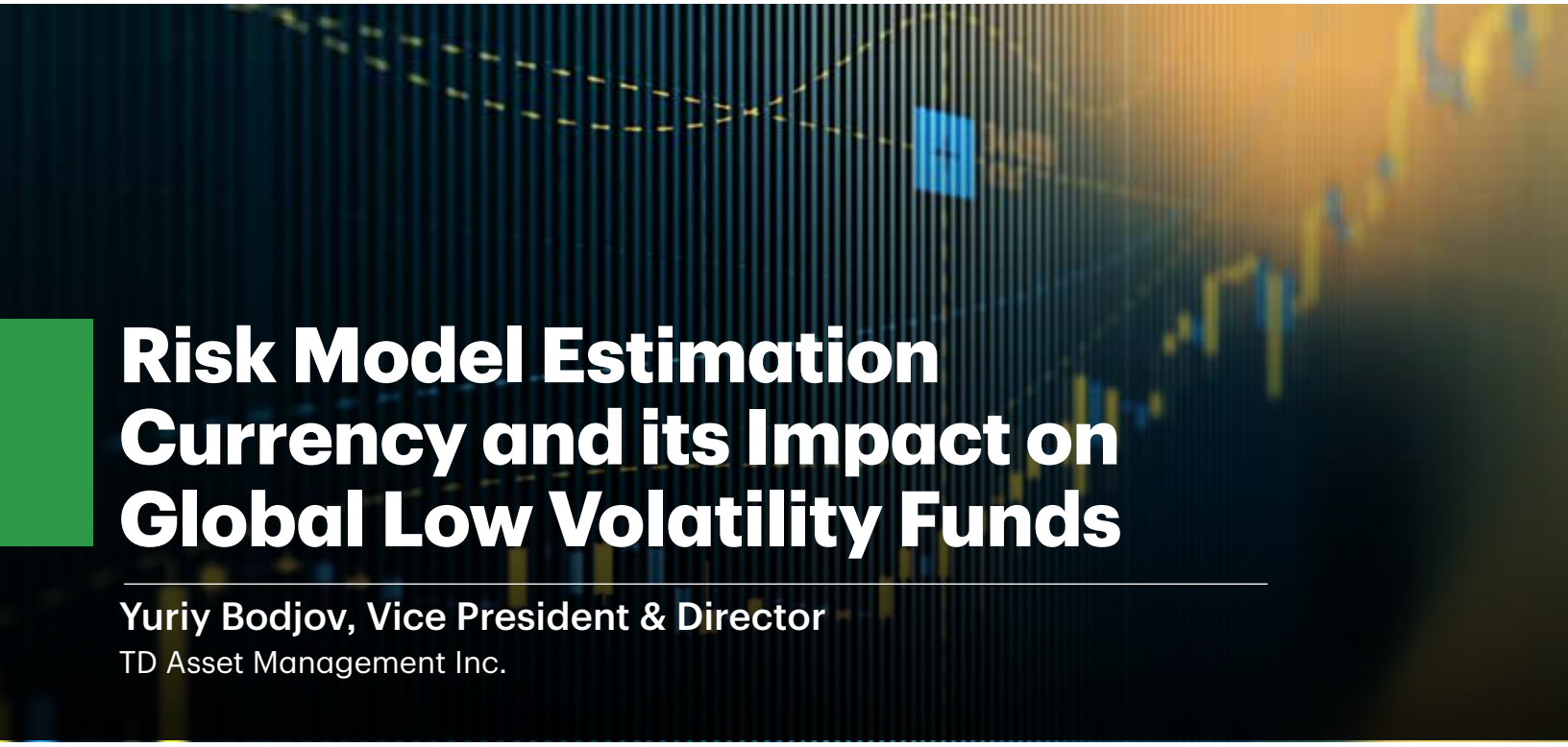

Risk Model Estimation Currency and its Impact on Global Low Volatility Funds

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Risk models are systems developed to forecast the risks of a group of assets. Quantitative asset management relies heavily on the use of risk models. Knowing which model to use, for what purpose and which market environment is the key to success for any strategy. Low volatility equity strategies are particularly dependent on the choice of equity risk models. There is an unlimited number of risk models that could be used to build a low volatility strategy. As a matter of fact, we don't even need a model; any measure of volatility could be used to rank the investments and construct a low volatility portfolio. However, it becomes more complicated if we consider foreign investments.

The goal of this paper is to investigate the role of the base currency in equity risk modeling when applied to global low volatility strategies. The choice of the base currency will shape the structure of the low volatility portfolio and will significantly impact its performance, especially during periods of market turmoil. Models with different base currencies will lead to different risk estimates that vary over the economic cycle.

The first question we need to ask ourselves is how do we measure the risk of a foreign investment? Providing an answer to this question may seem easy at first glance but has proven to be more difficult without first answering other questions. For example: Where is the investor located and in which country is the investment being made? What is the nature of the investment: equity, fixed income, commodities, real estate, infrastructure or cash? Is it liquid or not? Is this the only foreign investment the investor owns or are there others in the same or other countries? How does the investor define risk: The volatility of returns on the investment, the probability of losing money, or something else?

Often, modern finance takes shortcuts ignoring most of these questions and focusing instead on the first and most simple definition of risk: the volatility of returns on investment. Although simplistic, this approach is not necessarily wrong, as it allows for more systematic and quantifiable measures, which could be used as a basis for comparison. Moreover, finance professional can build models to estimate and decompose the volatility of investments.

Risk models frequently express the risk of foreign investments as being the sum of the volatility of the investment in local terms and the currency volatility. Measuring the volatility in local terms is relatively easy because the returns are measured using the exact same yardstick: the local currency. But what is currency volatility? Currencies are exchanged for other currencies at market or fixed exchange rates. So, when we talk about currency volatility, what we really mean is the exchange rate volatility. The exchange rate volatility depends on each one of the currencies composing the pair. Here we could have various scenarios. For example, one of the currencies could be very sensitive to economic cycles, while the other could be unsensitive or even countercyclical. For example, the volatility of AUD/CHF exchange rate comes mostly from the Australian economy's dependence on commodity prices. Alternatively, we could have a very low volatility of the exchange rate between two currencies which are both highly dependent on commodities such as the Brazilian real and the Russian ruble. However, both currencies are individually very volatile if exchanged against most developed market currencies. Measuring currency volatility requires a common yardstick against which to measure the volatility. Historically gold played the role of a world currency. Gold ceded its role as the common yardstick to exchange currencies in the 1930s in favor of the US dollar. It is useful to remember that the USD itself is volatile (as is gold).

From a Canadian investor's perspective, the volatility of any foreign investment depends significantly on the volatility of the Canadian dollar against the currencies of the securities in the portfolio. When thinking about currency volatility, most Canadian investors limit their considerations to the volatility of the exchange rate versus the U.S. dollar. This is understandable because of the importance of bilateral trade between Canada and the United States of America and the large portion of foreign holdings of Canadian investors taken by U.S. securities. In addition, the U.S. dollar keeps its role as the most stable and respected currency in the world. In the CAD/USD currency pair, the volatility comes mostly from fluctuations in the Canadian dollar. The Canadian dollar is considered a pro-cyclical currency, because of the domestic economy's exposure to commodities, and to oil in particular. As such, the Canadian dollar goes up and down with the economic cycles. This pro-cyclical behavior frequently causes the returns on foreign investments measured in Canadian dollars to be lower than the return measured in local currency during economic expansions. However, during crises the depreciation of CAD against foreign currencies helps to reduce losses. This is the general rule, but many investors fail to recognize some very important additional aspects of the question: First, exposure to international markets is not limited only to the United States, and other countries' currencies behave differently than the USD; some are even more cyclical than the CAD. Second, investors should acknowledge the asset's own volatility in local terms. The lower the volatility of returns measured in local currency terms, the more important is the role played by currency volatility. Third, the current market environment matters. During calm periods currency volatility matters more than it does during times of stress.

While many competitors use commercial risk models with the USD as a base currency, TDAM's Quantitative Equity Team is building risk models for Canadian clients using the CAD as the model estimation currency. This corresponds to our investors home currency. However we clearly understand that there are some implications of doing so and take it into account when managing global low volatility funds. We also incorporate the hedging of some of the more cyclical currencies or the currencies we hedge for tactical reasons. Historically, such a strategy has proven to be the one with the lowest overall volatility solutions.

The choice of the base currency will shape the structure of the low volatility portfolio and will significantly impact its performance, especially during periods of market turmoil.

Volatility of All World Low Volatility Equity Strategies Based on Different Estimation Currencies (Dec. 2001 – Mar. 2020)

	MSCI All Country World Index	MSCI ACWI Minimum Volatility Index Using Risk Model in USD	Low Volatility Strategy Using TDAM Risk Model in USD	Low Volatility Strategy Using TDAM Risk Model in CAD	Low Volatility Strategy Using TDAM Risk Model in CAD + Hedge
Risk (st. dev)	11.73%	8.87%	8.95%	8.66%	8.62%
Risk Reduction		24.4%	23.7%	26.2%	26.5%

Source: TDAM, MSCI. Simulated Performance. Data as of March 2020. Risk measured as the annualized standard deviation of monthly returns over the period Dec. 2001 – Mar. 2020.

Long-term back-tests are helpful. How about the more recent period? Let's examine the first quarter of 2020, a period with extremely high equity market volatility amid a significant market drop.

Volatility of All World Low Volatility Equity Strategies Based on Different Estimation Currencies (Dec. 31, 2019 – Mar. 31, 2020)

	MSCI All Country World Index	MSCI ACWI Minimum Volatility Index Using Risk Model in USD	Low Volatility Strategy Using TDAM Risk Model in USD	Low Volatility Strategy Using TDAM Risk Model in CAD	Low Volatility Strategy Using TDAM Risk Model in CAD + Hedge
Risk (st. dev)	42.68%	34.58%	31.90%	29.41%	28.69%
Risk Reduction		19.0%	25.3%	31.1%	32.8%

Source: TDAM, MSCI. Simulated Performance. Data as of March 2020. Risk measured as the annualized standard deviation of daily returns over the quarter.

It appears that relative risks over the recent crisis (measured by the standard deviation) are consistent with those computed over the longer period. There are other ways to look at the risk of investments. Splitting the observations into "Strong Up", "Strong Down" and "Normal" markets provides additional insights, not in terms of volatility, but in terms of returns. Since 2001, the MSCI ACWI delivered monthly returns in excess of 2% in 75 months out of 219:

Strong Up Markets (ACWI>2%)	Number of Months	Average Strategy Return	Average Index Return	Average Excess Return	Hit Rate
Low Volatility (CAD Model)	75	2.69%	3.84%	-1.15%	**17.33%**
Low Volatility (USD Model)	75	2.53%	3.84%	-1.31%	**24.00%**

Source: TDAM, MSCI. Simulated Performance. Data as of March 2020. All returns measured in Canadian dollars. Hit Rate is the percentage of positive monthly excess returns.

During strong up markets, defined as months with index returns above 2%, the low volatility strategy built with the Canadian dollar as a base currency outperformed a similar strategy built with a TDAM risk model where volatilities are computed in US dollars. As expected, in such a scenario, both low volatility strategies would have underperformed the cap-weighted index.

Let's now look at "Normal" markets (102 months out of 219) where index monthly returns are bounded by -2% and +2%:

Normal Markets ACWI +/- 2%	Number of Months	Average Strategy Return	Average Index Return	Average Excess Return	Hit Rate
Low Volatility (CAD Model)	102	0.54%	0.23%	0.31%	**53.92%**
Low Volatility (USD Model)	102	0.55%	0.23%	0.32%	**54.90%**

Source: TDAM, MSCI. Simulated Performance. Data as of March 2020. Hit Rate is the percentage of positive monthly excess returns.

The average returns are almost the same. Both low volatility strategies would have outperformed the MSCI ACWI by about 30 bps with a hit rate above 50%.

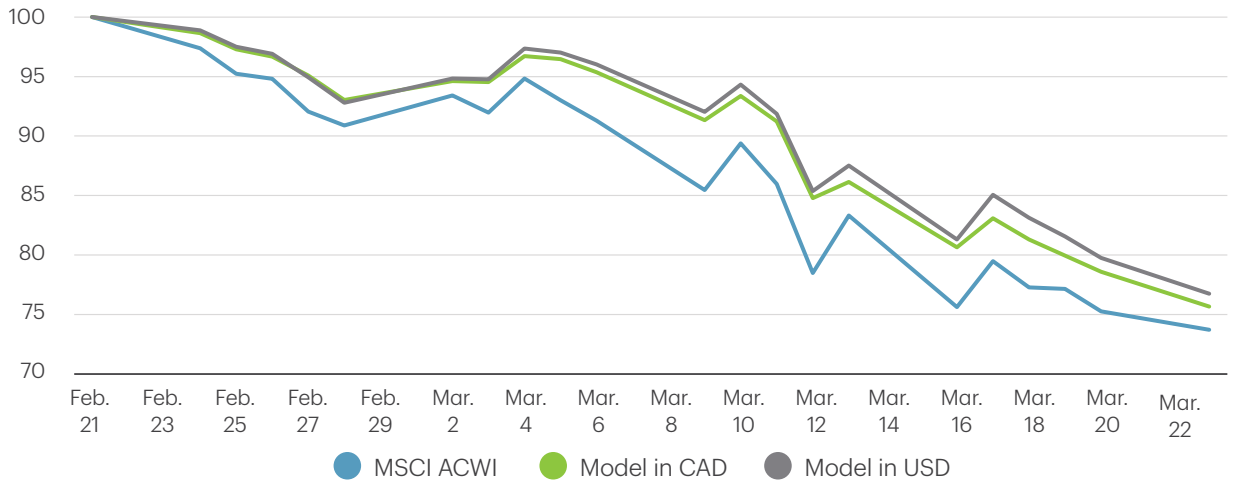
The last and most interesting comparison compares low volatility funds during down markets. These are defined as the 42 months since 2001 during which the index lost more than 2%.

Strong Down Markets (ACWI<-2%)	Number of Months	Average Strategy Return	Average Index Return	Average Excess Return	Hit Rate
Low Volatility (CAD Model)	42	-2.49%	-4.84%	2.35%	**88.10%**
Low Volatility (USD Model)	42	-1.98%	-4.84%	2.85%	**90.48%**

Source: TDAM, MSCI. Simulated Performance. Data as of March 2020. Hit Rate is the percentage of positive monthly excess returns.

It appears that low volatility strategies built using the US dollar as a base currency offer a significant edge in terms of returns during "bear" equity markets. Furthermore, if we examine the first quarter of 2020 we observe:

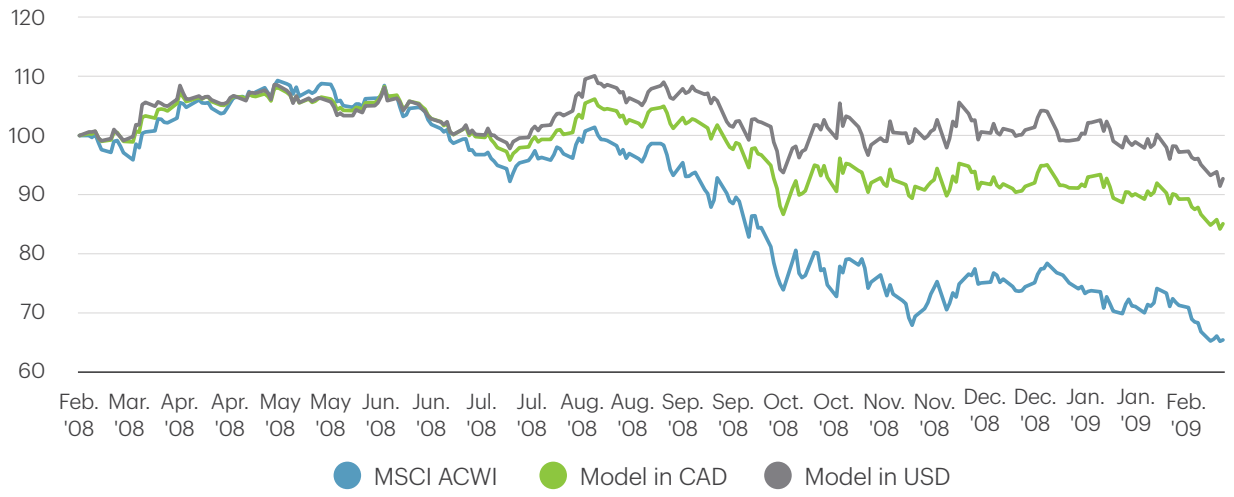
Performance of Low Volatility Strategies
(Feb. 21 – Mar. 23, 2020)



Source: TDAM, MSCI. Simulated Performance. Data as of March 2020.

And If we look at previous 2008-2009 financial crisis, we see a similar picture:

Performance of Low Volatility Strategies
(Feb. 2008 – Feb. 2009)



Source: TDAM, MSCI. Simulated Performance.

The analyses above are performed on simulations of low volatility equity strategies with identical constraints but different risk models. We have explored return volatility as well as performance in "strong down", "strong up", and "normal" markets. However, as previously mentioned, risk can be described in many ways. Alternative measures of risk include the maximum loss and how long the investment remains in negative return territory.

Drawdowns of All World Low Volatility Equity Strategies Based on Different Estimation Currencies (Dec. 2001 – Mar. 2020)

	MSCI All Country World Index	MSCI ACWI Minimum Volatility Index Using Risk Model in USD	Low Volatility Strategy Using TDAM Risk Model in USD	Low Volatility Strategy Using TDAM Risk Model in CAD	Low Volatility Strategy Using TDAM Risk Model in CAD + Hedge
Max Drawdown	-42.67%	-27.39%	-26.12%	-27.85%	-28.81%
Longest Drawdown	74 months	61 months	55 months	55 months	58 months

Source: TDAM, MSCI. Simulated Performance. Data as of March 2020.

The estimation currency of the risk model has a profound impact on the low volatility strategy during crises. The TDAM strategy built using an USD risk model has the shortest and lowest drawdown. The MSCI Minimum Volatility Index which is also built using an USD-based risk model also experiences a lower drawdown than the strategies built with CAD risk models. We can observe a similar picture during the first quarter of 2020:

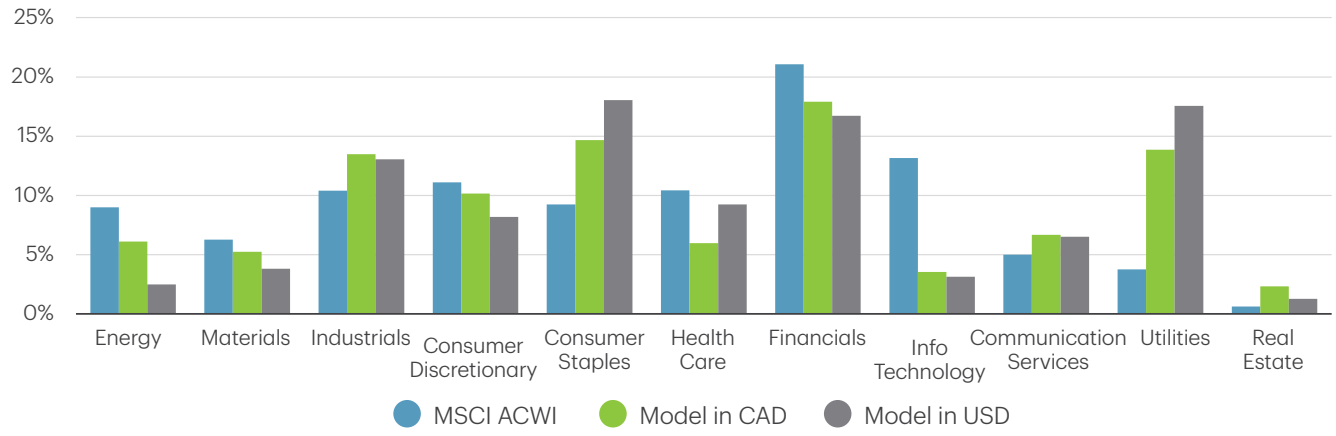
Drawdowns of All World Low Volatility Equity Strategies Based on Different Estimation Currencies (Dec. 31, 2019 – Mar. 31, 2020)

	MSCI All Country World Index	MSCI ACWI Minimum Volatility Index Using Risk Model in USD	Low Volatility Strategy Using TDAM Risk Model in USD	Low Volatility Strategy Using TDAM Risk Model in CAD	Low Volatility Strategy Using TDAM Risk Model in CAD + Hedge
Max Drawdown	-27.53%	-21.90%	-24.15%	-25.35%	-25.39%
Longest Drawdown	34 days	32 days	33 days	38 days	32 days

Source: TDAM, MSCI. Simulated Performance. Data as of March 2020.

To get better insights, we need to understand the impact of the base currency on the portfolio structure. Let's start by the average sector weights since 2014. The graph below compares the sector weights of two simulated TDAM Low Volatility equity strategies against the capitalization-weighted index.

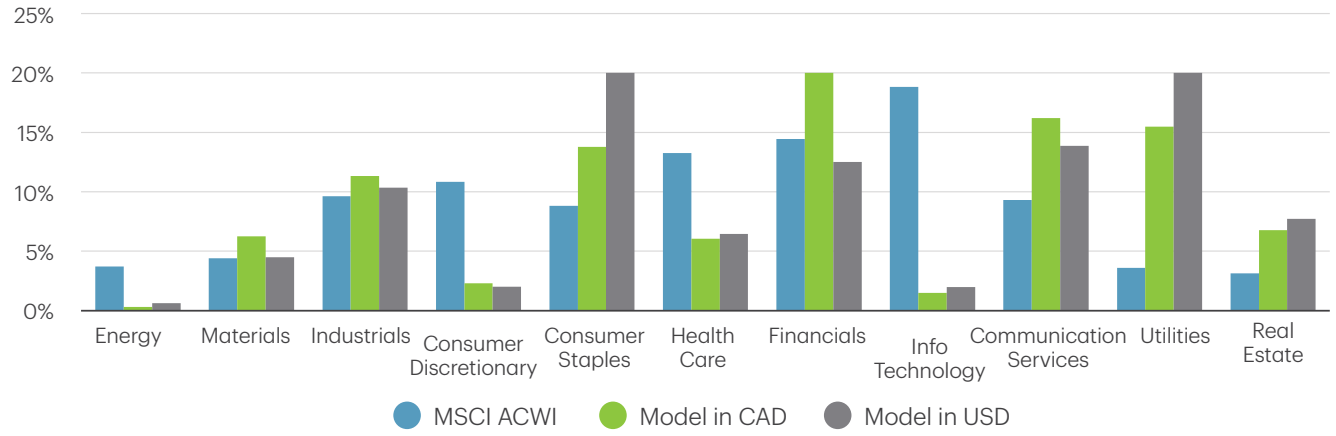
Average Sector Weights Since Dec. 2001



Source: TDAM, MSCI. Simulated Portfolios. Data as of March 2020.

The choice of the risk modeling currency influences portfolio construction significantly: The USD-based model leads to portfolios with less Energy, Materials, Industrials, Consumer Discretionary, Financials and Real Estate but more Consumer Staples, Health care and Utilities. These sector differences are significant. In the absence of other constraints, they can provide very different outcomes depending of which sectors are most impacted by shocks. Let's look at another snapshot for the end of March 2020.

Sector Weights in March 31, 2020



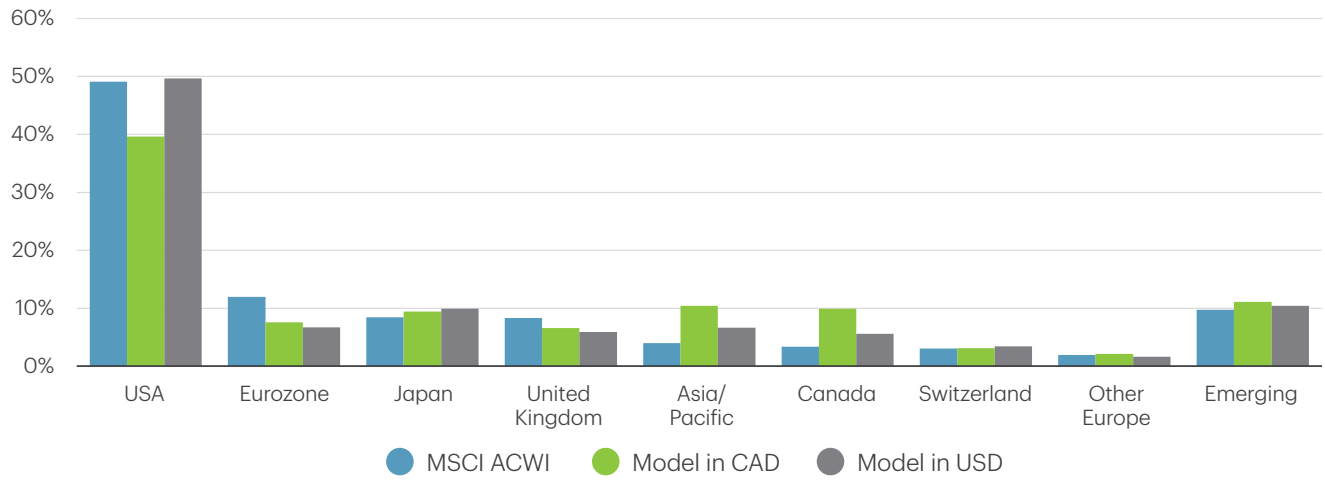
Source: TDAM, MSCI. Simulated Portfolios. Data as of March 2020.

The USD-based strategy is less exposed to Materials, Industrials, Financials and Communications, and more exposed to Staples, Health care, Technology, Utilities and Real Estate. Canadian dollar-based risk models find cyclical sectors to be less risky. The intuition behind this is that both the sectors and the CAD currency move in-sync.

We could expect consistent findings when examining country or regional preferences. Canadian dollar risk models should find cyclical economies such as Canada, Australia, Norway or emerging markets less volatile and consequently lead to higher weights to these cyclical markets when constructing a low volatility portfolio.

USD-based risk models will do the opposite. They will prefer stocks listed in the USA over stocks of firms listed in Canada or in emerging markets. Let's see if our intuition is supported by the data. The graph below illustrates the average regional or country weights since 2001.

Region Weights in March 31, 2020



Source: TDAM, MSCI. Simulated Portfolios. Data as of March 2020.

The USD-based risk model results in low volatility portfolios with higher average exposures to stocks based in the USA. It also results in greater exposures to countries with defensive currencies, such as Japan and Switzerland. On the other hand, using a CAD-based risk model to build a low volatility portfolio results in a strategy with more exposure to Canadian, Asia/Pacific and emerging markets equities.

As detailed in this paper, the risk model base currency could have a substantial impact on the structure and the performance of the Global Low Volatility strategies, and especially during periods of market turmoil. Finding the right balance between achieving the lowest possible volatility and good performance in normal and strong markets, and still having downside protection during crisis requires skill and is indictive of the investment decisions that have to be made by the TDAM Quantitative Equity Team. Our utmost priority is to safeguard, and grow, the invested capital of our clients; by ensuring that our investment actions are empirically sound and supported by research that reflects current market and economic facts. ■