Risk Management and its Application in the Portfolio Management Process at the Ontario Teachers' Pension Plan

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Chapter 1 – What is Risk?

Before we delve into a detailed discussion of the risk management process at the Ontario Teachers' Pension Plan ("OTPP") and its application in the portfolio management process, we should attempt to define risk.

In the investment world, risk is commonly defined as the chance (probability) of loss. The simplest definition will be the chance of an absolute loss. If you bought a security for $100 and it is now worth only $90, it is a bad outcome and will be considered a "risky" scenario whereas if it is worth $110 it is a good outcome. There is significant anecdotal evidence that many investors define risk this way, mostly small retail investors but perhaps some (or many?) "sophisticated" institutional investors. How many of us like to compare market values to book values, regardless of how long ago the investment was made? We feel good when market values exceed book values and uncomfortable when the opposite occurs. Many investors are reluctant to realize losses as they see it as an admission they have made a mistake. Look at what happens in the housing market. Volumes typically surge when prices trend higher as homeowners compare notes with others on the huge gains they are making on their properties. With a few exceptions, volumes shrink when prices decline. Many homeowners will be reluctant to list and sell in this environment. This is perverse logic (although perfectly explainable by behavioral reasons); for those upgrading to better/larger homes declining prices are more advantageous as the amount they have to add will be smaller, whereas rising prices mean a larger amount has to be dished out. But loss aversion makes us define risk as "the chance of losing money relative to what we spent;" with rising prices we feel good that we have "made money" on our original investment even though the actual subsequent outcome – having to add a larger amount for the upgrade to the newer home – is less favorable.

Statistical measures of risk are popular among institutional investors. These measures are based on various versions of volatility of returns: absolute (standard deviation of returns) or relative to certain policy or market benchmarks (tracking errors). These measures have become commonplace over the last few decades as the Markowitz mean-variance model of the 1950's and

the ensuing CAPM (Capital Assets Pricing Model), breaking risk to "systematic" and "non-systematic" (or "diversifiable" factors) took hold in academia and among "quant" practitioners. The popularity of these measures is also a function of their ease of calculation and the fact that they lend themselves relatively easily to mathematical/statistical processing and manipulation. As realistic measures of risk they suffer however from a few (sometimes serious) flaws:

a. They are based on the assumption that security and asset class returns conform to "normal" distributions. Significant empirical evidence has demonstrated that real life distributions of returns have "fat tails," namely the probability of extreme outcomes (particularly large losses) is much higher than the one implied by "normal" assumptions.

b. Traditional volatility measures do not distinguish between "good" volatility (positive results, either in an absolute sense or relative to benchmarks) and "bad" volatility (absolute or relative losses). Some modified measures such as "semivariance" have attempted to rectify this flaw by incorporating into the volatility measures only "bad" outcomes.

c. All traditional volatility measures do not distinguish between small, even minor losses and large ones. Most investors are far more sensitive to large losses than to small ones. More recent developments in the risk measurement area have started to emphasize the critical importance of "tail risk" or the risk of significant losses.

More sophisticated investors will define risk as the probability of not meeting a certain target return over the holding period of the investment. For instance, if you are saving for retirement, purchasing power is very important and just comparing nominal market-to-book values will not do. If you end up with $110 for every $100 you invested but inflation over the period eroded your purchasing power by 15%, you are not really ahead. Typically, just preserving the real value of the original investment is not sufficient. Most pension plans have certain real return thresholds they have to at least meet (and preferably exceed) in order for them to be able to pay agreed on benefits in the long run. The OTPP, as an example, has to earn a rate of return that exceeds about 5% (per year) in real terms in the long run. Therefore, one of the risks the OTPP is facing is that over a long horizon its annualized return on assets will be lower than this threshold. This is a risky outcome as it will likely require lowering benefits and/or increasing contribution rates.

The OTPP, similar to many other pension plans, also operates within a regulatory environment that does mandate minimum funding levels relative to the plan's marked to market liabilities. An important risk to consider therefore is the risk that liabilities (valued at market) will significantly exceed the plan's assets.

As one can see, risk is multifaceted and cannot be quantified in just one or two simple terms. To make things even more complex, there are also many qualitative elements of risk, such as embarrassment risk, job risk (the risk one will lose his/her job because of bad performance) and others. And the various quantitative measures are often significantly dependent on the investment horizon as they can vary heavily between the short and the long run.

Chapter 2 – Overview of the Ontario Teachers' Pension Plan

To understand the evolution of risk management at the OTPP, it will be useful to briefly overview the plan, its history and main elements.

Before 1990, the Plan was administered by the Ontario government and restricted to investing in non-marketable Government of Ontario debentures. In 1990, the Ontario government established an independent corporation to administer the pension plan and invest its assets in financial markets. Teachers' is currently the largest single-profession pension plan in Canada with C$96.4 billion in assets at the end of 2009.

Teachers' is a defined benefits pension plan with 289,000 members, including 114,000 retired teachers. The pension plan is sponsored by the Ontario Teachers Federation ("OTF") and the Ontario government, which matches teachers' contributions. The two sponsors have the following key responsibilities:

1. Share responsibility for surplus and shortfall
2. Determine the contribution rate and negotiate benefit changes
3. Appoint board members

The OTPP is governed by a board with nine members. Four members are appointed by the OTF and four by the Ontario government. Together, the sponsors appoint the chair. Unlike the practice in many North American public pension organizations, Teachers' adopted the "professional" board model where board members are selected for their qualifications in investments, finance, accounting, law, actuarial science, business management, and technology. The board is required to act independently of both the plan sponsors and the plan's management,

and to make decisions in the best interests of all beneficiaries of the plan. The structure of the board, and the process for appointing its members, ensures that board members are able to operate independently of management. For example, the roles of the chair and the CEO are separated and no member of management is a member of the board, the Audit and Actuarial Committee, or any of the board's other committees.

Board members are responsible for overseeing the management of the pension plan. They oversee investment policies, risk, benchmarks, performance, and compensation. They also approve annual performance objectives and financial plans.

The Plan had net assets of C$96.4 billion as at the end of 2009. A preliminary valuation showed a funding shortfall (excess of liabilities over assets) of C$17.1 billion at the same time. This happened despite good long-term performance along with strong performance in 2009 and demonstrates the funding challenges facing the Plan. The Plan's liabilities can be (somewhat simplistically) seen as a short position in a real return bond with a very long duration. A 1% change in real interest rates has a more than C$25 billion impact on future pension costs. With a significant decline in real interest rates, the Plan could not earn money fast enough to match the growing cost of future pensions. Continuing declines in real interest rates are therefore a major risk factor facing the Plan.

Other significant risk factors are of a demographic nature. The demographic profile of the Plan's membership has matured significantly over the last forty years:

1. In 1970, there were 10 active teachers per retiree. The expected number of years on pension was 20, the average contribution rate was 5.2%, and the required increase in contribution rate for a 10% loss in assets was 0.56%.

2. In 1990, there were 4 active teachers per retiree. The expected number of years on pension was 25, the average contribution rate was 8.0%, and the required increase in contribution rate for a 10% loss in assets was 1.9%.

3. In 2009, there were 1.5 active teachers per retiree. The expected number of years on pension was 30, the average contribution rate was 11.1%, and the required increase in contribution rate for a 10% loss in assets was 4.3%.

4. The maturing of the Plan is expected to continue in the next 10-20 years. In 10 years, the ratio of active teachers per retiree is expected to decline to 1.2:1 and in 20 years to 1:1! And as the Plan ages, it has raised the risk of large contribution rate increases.

The changing demographic profile of the Plan is starkly demonstrated in the relationship between years of work and years in retirement for the average teacher. The average age at retirement is currently about 58, following 26 years (on average) of service during which contributions are made. This is followed by 30 years of collecting an indexed pension. Plus, a survivor may be paid after that.

The maturing of the plan has also brought about higher liquidity requirements. C$4.4 billion in pension benefits were paid in 2009, whereas only C$2.7 billion in total contributions were collected. This gap is expected to grow. With an increasing liquidity risk, cash management will have an increasing importance.

Chapter 3 – Managing Policy/Long-Term Risk at the OTPP

The management of long-term risk at the Ontario Teachers' Pension Plan is facilitated through the periodic development of a long-term policy or strategic asset mix. The strategic asset mix is designed with the following goals in mind:

1. Keep contribution rates stable,
2. Provide stable benefits, and
3. Preserve the long-term sustainability of the plan.

As discussed earlier, the main risk the Plan is facing is not an absolute loss, a loss relative to certain benchmarks or underperforming its peers; rather, it is the risk of not being able to pay the benefits stakeholders agreed on with reasonably stable contribution rates.

Asset-liability modeling is a significant tool in the development of an appropriate policy asset mix. In addition to developing the long-term investment strategy, it is very useful in the analysis of various benefit and contribution rate policies. The model used at the OTPP was internally built and is capable of analyzing numerous scenarios up to a 40-year horizon. The Asset Mix and Risk ("AMR") department is mostly responsible for the development and operation of this tool, as well as developing the various economic scenarios used as inputs into the model and assessing their likelihood. Risk and return are mainly stated in terms of contribution rates and changes in inflation protection provided.

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In setting the Strategic Asset Mix Policy, the Board follows the following steps:

Quantitative Aspects

1. Development of economic and market outlooks
2. Completing an asset-liability study
3. Consider a level of liquidity risk acceptable to the fund

Qualitative Aspects

1. The Board's comfort level with existing and new asset classes
2. Realistic, feasible changes from previous policies
3. Implications on the organization
4. Expertise available at the OTPP

OTPP's staff and management team bring forward any revisions to asset mix policy to the Board of Directors' approval. The Total Fund Guidelines & Objectives is the document describing the delegation and limits between the Board and management. This document will outline the asset mix policy and allowable ranges around it, as well as the total risk budget and the active risk budget.

There are three main types of risk measures used at the OTPP:

1. Contribution Rate Risk: generated through the asset liability model. This is a long term risk indicator; one of the measures is the average of expected 10% worst contribution rates that will be observed over the next 20 years. It is a very long-term risk measure and used to set the asset mix policy.
2. Total Risk
3. Active Risk

The last two are shorter-term risk measures and will be described in chapter 5.

Chapter 4 – Evolution of Risk Management at the OTPP

The current approach to risk management at OTPP has evolved over a period of about 15 years. It was preceded by more traditional risk guidelines such as limits on individual positions or regional and sector positions. Although some elements of this more traditional approach (the use of so called "laundry lists") are still in place in some areas, the overall predominant approach is now based on a quantitative in-house risk system.

The development of this tool was prompted by the recognition in the early 1990's that reliance on the traditional approach is suboptimal and is not conducive to effective portfolio management. These guidelines were typically applied at individual portfolio levels, leading to significant over diversification as in many cases individual portfolio "bets" tend to offset each other in the context of overall departments, asset classes and the total fund. Also, the traditional approach does not lend itself to quantify, aggregate and manage risks in a more structured way. The quantitative approach applied at the OTPP allows setting of risk budgets with few limits rather than long, subjective "laundry lists."

Development of the risk system as well as continuous enhancements to the underlying methodology resides with the AMR department. Unlike the typical structure at many plans, this department is part of OTPP's investment division. This was designed so that people in this department will be actively involved in the investment process, understand the issues the more "hands on" investment people are concerned with, and not be considered to be a bunch of esoteric "quants" or "risk guys" with little understanding of the "real world." The actual process of daily measurement and reporting on risk is executed by Risk Analytics, part of the finance department. Risk Analytics is independent of the investment division, facilitating "arm's length" risk measurement and reporting.

Chapter 5 – Managing Total and Active Risk at the OTPP

Total Risk and Active Risk are both shorter-term risk measures, defined as:

Total Risk: Risk of the assets (actual holdings) relative to the liabilities over 1-year as % of assets. Calculated as the average of 1% of worst events. Used to monitor risk of overall investment plan (policy + active).

Active Risk: Risk of the assets (actual holdings) relative to the benchmarks[1] over 1-year (in $). Calculated as the average of 1% of worst events. Used to monitor risk of the active program at the total fund, department and portfolio levels.

These two risk measures are generated by OTPP's in-house risk system. They have proven to be excellent risk management and monitoring tools. The measurement is based on a Value at Risk (VaR) approach and emphasizes the "tail risk" where the tail includes the 1% of the worst outcomes.

The Investment Planning and Risk Committee ("IPRC") – a senior level committee that includes the chief investment officer, chief investment risk officer, all department heads, and other senior personnel – is delegated the responsibility of managing the total risk for the total fund within the limits as set forth in the Total Fund Guidelines and Objectives.

Following proposals and recommendations made by management, the Board of Directors approves annual risk budgets for the total fund and all departments. No specific limits are set for individual portfolios and department heads may allocate their overall risk budgets within their departments as they see fit. Allocating these risk budgets within departments is not a straightforward exercise; due to varying degrees of diversification, which may also change over time as portfolios change positions and characteristics, the total risk at a department level is often significantly lower than the arithmetic sum of individual portfolios risk levels. Much is done by way of trial and error as well as departments' abilities to manage their aggregate risk through overlay programs.

Let us use the Public Equities department as an example. The department receives its active risk annually (with occasional more frequent revisions) from the Board of Directors. No specific limits are set to individual areas within the department or portfolios within these areas; the senior vice president heading the department and a senior level committee ("PEP" – Public Equity Planning – comprised of the senior vice president and all area heads) ensure that overall department active risk is within limits. They do it by allocating risk and liquidity to areas that are expected to optimize return on allocated risk. As individual areas within Public Equities operate fairly independent of each other, the department's aggregate positions may end up out of the PEP committee's comfort levels. The committee then may put on a variety of overlay positions to mitigate or eliminate the undesirable exposures.

Similar to diversification within departments, there is also considerable diversification when individual departments' active risk levels are aggregated to the total fund.

[1]Weighted composite policy benchmark when applied to the total fund or more specific benchmarks when applied to asset classes, departments or individual portfolios.

The risk management system is not there just to report numbers; it is fully integrated in the portfolio management process. Performance expectations and compensation are based on return to allocated risk targets. Risk analysis is part of the decision making process when considering funding a new mandate (internal or external), unwinding a mandate, topping up or reducing a mandate. "What if" analysis is performed to ensure any of the above decisions keeps the total department risk levels within its allocated risk budget. Analysis is also performed to determine the contribution of any such decision to return relative to the incremental impact on measured risk.

Chapter 6 – Significant Issues with Quantitative Risk Management Systems

Since the financial crisis that started in late 2007 and lasted throughout 2008 and early 2009, much criticism has been thrown at quantitative risk management systems. Some critics even blame the whole financial crisis on over reliance of financial institutions on such systems. While it is entirely possible that in some cases this criticism has merit, I believe it is not the concept and principle that are at fault but rather the reliance on poor systems or poor understanding and application of quantitative systems.

In fact, the risk system applied at the OTPP did not fail. The losses of the fund in 2008 – in absolute terms as well as relative to its composite policy benchmark – were not out of line relative to allocated risk budgets.

Let us review some of the main points of criticism of quantitative risk systems:

- Data Issues – Many institutions rely on relatively short periods of data. It is not uncommon to see models using rolling three to five years of data. This may result from the difficulty and expense involved in building a good, clean long-term data base. The problem is that using such short-term data may capture only an up or down leg of a business/investment cycle and encourage pro-cyclical behavior, where during good times risk measures and perception are low (and the opposite occurs during down trends in markets). If too many institutions use the same short-term approach, bubble or panic situations may develop.

  Applying significant resources to the process, the OTPP has built a long-term database stretching all the way back to 1986. While models relying on short-term data often suffer from absence or dearth of "tail events," there is no shortage of these in Ontario Teachers' data.

- Methodological Issues – Many institutions use models that apply unrealistic assumptions regarding return distributions of various securities and asset classes. Returns are often assumed to conform to normal distributions, an assumption that has been refuted in many studies. The risk system used by the OTPP uses actual historical data whenever possible, allowing for any historically observed return path, without implying the underlying "normality" assumption or any fitted distributions. Any observed "tail" events end up being incorporated in the data.

- Inability or difficulties coming up with quantitative measures of risk for:

  - Non-transparent investments or investments with significantly delayed/limited transparency, such as many hedge funds or other forms of pooled investments. A potential solution used by the OTPP has been the use of third party risk providers to whom the managers of the above structures will disclose positions in a timely manner without this information being disclosed to the OTPP. These risk providers will "crunch the numbers" and forward the calculated risk measures to the OTPP.

  - Less liquid or illiquid investments with only periodic/infrequent pricing or non market based valuations, such as private equity, real estate or infrastructure investments. There is significant ongoing research at the OTPP to develop solutions such as using public markets proxies (adjusted for illiquidity) and incorporating default probabilities.

- Criticism of the use of historical data – Many articles written after the financial crisis came up with arguments such as "the future is going to be very different than the past, therefore models based on past data are useless." These critics advocate using more "qualitative" applications such as scenario analysis or "stress testing." The problem with these arguments is that admittedly the future may be different from the past but very few people, if at all, have proven to have the ability to consistently and correctly forecast future economic and financial turning points. Scenario analysis and stress testing can provide interesting additional information but their application is very subjective (we all have very different assessments of potential future events and the probabilities of their occurrence). As risk management tools they have limited benefits and cannot be an alternative practical tool for risk budgeting and control.

In the extreme, this kind of criticism becomes the "black swan" argument. "Black swans," in brief, are "tail events" that (by definition) occur rarely, appear to be improbable before they occur, and will likely be different than previous tail events. Therefore, no quantitative system can take them into account. The response to this critique will be the same as above; despite some well publicized claims, I doubt whether "black swans" can be forecasted with any degree of consistency. They are usually recognized as such after they already occurred.

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