Financial Planning Assumptions
(Factor Tilted Portfolio)

PWL

Factor Methodology and Data Update
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Introduction

This guide is intended to provide Canadian financial planners with our best estimates of future asset class returns and volatilities to produce financial projections for their clients. Throughout this document, it is assumed that investors hold a broadly diversified portfolio of publicly traded Canadian fixed income securities and global equity, the latter including both developed and emerging markets. These estimates are valid uniquely in the context of an investor who purposely avoids concentration in one or a few securities or sectors. Our investment horizon is 40 years. A comprehensive description of our methodology is also available. For users of the Naviplan financial planning software, key inputs are highlighted in green. We have added an appendix to provide users of Naviplan with data presented in a more compatible format.

We have created this report specifically to help financial advisors who are investing with the mutual funds from Dimensional Fund Advisors Canada. The asset class expected returns, standard deviations, correlations, and distribution yields are designed to replicate the characteristics of the DFA Global Equity fund. Importantly, these characteristics take into account the exposure of this fund to the size, relative price, profitability and investment factors. Due to the difficulties in mimicking the characteristics of DFA's fixed income funds (the nature of the variable maturity and the variable credit strategies makes it hazardous to estimate the factor premiums), we stuck to the FTSE Canada Bond Universe Index as our fixed income component.

Part I of this document provides some background to asset pricing factors. It also details our calculations of historical factor premiums, and why and how we adjust historical premiums to obtain a forward-looking expected premium for the DFA Global Equity Fund. Part II provides the data to update financial plans, assuming the investor holds a factor tilted portfolio such as the DFA Global Equity Fund.

PART I

FACTOR PREMIUM METHODOLOGY

1. Estimating Factor Risk Premiums

The PWL Capital Financial Planning Assumptions have historically been approached from the perspective of a market capitalization weighted index investor. A market capitalization weighted investor expects to earn the equity risk premium – the premium of stock returns in excess of less-risky bonds or bills – for taking on the risk of stock ownership. Since the 1980's research in financial economics has identified other risks for which investors seem to expect compensation for bearing. Depending on who you ask, there may be more than 400 of these systematic pricing factors, commonly referred to simply as "factors," documented in published literature. The proliferation of factors was referred to as a "factor zoo" by then president of the American Finance Association John Cochrane in his 2011 presidential address. In a multi-factor world, investors may choose to structure their portfolios to capture more than a single risk premium.

1.1 Taming the Factor Zoo

Given the zoo of factors and the replication issues across many scientific fields, a fair question to ask is whether factors are robust out of sample or impossible to replicate due to in sample data mining. Jensen, Kelly, and Pedersen (2021) analyze 153 factors across 93 countries using a Bayesian framework which is effective for making reliable inferences in the face of multiple testing. The framework starts with the prior belief that factors have zero expected return and allows the in-sample results to incrementally increase the estimated premium. They found that the majority of factors in their sample can be replicated in sample, can be organized into 13 themes, work out of sample, and are strengthened (not weakened) by the large number of observed factors. They additionally show that some out of sample factor decay should be expected in light of Bayesian posteriors based on published evidence. Stated simply, starting from the prior belief that a factor premium is not different from zero, a published observation strong enough to update this belief may be partially due to luck in which case some of the out of sample premium should be expected to decay. Based on this Bayesian perspective, lower out of sample factor premiums are exactly what we would expect to see. Jensen, Kelly, and Pedersen (2021) find a decline of about a third in post-publication premiums. McLean and Pontiff (2015) study out-of-sample and post-publication return predictability of 97 variables shown to predict cross-sectional stock returns and find that portfolio returns are 26% lower out-of-sample and 58% lower post-publication. They estimate a 32% (58%–26%) lower return from publication-informed trading.

1.2 Choosing Factors

Factor premiums stand up to scrutiny in the data, though we should expect a post-publication decline in the premium of approximately a third. We still need to identify which factors in the zoo we want to pursue in designing investment portfolios. Fama and French (2018) test six possible factor models based on the maximum squared Sharpe ratio and find that a model including the market risk factor (Mkt), the small cap factor (SMB), the value factor (HML), the profitability factor (RMW), the investment factor (CMA), and momentum factor (UMD) performs well in all tests. They provide caution that while momentum appears to perform well in the model, deviating too far from theory should be approached with caution. Fama and French (2015) offer the dividend discount model as a theoretical anchor for the factors in their Five-Factor model, but the strong performance of momentum in tests does still pose a problem for portfolio construction.

Despite its challenging theoretical story, momentum is difficult to ignore empirically. However, Detzel, Novy-Marx, and Velikov (2021) find that when transaction costs are taken into account, models containing high-cost-to-implement factors like momentum perform worse than the Fama and French Five-Factor model.

1.3 The Fama and French Five Factor Model

The dividend discount model says that the theoretical value of a share of stock is the discounted value of expected dividends per share at the infinite horizon.

$$m_t = \sum_{\tau=1}^{\infty} E(d_{t+\tau})/(1+r)^{\tau} \qquad (1)$$

Equation 1 shows that the price m_t at time t is equal to the expected future dividends per share, E($d_{t+\tau}$), discounted at the long-term average expected stock return r.

One of the problems with the dividend discount model is that not all firms pay dividends. Miller and Modigliani (1961) show that given investment policy, dividend policy is irrelevant to the valuation of shares. With dividend policy irrelevance, the value of expected dividends is equal to expected earnings minus expected investment. According to Miller and Modigliani (1961), the total market value of the firm's stock is given by Equation 2:

$$M_t = \sum_{\tau=1}^{\infty} E(Y_{t+\tau} - dB_{t+\tau})/(1+r)^{\tau} \qquad (2)$$

here $Y_{t+\tau}$ is the earnings and $dB_{t+\tau}$ is the expected change in book equity (asset growth). Scaling both sides of Equation 2 by the book value of equity, Bt, Equation 3 gives the theoretical valuation equation as presented by Fama and French (2015).

$$\frac{M_t}{B_t} = \frac{\sum_{\tau=1}^{\infty} E(Y_{t+\tau} - dB_{t+\tau})/(1+r)^{\tau}}{B_t} \qquad (3)$$

This theoretical valuation equation makes three statements about expected stock returns.

1. If we hold everything in Equation 3 constant except for the market value of the stock, Mt, and the expected stock return, r, then a lower ratio of M_t / B_t must imply a higher expected stock return. All else equal, a company with a lower price must have a higher discount rate. This is an expression of the relative price premium.
2. If we hold everything in Equation 3 constant except for expected future earnings, $Y_{t+\tau}$, and the expected stock return, r, then higher expected earnings must imply a higher expected stock return. All else equal, if two companies trade at the same price, the company with higher profits must have a higher discount rate. This is an expression of the profitability premium.

1. If we hold everything in Equation 3 constant except for the expected growth in book value of equity, $dB_{t+\tau}$, and the expected stock return, r, then higher expected asset growth must imply a lower expected stock return. All else equal, if two companies trade at the same price, the company with higher investment must have a lower discount rate. This is an expression of the investment premium.

Measuring expected profitability and expected investment had been a challenge for many years. Novy-Marx (2012) documents the finding that profitability, measured by gross profits-to-assets, adds further explanatory power to asset pricing models. He found that controlling for gross profitability explains most earnings-related anomalies that the Three-Factor model had been unable to explain. Aharoni, Grundy, and Zeng (2013) document a weaker but statistically reliable inverse relationship between asset growth and average returns. Firms with aggressive investment policies, as measured by the growth in the book value of their assets, tend to have lower average returns.

Informed by the theoretical valuation equation and the advances in measuring expected profitability and investment, Fama and French (2015) propose a five-factor asset pricing model. The five factors include market beta, company size, relative price, gross profitability, and investment.

One of the most important insights that we gain from the valuation equation is that the factors should not be considered in isolation. Empirically, Fama and French (1995) show that value stocks tend to have low profitability and investment, and growth stocks, in particular large growth stocks, tend to be profitable and invest aggressively. A portfolio that focuses on profitability without controlling for relative price is likely to result in a portfolio of growth stocks, and a portfolio that focuses on relative price without controlling for profitability is likely to result in a portfolio of stocks with weak profitability. Novy-Marx (2014) argues that buying stocks with robust profitability without paying premium prices is just as much value investing as buying average profitability assets at discount prices. The stocks with the highest expected returns in the market would tend to be the stocks with low relative prices and robust profitability. This makes targeting value and profitability jointly one of the most important aspects of managing a multi-factor portfolio.

Company size was the original pricing anomaly. Interestingly, company size does not make an explicit appearance in the theoretical valuation equation, and the standalone size premium has not been statistically different from zero since publication of the effect by Banz (1981). It would be easy to dismiss the inclusion of small cap stocks based on this information, but that would ignore one of the other empirical realities: other factor premiums are much stronger in small cap stocks. Blitz and Hanauer (2021) show empirically that there are powerful interaction effects between size and other factors, such as value. They show that academic factor portfolios, which consist of 50% large caps and 50% small caps, have significant alphas compared to factor portfolios constructed with 90% large caps and 10% small caps representing market capitalization weights. The conclusion is that the interaction between size and other known factors may be a sufficient reason for long-only investors to systematically overweight small-cap stocks, even if the size characteristic itself is not rewarded with a premium.

From a theoretical perspective, small companies may still fit (with a stretch) into the low-price phenomenon that explain the value premium. If current fundamentals are reasonable proxies for expected cashflows, low prices relative to fundamentals should be related to higher expected returns. Small companies have low prices in absolute terms.

Given this research, we take the view that the factors contained in the Fama and French Five-Factor model provide a good proxy for the priced risk factors available to investors; our client portfolios reflect this by overweighting securities with exposure to these factors.

1.4 Univariate Portfolio Sorts

To develop expectations for future factor premiums, we begin with history. The following long-only portfolios are univariate sorts on company size, book-to-market equity, operating profitability, and investment. In some cases, we expect a premium from the "low" side of a sort, for example low price to book, whereas in other cases we expect it from the "high" side of a sort, for example high operating profitability. The tables have been arranged with the higher expected return side of the sort on the right.

We report the sorted portfolios for size, value, profitability, and investment for US companies over the period July 1963 through May 2022, and for size and value over the period July 1926 through May 2022 based on the availability of data. For additional context, over the period July 1963 through May 2022 the CRSP 1-10 index representing the capitalization weighted US market returned 10.40% with a standard deviation of 15.32% while over the period July 1926 through May 2022 it returned 10.06% with a standard deviation of 18.32%.

Table 1: US Stock Returns 7/1963 – 5/2022

Size	Biggest 30%	Middle 40%	Smallest 30%
Annualized Return	10.27%	11.95%	11.86%
Annualized Standard Deviation	14.87%	18.60%	21.44%

Book / Price	Lowest 30%	Middle 40%	Highest 30%
Annualized Return	10.21%	10.81%	13.45%
Annualized Standard Deviation	16.17%	15.01%	17.37%

Profitability	Weakest 30%	Middle 40%	Most Robust 30%
Annualized Return	7.99%	10.35%	11.83%
Annualized Standard Deviation	18.16%	15.08%	15.23%

Investment	Aggressive 30%	Middle 40%	Conservative 30%
Annualized Return	9.55%	10.82%	13.05%
Annualized Standard Deviation	17.98%	14.20%	15.28%

Table 2: US Stock Returns 7/1926 – 5/2022

Size	Biggest 30%	Middle 40%	Smallest 30%
Annualized Return	9.97%	11.65%	11.80%
Annualized Standard Deviation	17.89%	23.09%	28.65%

Book / Price	Lowest 30%	Middle 40%	Highest 30%
Annualized Return	9.86%	10.35%	12.85%
Annualized Standard Deviation	18.46%	19.61%	24.93%

Source: Teranet - Ken French

1.5 Long-Short Factor Portfolios

Factor portfolios are portfolios constructed to proxy for sensitivity to common risk factors related to variables that capture the variation in returns. Factor portfolios are constructed as long-short portfolios, meaning that they own (long) the side of the factor that is expected to deliver a positive premium, like value stocks, while they sell (short) the side of the factor that is expected to deliver a negative premium, like growth stocks. For the small company premium, we are observing the small company sort minus the big company sort (SMB); for the value premium we are observing the high book to price sort minus the low book to price sort (HML); for the profitability premium we are observing the robust sort minus the weak sort (RMW); and for the investment premium we are observing the conservative sort minus the aggressive sort (CMA). Importantly, by construction the Fama French Five-Factor portfolios consist of portfolios of 50% small stocks and 50% big stocks sorted on each variable for example, HML (High Minus Low) is the average return on the two value portfolios minus the average return on the two growth portfolios,

$$HML = 1/2\,(Small\,Value + Big\,Value) - 1/2\,(Small\,Growth + Big\,Growth)$$

Constructing the factor portfolios this way results in portfolios with about the same weighted-average size, making the difference between the long and short returns largely free of the size factor in returns. Using linear regression, we can measure an investment's sensitivity to the factors in the Fama and French Five-Factor model to approximate its sensitivity to the known drivers of expected returns. If a fund has a regression loading of 1 on a factor, it would be expected to approximately capture 100% of that factor premium. Typically, long-only funds will have a loading below 1 to factors other than market beta.

Table 3: US Stock Premiums 7/1963 - 5/2022

Book / Price	MKT	SMB	HML	RMW	CMA
Annualized Return	5.70%	2.13%	3.26%	3.07%	3.41%
Annualized Standard Deviation	15.44%	10.49%	10.24%	7.67%	6.98%

Source: Ken French

Table 4: Developed Markets ex-US Premiums 7/1992 - 5/2022

Book / Price	MKT	SMB	HML	RMW	CMA
Annualized Return	3.79%	0.73%	3.86%	3.61%	1.52%
Annualized Standard Deviation	15.97%	6.75%	8.18%	4.74%	6.31%

Source: Ken French

Table 5: Emerging Markets Premiums 7/1992 - 5/2022

Book / Price	MKT	SMB	HML	RMW	CMA
Annualized Return	5.01%	0.90%	7.69%	2.09%	3.08%
Annualized Standard Deviation	20.95%	7.24%	7.99%	5.55%	6.66%

Source: Ken French

1.6 Historical Factor Premiums

There is a tremendous amount of variability in the factor premiums across time and regions. We estimate the historical premiums for the world as the market cap weighted average of the developed and emerging markets. To estimate the forward-looking premiums, we will apply a shrinkage factor to the historical premiums which is discussed in the following section

Table 6: World Premiums 7/1992 – 5/2022

Book / Price	MKT	SMB	HML	RMW	CMA
Annualized Return	5.54%	0.36%	3.07%	3.91%	2.65%
Annualized Standard Deviation	15.08%	6.27%	8.69%	4.88%	6.53%

Source: Ken French

2. The Decline of Out-of-Sample Alpha

2.1 Pre/Post Publication Alpha

The decline in post-publication alpha for each non-market risk factor was investigated for the US, developed markets ex US, and emerging markets using Ken French's 5 factor data up to and including April 2022. The full results are presented in Table 7. For the purposes of this analysis, the 1993 publication date of the Fama-French 3 factor model was considered the in/out of sample breakpoint for the size and value factors, while the 2015 publication date of the Fama-French 5 factor model was considered for the profitability and investment factors. Despite the individual factors being found earlier than these dates, the publication dates of the Fama-French papers more accurately represents when the implementation of the factors into portfolio management strategies began.

Table 7 - Pre/Post-Publication alphas for the four non-market risk factors of the Fama-French 5-Factor model for the US, Developed ex US, and Emerging markets.

	US				Developed Ex US				Emerging			
	Full Data	Pre Pub	Post Pub	PP Decline	Full Data	Pre Pub	Post Pub	PP Decline	Full Data	Pre Pub	Post Pub	PP Decline
SMB	0.00110	0.00220	0.00010	95.5%	0.00120	0.00000	0.00150	-	0.00260	0.01260	0.00140	88.9%
HML	0.00380	0.00510	0.00230	54.9%	0.00330	0.00000	0.00360	-	0.00630	0.00260	0.00670	-157.7%
RMW	0.00330	0.00330	0.00300	9.1%	0.00370	0.00390	0.00330	15.4%	0.00260	0.00260	0.00260	0.0%
CMA	0.00390	0.00420	0.00190	54.8%	0.00170	0.00260	0.00000	100.0%	0.00330	0.00390	0.00170	56.4%
Average	0.00303	0.00370	0.00183	50.7%	0.00248	0.00163	0.00210	-29.2%	0.00370	0.00543	0.00310	42.9%

Source: Mclean and Pontiff; Jensen, Kelly and Pederson

The decline in post-publication alpha in US and Emerging markets agrees with findings of McLean and Pontiff (2016) and Jensen et al. (2022) of 58% and 47% respectively. However, the Developed ex US data showed a different relationship, with a larger alpha post-publication. This was due to the lack of data for Developed ex US markets. With the time series beginning in July 1990, this left only ~2.5 years of in-sample data – not enough to draw strong conclusions with. The same can be said for the Emerging markets data set, with only ~3.5 years of in sample data pre-1993. As a result, we consider the 50.7% decline in US post-publication alpha to be the only meaningful result out of the three regions studied.

2.2 Bayesian Shrinkage Factor

The Bayesian approach introduced by Jensen et al. (2022) was applied to this work to determine the Bayesian shrinkage factor, SF, to be applied to the posterior alpha. As derived by Jensen et al. (2022), the shrinkage factor can be calculated using Eq. 4

$$SF = \frac{1}{1+\frac{\sigma^2}{\tau^2 T}} \tag{4}$$

where τ^2 is the variance around a zero mean alpha, σ^2 is the variance of the OLS error terms, and T is the sample size. The shrinkage factor then is multiplied by the historical alpha, $\hat{a}$, to generate the posterior (future expected) alpha, $E(a\,|\,\hat{a})$, illustrated by Eq. 5. Since the shrinkage factor is bound between 0 and 1, the posterior alpha will be bound between 0 and the historical alpha.

$$E(\alpha|\hat{\alpha}) = SF * \hat{\alpha} \tag{5}$$

To examine the consequences of Eq. 4, let us examine the behavior of Eq. 4 at the extremes for each of the three variables, σ, τ, and T, while holding the other variables constant.

For the case of $\sigma = 0$ (meaning 0% standard deviation of error terms – or a high confidence level in the model), SF would simplify to 1/(1+0) = 1. In this case, the expected future alpha would be equal to 100% of the historical mean alpha. That is, we would expect the same alpha moving forward as we have seen in the past – once again because we have a high confidence level in the model.

In the reverse case of high σ (high standard deviation of error terms – low confidence in the model), the shrinkage factor would trend towards zero, meaning that the future expected alpha would trend towards zero as well (see Eq. 5). Since we have low confidence in the model, we cannot rule out that a significant portion of historical alpha was due to luck, hence a lower expected alpha moving forward.

If the standard deviation around a zero-mean alpha, τ, approaches zero, this means we have high confidence that the true alpha is zero, or in other words, the deviations from the CAPM model are zero. That is, the non-market risk factors do not generate outperformance, and the entire performance of the factor can be captured by the market. Looking at Eq. 4, when $\tau^2 \rightarrow 0$ the shrinkage factor also goes to zero. This would lead the expected future alpha to be zero as well (Eq. 5), which would make sense given that we have strong conviction that the factor does not generate alpha.

When we have a high standard deviation around a zero-mean alpha, τ, the shrinkage factor will approach one. The high standard deviation around a zero-mean alpha tells us that the deviations from the CAPM model are high, and we have low confidence that the alpha is zero. The higher the deviations from CAPM, the higher the shrinkage factor, and the closer the expected alpha will match the historical alpha.

Finally, looking at the number of samples, T, we observe the simple relationship that with more data (higher T) the higher the shrinkage factor, the more confident we are that the historical alpha will persist (high expected alpha). With a lower amount of data (low T), the lower the shrinkage factor, the less confident we are that the alpha will persist (low expected alpha).

To begin the analysis, a simple ordinary least squares (OLS) regression was performed on each of the non-market risk factors against the market. The OLS regression is governed by Eq. 6

$$r_t^f = \alpha + \beta r_t^m + \varepsilon_t \tag{6}$$

where r_t^f is the return of the non-market risk factor at time t, r_t^m is the return of the market at time t, a and β are the OLS regression parameters for intercept and slope respectively, and ε_t is the error term. The OLS analysis was performed for the four non-market risk factors for each of the three regions studied. The average shrinkage factor across the three regions was 0.91, in agreement with the 0.9 shrinkage factor calculated by Jensen (2022). Table 2 summarizes the shrinkage factor for each of the three regions.

Table 8: Average shrinkage factor for US, Developed ex US, and Emerging markets.

	SF
US	0.94
Developed Ex US	0.87
Emerging Markets	0.91
Average	0.91

Source: PWL Capital

2.3 Expected Alpha

The results from the Pre/Post Publication Alpha suggest a 0.5 shrinkage factor in post-publication alpha, while the results from the Bayesian approach suggest a 0.9 shrinkage factor. To calculate the expected alpha, we have decided to use the average result between the two theories. The result is a 0.7 shrinkage factor, that is then applied to the historical alpha to generate the expected alpha using Eq. 5. Table 9 summarizes our expected alphas for each factor.

Table 9: Expected alpha for each factor for each region studied.

	US		Developed Ex US		Emerging	
	$\hat{a}$	$E(a \mid \hat{a})$	$\hat{a}$	$E(a \mid \hat{a})$	$\hat{a}$	$E(a \mid \hat{a})$
SMB	0.11%	0.08%	0.12%	0.08%	0.26%	0.18%
HML	0.38%	0.27%	0.33%	0.23%	0.63%	0.44%
RMW	0.33%	0.23%	0.37%	0.26%	0.26%	0.18%
CMA	0.39%	0.27%	0.17%	0.12%	0.33%	0.23%

Source: PWL Capital

3. Forward-Looking Factor Premium: Putting it All Together

In table 6, we have the world historical premiums for the SMB (size) , HML (relative price), RMW (operating profitability) and CMA (investment). We have also established those historical premiums will be adjusted downward by a “shrinkage factor” of 0.7 to reflect the tendency of premiums to decline following their publication in the scientific literature.

Table 10: World Premiums 7/1992 – 5/2022

Book / Price	SMB	HML	RMW	CMA
Historical Premiums	0.36%	3.07%	3.91%	2.65%
Expected Premiums (Shrinkage factor = 0.7)	0.25%	2.15%	2.74%	1.86%

Source: PWL Capital

Next, to arrive at a final factor premium for the factor tilted portfolio, we must apply the factor loadings of the individual source funds underlying to the DFA Global Equity fund. To evaluate these loadings, we have studied the period 1/2012 to 3/2022, which is a period for which all the underlying funds have complete data. The regression results and the factor premiums for the individual funds are displayed in Table 11.

Table 11: Factor Analysis of DFA Canada Equity Funds

		5 FACTORS						
		Market	Size	Relative Price	Profit-ability	Invest-ment		
Fund	**Alpha**	**RM-RF**	**SMB**	**HML**	**RMW**	**CMA**	**R2**	**Gross Expected Premium**
Canadian Core	0.020	1.016	0.104	0.162	0.003	-0.026	0.994	0.37%
t stat	0.479	73.703	5.526	12.287	0.205	-1.509		
Canadian Vector	-0.032	1.050	0.272	0.267	-0.032	-0.066	0.990	0.52%
t stat	-0.525	50.642	9.634	13.491	-1.416	-2.505		
U.S. Core	-0.013	0.995	0.099	0.138	0.066	0.017	0.997	0.50%
t stat	-0.424	117.387	6.973	11.213	3.604	0.810		
U.S. Vector	-0.070	1.022	0.272	0.372	-0.009	-0.062	0.994	0.87%
t stat	-1.407	76.342	12.104	19.199	-0.318	-1.837		
International Core	-0.042	1.045	0.059	0.204	0.223	-0.044	0.992	1.05%
t stat	-0.753	71.252	1.372	3.965	3.128	-0.564		
International Vector	-0.070	1.065	0.191	0.339	0.224	-0.091	0.991	1.39%
t stat	-1.164	66.752	4.062	6.048	2.883	-1.082		
Global Equity Portfolio								0.69%

Source: Ken French, PWL Capital

The last column of table 11 displays the expected premiums for each individual fund. We also know that the DFA Global Equity Fund consists of 70% Core and 30% Vector equity funds. The weights of Canadian, US and international equity within the DFA Global Equity Fund is also known (34%/41%/25%). We can then calculate the gross expected premium for the DFA Global Equity Fund.

As a final step, we subtract the MER estimate of the DFA Global Equity Fund in the coming year to obtain the net expected premium figure:

Gross Expected Premium	Minus: Estimated MER	Equals: Net Expected Premium
0.69%	0.34%	0.35%

Source: Ken French, DFA, PWL Capital

PART II

FINANCIAL PLANNING ASSUMPTIONS – DATA UPDATE

4. Expected Inflation

We estimate long-run Canadian inflation by averaging 30-year Government of Canada bond breakeven inflation, historical Canadian inflation from 1900 to 2021, and the Bank of Canada's inflation target. At the time of writing, these figures are 1.8%, 3.0%, and 2.0% respectively for an inflation expectation of 2.3%, unchanged from the 12/31/2021 Financial Planning Assumptions.

Our estimate for long-run Canadian inflation has not changed despite the high rate of inflation recorded recently. The annual rate of inflation as of last June has been 8.1% in Canada and 9.1% in the United States, which stand as multi-decade records. Inflation has become a major concern in the media, for policy makers and for the population in general. But for a projection over 30 years, 2.3% is still our best estimate, as future long-term inflation will likely be made from a mix of periods with low, medium and high inflation. For example, despite the recent high figures, Canadian inflation has nevertheless remained at 2.1% over 20 years and 2.0% over 30 years. Furthermore, our estimate is partly based on the breakeven rate of inflation, which is driven by bond market expectations. In other words, our inflation projection is adjusted to market expectations.

Table 12 - Expected inflation composition

0.33 x (Breakeven Inflation) Plus	0.33 x (Historical Inflation) Plus	0.33 x (Bank of Canada Target Inflation)	Equals Expected Inflation
1.8%	3.0%	2.0%	2.3%

Source: PWL Capital; Data Sources: Elroy Dimson, Paul Marsh and Mike Staunton, Triumph of Optimists: 101 Years of Global Investment Returns, Princeton University Press, 2002; Elroy Dimson, Paul Marsh and Mike Staunton, Credit Suisse Global Returns Yearbook and Sourcebook, 2018, Zurich: Credit Suisse Research Institute, 2021, Bank of Canada

5. Primary Residence

We estimate the expected real capital return for personal residences at 1% annually. The carrying costs of real estate including maintenance and insurance costs, and property taxes, must also be captured. We estimate a 1% annual cost for maintenance and insurance. As property taxes vary greatly, we do not attempt to prescribe a figure here, but users should be sure to include them based on their circumstances. A 1% real return less maintenance and property taxes (not to mention the opportunity cost of home equity) may make housing look like a poor investment, but it is important to remember that the owner is receiving imputed rent as a benefit.

To estimate the volatility of the returns on residences, we used the Teranet-National Bank House Price Index for the eleven largest Canadian cities. Like we do for fixed income and equity, we calculate an average of the 5 and 20 years annualized standard deviations of monthly returns. Our results are presented in table 13 below.

Table 13 - Standard Deviation of the Return on a Canadian Residence

Asset Class	Five-year Standard Deviation	20-year Standard Deviation	Estimated Standard Deviation
Primary Residence	3.37%	2.76%	3.07%

Source: Teranet - National Bank

6. Asset Class Expected Returns

We first estimate expected returns for market capitalisation weighted "Standard" portfolios. Our estimate for asset class expected returns is a weighted average of the Market-Based Expected Return (MBER) and the Equilibrium Cost of Capital (ECOC). The MBER is an estimate of expected returns based on current market conditions. The ECOC is an estimate of expected returns based on more than 120 years of global asset class return historical data.

Once we have our expected return estimate for each asset class on a market capitalisation weighted basis, we simply add the premium for the factors. Our current estimate of the factor premium is, net of fees, 35 basis points.

Table 14 - Asset Class Expected Returns

Asset Class	Nominal Expected Return - Standard	Plus: Factor Premium	Equals: Nominal Expected Return - with Factor Tilt
Cash	2.33%	NA	2.33%
Short Term Fixed Income	3.57%	NA	3.57%
Fixed Income	3.91%	NA	3.91%
Canadian Equity - with Factor Tilted	6.69%	0.35%	7.04%
U.S. Equity - with Factor Tilted	6.41%	0.35%	6.76%
International Equity - with Factor Tilted*	7.34%	0.35%	7.69%
Global Equity - with Factor Tilted**	6.74%	0.35%	7.09%

*International Equity includes developed and emerging markets

**Global Equity – Factor Tilt is a global equity portfolio made of 1/3 Canadian equity, with the balance being allocated on a market cap weighted basis to U.S. and international equity.

Source: PWL Capital; Data sources: Bloomberg, Morningstar, Robert Shiller, Elroy Dimson, Paul Marsh and Mike Staunton, Triumph of the Optimists: 101 Years of Global Investment Returns, Princeton University Press, 2002; Elroy Dimson, Paul Marsh and Mike Staunton, Credit Suisse Global Returns Yearbook and Sourcebook, 2018, Zurich: Credit Suisse Research Institute, 2021

7. Explaining Changes in Expected Returns

As illustrated in Table 15, the expected return for fixed income has increased by a whopping 143 basis points – from 2.48% to 3.91% – since 12/31/2021. This is completely explained by the radical increase in bond yields over the period. For example, the bellwether Government of Canada 10-year bond yield has shot up from 1.42% to 3.23%, one of the fastest yield increases in history. Our prior research has suggested that bond yields have a high predictive power over subsequent returns. This explains why the model we use to estimate expected fixed income returns is very sensitive to changes in bond yields. It is important for users to understand that this dramatic change is indeed dramatic. It will affect financial planning projections. The future consumption liabilities of most investors are more sensitive to interest rates than the fixed income assets in our assumed fixed income portfolio. The result is that while bond prices have fallen on recently rising yields, the liabilities of most investors have fallen more.

The expected return for global factor tilted equity is 47 basis points higher than our 12/31/2021 market cap weighted estimate, rising from 6.62% to 7.09%. The primary reason for this change is the integration of the factor expected return for portfolios using the DFA equity funds, which added 35 basis points. The factor tilted expected returns were not estimated in the previous edition of the Financial Planning Assumptions. The decline in stock prices explain another 13 basis points of expected return increase. While equity prices have gone down significantly during the period (the MSCI All Country World All Cap price index in local currency has dropped by 18.5% over the semester), our research has demonstrated that the equity price-to-earnings ratio have only weak predictive power over subsequent returns. This explains why the model we use to estimate expected equity returns is moderately sensitive to changes in stock prices.

Table 15 - Reconciling Changes in Expected Returns from the Previous Edition

	Fixed Income	Global Equity – Factor tilted
Nominal Expected Return as of 12/31/2021	2.48%	6.62%
Plus: Difference Due to Changes in		
Expected inflation	0.00%	0.00%
Bond yields	1.46%	NA
Equity prices	NA	0.13%
Historical premiums	-0.03%	-0.01%
Addition of the Factor Premium	NA	0.35%
Equals:		
Nominal Expected Return as of 06/30/2022	3.91%	7.09%

Source: PWL Capital;

8. Expected Standard Deviations

Asset Class correlations are estimated using a simple average of the 5-year and 20-year historical data.

Table 16 - Estimated Volatility of Major Asset Classes

Asset Class	Five-year Standard Deviation	20-year Standard Deviation	Estimated Standard Deviation
Fixed Income	5.12%	4.18%	4.65%
Canadian Equity - Factor tilted	19.08%	16.02%	17.55%
U.S. Equity - Factor tilted	16.22%	14.35%	15.29%
International Equity - Factor tilted	12.85%	14.42%	13.64%
Global Equity - Factor tilted	15.52%	13.35%	14.44%

Source: PWL Capital; Data Source: Morningstar

9. Expected Correlations

Asset Class correlations are estimated using a simple average of the 5-year and 20-year historical data.

Table 17 - Estimated Volatility of Major Asset Classes

Asset Class	Fixed Income	Canadian Equity - Factor Tilted	U.S. Equity - Factor Tilted	International Equity - Factor Tilted
Fixed Income	1.00	0.15	0.21	0.27
Canadian Equity - Factor Tilted	0.15	1.00	0.74	0.77
U.S. Equity - Factor Tilted	0.21	0.74	1.00	0.83
International Equity - Factor Tilted	0.27	0.77	0.83	1.00

Source: PWL Capital; Data Source: Morningstar

10. Composition of Asset Class Returns

The composition of returns, primarily consisting of the mix between capital appreciation, interest income and dividends, is important for financial planning. The tax liability in taxable and non-taxable (due to foreign withholding tax) accounts will hinge on the portion of returns assumed to be coming from dividends, realized capital gains and unrealized capital gains.

To determine the composition of asset class returns, we proceed as follows:

- Establish one or more mutual funds or ETFs that represent the passive benchmark for each asset class.
- For fixed income, the average distribution yield is assumed to be the lowest of the underlying fund's yield and the asset class expected return. Distributions are also assumed to be 100% interest income.
- For Canadian equity, the average distribution yield is assumed to be 100% Canadian dividends.
- For U.S. and International equity, the average distribution yield is assumed to be 100% foreign dividends.
- The balance of expected returns (net of distribution yields) is treated as capital gains.
- We assume a 50%/50% split between realized and unrealized capital gains.

Current funds in use to estimate the composition of asset class returns:

Fixed income: 100% Vanguard Aggregate Bond ETF (VAB)

Canadian equity: 70% DFA Canadian Core Equity, 30% DFA Canadian Vector Equity

U.S. Equity: 70% DFA US Core Equity, 30% DFA US Vector Equity

International Equity: 70% DFA International Core Equity, 30% DFA International Vector Equity.

Our estimates for the composition of expected returns are illustrated at Table 6. This data is reproduced in a Naviplan-compatible format in the Appendix.

Table 18 - Composition of Expected Asset Class Returns

Asset Class	Expected Return	Current Yield	Interest & Foreign Dividends	Canadian Dividends	Realized Capital Gains	Unrealized Capital Gains
Fixed Income	3.91%	2.82%	2.82%	0.00%	0.54%	0.54%
Canadian Equity - Factor Tilted	7.04%	3.04%	0.00%	3.04%	2.00%	2.00%
U.S. Equity - Factor Tilted	6.76%	1.41%	1.41%	0.00%	2.68%	2.68%
International equity DV + EM - Factor Tilted	7.69%	3.26%	3.26%	0.00%	2.21%	2.21%

Source: PWL Capital; Data Sources: Bloomberg, Morningstar, Robert Shiller, Elroy Dimson, Paul Marsh and Mike Staunton, Triumph of the Optimists: 101 Years of Global Investment Returns, Princeton University Press, 2002; Elroy Dimson, Paul Marsh and Mike Staunton, Credit Suisse Global Returns Yearbook and Sourcebook, 2018, Zurich: Credit Suisse Research Institute, 2021

11. Portfolio Expected Returns

To simplify the practical application of the information presented in this paper, we present portfolios consisting of various mixes between stocks and bonds.

Table 19 - Composition of Expected Portfolio Returns

Asset Mix (Equity/Bond)	Expected Return	Expected Standard Deviation	Interest & Foreign Dividends	Canadian Dividends	Realized Capital Gains	Unrealized Capital Gains
0/100	3.91%	4.65%	2.82%	0.00%	0.54%	0.54%
5/95	4.07%	4.69%	2.74%	0.05%	0.64%	0.64%
10/90	4.23%	4.73%	2.65%	0.10%	0.74%	0.74%
15/85	4.39%	4.95%	2.56%	0.15%	0.84%	0.84%
20/80	4.55%	5.28%	2.47%	0.20%	0.94%	0.94%
25/75	4.72%	5.72%	2.38%	0.25%	1.04%	1.04%
30/70	4.86%	6.15%	2.30%	0.30%	1.14%	1.14%
35/65	5.03%	6.70%	2.21%	0.34%	1.24%	1.24%
40/60	5.18%	7.25%	2.12%	0.39%	1.33%	1.33%
45/55	5.33%	7.80%	2.03%	0.44%	1.43%	1.43%
50/50	5.49%	8.45%	1.94%	0.49%	1.53%	1.53%
55/45	5.65%	9.11%	1.85%	0.54%	1.63%	1.63%
60/40	5.81%	9.77%	1.77%	0.59%	1.73%	1.73%
65/35	5.96%	10.42%	1.68%	0.64%	1.82%	1.82%
70/30	6.14%	11.19%	1.59%	0.69%	1.93%	1.93%
75/25	6.29%	11.85%	1.50%	0.74%	2.02%	2.02%
80/20	6.44%	12.50%	1.41%	0.79%	2.12%	2.12%
85/15	6.61%	13.27%	1.33%	0.84%	2.22%	2.22%
90/10	6.78%	14.04%	1.24%	0.89%	2.33%	2.33%
95/5	6.92%	14.69%	1.15%	0.93%	2.42%	2.42%
100/0	7.09%	15.46%	1.06%	0.98%	2.52%	2.52%

Source: PWL Capital; Data Sources: Bloomberg, Morningstar, Robert Shiller, Elroy Dimson, Paul Marsh and Mike Staunton, Triumph of the Optimists: 101 Years of Global Investment Returns, Princeton University Press, 2002; Elroy Dimson, Paul Marsh and Mike Staunton, Credit Suisse Global Returns Yearbook and Sourcebook, 2018, Zurich: Credit Suisse Research Institute, 2021

Appendix: Financial Planning Assumptions – Naviplan Input Format

Table 20 - Composition of Asset Class Returns (Market Cap Weighted and Factor tilted Portfolios)

Asset Class	Interest	Dividends	Capital Gains	Deferred Growth	Total	Standard Deviation
Fixed Income	2.82%		0.54%	0.54%	3.91%	4.65%
Canadian Equity - Factor Tilted		3.04%	2.00%	2.00%	7.04%	17.55%
U.S. Equity - Factor Tilted	1.41%		2.68%	2.68%	6.76%	15.29%
International Equity - Factor Tilted	3.26%		2.21%	2.21%	7.69%	13.64%
Canadian Equity - Market Cap Weighted		2.89%	1.90%	1.90%	6.69%	15.11%
U.S. Equity - Market Cap Weighted	0.90%		2.75%	2.75%	6.41%	14.30%
International Equity - Market Cap Weighted	2.77%		2.28%	2.28%	7.34%	12.38%

Source: : PWL Capital; Data Sources: Bloomberg, Morningstar, Robert Shiller, Elroy Dimson, Paul Marsh and Mike Staunton, Triumph of the Optimists: 101 Years of Global Investment Returns, Princeton University Press, 2002; Elroy Dimson, Paul Marsh and Mike Staunton, Credit Suisse Global Returns Yearbook and Sourcebook, 2018, Zurich: Credit Suisse Research Institute, 2021

Table 21 – Correlations Estimates (Market Cap Weighted and Factor tilted Portfolios)

	Fixed Income	Canadian Equity-Factor tilted	US Equity - Factor tilted	International Equity - Factor tilted	Canadaian Equity - MCW	US Equity - MCW	International Equity - MCW
Fixed Income	1.00	0.15	0.21	0.27	0.22	0.29	0.28
Canadian Equity - Factor Tilted	0.15	1.00	0.74	0.77	0.97	0.66	0.72
US Equity - Factor Tilted	0.21	0.74	1.00	0.83	0.77	0.97	0.82
International Equity - Factor Tilted	0.27	0.77	0.83	1.00	0.77	0.78	0.98
Canadian Equity - Market Cap Weighted	0.22	0.97	0.77	0.77	1.00	0.72	0.74
US Equity - Market Cap Weighted	0.29	0.66	0.97	0.78	0.72	1.00	0.81
International Equity - Market Cap Weighted	0.28	0.72	0.82	0.98	0.74	0.81	1.00

Source: PWL Capital; Data Sources: Bloomberg, Morningstar, Robert Shiller, Elroy Dimson, Paul Marsh and Mike Staunton, Triumph of the Optimists: 101 Years of Global Investment Returns, Princeton University Press, 2002; Elroy Dimson, Paul Marsh and Mike Staunton, Credit Suisse Global Returns Yearbook and Sourcebook, 2018, Zurich: Credit Suisse Research Institute, 2021

Table 22 - Portfolio Asset Mixes

Asset Mix (Equity/ Bond)	Fixed Income	Canadian Equity	US Equity	International Equity
0/100	100.00%	0.00%	0.00%	0.00%
5/95	95.00%	1.70%	2.05%	1.25%
10/90	90.00%	3.40%	4.10%	2.50%
15/85	85.00%	5.10%	6.15%	3.75%
20/80	80.00%	6.80%	8.20%	5.00%
25/75	75.00%	8.50%	10.25%	6.25%
30/70	70.00%	10.20%	12.30%	7.50%
35/65	65.00%	11.90%	14.35%	8.75%
40/60	60.00%	13.60%	16.40%	10.00%
45/55	55.00%	15.30%	18.45%	11.25%
50/50	50.00%	17.00%	20.50%	12.50%
55/45	45.00%	18.70%	22.55%	13.75%
60/40	40.00%	20.40%	24.60%	15.00%
65/35	35.00%	22.10%	26.65%	16.25%
70/30	30.00%	23.80%	28.70%	17.50%
75/25	25.00%	25.50%	30.75%	18.75%
80/20	20.00%	27.20%	32.80%	20.00%
85/15	15.00%	28.90%	34.85%	21.25%
90/10	10.00%	30.60%	36.90%	22.50%
95/5	5.00%	32.30%	38.95%	23.75%
100/0	0.00%	34.00%	41.00%	25.00%

Source: PWL Capital; Data Sources: Bloomberg, Morningstar, Robert Shiller, Elroy Dimson, Paul Marsh and Mike Staunton, Triumph of the Optimists: 101 Years of Global Investment Returns, Princeton University Press, 2002; Elroy Dimson, Paul Marsh and Mike Staunton, Credit Suisse Global Returns Yearbook and Sourcebook, 2018, Zurich: Credit Suisse Research Institute, 2021

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