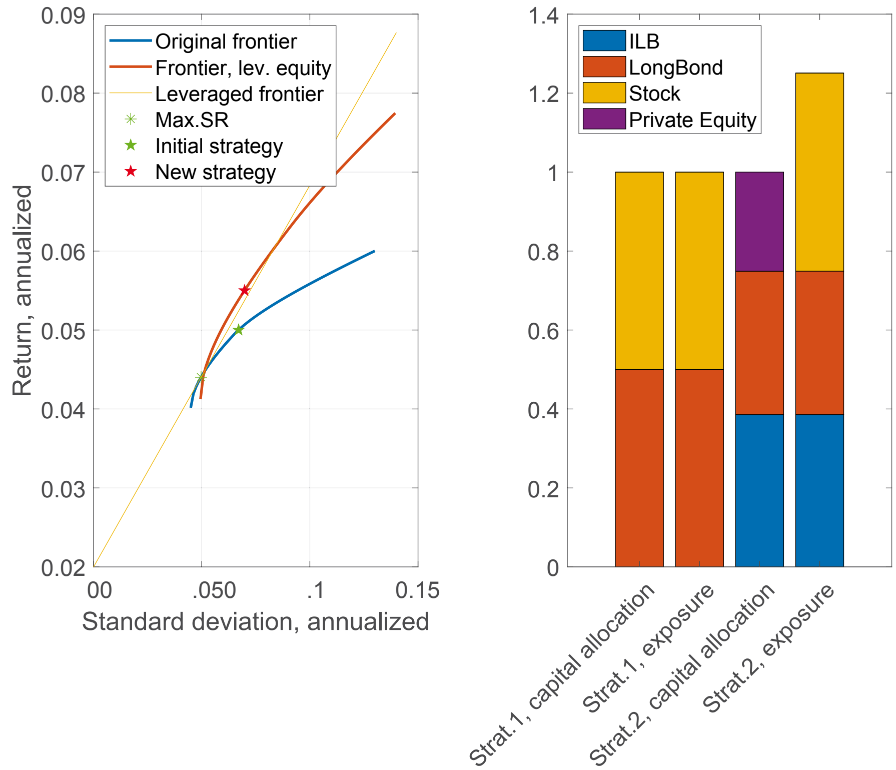


Figure 8. *Increasing performance and improving diversification with private equity investment*

Use of leverage by a large asset owner. The final example of this article introduces a large public pension plan. The plan has an experienced and sophisticated investment team with long history of delivering benefits to the plan members thanks to superior investment outcomes. The plan is fully funded with conservative discount rate assumptions. The plan valuation includes conditional provisions to reduce benefits when the investment performance lags. The board formulates the objective for investment performance so that conditional reduction of benefits would not be normally triggered. Thus, the investment performance objective of the plan is significantly above the discount rate used for the valuation of liabilities. The plan is mature with negative cash flows (annual contribution from the members minus benefits paid out) which imposes strict demands on the plan's liquidity.

The board, in consultation with the management, decided against the formal LDI framework and instead formulated the objective in terms of absolute performance. The Board and the management concluded that given the ambitions investment goals of the plan and a significant investment risk appetite necessary to achieve these goals, following a strict LDI paradigm would impose costly constraints. The investment framework of the plan is, however, conscious of the liabilities when constructing the asset mix and policy benchmarks.

As the plan takes upon ambitious investment performance goals, it will use all tools available, including a wide use of leverage. The team responsible for total portfolio management designs a strategy to achieve the performance objectives while meeting liquidity constraints even in adverse market conditions and within the risk appetite of the board expressed as likelihood for the funding status to remain above a defined threshold[12]. The resulting strategy, expressed as top level exposure to asset classes at any given time[13], incorporates the optimal level of leverage.

As the strategy portfolio is constructed, it is implemented using tools and means that are available and that are

12 Some of the constraints are intentionally formulated as soft constraints, such as the funding status that is protected thanks to the conditional benefit adjustment arrangement. Use of soft constraints reduces the cost of the constraints.

13 Modern investment science developed models that express asset allocation strategies in terms of risk factors. We do not argue advantages of using risk factors versus asset classes in this article- almost everything we discuss in terms of asset classes will be applicable to a risk factor approach. We use asset classes as they require a lower degree of abstraction and thus - less efforts set up the framework optimal at the moment. The financing of investment activities is achieved using the balance sheet, on-balance sheet funding (commercial paper and mid-term debt), REPO agreements, off-balance sheet funding (derivatives - futures, options, and swaps), and investments with embedded leverage (private equity vehicles and structured financing contracts).

The process of managing the strategy is dynamic and takes into account current funding situation, liquidity obligations, and future plans. Essentially, given the mandate and objectives formulated by the board, the investment team plots a path for the portfolio over the planning horizon and moves along this planned path.

7. CONCLUSIONS

We demonstrated in this article that leverage is a powerful tool in the toolbox of a pension investment manager and that use of leverage can be an important source of value creation for the plan members.

We show that a diversified portfolio, when leverage is not allowed, is a portfolio with a low expected return. As pension investors have objectives expressed in terms of expected returns and face fixed costs, the investors are forced to allocate to high-return assets while sacrificing risk-adjusted performance. Leverage allows to achieve higher return targets and to hold a well-diversified portfolio.

The potential to create value thanks to leverage depends on particular circumstances of a pension plan- for example, plans with higher return targets and more appetite for risk rip greater benefits from using leverage. In the context of Canadian defined-benefit pension plans, corporate pension plans must use mark-to-market discount rate and have lower return targets, while public pension plans have latitude in determining the discount rate and take more risk to achieve more ambitious return objectives. The latter benefit more from leveraged strategies, and they are more likely to use them. Both public and private plans need to use leverage if they adopt the LDI framework.

We show how investing in assets with embedded leverage can benefit an investor that is constrained in using leverage at the total portfolio level. Adding an asset with embedded leverage to the investment universe can effectively relax the constraint and improve portfolio diversification. The benefit from investing in an asset with embedded leverage depends crucially on correct assumptions about the asset's expected return. Assets with embedded leverage often have higher internal cost of financing, they are sometimes not transparent, and research suggests that market demand may put upward pressure on their price (see [Frazzini and Pedersen, 2012a]) it is possible to form performance expectations that are too optimistic.

While the examples in this article use one-period Markowitz framework, we argue that it is essential to model leveraged strategies in dynamic multi-period context for practical applications. Dynamic modelling allows to take into account transaction costs, cost of financing, and dynamic relationship between leverage, risk, and asset returns.

We argue that it is essential to model leverage at the total portfolio level rather that at the level of constituent components, and to use a uniform measure of leverage. In particular, assets with embedded leverage, such as private equity or structured finance deals, should be subject to a transparent look-through analysis with a clear understanding of the contribution of these assets to the leverage, expected return and risk of the total portfolio.

Use of leverage can impose demands on liquidity that are not present in a portfolio without leverage. When using leverage, it is important to model and plan liquidity jointly with optimal capital allocation, as capital and liquidity demands often compete one with another.

While using leverage requires advanced knowledge of theory and practice of investments, pension plans with varying level of governance complexity and investment management sophistication can benefit from leverage in strategic asset allocation. We presented three stylized examples with increasing complexity and demands on governance and investment skills. The examples illustrate how very different pension plans address their problems with the help of leverage and arrive to better investment outcomes. The essential take-out from these examples is the approach to making investment decisions: from precise formulation of the investment objective by the board and investment managers, to analysis of available solutions, given the constraints and capabilities, and to choosing the optimal solution from the set of possible.

APPENDIX A.

PORTFOLIO CONSTRUCTION FORMULAS

The mean-variance optimisation used in the example is formulated as follows: denoting expected returns as R and the $N \times N$ covariance matrix as Ω, the long-only fully invested portfolio with target return R_0 is a solution to the following problem:

(A.1)
$$w_p = \arg \min_{\substack{w \\ w \geq 0 \\ w'i = 1 \\ w'R = R_0}} (w'\Omega w)$$

where w is a $N \times 1$ column vector and i is a column of ones.

Equal risk contribution (ERC) portfolio is defined as follows: portfolio volatility is $\sigma_p(w) = \sqrt{w'\Omega w}$.
The Euler decomposition of this yields:

(A.2)
$$\sigma_p(w) = \sum_{i=1}^{N} \sigma_i(w) = \sum_{i=1}^{N} w_i \times \frac{\partial \sigma(w)}{\partial w_i}$$

Thus, risk contribution from asset i is $\sigma_i = w_i \times \frac{\partial \sigma(w)}{\partial w_i}$.
ERC portfolio sets $\sigma_i = \sigma_j$ for all assets. Risk contributions can also be set to budgets as assigned by the portfolio manager.

APPENDIX B.

STRATEGIC VERSUS TACTICAL DECISIONS

The focus of this article is use of leverage for strategic asset allocation. The question arises how to distinguish strategic decisions from tactical, how to attribute performance to strategic versus tactical decisions, and how to attribute impact of using leverage to strategic versus tactical management.

Investopedia defines strategic asset allocation as defining percentages of capital allocated to asset classes (developed market stocks, emerging market stocks, bonds, commodities, etc.) that is likely to meet investor's objectives, investing capital according to these percentages, and rebalancing portfolio periodically. This definition does not address modern investment management technologies and strategies used by managers and asset owners - for example, strategies based on allocating risk or strategies defined in terms of abstract risk factors.

We define strategic asset allocation as a plan and method of making investment decisions in all foreseeable contingent situations with the objective of achieving a strategic goal (i.e. a goal important for the mission of the organisation). Tactical asset allocation is a series of actions and decisions to accomplish strategic asset allocation in current market situation. We define as tactical decisions that taken on current information sets and that are not defined or prescribed as strategic contingent decisions.

This definition still leaves room for subjectivity in deciding whether a decision was tactical or strategic, and we believe that this is acceptable - a decision is defined as strategic or tactical as long as the manager thinks of them as strategic or tactical.

One may think of the statement above as a tautology, similar to "an apple is what is thought to be an apple", but the difference is that an apple exists objecti-vely, while classification into tactical or strategic is defined subjectively by how the manager thinks of her decisions.

To demonstrate the point, assume that a manager uses an estimate of a covariance matrix to construct her investment portfolio, and this covariance matrix is estimated based on current information (for example, a manager uses a historic window to estimate the matrix). As we saw in the example, the covariance matrix drives the portfolio composition. As the manager defined her algorithm upfront and carefully analyzed how a specific estimator of covariance matrix interacts or may interact with market dynamics, the use of the estimated matrix is strategic, even though it is computed with the current information.

Consider now a situation when a manager decided to modify the estimator of the matrix due to either an event that recently happened, that manager believes to be one-off, or her knowledge about forthcoming changes in the market dynamics. This decision is tactical, and the deviation of the portfolio from its strategic composition is tactical. However, if the manager decides to systematise her decision and define new behaviour for a class of similar contingencies, then it becomes a part of strategic asset allocation.

REFERENCES

[Mor, 2017] (2017). 2017 survey. Economic in accounting for pension and other post-retirement benefits. Technical report, Morneau-Shepell.

[Lev, 2017] (2017). Canada's public pension funds are piling on leverage and risk, warns moodys. Financial Post.

[Bla, 2018] (2018). Capital Markets Assumptions 2018. Online, BlackRock, Inc.

[HOO, 2018] (2018). Health Care of Ontario Pension Plan Annual Report. Technical report, HOOPP.

[Anderson et al., 2013] Anderson, R. M., Bianchi, S. W., and Goldberg, L. R. (2013). The Decision to Lever.

[Blitz and Vliet, 2007] Blitz, D. and Vliet, P. (2007). The volatility effect: Lower risk without lower return. 34.

[Chaves et al., 2011] Chaves, D., Hsu, J., Li, F., and Shakernia, O. (2011). Risk Parity Portfolio vs. Other Asset Allocation Heuristic Portfolios. The Journal of Investing, 20(1):108–118.

[Frazzini and Pedersen, 2012a] Frazzini, A. and Pedersen, L. H. (2012a). Embedded leverage. Technical report, National Bureau of Economic Research.

[Frazzini and Pedersen, 2012b] Frazzini, A. and Pedersen, L. H. (2012b). Embedded leverage. Working Paper 18558, National Bureau of Economic Research.

[L'her et al., 2016] L'her, J. F., Stoyanova, R., Shaw, K., Scott, W., and Lai, C. (2016). A bottom- up approach to the risk-adjusted performance of the buyout fund market. Financial Analysts Journal, 72(4):36–48.

[Litterman et al., 2004] Litterman, B. et al. (2004). Modern investment management: an equilibrium approach, volume 246. Wiley.

[M.Anderson et al., 2014] M.Anderson, R., W.Bianchi, S., and R.Goldberg, L. (2014). Determinants of levered portfolio performance. Financial Analysts Journal, 70(6).

[Mercer, 2018] Mercer, J. (2018). Moody's: Higher leverage due to low interest rate environment raises risk for canadian pension funds. Technical report, Moody's.

[Rausch, 2018] Rausch, M. (2018). 10-Year Capital Market Return Assumptions. Technical report, BNY Mellon, Inc.

[Sbruzzi and Phelps, 2018] Sbruzzi, E. and Phelps, S. (2018). Optimal level of leverage using numerical methods.

[Shen, 2017] Shen, S. (2017). Discount Rate Regulation for Canadian Private Defined Benefit Pension Plans. Technical report, Global Risk Institute, Toronto.

[Stafford, 2016] Stafford, E. (2016). Technical report, Harvard Business School.

About the Author

Dr. Serguei Zernov is Investment Strategy Advisor for AGAWA Fund Management. Prior to GRI and AGAWA Serguei was Director, Quantitative Investment and Research at OMERS Capital Market (OCM) where he led a team responsible for developing and successfully managing active systematic strategies invested across asset classes and geographies. He was a member of the OCM leadership team. Serguei also worked as Portfolio Manager and a quantitative researcher at TD Asset Management where he developed and managed systematic equity strategies.

Dr. Zernov received Ph.D. in Economics from McGill University and Diploma with Distinction in Physics and Computer Technologies from Byelorussian State University. Results of his research on topics in financial econometrics were published in journals such as Journal of Financial Econometrics and Applied Financial Economics. He was invited to speak at practitioner's conferences about managing systematic investment strategies and building investment teams.