Divesting and Re-investing in a Greener Future for Canada

by

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Authors Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public.

Abstract

Whether Canada chooses to adhere to its responsibilities to meet its climate change targets or not, investors in Canada have a lot to be concerned about. The imminent threat of human induced climate change will have the global community reacting in ways that will affect Canada and their investors. This thesis explored the Canadian equity market through the lens of an investor who is interested in investing with particular strategies that address climate change with respect to carbon emissions. Both modern portfolio theory and behavioral finance theory were explored and demonstrated that both investor types should be concerned about the climate change related risks; that the two theories contending paradigms are bridged on the topic of socially responsible investing concerning carbon related risks in respect to climate change. The two techniques utilized for portfolio construction that addressed carbon related risk and supported moral and ethical ideologies were: tiered divestment of fossil fuel related companies and utilizing carbon footprinting metrics to create best in-class portfolios. Throughout the period of January 2011 to August 2015 the resulting portfolios of the two strategies outperformed relative to their associated benchmark; that is, offering a superior risk/return while mitigating the risk associated to carbon emissions. These results contribute the body of the literature that analyzes the link between socially responsible investing and financial performance.

Acknowledgements

I would like to acknowledge my supervisor, Olaf Weber, whose contributions and support, guided me to completing a thesis that offered both the academic and industry communities more evidence to suggest Canada needs to find solutions for the Canadian markets to better support green companies- if Canada seriously wants Canadians to keep their money within their country. I would also like to acknowledge my partner, Tyler Plante, whose editorial and emotional support, made this thesis comprehensible and kept me sane ☺.

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1 Background

This paper will explore the Canadian equity market through the lens of an investor who is interested in investing with particular strategies that address climate change with respect to carbon emissions. The following paragraphs will provide background for this research topic and why it is of current importance to study.

Human interaction with global ecosystems, ranging from agricultural to colonialism, has not escaped Earth's natural variability for the past 10,000 years. Evidence such as abnormal increases in global average atmospheric temperature, sea level rise, and an increase in atmospheric nitrogen support the assertion that humans are no longer interacting with the planet at a sustainable rate (Steffan, 2011). This is commonly referred to as anthropogenic climate change. Although the definition of climate change is varying and debated, there is general consensus that the earth is changing and countries need some form of action, interacting on a global stage (IPCC, 2016).

The United Nations Framework Convention on Climate Change (UNFCCC) is the primary international membership organization representing 196 parties (UNFCC, 2016). This organization has brought forth non-binding treaties such as the 1997 Kyoto Protocol and agreements such as the 2015 Paris agreement amongst parties (countries). The Paris agreement established a two degree target for a maximum of average global temperature rise from pre industrial levels but urges efforts to limit the increase to 1.5 degrees (UNFCCC, 2015; European Commission 2015; Centre for Climate and Energy Solutions, 2016) and adds longer term targets for individual countries to lower their emissions levels. The main goal of the UNFCCC is to bring awareness to climate change with the intention of stabilizing greenhouse gas (GHG) concentrations, the main human contributor to climate change, to prevent irreversible damage to our ecosystems (UNFCCC, 2016). Carbon dioxide (CO_2) is the primary greenhouse gas emitted from human activities; the latest IPCC report states CO_2 accounted for approximately 60% of all GHGs in 2010 (Intergovernmental Panel on Climate Change, 2014). While CO_2 comes from a variety of natural sources, human-related CO_2 emissions are responsible for the abnormal increase in temperature that has occurred since the industrial revolution (EPA, 2016). Understanding that all the inhabitants of Earth have to live within a GHG constrained society has brought forth many sub issues or problems that are attempting to be solved through many different angles and multifaceted approaches, implications from which are important for investors to address and understand.

Investors are seeking out ways to understand how companies' GHG emissions and associated operations can affect their investment portfolios; not only how they can mitigate risk, but also how they can re-allocate their capital to support a lower GHG society (it is worthwhile to note here that most industry jargon does not use GHG but rather "carbon" and is calculated as the total amount of carbon equivalent; going forward carbon will assume to be as such).

In September 2014, two investor climate pledges were announced. The Montreal Carbon Pledge, which focuses on mobilizing investors to measure and disclose the carbon footprint of their portfolios (Montreal Carbon Pledge, 2016) and the Portfolio Decarbonization Coalition (PDC), which focuses on decarbonizing portfolios (Portfolio Decarbonization Coalition, 2016). Both are supported through the United Nations Principles for Responsible Investment (UNPRI) and the United Nations Environment Programme Finance Initiative (UNEP-FI), accordingly. This demonstrates that the global governing body for climate change, the United Nations, supports the GHG disclosure from companies and for investors to re-allocate their capital based upon a company's practices, specifically related to carbon emissions.

Canada's role within addressing climate change is a very delicate and tangled issue. The country's energy sector in 2013 contributed to 10% of gross domestic product (GDP- nominal) and directly employed nearly 300,000 people (Stats Canada, 2013). The oil sector in 2014 alone represented 8.5% of Canada's total GHG emissions, which includes the Alberta oil sands - the 3rd largest oil reserve in the world (Natural Resources Canada, 2016). Between 1999 and 2013, approximately $201 billion was invested in the oil sands industry, and in 2013, 133, 053 people were employed in Alberta's upstream oil sector (Energy Alberta, 2016). The international commitments made by Canada through the Kyoto Protocol in 1997 were not met and the more recent commitment of 30% by 2030 from the Paris agreement will be unlikely achieved if Canada continues to expand its oil sector within the Alberta tar sands. Therefore, new regulations such as an economy-wide carbon tax, a cap on emissions from the oil sands and a phase-out of coal-fired power, are being considered by Alberta (Jones & Humes, 2016) alone. If Canada is to adhere to its climate change targets, fossil fuel production and consumption are significant areas for GHG reductions.

Canada's commitment to GHG reduction is not the main concern of Jeff Rubin, a senior fellow at the Centre for International Governance Innovation (CIGI), for investors. "It is the sector's huge production costs, not its emission profile, that poses the greatest threat. As one of the most expensive sources of oil in the world, no improvement in oil sands emissions is going to safeguard production level in a decarbonizing global economy that will be consuming less and less oil over time" (Rubin, 2016, 1). This brings forth the topic of an industry collapse regardless if the government is in support or not and the issues of stranded assets and high capital expenditure costs for investors. Therefore, regardless if Canada takes an active approach for GHG reduction or not, investors within Canada have many factors to consider when deciding if fossil fuel investments and carbon intensive companies are going provide adequate payoffs.

The fear of negative consequences for holding onto fossil fuel assets came into fruition for pension plans in 2014. In the second half of 2014, when the commodity price for oil dropped, Canada's five biggest pension funds lost approximately $2.5 billion because of fossil fuel exposure. Canada's ten largest pension plans hold an equivalent of 45% of Canada's GDP, accounting for $1.1 trillion (Canada Benefits, 2015). This sent a signal out to Canadians they need to be aware of climate change risks for their investments.

The additional issue for investors is that regardless of Canada's action or inaction, there is a building urgency for these institutions to take their own action to tackle climate change, that it should be part of their moral and ethical responsibilities. The Responsible Investment Association (RIA) Canada, the leading membership organization for responsible investment, has a purpose to promote the practice of responsible investing in Canada, showcasing the positive risk adjusted returns and societal impacts of these investments (RIA Canada, 2016). This addresses the concerns from Canadians about the behavior of companies they invest in, in particular, the impact that corporations have on their communities and constituencies.

This topic of investing within the Canadian equity markets to address carbon related climate change risk and moral and ethical perspectives will be explored in detail in this thesis using a quantitative portfolio management approach. First, to gain a greater understanding of how investors interpret climate change with respect to carbon emissions through investment theory and industry approaches, and why this topic is critical to approach in a thorough study, a literature review has been completed. The predominant financial theories that are used in the market and studied heavily by economists will be discussed first, how the equity markets view climate change, then what is socially responsible investing, supported empirical evidence and lastly, the approaches used for environmentally social responsible investors.

2 Literature Review

Public markets had been well established prior to the commencement of the London Stock Exchange (LSE) in 1773. Whether it was buying stock of one of the East India companies in coffee shops or even earlier, or dealing with the moneylenders in Venice back in 1300s, these were all forms of a public market (Bramble & Media, 2016). Organized exchanges started to form when investors realized that they functioned more effectively, requiring the disclosure of at least some information as part of the price of access to the exchange. Throughout time the evolution of technology and further regulation has made the equity markets what they are today, namely a method for the diffusion of ownership of companies (Knight Capital Group, 2010), supplying personal wealth for private investment and supplying capital to support industry growth (Bramble & Media, 2016). The original goal of markets was not to make money from fluctuating share prices, but rather to provide financial resources for enterprises, thereby increasing economic growth (The Guardian, 2013). Although taking a systems approach to disentangle the issues of investor responsibility would be interesting, this paper focuses on a different approach, utilizing investor responsibility for adhering to Canada's climate change targets.

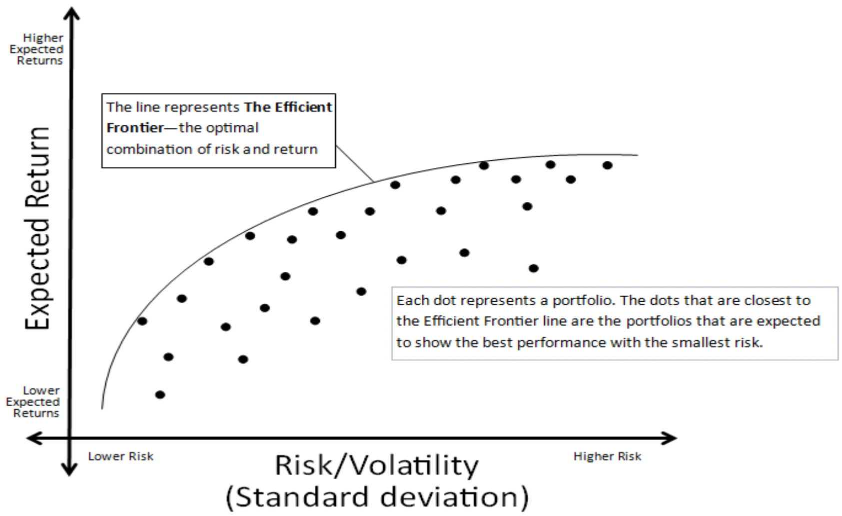
Through the lens of the investor, this paper will investigate if one can invest in a climate-constrained society within the Canadian equity markets to reduce their exposure against carbon emissions and carbon related industries. How the equity markets operate and the methods for portfolio construction amongst investors vary, therefore, prior to discussing how an investor with an environmentally conscience mind can invest, the modern predominant theories for stock selection and portfolio construction will be discussed. Modern portfolio theory and behavioral theory are examined because they are the two prevailing ways investors view the stock market. Rational investors tend to lean towards modern portfolio theories to support their claims whereas humanistic investors use behavioral theories to support their rationale for resource allocation. What is of importance here is that, as will be shown, although socially responsible investing stems out of behavioral finance, these investors use conventional modern portfolio theory techniques to prove their strategies can at least adhere to the same risk/return profile. This is of great importance to not only convince traditional investors to incorporate the idea of climate change when investing but also to demonstrate the market is digesting climate change as a risk.

2.1 Modern Portfolio Theory

2.1.1 Mean Variance Optimization and the Efficient Frontier

Harry Markowitz, often times referred to as the father of modern portfolio theory (MPT), clearly articulated an approach to portfolio construction, which has been cited as the origin of portfolio theory for many who have tracked the advancement of this field (Elton & Gruber, 1997; Fabozzi, Gupta, & Markowitz, 2002; C. Gregory, 2004). In Markowitz's 1952 paper he describes how diversification does not solely depend upon the number of securities held but rather by having low co-variances amongst the stocks selected, commonly done by diversification across sectors. Additionally, how that efficiency, highest return (mean) for a given level of risk (as measured by a stock's variance), might be the hypothesis for portfolio selection (Markowitz, 1952). This means that rather than choosing stocks solely with the highest discount rate, portfolio selection is to be done by choosing the stocks that offer a given level of return for the lowest level of risk, as measured by the price movements of the stocks within a portfolio. The theory is an alternative of older methods that only looked at the individual merits of a stock. These concepts are later expanded in his 1959 book (Markowitz, 1959) and proved the fundamental theorem of mean variance optimization for portfolio theory; specifically, holding constant variance and maximizing expected return or holding constant expected return with minimal variance. These concepts led to the efficient frontier which allows investors to choose their portfolio based upon their risk return attributes (Elton & Gruber, 1997). The efficient frontier is commonly defined as the set of optimal portfolios (utility maxims) that offer the highest expected return for a defined level of risk or the lowest risk for a given level of expected return. This simplified approach, has been the predominant approach for portfolio construction amongst investors worldwide for at least the last few decades, when Markowitz was awarded a Nobel Prize in Economics in 1990 (Gregory, 2004). Figure 2-1 demonstrates how a piecewise linear curve is used as the efficient frontier and is the optimal line for risk and return.

Figure 2-1: The Efficient Frontier



(Smart 401k, 2016)

Where expected return on the portfolio is calculated as the sum of the expected returns of each asset multiplied by the weight within the portfolio and portfolio return variance and standard deviation (equation 2-1) is calculated as:

Equation 2-1: Variance and Standard Deviation

$$\sigma_p^2 \;=\; \sum_{\alpha=1}^{n} W_\alpha^2\, \sigma_\alpha^2 + 2\sum_{\alpha 1=1}^{n}\sum_{\alpha 1=1}^{n} w_{\alpha 1}\, w_{\alpha 2} r_{\alpha 1,\alpha 2}\sigma_{\alpha 1}\sigma_{\alpha 2} \text{ and } \sigma_p = \sqrt{\sigma_p^2}$$

Where w is the weight of the n assets; σ is the standard deviation of the individual asset 1,..,n; r is the correlation between two assets in the portfolio (Markowitz, 1959).

This theory is important to understand not only because it is a predominant part of investors' strategies, but also because it can be used as a means of justification to investors when choosing alternative strategies that incorporate other criteria for the investments. For example, investors who divest from the fossil fuel sector and want to re-allocate the capital to the renewable sector can use statistics such as the returns of the portfolio and the measure of volatility to demonstrate that this approach is equivalent to the former, meaning the portfolios would have the same risk/return profile. If the latter approach was to have a better risk/return profile then it would show that excluding fossil fuel companies and including renewable companies is in fact more of an efficient portfolio, either decreasing risk while maintaining or raising the return or increasing return for a given level of risk. In this scenario it would also mean that these investors were not investing at their utility maxim (at the efficient frontier) in the first place.

2.1.2 Efficient Market Hypothesis (EMH)

The second theory, which grounds the modern portfolio theories of mean variance optimization and the efficient frontier, is that an efficient market price “fully reflects” all available information so the future returns is a function of the risk. This theory is entitled the efficient market theory or the theory of efficient markets, and claims that investors in the long term cannot beat the market. This theory has come out the empirical findings of market equilibrium (Jensen, 1968; Lintner, 1965; Malkiel & Fama, 1970). This is essential to know and understand because efficient market models are based upon market equilibrium (when supply and demand are equal) and that any information that is relevant to a stock price would be fully incorporated in the long run. Therefore, if the market understood the pending climate change targets as a risk, investors would start seeing prices changes to stocks that would be affected by these targets. For example, if the market believed that the oil sands would not be able to extract all the proven reserves due to new regulation or decreased oil prices or lack of demand, then it would discount the future earnings and assets, lowering the stock price of these fossil fuel firms. Next, asset-pricing theories will be discussed, including how they relate to carbon emissions.

2.1.3 Asset Pricing Theories

Asset pricing theories evolved out of the modern portfolio theory normative models that Markowitz and others such as Tobin (1958) and Hicks (1962) have contributed to. As previously stated, these normative models deal with asset choice under conditions of risk, for example portfolio creation, but none attempt to extend them to construct a market equilibrium theory of asset prices under conditions of risk. What this extension of the theory provides is the relationship between the price of an asset and the various components of its overall risk. Sharpe (1962) and Linter (1965) proved that prices could be understood as a function of systematic (market/beta) and unsystematic risk. The infamous one factor capital asset pricing model was created out of these and demonstrated that approximately 70% of all risk could be attributed to systematic market risks, leaving the rest of the risk or the return to be attributed to stock specific characteristics (Fama & French, 1993). Over the past decades, researchers and asset managers for both individual assets and portfolios have used this model heavily. Later, Fama and French elaborated on the use of firm specific characteristics in explaining the return behavior of different types of portfolios. The size of a firm and the book to market value of a firm increases predictability of asset returns (Sharma & Mehta, 2013). Lastly, Carhart (1997) added a fourth factor, 12 month momentum, and demonstrated that this factor not only further increases predictability but more so that the differences in a fund's expenses and transaction costs explain almost all of the remaining return differences after applying the four factor model (the expanded definition of each factor and model creation will be discussed more thoroughly in the methodology section). Equation 2-2 is the Carhart model that incorporates the systematic and unsystematic risk (with three stock specific factors), which is used today by many investors for future price predictions.

Equation 2-2: Cahart Model

$$r_{it} = \alpha + b_{iT}RMRF_t + s_{iT}\,SMB_t + h_{iT}HML_t = p_{iT}PR1YR_t + e_{it} \qquad t = 1,2,\ldots,T$$

Where r_{it} is the return on a portfolio in excess of the one-month T-bill return; RMRF is the excess return on a market proxy (market return- one-month T-bill return); and SMB, HML, PR1YR are the returns on the value-weighted, factor-mimicking portfolios for size, book-to-market equity, and one-year momentum in stock returns (Carhart, 1997).

These theories make it seem that the market can be understood algebraically in a way that explains investor behavior not by superior stock picking but rather by identifying the type of investor you are. It draws ease to investing because investors can seemingly remove the noise and simplistically invest by their risk/return profile. Asset pricing theories are a well-used method to calculate the value of a stock, but can also be used for empirical evidence that the market is valuing carbon emissions by understanding the value at risk from carbon exposure.

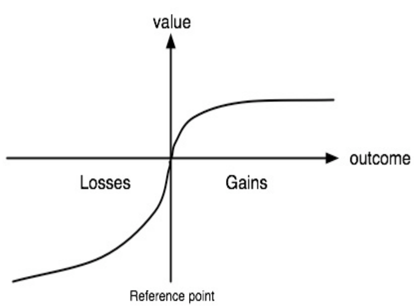
2.2 Behavioral Finance

'Better late than never' is how some might describe the adoption of Markowitz's and pricing model theorist's work. It has revolutionized how investors understand how the markets work and operate (Fabozzi et al., 2002). It is, however, one approach; the rational non-humanistic approach. As with most concepts and theories there are limitations and countering approaches. Issues such as the assumed risk free rate, measured commonly by government securities where the expected return equals the actual return (Damodaran, 2008), have led investors to use this quantitative approach alongside other strategies. This provides an advantage both by allowing the investor to verify that the portfolio is in itself diversified but also by diversifying their approach by adding in some unique strategies of their own. This leads to the countering approach and the field of behavioral finance; an area of research that proves that although investors (humans) would like to always invest at a point of optimality, their utility maxim, it is inherently impossible because humans are not 100% rational, they are normal (Brunel, 2003; Statman, 2010).

2.2.1 Prospect Theory

Considered to be the earliest researchers of behavioral finance and decision-making, Daniel Kahneman and Amos Tversky in 1977 and 1979 wrote papers speaking about the pitfalls of intuition and prediction, drawing on psychological literature to substantiate their claims. Their papers present a critique of expected utility theory (MPT) as a descriptive model of decision-making under risk, and developed an alternative model called prospect theory. It states that people underweight outcomes that are merely probable in comparison with outcomes that are obtained with certainty, called the certainty effect or risk aversion (Kahneman & Tversky, 1977, 1979). Figure 2-2 shows the alternative function to expected utility under risk, where the reference point is asymmetrical. Modern portfolio theory assumes the agents (investors) as rational, where the reference point does not matter.

Figure 2-2: The Value Function: Outcomes of Individuals making decisions under risk.



$V = \sum_{i=1}^{n} \pi(p_i)v(x_i)$. Where $x_1,\ldots,x_n$ are potential outcomes, p1,…,pn are the probabilities, and v is the function that assigns the value to the outcome. The function that passes through the reference point is asymmetrical. (Kahneman & Tversky, 1979).

Kahneman and Tversky's theory supports the idea that people generally discard components that are shared by all prospects under consideration, commonly referred to as the isolation effect, and other violations of the expected utility paradigm (Barberis, Huang, & Santos, 2001). Studies have proven that when faced with sequential gambles, people are more willing to take risk if they made money on prior gambles than if they lost (Thaler & Johnson, 1990). This demonstrates that rather than looking ahead at the future value of an investment, people take the past into account, where previous losses or the actual amount of money they currently have in hand are used to base their decision upon. Kahneman and Tversky's paper on prospect theory has been cited tens of thousands of times and was decisive in presenting Kahneman with the Nobel Prize in economic sciences in 2002 (Barberis, 2013). Prospect theory can be used to demonstrate why investors who are risk averse would rather invest within a safer asset that offers lower return, rather than a higher return riskier asset. If an investor understands the pending threats climate change can have on the financial markets and has lost money from previous carbon bubbles, they might be more prone to spending their money on investments that mitigate against these risks (this will be discussed further in The Carbon Bubble section).

2.2.2 The Equity Premium Puzzle

The economist Richard Thaler, one of the largest contributors to the evolution of behavioral finance, has published numerous papers within this field (Barberis, Huang, & Thaler, 2006; Kahneman & Thaler, 2006; Thaler, 1997, 2010; Thaler & Johnson, 1990). Blending economics and psychology he continues to demonstrate that human irrationality is not considered in the traditional economic models. His contributions aided in the most well-known application for prospect theory in finance, the aggregate stock market, which is the idea that loss aversion in particular can explain the equity puzzle; that the average return of the US stock market has historically exceeded the average return of treasury bills by a much greater margin than predicted by traditional consumption-based models of asset prices annually (Bernartzi & Thaler, 1995). Coined as the equity premium puzzle (Mehra & Prescott, 1985), due to investors being loss averse, the high dispersion of the distribution of returns is unappealing; the stock market, therefore, needs to have a high average return that is significantly higher than a safe asset like treasury bills. This also plays into arbitrage models where the pricing of the same company can be different in different markets and in different currencies. Thaler's work strengthens the ideology that investors want to be paid more for what they consider as risk, as defined by traditional asset pricing models. The equity premium puzzle and loss aversion theories are important to understand because they show that investors who enter into the equity markets are seeking a higher pay-off relative to other asset classes. This empirically proven theory draws into the psychology of the investor. The equity markets, in Canada or not, are a private market mechanism that can be used to help mitigate the risks of climate change, and it is useful to understand the compensation expectation of these investors.

2.2.3 Market Anomalies

Two other main concepts within finance that prospect theory helps to explain are: the cross section of average returns and the trading of financial assets over time. Using the prospect theory utility from the change in the value of an investor's portfolios over the course of a period, it leads to a new prediction of asset prices or the cross section of average returns that is not based on the traditional model of expected utility. Using cumulative prospect theory (Tversky & Kahneman, 1992), a security's skewness in the distribution of its returns will be priced. The main result is that in contrast to the prediction of a standard expected utility model, a positively skewed security can be "overpriced" and can earn a negative average excess return (Barberis & Huang, 2008). For example, positive skewness is found if a stock has years of average returns, punctuated by selective high returns. Investors are entranced by the chance event of being very wealthy; they believe the stock could be the next Microsoft. As such, due to their poor probability weighting of future events, they overweight the stock, investors pile in, and the returns fall (The Economist, 2013). Cumulative prospect theory has explained several financial phenomena: bankrupt stocks, out of the money stocks, and initial public offerings, among others. Additionally, there is research that supports people trade financial assets counterintuitive to what the empirical findings demonstrate. Relating specifically to the "disposition effect" where investors sell stock that have risen in price and hold stock that have fallen in value although empirically over the same horizon, stocks that have risen continue to rise due to the momentum effect and stocks that do poorly continue to lag (Barberis, 2013; Odean, 1998). Jagedeesh and Titman (1993) have also documented short-horizon momentum. Winners over the past 6 months subsequently outperformed 6-month past losers. Testing years later, the momentum strategy remained profitable, providing support to delayed overreaction behavioral models (Jegadeesh & Titman, 2001).

Behavioral finance does not alone demonstrate empirical evidence on how human cognitive biases inhibit the ability to function like an operating system (loss aversion, disposition effect) but that the market system does not react in clearly articulated algorithmic approaches (equity premium puzzle). This field goes against the modern portfolio theorist's work by stating that a price of a security does not reflect all relevant information that is released (the markets are not fully efficient), and that financial models are not solely what humans cognitively use when making investment decisions. Due to the integration of various scientific knowledge, psychology and sociology, behavioral finance better explains market anomalies and financial behavior of individuals. This is important to understand because it highlights some of the flaws within the financial system and also provides support to investors who might not be interested in investing at a point of conventional optimality. Behavioral finance demonstrates that the “irrational” investors and their financial behavior have an impact on prices, therefore, “irrational” investors are marginal and invest with non-random strategies. The spread of socially responsible business ideas has encouraged the need to invest in companies that apply such a business practice. “The investment instruments selection process involves a detailed and thorough analysis of financial indicators, enabling to conduct the investment activities and combine the investment in pursuit of profit and improvement of the public social environment” (Guzavicius, Vilkė, & Barkauskas, 2014, 523). This alludes to the understanding that a non-random investment approach that incorporates a well-articulated climate change aspect could cause an effect within the markets. The idea of socially responsible investing and how it is used within the context of the equity markets will be discussed in detail below. First, it is worthwhile to discuss the contentions between these two theories and how these contentions lean support to finding a suitable alternative for investment theory that can bridge these two contending fields.

2.3 Contending arguments for MPT and Behavioral Finance

The issues of modern portfolio theory (MPT) will be discussed first. Then the issues with behavioral finance will be discussed, noting the pitfalls between both fields. The issues between both schools of thought are not displayed to evaluate one set of theories against another, although it might seem so due to the criticisms of each field being mainly sourced from advocates of the alternative approaches. This is how the field of study has developed. The reason for displaying the issues of both theories is that it is to demonstrate that neither paradigm nor approach to investment is perfect and that perhaps most investors might apply a blended approach when investing.

2.3.1 Issues of MPT

As Thaler simplistically states, “modern financial theory is based on the assumption that the ‘representative agent’ in the economy is rational in two ways: The representative agent (1) makes decisions according to the axioms of expected utility theory and (2) makes unbiased forecasts about the future. An extreme version of this theory assumes that every agent behaves in accordance with these assumptions” (Thaler, 2010, 13). He states that there are two arguments with this approach. First, knowing what individual investors are doing might still be of interest, regardless if asset prices are not set by these irrationalities. Secondly, although the argument is appealing and somewhat reassuring, its supporters have not been able to carefully execute it, leading to large issues of it only being proper in theory because humans are not rational, they are normal.

Given that MPT, EMH and the pricing models are based upon mathematical concepts, the second main critique lies within the assumptions that are made. Risk is defined as volatility; investors are risk adverse and are willing to take on more risk for a higher payoff, only measured by standard deviation or beta. Risk has not been defined as the financial strength, earnings, debt etc. that management uses when discussing the financial health of their company. Volatility is a measure that regards upside movement equally as bad as downside movement and when looking long term there is not a permanent correlation between risk and return (Travismorien, 2016). As empirical evidence has demonstrated, high volatility does not necessarily offer higher returns, nor does lower volatility offer lower returns (Haugen & Heins, 1975; Murphy, 1997).

2.3.2 Issues of Behavioral Finance

The modern portfolio theorists contend the arguments made by the behavioral theorists by stating that irrational investors, the people that make suboptimal investment decisions, are not marginal; they do not make an effect to the asset prices. Economists that support conventional theories, such as Friedman and Fama, use their confined approaches to disprove certain concepts. Fama actually notes within his 1998 paper that many of the anomalies found in conventional theories could be considered shorter-term chance events that are eventually corrected over time (Fama, 1998). Fama's article specifically looks at the field of behavioral finance and uses many of the previously cited articles within this thesis to demonstrate that in fact evidence does not exist that market efficiency should be abandoned. Consistent with the market efficient hypothesis that the anomalies are chance results is about as frequent as post-event reversal, and that these apparent anomalies can be due to methodology, that slight change in technique allow these anomalies to disappear (Fama, 1998). This means that chance events over the long run are insignificant, and the differing methodologies are a causation to market anomalies.

Another critique of behavioral finance, or more specifically with prospect theory, is although having excellent descriptions in experimental settings, the theory is not readily applicable in real world applications. A good critique that points out this problem of the prospect model is the lack of a clear definition of how one perceives an actual "gain" or "loss". For example, if an investor's focus is on the gains and losses in the value of their stock market holdings is it simply on the return or the return less the risk-free rate or actually beating the market rate? Although some researchers are attempting to clarify these definitions further, other authors are stating that the question at hand is not whether one should replace traditional models with models in which people derive utility only from gains and losses, but rather whether it is useful to consider models in which people derive utility from both gains and losses and traditional models (Barberis, 2013). Again, this demonstrates that some behavioral finance theorists argue for the need to find a blended approach that incorporates more humanistic approaches to model investors returns.

Lastly, given these criticisms it is clear that behavioral finance is descriptive in nature whereas modern portfolio theory is prescriptive in nature. Behavioral finance explains how agents in the market are inherently human but does not offer any solutions of how one can use the market to their advantage; drawing to their positive cognitive bias' such as investing when they perceive a company is 'good.' Modern portfolio theory explains how the markets operate than prescribing action orientated approaches for investment; they have now seemingly become well applied within the investment world.

It should be noted that there is wide support for both theories and the contention amongst researchers draws attention to the different paradigms that investors themselves can live within with regards to their investment approaches and the beliefs into how they understand how the markets should or do operate. This part of the literature review does not attempt to cover all the articles that have been published in regards to the theories and evidence but rather to outlay the findings of the predominant theories related to the two contending fields. These two fields, as demonstrated, have a large history of debating which is correct in understanding how the market works and operates. Both address the price (return and risk) and how an investor perceives it. An investor who is wanting to buy into companies that can support a carbon constrained future does not necessarily care only about the values of the companies and their attempt to counteract the prevailing issues of climate change; they are not a philanthropist and might also want to turn a profit. Therefore, the use of MPT's applications such as the Carhart model would be useful to this investor to ensure that they are still investing at a point of optimality. Which means think of return and risk first, then attempt to invest with climate change on their mind secondary. Alternatively, if one forgoes the idea that market prices are determined not by the discounted future earnings of a company but rather how the agents interact with it, investors who are looking to invest in a climate constrained future might make less optimal investment decisions from a returns perspective, and reallocate their capital to the companies that they want to see be supported for industry growth and help mold our society first. Regardless, of where an investor lies within the spectrum of how they think the markets should or do operate, climate change has brought forth a problem that all investors need to be aware of, this is entitled the carbon bubble, and will be discussed next.

2.4 The Carbon Bubble

To contextualize globally, the Intergovernmental Panel on Climate Change (IPCC), which is comprised of some of the world's most acknowledged climate scientists, released a series of reports in 2013 and 2014 that for the first time quantified the global "carbon budget," the amount of carbon dioxide emissions humans can emit while having the likelihood to remain below a 2 degree Celsius increase in temperature above pre-industrial levels (Intergovernmental Panel on Climate Change, 2014). As the IPCC and other climate scientists have demonstrated, the combustion of fossil fuel creates carbon emissions, which is directly linked to climate change. In addition, to remain within the global carbon budget, the amount of GHG that can be emitted before catastrophic changes happen to the earth ecosystems, equivalent 2/3 of proven reserves of fossil fuels, cannot be burned (Intergovernmental Panel on Climate Change, 2014; McGlade & Ekins, 2015). This means that proven reserves far exceed the amount that can be burned while staying within this budget, aside from technologies that prevent emissions such as carbon capture and storage (CCS). The global economy, faces the prospect of assets becoming stranded, in effect creating a carbon bubble (Carbon Tracker, 2013).

Support for the existence of a carbon bubble within Canada can be viewed from two perspectives: Canada taking action on climate change and Canada not taking action on climate change. If Canada chooses to remain within its carbon budget, the maximum amount of CO_2 that can be emitted in the future to maintain Canada's portion of an increase in average global temperature below 2 degrees Celsius, it is implausible to operate business as usual within the fossil fuel industry. The country's proven fossil fuel reserves are equivalent to 91 Gt, or 18% of the global carbon budget, whereas the plausible budget would be between 2 and 20 Gt. Therefore, regardless of an internationally negotiated budget based on export arrangements or any technological advancement, Canada will have to implement regulations or coerce the fossil fuel industry to lower their production levels in the oil sands (Lee & Ellis, 2013). From the other perspective, if Canada chooses not to act to maintain its carbon budget, the costs of the oil sands production are too high to remain competitive in a global society that is decreasing its consumption of oil. This has the effect of making this industry no longer economically viable (Rubin, 2015). Both of these perspectives lead to what some researchers and industry analysts are terming stranded assets, which will be discussed below.

A ‘bubble’ is “a market phenomenon characterized by surges in asset prices to levels significantly above the fundamental value of that asset. Bubbles are often hard to detect in real time because there is disagreement over the fundamental value of the asset” (Nasadq, 2016, 1). Therefore, regardless if Canada were to take action or not, supporters of the idea of living within a GHG constrained society or that the economic viability of certain assets are unlikely, believe that the stock prices of fossil fuel companies are overpriced. In Canada, the energy sector is the second largest by market capitalization, after the financial sector, representing 19.25% of the total S&P/TSX Composite. By the market currently failing to incorporate the new earnings trajectory of these firms or furthering discounting the earnings based upon the perceived risk for earnings potential these companies in aggregate have created an inflated sector price. This phenomenon of overpricing the aggregated fossil fuel companies is referred to as the ‘carbon bubble’.

Market bubbles, as behavioral theorists point out, occur due to an over extrapolation where many investors’ beliefs about the future stock market are based on past performance. Many investors believe that stock prices will continue rising after they have previously risen, which is hard to reconcile with existing models of the aggregate stock market (Barberis, Greenwood, Jin, & Shleifer, 2015). Continual price rises create a mispricing where the stock’s price starts to exceed its fundamental value. One would think that in a completely rational world no one would buy such a stock, but behavioral theorists suggest that the considered rational investors would purchase based upon speculation of further price increase and the ability to sell at a greater price. For that to be the case, the new purchaser would have to either be irrational or another rational investor who thinks the price will still resell at yet higher prices, and so on. This demonstrates that informed and trained subjects produce substantial bubbles and crashes in the absence of common knowledge of rationality (Palan, 2013; Shiller, 2003).

When compared to other market bubbles that have occurred in the past, such as the Dutch tulip mania, the stock market crash of 1929, Japan’s bubble economy of the 1980s, or the dot com bubble of the late 1900s (The Bubble Bubble, 2016) the carbon bubble is unique because it is the first bubble that not only is being debated as having firms being mispriced from a fundamental perspective but from that of a moral and ethical perspective and based on pending policy changes. Some investors are screening out fossil fuel companies from a moral and ethical environmental perspective because they believe it is unjust to support companies that do not have the idea of living in carbon constrained society in mind. They are pricing the externalities of carbon or other natural resources.

An investor's decision not to purchase a fossil fuel company's stock due to the moral and ethical practices that the firms engage in is rooted within the field of behavioral finance, and is commonly referred to as a type of socially responsible investing (SRI). Some research explains the evolution of SRI and its current discourse as being premised on the idea that markets are a positive and creative means for allocation of resources. It is founded on the view that the market mechanism is not a law of physics but instead a human-construct, which can be molded and tweaked to work in different ways (Bakshi, 2007). As stated previously, the human element is a large component of how behavioral theorists understand market pricing. In the following section, the definition of socially responsible investing, the past performance of SRI funds, and the type of SRI approaches, specifically with environmental SRI concerning the fossil fuel industry and carbon, will be discussed. First this paper will briefly discuss how the 'carbon bubble' is the first bubble that is considered to be within the field of SRI and how that plays a role within both behavioral and conventional finance. This will shed some light on why modern portfolio theory along with behavioral finance was critical to review and understand, drawing more towards the founded research gap.

As a result of the 2008 global financial crisis, investors are starting to become much more aware of the driving patterns for bubble creation and are tending to be more risk averse. The 2008 crisis was due to securities funded by mortgages of people that were said to be as credit worthy as government of Canada treasury bonds. The thought was that housing pricing would continue to rise. Similarly, the carbon bubble is proposed to be due to the implicit assumption that we can burn and emit as much carbon as we can, and that the price of oil will continue to rise (The Star, 2015). Conventional investors are starting to understand the idea that only a fraction of this carbon can be burned, hence many proven reserves cannot be extracted, and as a result the global economy faces the prospect of assets that are currently recorded on companies' books to be discounted. These assets are becoming known as stranded assets, which are environmentally unsustainable assets that suffer from unanticipated or premature write-offs, downward reevaluations or are converted to liabilities (Ansar, Caldecott, & Tilbury, 2013). Whether these assets become stranded due to governmental legislation such as a cap on extraction and production or legislation at the end use such as market schemes (carbon pricing or cap and trade), this can affect the price of these fossil fuel securities. Stranded assets are an inevitable effect of climate change policy (Fischer, 2015). Therefore, putting the moral and ethical debate aside, investors will want to find lower carbon securities to invest in that maintain their conventional risk/return profile. Conventional investors around the world are starting to be receptive to the information that a risk aversion market is a sustainable one that needs to incorporate non-financial criteria into their investment strategies. The United Nations Principles for Responsible Investing states that "responsible investment should be pursued even by the investor whose sole purpose is financial return, because it argues that to ignore environmental, social or governance (ESG) factors is to ignore risks and opportunities that have a material effect on the returns delivered to clients and beneficiaries (PRI, 2016, 1). Consequently, whether an investor that engages with the markets is framed within the behavioral paradigms or not, the idea of the carbon bubble is real and needs to be addressed. Therefore, this analysis is applicable to both types of investors and as such both types of theories need to be incorporated in the methodology so that solutions of how one can invest with these problems in mind will utilize their financial language.

2.5 Socially Responsible Investing

Milton Friedman believes the sole social responsibility of business is to increase its profits, and that anyone preaching about eliminating discrimination or avoiding pollution or any other catchwords that encompass a firm's "social conscience" is preaching pure and unadulterated socialism (Friedman, 1970). Those catchwords would only be relevant if they affected the bottom line. Preach they will do because the field of corporate social responsibility (CSR), the firm's responsibility to society, has been growing through both academic and industry communities for over 50 years. Dating back to the Religious Society of Friends in 1758, and more modernly to the civil rights issues of the 1960s, SRI has been used as a means to address injustices that should not be financially supported. Davis (1960) suggested that social responsibility refers to business' "decisions and action taken for reasons at least partially beyond the firm's direct economic or technical interest" (Davis, 1960,70). This definition was used to understand the four types of social responsibility that constitute CSR in total. They are: economic, legal, ethical, and philanthropic. The field of socially responsible investing is driven by the economic field of CSR where the investors are considered a stakeholder and where their investments into a company demonstrate them morally supporting the actions of the firm. As an aside, it is worthwhile to note although research cites SRI came out of CSR, it does not prove the linkage between CSR and SRI is a one-to-one connection. That is, if an investor is interested in a firm's responsibility to the environment, they will invest with such ideals. Although the few studies that have explored this topic have demonstrated that understanding investors' decision making process is important, further research needs to be completed (Glac, 2009, 2012).

Socially responsible investing (SRI) is commonly referred to as ethical investing, sustainable investing, triple-bottom-line investing, green investing, ESG (environmental, social, and governance) investing, value based investing, socially conscious investing, impact investing, among others. This paper will utilize the broadly used and supported term SRI. Although the approaches to SRI and its empirical support vary, socially responsible investing when loosely defined is normally in such agreement. Some definitions involve "integrating personal values and societal concerns with investment decisions" (Statman 2006; Schueth 2003; Shank et al. 2005) (from Berry & Junkus, 2008, 708). Others are "often defined as the integration of certain non-financial concerns, such as ethical, social, or environmental, into the investment process" (Sandberg, Juravle, Hedesström, & Hamilton, 2009, 521). The Forum for Sustainable and Responsible Investment defines SRI as "an investment discipline that considers environmental, social, and corporate governance (ESG) criteria to generate long-term competitive financial returns and positive societal impact" (USSIF, 2016, 1). Others state that these investment types are a matter of taste and do not see a need for a general definition, that sustainability means something different for every individual investor, and that sustainable investments sufficiently summarize every desirable non-financial impact an investment may have (von Wallis & Klein, 2015).

Regardless of the different words used, they all reflect the integration of non-financial criteria to support the wellness of the firm and non-economic stakeholders within the investment process. "SRI is of interest even to those who have a sharp critique of the prevailing form of market driven globalization but are keen to deploy varied means to contain its socially and environmentally destructive trends. SRI is merely one-dimension of the unfolding process of altering the operating system of Markets- so that externalities are more clearly accounting for and paid for, by both the producer and consumers. This could potentially encourage more realistic pricing of both natural resources and nature's sinks, thus making way for sustainable prosperity" (Bakshi, 2007, 523).

The terminology and definitions alone support the field of behavioral finance in that investors are not investing with cognitive biases but are actively selecting firms that go against their utility maxim. As a result of their personal choice on how they want to pursue investment opportunities, their utility maxim has moved from the conventional risk/return optimum to a subjective maxim. Sandberg et al. (2009) state that cultural differences might be one explanation for heterogeneity in the field of SRI and that it is quite unlikely that these differences might be resolved in the near future. It is important to discuss the empirical evidence of SRI to demonstrate the efficacy of investing responsibly because this will shed some light into the debate on whether one can invest against their utility maxim techniques without actually suffering from a loss in return/risk profile. Capelle-Blancard and Monjon (2012) find that near two-thirds of all published academic articles cover performance measurement, which the researchers explain by the fact that the research in this field is very data driven. Additionally, it is important to discuss the predominant methodological approaches that are used, specifically among environmentally conscience investors, because this will yield the approaches taken within this analysis. Therefore, SRI performance and SRI approaches are discussed.

2.5.1 SRI Performance

As noted previously, based upon efficient market hypothesis all relevant information is reflected within the equity prices. This means that anything the market considers as risk will be reflected in the stocks discount rate and any predicted future event would be reflected within the future earnings of the company's cash flows. In a perfect world for SRI investors, the market does see environmentally dangerous practices, such as the extraction of fossil fuels, as something that will come to an end. Therefore, it would lessen if not delete the future earnings of the fossil fuel extraction companies to zero, significantly driving down their stock price. The market would fully discount all non-climate conscience practices (such as pollution and waste) and price all natural capital. This is clearly not the case since, as mentioned above, the carbon bubble has not burst. Are SRI funds, however, outperforming and can investors make money by buying green or socially conscience? If the answer were yes, this would lean support to behavioral theory that there is a link between CSR practices and economic performance.

Most SRI funds aim to offer products that reflect investors' values and provide investment returns to satisfy their financial goals. Bauer et. al (2008) noted that financial performance is a critical factor that determines the entrance of ethical funds into mainstream finance. As mentioned previously, some believe that the SRI portfolios under-perform conventional portfolios as the investment opportunity is constrained by the non-financial criterion and mean-variance efficient portfolios are not achievable (Tippet, 2001; Kahn et al. 1997; Geczy et al. 2005; Gregory et al. 1997). The empirical evidence to demonstrate whether SRI portfolios can 'do well and good', be socially responsible and offer competitive returns, is well supported starting in the 1970's and more heavily researched from the mid-2000's and beyond. A review of the empirical literature on SRI performance was done in two-fold: what is the empirical evidence demonstrating and specifically, what is the evidence demonstrating within the Canadian markets?

Empirical Evidence: General

Given that risk is important when evaluating returns, studies have demonstrated that SRI mutual funds do not do worse than conventional mutual funds on a risk-return basis (Goldreyer & Diltz, 1999; Renneboog, Ter Horst, & Zhang, 2008; Statman, 2000). A unique study understood risk differently and found evidence that suggests that preferences of social SR investors can be represented by a conditional multi attribute utility function in the sense that they appear to derive utility from being exposed to the SR attribute, especially when it delivers positive return (Bollen, 2007). The list goes on for the studies with slightly varying approaches in regards to SRI type and timeline. Therefore it is useful to review meta studies that have been completed to understand the overarching conclusions. The following are two meta studies, completed in 2015, providing a more well rounded idea of the linkage between SRI and financial performance. The first study reviewed 60 review studies, combining more than 3700 study results from more than 2200 unique primary studies, and found that more than 90% of studies demonstrate a non-negative relation between SRI and financial performance. The main conclusion is that the orientation toward long-term investing should be important for all kinds of rational investors in order to fulfill their fiduciary duty and may better align investors' interests with the broader objectives of society (Friede, Busch, & Bassen, 2015). The second study, lists 53 studies of mainly the past 15 years that outlay the articles in categories of their results: equal performance, over performance or underperformance. The study then added a chart in each category to list the timeline, performance measurement and selection of social component. Although most studies analyzed did not demonstrate underperformance, the study concluded given the diversity of study type, a common understanding should be reached on what is considered an SRI fund (von Wallis & Klein, 2015).

Therefore, developing a measurement to quantify how socially responsible a specific investment vehicle really is. Although these two meta studies are surely not an exhaustive summary of all empirical studies relating to SRI and financial performance, it does demonstrate that an investor can 'do well and good,' at least under certain conditions.

Empirical Evidence: Country Specific

Most studies focused on SRI fund performance in individual countries such as the US (Cox & Schenider, 2006; Goldreyer & Diltz, 1999; Statman, 2000) and the UK (Cox & Schneider, 2006; A. Gregory & Whittaker, 2007; Hellsten & Mallin, 2006). Every study had differing timelines but demonstrated that SRI funds are not significantly different from that of non-SRI funds. There have also been studies that compare US and European performance (Cortez, Silva, & Areal, 2012; Mollet & Ziegler, 2014). Only one study has been conducted in Canada, demonstrating insignificance amongst their conventional peers (Bauer, Derwall, & Otten, 2007). Lastly a cross-country study, evaluating 103 mutual funds across UK, US, and Germany demonstrated that when controlling for the factors within the Carhart models, there is no statistical difference in returns (Bauer, Koedijk, & Otten, 2005). This demonstrates that Canadian based research for the link between ESG and financial performance is understudied and that using the Carhart model is useful to explain return attribution.

As Berry & Junkus (2008) note, there is no underlying financial framework to relate the marginal social responsibility of an investment to an investment's performance. In other words, there exists nothing that defines the optimal trade-off between social responsibility and other investment criteria, primarily risk and return. This summarizes well the lack of understanding on the years of conducted studies to analyze the difference types of SRI investments and whether that matters for fund performance. The majority of studies labeled them as 'ethical funds' or 'social funds'. Although it is important to show evidence that, generally, past strategies within the SRI field have performed well, it shows little evidence in the field of SRI that is specific to environmental criteria and outperformance. Additionally, given that the breadth of this research was completed over 5 years ago, the industry could have since reacted to climate change whereas the academic research has not been at the forefront. The following section will briefly outline the common different SRI strategies then narrow down on the current approaches used for an environmentally conscience investor, which are primarily industry driven.

2.5.2 SRI Approaches

SRI approaches can come in many forms. Berry & Junkus (2012) did a survey of 5,000 investors, with both investors who have used SRI criteria in investment decisions and those who have not. Their study found that the surveyed investors considered environmental issues to be the most important, and that most investors prefer to award firms who display overall positive social practices. It also found that most SR vendors focus on an exclusionary approach, which is a disconnect that could be a factor in limiting the growth of SRI. This study and the evolving definition of SRI demonstrate that it is difficult for investors, vendors, and those who research the field to definitively categorize how SRI is applied. Sandberg et al. (2008) states the heterogeneity of SRI in regards to the terminological, practical, and strategic differences can stem from cultural and ideological differences. Furthermore, that the SRI stakeholders, the actors involved, can change the process which actually creates incentives for fund companies to develop terms, strategies and criteria slightly differently than their competitors. Given that the focus of this research is to understand the approaches used by industry for SRI in the minds of environmental investors, the use of approaches by investors and vendors will be discussed. First, the overarching approaches to SRI will be discussed to get an understanding of where the environmental approaches stem from.

Corporate socially responsibility (CSR) standards attempt to create quantitative metrics to define the appropriate business behavior and responsibilities of business firms. Behind this lies the assumption that positive corporate behavior provides positive economic consequences (Berry & Junkus, 2013). This is the idea that firms will do well by doing good (Statman, 2000) and is used to justify applying SRI criteria for investment decisions. As discussed previously, this is one reason why the link between SRI portfolios and economic performance was so heavily researched and is needed for the buy-in of traditional investors. CSR standards and principles have been circulated by many international organizations and NGOs in the past. The Sullivan Principles were used for the anti-Apartheid movement (Gosiger, 1986), the Caux Principles for moral capitalism (Caux Roundtable, 2016), and the Global Reporting Initiative for sustainability (GRI, 2016) and all have been circulated and then used by investment professionals. The UN Global Compact is an initiative for companies to align their strategies and operations with global principles on human rights, labour, environmental and anti-corruption. It urges companies to be more transparent and accountable, noting that capital markets now evaluate companies' performance on environmental, social, and governance (ESG) issues (UN Global Compact, 2016). ESG is the catch-all term for the criteria being used within SRI (David Suzuki Foundation, 2016). The Global Compact notes that investors know how to use ESG within their investment decisions due to UN-supported initiatives such as Principles for Responsible Investment (PRI), UNEP Finance Initiative (UNEP FI), Equator Principles, Principles for Sustainable Insurance and the UN Sustainable Stock Exchanges Initiative.

The ESG standards are one method of how to aid in the exclusionary or inclusionary, also known as positive and negative screening, approaches to investment; exclusionary means screening out firms that do not pass certain criterion and inclusionary means investing within firms that might encompass positive ESG criteria. Although they sound the same, their applicability is different. Investors who tend to use the exclusionary approach to investing create their portfolio based upon their conventional risk/return profile, then screen out the ones who do not meet ESG criterion. Investors who tend to use inclusionary approaches tend to use seek out firms who pass certain criterions then invest in a mix that can fulfill their risk/return profile (SRI Services, 2016; CFA Institute, 2014). RIA Canada notes that 'screening in' or 'screening out' should not be used for ESG, that integration must be verifiable by a transparent and systematic process by ESG research and analysis (RIA Canada, 2016). Additionally, other investor's employ a strategy entitled best in class, where they rank companies against their industry peers and invest in the top by whichever criteria they use. This can be seen as a means for a positive selection technique. This demonstrates the understanding of ESG and the criterion used varies among investment professionals and the vendors vary, including their data.

Other general approaches under the SRI umbrella are engagement/shareholder action, norms-based screening, thematic investing, and impact investing (Global Sustainable Investment Alliance, 2014; RIA Canada, 2016). Given that these terms mean something different to each company, the first two will be defined by the Responsible Investment Association (RIA) Canada, the membership organization for RI in Canada, and impact investing will be defined by the Global Impact Investing Network (GIIN). Engagement/shareholder action is engaging in dialogue with companies' management, voting proxies, and filing or co-filing shareholder resolutions. This is being an active shareholder. Thematic investing is investing in adaptive solutions that address challenging issues such as energy efficiency or green infrastructure (RIA Canada, 2016). Lastly, impact investing are "investments made into companies, organizations or funds with the intention to generate a measurable, beneficial social and environmental impact alongside a financial return" (GIIN, 2016). The engagement approach was not selected within this research due to the inability to track their impact and how these approaches could effectively have an investor allocating their resources to equip Canada to a carbon constrained society. The thematic approaches are used in this analysis in conjunction for exclusionary approaches as re-investment opportunities to further strengthen an investor's position in regards to their environmental beliefs. Lastly, the impact investing approach is arguably an evolving new field that although is complimentary to supplementing the capital markets to a carbon constrained society it is far out of scope of this research. Therefore, the remaining part of the literature review will define the predominant inclusionary/exclusionary approaches for portfolio managers for the environmental aspect for ESG investing.

2.6 Environmental SRI Approaches

There is an array of environmental issues that can be looked at when evaluating a company and choosing whether to invest or not. MSCI, a leading data provider on ESG factors for investors to integrate within their portfolio construction and management process, identifies four themes under the environmental pillar. They are: climate change, natural resources, pollution & waste, and environmental opportunities. As aforementioned, this research is looking at the issues of adhering to Canada's climate change targets, therefore, the theme of climate change will be addressed. The five key issues that MSCI outlays for climate change are: carbon emissions, energy efficiency, product carbon footprint, financing environmental impact, and climate change vulnerability (MSCI ESG Research Inc., 2014). Understanding that carbon emissions (equivalent GHG) is the main factor that attributes to climate change, this issue will be discussed in the context of climate change. The two main approaches of how an investor can invest with a concern of carbon within the industry are the fossil fuel free divestment movement and carbon footprinting.

The fossil fuel free divestment movement and carbon footprinting both cater and appeal towards both definitive SRI investors and conventional investors. The divestment movement supports the idea of stranded assets, appealing to a risk aversion technique for conventional managers. Additionally, it appeals to SRI investors due their moral and ethical ideologies. The carbon footprinting approach will appeal more to the conventional investors who are embracing an SRI approach because of fear of end use policy and regulations, such as a limit on fossil fuels a firm can burn or a price on carbon. Furthermore, it appeals to SRI investors because they are reallocating their capital to support a lower carbon society. Next, the two approaches will be discussed in detail.

2.6.1 Fossil Fuel Divestment

This alternative approach is under what is known as the fossil fuel divestment movement and has been heavily published and discussed since the launch of the campaign in 2012 (The Guardian, 2015). This campaign spread around the world and is seen as a means to challenge institutions worldwide to put their money with their mouth is. Simply put, divestment is the process in which an investor sells their shares, bonds, or investment funds due to moral or ethical reasons (Kaempher et. al, 2001). It is the opposite of investment, where the assets are now considered against their own moral and ethical beliefs and their fiduciary duties and now need to be sold to adhere to their investment philosophies. "It is a socially motivated activity of private wealth owners, either individuals or groups such as university endowments, public pension funds, or their appointed asset managers" (Ansar et. al, 2015, 9). Used primarily as an exclusionary technique, divestment is under the umbrella of SRI because it integrates non-financial criterion within its investment process. Divestment has been used within the past for perceived injustices such as the atrocities in Sudan's western region of Darfur, tobacco, munitions, and most famously for the racial and human rights violations of the South African Apartheid government (Kaempfer, Lehman, & Lowenberg, 1987).

Although while excluding investments are the main method used by divestment campaigns historically, it can be combined with other methods, such as positive selections. The divest-invest movement for example, combines exclusionary approaches with investment strategies in renewable energy industries or other climate solutions (DivestInvest, 2015). The movement's intention is to shift capital flows away from problem industries and accelerate the transition to a global economy fueled by renewable energy. Financially, advocates of the divestment campaign state that market data and trends demonstrate that people and institutions are getting out of fossil fuels before the carbon bubble bursts and assets are stranded.

Divestment can be considered effective or successful in a few ways depending on what goals are embraced. 350.org's (2016), the leaders of the movement, goal is to have the fossil free campaigns as one part of their overall movement to hold our leaders accountable to the realities of science and the principles of justice and to put an end to fossil fuel extraction. They see a divestment success to be when other institutions, such as a university or church, release a divestment plan. The point is to remove the companies' social license to operate. The Stranded Assets Programme (SAP) at the University of Oxford states the three aims of the fossil fuel divestment campaign are: i) force the fossil fuel companies and pressure the government, eg. via legislation, to leave fossil fuel in the ground, ii) pressure fossil fuel companies to undergo transformative change that can reduce emissions, and iii) pressure governments to enact legislation such as a ban on further drilling or carbon tax (Ansar et al., 2013). Hunt et al. (2016) does a comparative analysis on the anti-Apartheid and fossil fuel free campaigns to understand the similarities and differences between the campaigns. They state that discrepancies arise from an evolving understanding of what constitutes a socially responsible investment and that these campaigns strategies differ. Therefore, it is important to recognize that pursuing the fossil fuel divestment in the same manner as the anti-Apartheid movement would not be reasonable given the intended overall strategy and outcome, perceived best practices, or successes of the anti-Apartheid campaign should not be readily replicated.

Ritchie and Dowlatabadi (2014) attempted to reduce the carbon emissions associated with a Canadian university endowment through divestment but noted various challenges because of the structures of currently available financial instruments. Additionally, due to using a life cycle assessment approach, it was difficult to make significant reductions in the carbon shadow of a large pooled funding using conventional approaches to risk and return distribution across sectors. This study demonstrates the effects of divestment are debated amongst professionals and that even the use of divestment might not possible for endowments within a Canadian context. Others studies are attempting to discover whether divestment affects share prices (Ansar et al., 2013; Teoh, Welch, & Wazzan, 1999) or rather what the effects of divestments are (Hunt et al., 2016). As aforementioned, this research is from the lens of the investor. Therefore, what is important is not whether divestment effects share prices, companies or the economy but rather if it is possible for an investor to divest and perhaps, reinvest into lower carbon solutions without suffering from financial loss. In the following paragraph, the varying approaches to divestment will be discussed, understanding that the strategies for the reallocation of capital can also vary, and that re-allocation to lower carbon solutions is one strategy.

As the fossil fuel divestment campaign continues to evolve institutions are selecting methods for divestment such as only divesting from coal (The Guardian, 2015), divesting in only the top 200 companies by fossil fuel reserves, divesting from specific types of fossil fuel players

(BrightNow, 2015) or full divestment from the fossil fuel industry (University of Glasgow, 2014). These approaches allow the institutions to take a stance on the perceived injustices from the fossil fuel industry without hurting their risk/return profile and changing their existing investment mandate. Fossil Free, the campaign supported by 350.org has a full list of the varying approaches to divestment and the institutions engaging within it (Fossil Free, 2016).

2.6.2 Carbon Footprinting

Carbon footprinting is a new buzzword that has gained popularity over the last few decades. Rooted in Ecological Footprinting, Wackernagel (1996) describes it to stand for a certain amount of gaseous emissions that are relevant to climate change and associated with human production or consumption activities. Carbon footprinting can be used in detailed, more accurate approaches such as life cycle analysis (LCA) to input-output models to simplistic approaches such as an online tool that estimates the carbon footprint of a flight from, for example, Copenhagen to San Francisco (Weidema et al., 2008). The broad appeal of allowing estimation models versus LCA to flood the market is that it simplistically enables the masses to understand what generates higher levels of CO_2 equivalent, which is the key focus for everyone to understand how to mitigate emissions output.

This trend has hit the socially responsible and risk adverse investment world, notably in 2005 when Europe introduced their emissions trading scheme, for disclosing a company's annual carbon emissions output and using exclusionary/inclusionary approaches. As described by some of the leading climate strategists for investing "carbon footprinting data is, at its core, a measure of the GHG emissions of an underlying company allocated to its investor. Thus, it represents an absolute value (annual GHG emissions) that needs to be normalized to be comparable across companies, sectors, or portfolios" (2 degrees Investing Initiative, WRI, and UNEP-FI, 2015). Carbon footprinting is the most commonly used metric for climate friendliness and an integral part of the Montreal Carbon Pledge. As discussed previously, the idea of looming carbon pricing and regulations appeals to conventional investors and they are using carbon footprinting as a way to mitigate against this downside risk. SRI investors are implementing this approach not only for risk aversion but because it provides capital in favor of lower-carbon and climate-friendlier companies, projects, or assets. How investors use carbon footprinting in their investment process will be explored in the following paragraphs.

Although there is guidance issued from certain sources, such as the Greenhouse Gas Protocol, there are no mandatory guidelines for companies on how to account their GHG emission inventory within Canada. Challenges arise from which emissions sources a company should include in their inventory and how to calculate them, what constitutes a full list of indirect supply chain activities, and how to determine which activities from such a list are significant by application. Carbon Disclosure Project (CDP) is the leader in compiling voluntary data from companies, and urges all companies to use the Greenhouse Gas Protocol as a guideline. Many vendors such as Trucost, South Pole Carbon, and Carbon Screener use CDP as a starting point then build in their own propriety methodology to fill in the gaps (2 Degrees Investing Initiative, 2013). This contributes to the next challenge for standardization within the marketplace: how vendors use and sell company data.

2 Degrees Investing Initiative, a multi-stakeholder think tank, did an analysis that reviewed the different types of portfolio footprint data sets and methodologies from the available vendors in the marketplace. Among others, the features compared were: scope of emissions (scope 1,2&3), rule of allocation to investors (share of ownership, share of financing, share of investment), asset types (equities, corporate bonds, real estate, sovereign bonds), GHG data used to calculate investees' footprint (CDP, EEIO model, LCA analysis, GHG emission factors based on national inventories), sources of activity data and methods used for matching emissions factors of the model (sales, assets, outputs, industry specific approximations). The data providers typically aggregate and sell the data that flood the market place (2 Degrees Investing Initiative, 2013). Studies have researched which approach is most accurate in encompassing the appropriate GHG emissions for a company (Huang, Lenzen, Weber, Murray, & Matthews, 2009; Carnegie Mellon University, 2016). Although it is imperative to understand the most accurate way to calculate and estimate emissions for the issues of taking into account the total direct and indirect emissions (Carneige Mellon's study demonstrates that on average scope 1+2 emissions are on average only 26% of the total supply chain), it is not the objective within this analysis. The objective here is to understand how carbon emissions are used for portfolio construction.

Depending on which philosophy is embraced for investing you can use carbon data differently for portfolio construction. Using relevant metrics to assess a portfolio's baseline exposure to climate related risks and opportunities is an important first step and will allow for normalization across sectors and other portfolios if need be. Advocates of the divestment approach associates the carbon emissions with the proven reserves in the ground, the proven potential of CO_2 emissions. This approach leans more towards the stranded assets/balance sheet approach, using assets to measure emissions potential. Using total carbon emissions considers the end use of these fossil fuel resources, being risk averse to pending policies and regulations associated with the use of fossil fuels. There are two approaches that commonly use total carbon emissions (equivalent GHG). The balance sheet approach is emissions related to share of ownership. This calculates the carbon footprint of the investor's money or financed emissions. MSCI noted from a 2015 survey that carbon emissions per amount invested is regarded as the most important approach by investors (Frankel, Shakdwipee, & Nishikawa, 2015). The other dominant approach is the income statement approach, a way to calculate the total emissions burned (end-use) against revenue or sales. This takes into account the carbon efficiency of the company. In particular, it corrects for the biases introduced by market cap and price-to-sales ratio (Raynaud, 2015). Investors who are concerned about market or regulatory risks commonly use this approach. These two approaches use the exclusionary/inclusionary approach, applying an ESG criterion of a carbon emissions indicator as a screen. The formulas and details on how the carbon emissions indicators are applied will be expanded in the methods section.

Lastly, it is important to understand which approach one is taking so that emissions data are not double count data emissions within the analysis. Double counting can occur within an investment portfolio primarily when using scope 2 and scope 3 in the analysis and different asset classes. According to Cross-asset footprint calculations, double-counting can reach 30-40% of an investor's portfolio emissions (Raynaud, 2015). Ensuring that the data sources do not double count is important for portfolio construction because it can alter the investment decisions. Double counting can also occur given the nature of investment and divestment drawing in the problem of allocation amongst firms. Carbon is produced by the fossil fuel firms and used by all other industry including the firms themselves. Additionally, these footprinting approaches assume some responsibility to the investor, whether it is the equity or fixed income investor or bank. It is imperative to clearly define the approach that is taken and how much responsibility is allocated to whom so there is no overlap amongst supply chains, asset classes and investment types, the firm morally responsible etc., especially when an large investor implements these metrics alongside divestment strategies.

To understand more of the risks and opportunities, an approach used alongside carbon footprinting, 'green/brown' metrics, is used to get an understanding of the dispersion of the climate challenge and opportunities within a portfolio. It allows a portfolio manager to differentiate the firms within a sector that might have other quantifiable characteristics that could differentiate actors who are supporting a lower carbon society or not. For example, two car manufacturers can produce the same output for scope 1+2 emissions but one company could be making electric vehicles while the other is making combustion engine trucks. Measuring the average fuel economy of their fleet can solve this problem. Alternative industry and sector classification such the Sustainability Accounting Standards Board's (SASB) is another tool, which considers green/brown data. The downfall of these metrics is that they are limited to a number of industries, there is no agreed classification system, and the data is not easily accessible in financial databases (2 Degrees Investing Initiative, 2013). These techniques are still within their infancy and need to have more clarity and be more accessible for the portfolio management process.

3 Objectives, Research Question, and Hypothesis

This literature review has outlaid the problems that need to be addressed for investors, whether they want to embrace the moral and ethical ideologies for climate change, or not. This problem was supported by first describing the theories (MPT and behavioral theory) that support the two predominant paradigms, investing for profit or investing for resource allocation, that investors are operating within when understanding why the equity markets exist and how they operate (others theories were not chosen because they are considered to be less researched and applied). These theories demonstrate many contentions and brought forth an understanding that investors might live within a blended spectrum of these two paradigms, demonstrating the need for further research within this area. The topic of a carbon bubble in Canada is an example that has allured investors of both types to embrace unconventional strategies to mitigate their risks of the carbon bubble bursting and/or supporting a lower carbon society. A dynamic and changing blended approach, called socially responsible investing, is the umbrella term used to describe how investors can deploy investment strategies that utilize non-financial investment criterion. This literature review continued to explore the idea of socially responsible investing in respect to the environment, specifically climate change, and detailed the predominant strategies investors are using within the industry today. This brought forth two main research gaps. First, that research that analyzes the link of SRI techniques and financial performance is understudied within the Canadian market. Second, and more specifically, there are no studies that have analyzed Canadian broad market fund performance utilizing industry specific techniques for climate change in respect to carbon emissions within the academic community. Notably, this literature review discovered that there is a research gap in understanding if the broad Canadian equity market is equipped and can be utilized to fund a lower carbon society. As discussed previously, if Canada chooses to adhere to its climate change targets, action needs to be taken and the public equity markets can be a mechanism used. Next the objectives for the research will be outlined, followed by the research questions and hypotheses.

3.1 Objectives

The study has the following objectives:

- To investigate and understand how an investor within the Canadian equity markets can invest while considering Canada's climate change targets.
- To better understand the link between environmental SRI and financial performance
- To provide more research in the field of socially responsible investing for academics and industry analysts with an interest in the Canadian equity markets.
- To understand if an investor interested in investing within the Canadian equity markets can mitigate their risks from climate change, specifically pertaining to carbon emissions.
- To determine if an investor can re-allocate their capital to aid in climate change mitigation and adaptation, specifically lower carbon solutions.
- To educate investors in understanding risk must consider more factors than price volatility alone. There are other drivers of risk that can be quantified and used for investment criterion.
- To further understand if the Canadian equity markets are currently a mechanism investors can use to allocate their capital to fund a sustainable future.

3.2 Research Question and Hypotheses

The two research questions and hypotheses derived from the research gaps are as follows:

1. Does divesting from Canada's S&P/TSX Composite index as an investment strategy financially underperform?

H_0: Divesting from Canada's S&P/TSX Composite index as an investment strategy financially underperforms relative to the S&P/TSX Composite benchmark.

H_1: Divesting from Canada's S&P/TSX Composite index as an investment strategy does not financially underperform relative to the S&P/TSX Composite benchmark.

Divestment here is in reference to the fossil fuel free divestment movement.

2. Does using carbon emission metrics as an investment strategy financially outperform?

H_0: Using a carbon emission metric as an investment strategy financially underperforms relative to the benchmark universe.

H_1: Using a carbon emission metric as an investment strategy does not financially underperform relative to the benchmark universe.

Carbon metrics here are used to create a best in-class portfolio, creating a portfolio with the most efficient companies against their sub-industry peers. The universe benchmark was the market capped weighted benchmark of the companies that disclosed carbon footprint data annually.

4 Methods

4.1 General Methodology

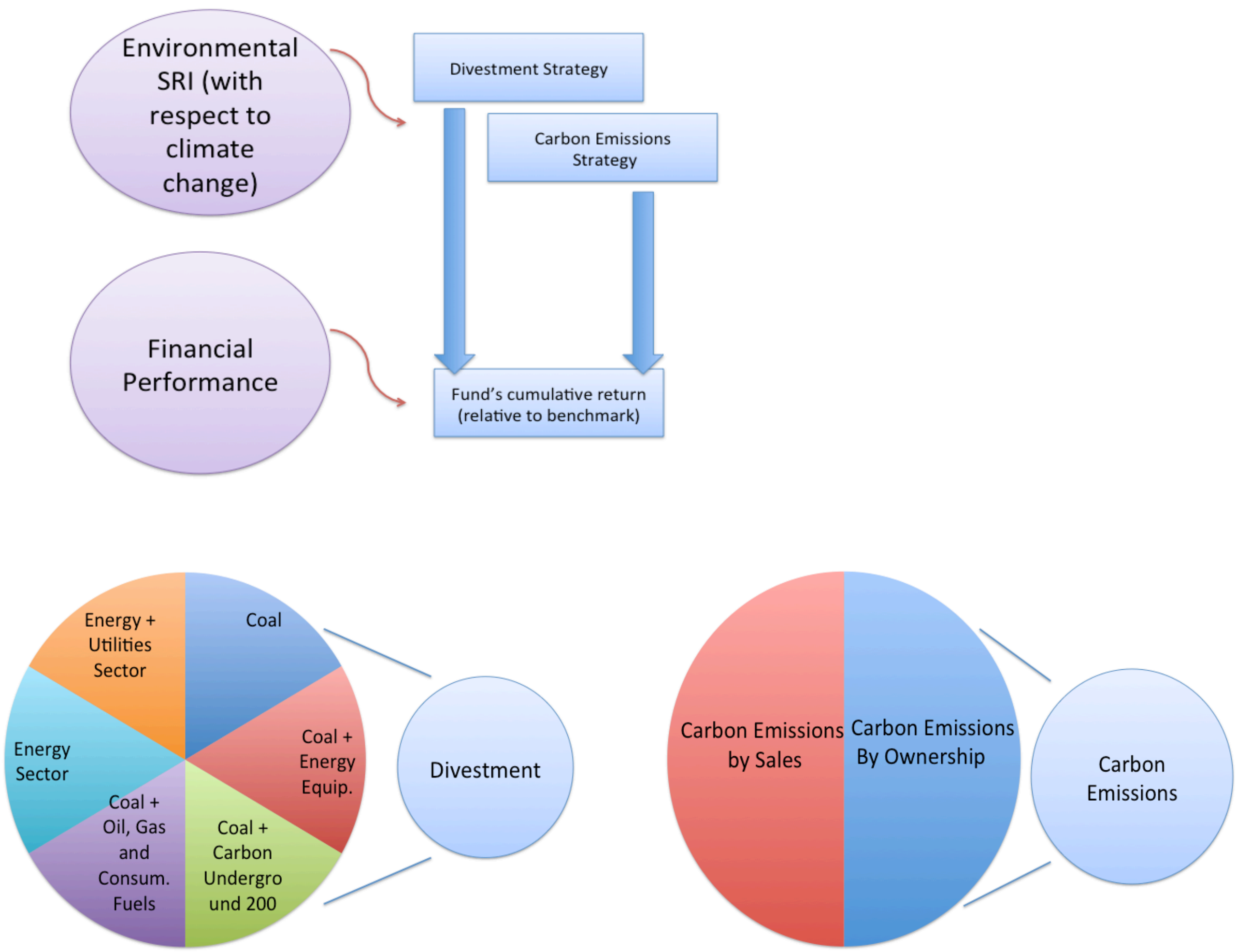
Using a quantitative research approach, this study seeks to provide more information for portfolio managers and investors in the equity markets who consider carbon emissions a concern within their investment criteria. This research uses a quantitative approach because the methods and results are framed around numeric variables to be analyzed using statistical procedures. This thesis also holds assumptions grounded in portfolio theory and thus uses a deductive approach to protect against bias. The methods, including assumptions and limitations, are explained below.

A post-positivist worldview is the dominant paradigm that provided influence for how the questions and methods were selected. "Post-positivists hold a deterministic philosophy in which causes (probably) determine effects or outcomes. It is also reductionist in that the intent is to reduce the ideas into a small, discrete set to test, such as the variables that comprise hypotheses and research questions" (Creswell, 2014, 7). In this paper two assumptions are held: 1. investing into a portfolio with lower carbon emissions will afford less exposure to the risks associated with the use of carbon, and 2. by divesting from the fossil fuel and utility sectors one can mitigate risks from fossil fuel industries while supporting a lower carbon future. The variables, and the relationships among variables, will be tested (explained in greater depth shortly) to produce objective evidence that can be brought back into the real world for application; another belief held by post-positivists. Within this worldview, data, evidence, and rational considerations shape our knowledge.

It is worthwhile to note here that this thesis draws heavily from financial theory and the methods that are used within the industry. This thesis, therefore, applies the necessary statistics that are related to such an analysis. The statistics used within the results section are typical to what would be used within quantitative finance stock return analysis with the additional layer of applying the Carhart model for return attribution. This analysis is not attempting to predict the future value of a portfolio return with a certain investment strategy (ie. evaluating the information coefficients) but rather analyzing a strategy with regard to perceived risk and moral ideologies, then analyzing the return performance.

Figure 4-1 displays the two main constructs that were derived from predominant theories discussed within the literature review that pertain to the research questions and hypotheses; that is, environmental SRI and financial performance. The variables that operationalize these constructs are divestment strategy, carbon emissions strategy and the resulting cumulative return. This analysis uses the divestment and carbon emissions strategies as the independent variables to test the effect on the cumulative return, the dependent variable. To clarify, by applying a divestment strategy or carbon emission strategy to an initial fund (or universe), this study tests the performance of this fund relative to the initial fund by looking at the effect on cumulative return performance relative to the initial fund (also known as the benchmark).

Figure 4-1: Constructs, Operationalization, IV and DV

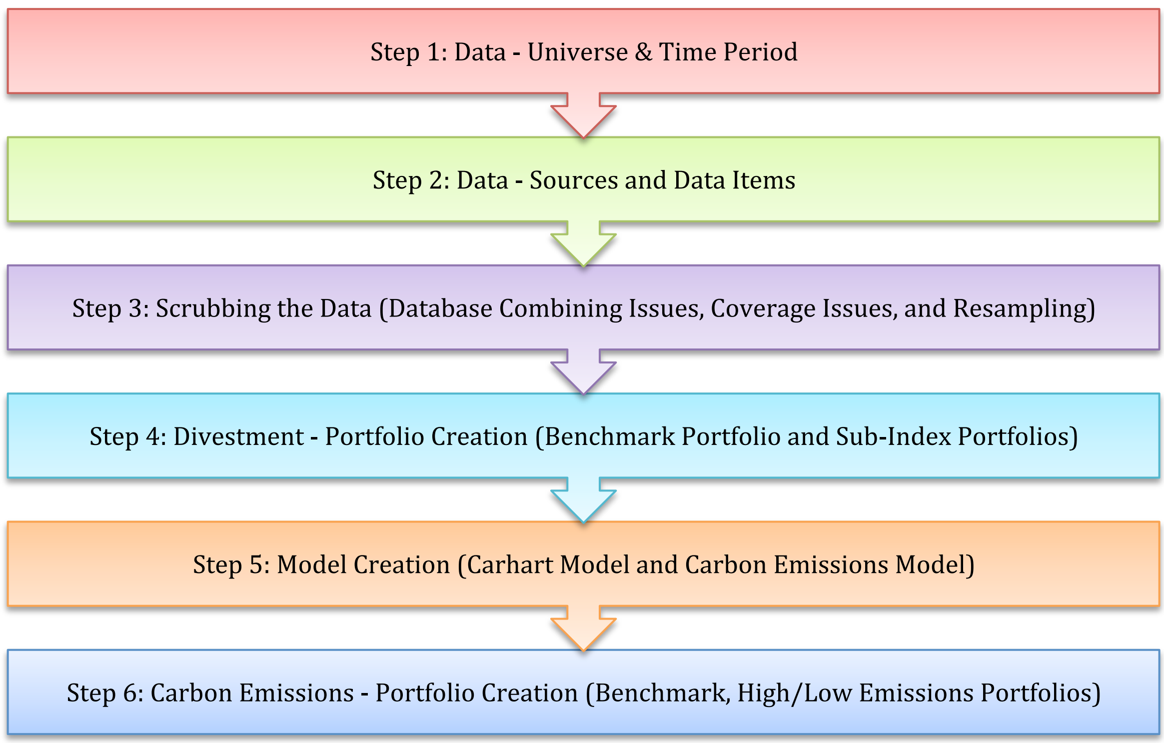


(Creswell, 2014).

Where Environmental SRI is defined as the strategies that embrace the moral and ethical ideologies and risk concern of investors who are concerned about climate change with respect to carbon emissions. Financial performance is defined as the financial returns of investments in companies from share ownership. The variables and sub variables will be described in detail in the following section, explaining how they are defined and quantified.

Figure 4-2 displays the general steps that were used for the methods, which correspond to the headings in this section of the paper. The main goal within the methods section is to clearly outlay the process in which the divestment and high/low emissions portfolios were created to provide a well-defined understanding how a researcher or an investor could approach these strategies themselves. The steps are presented in the chronological order in which the research was conducted to aid readers in understanding any boundaries encountered during the research.

Figure 4-2: Methodology Steps



4.2 Step 1: Data - Universe and Time Period

4.2.1 Canadian Equity Universe

The choice to use the Canadian equity market versus other country markets and assets, such as the United States and fixed income securities, was fourfold: i) it is the country where the research is being conducted, thus this research has the opportunity to gain greater value for both industry analysts and the surrounding academic community; ii) the Canadian market is understudied (this was addressed in the literature review above); iii) equity is the asset class that is the focus of the divestment movement and has been predominantly used for carbon emission quantification; iv) most importantly, the non-renewable energy sector is heavily over-weighted in the Canadian market compared to the global equity market, perhaps making the transition for capital support to cleaner energy and a lower carbon society more difficult.

As of January 29th 2016, the S&P/TSX 60 was overweighted 12.9% and 18.8% in the energy and financial sector, respectively against the S&P Global 1200 (shown in table 4-1). The S&P Global 1200 captures approximately 70% of the global market capitalization and is a combination of the top 7 major indices. This includes: S&P 500 (United States), S&P/TSX 60 (Canada), S&P/ASX All Australian 50, S&P Asia 50 and S&P Latin America 40. The S&P/TSX 60 is an index that captures the large capitalization segment of the Canadian market. It is structured to reflect similar sector weights to that of the S&P/TSX Composite Index.

Table 4-1 : Sector Breakdowns: S&P/TSX Composite vs. S&P Global

Sectors	S&P Global 1200	S&P/TSX 60	Over / Under Weight
Consumer Discretionary	12.4%	6.6%	-5.8%
Consumer Staples	10.7%	5.2%	-5.5%
Energy	6.3%	19.2%	12.9%
Financials	20.5%	39.3%	18.8%
Health Care	13.2%	3.4%	-9.8%
Industrials	10.8%	7.4%	-3.4%
Information Technology	14.9%	7.3%	-7.6%
Materials	4.4%	8.3%	3.9%
Telecom Services	3.7%	7.3%	3.6%
Utilities	3.1%	0.9%	-2.2%

(S&P Dow Jones Indices, 2016).

*As at December 31st, 2015

The S&P/TSX Composite index is the broadest index in Canada; it is the basis for numerous sub-indices (including the S&P/TSX 60), which breakdown the market by different factors such as size and global industry classification standards. It is comprised of common stocks and income trust units, and maintains liquidity characteristics of narrower indices. The S&P/TSX SmallCap Index is separate to the S&P/TSX Composite and its sub-indices because many stocks that fall within this index do not meet the minimal requirements of the Composite index and the index also does not follow a similar sector composition. To be eligible for inclusion in the Composite a security must meet two main requirements: i) Market Capitalization: based upon volume weighted average price (VWAP) the security must have a minimum weight of .05% over the last three trading days of prior month-end and the security must have a VWAP of one dollar Canadian over the past three months and over the last three trading days of the prior month before quarterly review; ii) Liquidity: must be .5 for eligibility. “The unique combination makes the S&P/TSX Composite Index ideal for portfolio management and index replication” (TMX Money, 2015, 1).

The S&P/TSX Composite index was chosen as the investible universe because it is the broadest index to reflect the overall Canadian equity universe, approximately 70% of all market capitalization. The S&P/TSX 60 index is used by many Canadian investors as a benchmark because it is structured to offer many similarities to that of the Composite index but when choosing the universe for stock selection the Composite offers more diversification by simply having more stock to choose from. Albeit, the S&P/TSX SmallCap index does contain securities that are considered liquid-able; this index was not chosen because it would only capture a fraction of the market and data availability for pricing can be very difficult. The investible securities within S&P/TSX SmallCap will be considered for reinvestment options for portfolio construction. Additionally, to avoid survivorship bias, all securities that were within the index at a point and time where priced and considered regardless if a security eventually fell out of the S&P/TSX Composite or were delisted.

4.2.2 Time Period

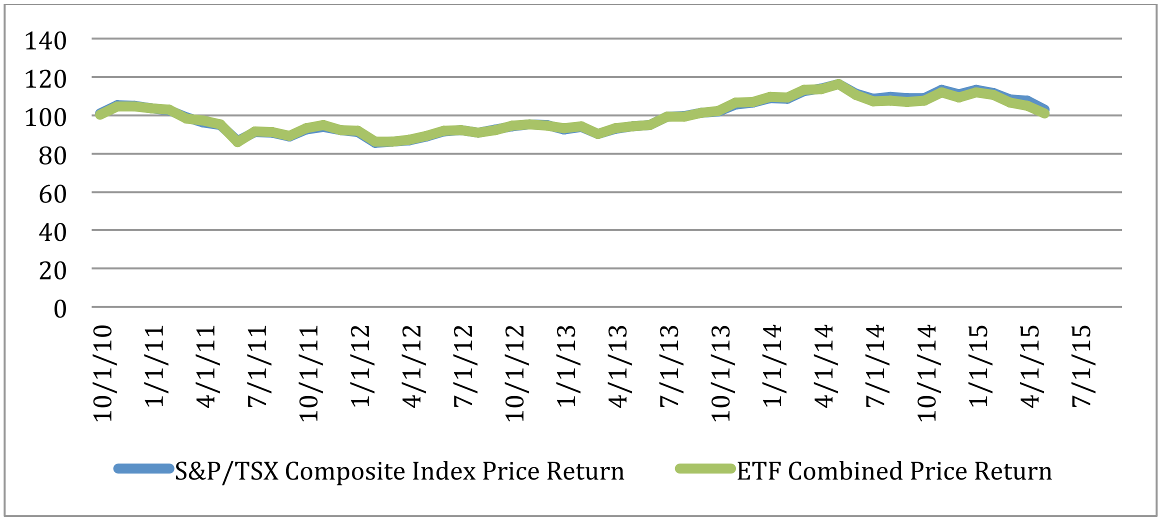
The time period chosen looks backward five-years from the date data collection took place. Therefore, the data collected encapsulates the time period 09/30/2010-08/31/2015. As will be discussed in the Data Issues section below, there were significant problems with the data prior to the 2011 period, therefore, the final time period used for analysis was revised to 01/31/2011-08/31/2015.

4.3 Step 2: Collecting Data - Sources and Items

4.3.1 Constituent Information: Funddata Canada Inc.

To receive the constituent holdings information for the S&P/TSX Composite index throughout the historical period one has to go through a data provider that has index constituent information. Funddata Canada Inc. offers a variety of products and services, one of which being their fund database. This company compiles and analyzes many funds within the Canadian market including exchange-traded funds (ETFs). An ETF is a type of fund that tracks an index and can be traded on an exchange. Although there is not an ETF that tracks that S&P/TSX Composite Index, there are funds that track the S&P/TSX 60 and the S&P/TSX Completion index. When these two are combined they mimic the same constituents holdings as the S&P/TSX Composite. A data request was sent to Fund Data to receive the ETF constituents, security names, and ticker information, monthly ETF prices and Fund Data key (to differentiate between ETFs) of both the iShares S&P/TSX 60 and the iShares S&P/TSX Completion index funds for the five-year time period stated above. In exchange for a free license and the ability to use the data for a master's thesis and academic publications, an agreement was made to create two 750-word reports that summarize the findings of the research. Lastly, to ensure that in fact, these two ETF's did mimic the overall return of the S&P Composite index, the monthly return for the two ETF prices should yield the same result. Figure 4-3 below displays the ETF Combined Return against the S&P/TSX Composite Index Return (the data source for the S&P/TSX Price Return will be explained below).

Figure 4-3: S&P/TSX Composite Cumulative Price Return vs. ETF Combined Cumulative Price Return



(S&P Dow Jones Indices, 2016)

4.3.2 Fundamental Information: WRDS (Compustat)

There are numerous open source websites to receive pricing information for securities such as Google finance or TMX Money. These sites lack the reliability of accurate pricing information and also do not provide historical balance sheet and income statement information that is pertinent to the analysis. Wharton Research Data Services (WRDS) is a database provider that is free for graduate students at the University of Waterloo and was used for the analysis. WRDS provides access to Compustat's security pricing and company information that is owned by S&P Capital IQ and is accurate and reliable. This database was used for the following information: security month end prices, global industry classification standard (GICS) codes, common shares outstanding monthly, total assets, total liabilities, total preferred shares, float shares outstanding monthly, Compustat ticker (CAD), currency exchange rate for US dollar to Canadian conversion, and security name. The descriptions for each data item can be found in Table 4-2 below. All balance sheet and income statement items were on a quarterly basis and resampled to reflect month end dates. To account for a lookback bias, the most recent quarterly figure that was released, such as on December 31st, 2013, has been used as the figure for January and February as well. Point in time data, also produced by Compustat, is the most reliable to address types of lookback and resample issues, however, the University of Waterloo does not have access to these databases.

Table 4-2 : Data Items and Descriptions

Data Item	Description
Monthly end pricing (PRCCM)	This item contains the absolute close market prices for each calendar month.
Shares Outstanding Monthly - Issue (CSHOM)	Common shares outstanding, presented on a month end basis
Common Stock Float Shares -Canada	Common Stock Float Shares represent all common shares outstanding less controlled block shares as of month-end.
Global Industry Classification Codes: GIC Groups (GGROUP) GIC Industries (GIND) GIC Sector (GSECTOR) GIC Sub-Industries (GSUBIND)	Items representing the first, second, third and fourth level of the hierarchies.
Assets – total (AT)*	This represents the total assets/liabilities of a company at a point in time
Liabilities – total (LTQ)	U.S. and Canadian GAAP definition. This items represents the current plus long-term debt plus other noncurrent liabilities, including deferred taxes and investment tax credit
Preferred/ Preference Stock (Capital)- total (PSTK)	U.S. and Canadian GAAP definition. This item represents the net number of preferred shares at year-end multiplied by the par of stated value per share as presented in the company's Balance Sheet.
Compustat Ticker	This items identifies the symbol associated with trading of a particular issue on an exchange
Company Name	This identifies the company for which data is presented.
Revenue- Total (REVT)	This item represents the gross income received from all divisions of the company, it is a component of pre-tax income
Fiscal Year End (FYR)	This identifies the month in which a company ends its fiscal year.
US Canadian Translation Rate (CURUSCN)	The rate of exchange used to translate CAD currencies into USD amounts. For companies reporting in both U.S. and Canadian accounting standards, Federal Reserve period rates.

(WRDS, 2016).

For transparency, it is worthwhile to further outline here the GICS classification codes. These will be used throughout the divestment process and for sector analysis within the results section. Table 4-3 highlights the names for each GICS hierarchy and associated code. The energy and utility sectors are fully expanded through to Sub-Industry level of the GICS hierarchy, as they will be the focus for divestment.

Table 4-3: Global Industry Classification Standards

Sector	Industry Group	Industry	Sub-Industry
10 Energy	1010 Energy	101010 Energy Equipment & Services	10101010 Oil & Gas Drilling
			10101020 Integrated Oil & Gas
		101020 Oil, Gas & Consumable Fuels	10102010 Integrated Oil & Gas
			10102020 Oil & Gas Exploration & Production
			10102030 Oil & Gas Refining & Marketing
			10102040 Oil & Gas Storage & Transportation
			10102050 Coal & Consumable Fuels
15 Materials	1510 Materials		
20 Industrials	2010 Capital Goods		
	2020 Commercial & Professional Services		
	2030 Transportation		
25 Consumer Discretionary	2510 Automobiles & Components		
	2520 Consumer Durables & Apparel		
	2530 Consumer Services		
	2540 Media		
	2550 Retailing		
30 Consumer Staples	3010 Food & Staples Retailing		
	3020 Food, Beverage & Tobacco		
	3030 Household & Personal Products		
35 Health Care	3510 Health Care Equipment & Services		
	3520 Pharmaceuticals, Biotechnology & Life Sciences		
40 Financials	4010 Banks		
	4020 Diversified Financials		
	4030 Insurance		
	4040 Real Estate		
45 Information Technology	4510 Software & Services		
	4520 Technology		

	Hardware & Equipment		
	4530 Semiconductors & Semiconductor Equipment		
50 Telecom. Services	5010 Telecom. Services		
55 Utilities	5510 Utilities	551010 Electric	55101010 Electric
		551020 Gas	55102010 Gas
		551030 Multi-Utilities	55103010 Multi-Utilities
		551040 Water	55104010 Water
		551050 Independent Power & Renewable Electricity Producers	55105010 Independent Power Producers & Energy Traders
			55105020 Renewable Electricity

* Effective after business close on February 28th, 2014

(S&P Capital IQ, 2016).

4.3.3 Carbon Emissions Data: CDP and Bloomberg

Greenhouse gas emission data for each company was also needed for the analysis. Carbon Disclosure Project (CDP) motivates companies and cities to voluntarily disclosure their environmental impacts such as total greenhouse gas emissions and water usage to give decision makers the data they need to change market behavior. They are considered the largest source of free data for company level emissions and will be used for the analysis here. CDP sends an information request to the largest 200 Canadian companies by market capitalization, on behalf of a large group of institutional investors (signatories), with cumulative assets over trillions of dollars, to report their greenhouse gas emissions and other pertinent information. This data is compiled into an annual report produced by CDP and only companies that voluntarily issue this information and opt in for their information to be public can be found within the reports. The emission data that was used in this analysis includes scope 1 and scope 2 emissions. Scope 3 emissions were not used because they is a lot of missing data, and the data is unreliable, they do not have adequate guidelines on how to properly scope these set of emissions. GHG data will be referred to carbon data at many points throughout this analysis and will be assumed to be the carbon emissions equivalent to the amount of GHG emissions.

Given CDP's voluntary nature, it was worthwhile to seek out other institutions that provide company level GHG data. MSCI was contacted, however, their data cannot be accessed without a paid license. Corporate Knights, a media and research company that includes an award winning business and society magazine, has access to GHG data and was able to provide free access to their Bloomberg data set. The Corporate Knights data also included scope 1 and scope 2 emissions and included different companies than that of CDP (as will be shown below). Corporate Knights also, in some cases, verified that the data was correct with companies by either extracting the information from annual reports or being directly provided with the data.

4.3.4 Index Level Pricing: S&P Dow Jones Indices

Index level pricing data was used within the analysis for index creation, comparison, benchmarking, and re-investment options. S&P Dow Jones Indices have a downloadable option for S&P/TSX Composite index total price level month end (S&P Dow Jones Indices, 2016). This was used while ensuring that two ETF's matched the same overall return, whether it be by combining the two ETF prices or aggregating the price of the individual securities (which is shown below). Additionally, S&P/TSX offers indices, such as S&P/TSX Renewable Energy and Clean Technology Index that measures the performance of companies listed on the TSX whose primary business is the development of green technologies and sustainable infrastructure solutions. An independent data analytic provider, Sustainalytics, who focuses on environmental, social, and government research and analysis, screens these constituents. The data for the index level month end prices was retrieved from the S&P Dow Jones Indices website (S&P Dow Jones Indices, 2016). This price level data was used to measure the returns for re-investments purposes.

4.4 Step 3: Scrubbing the Data

4.4.1 Database Combining Issues: Fund Data and Compustat

The intention of requesting the ticker identifications for every constituent was for it to be the unique identifier that could match the securities within the Fund Data file to the Compustat database. Fund Data gathers ticker information from the providers of the ETF's and entrusts that they record and provide all ticker information. Some tickers, however, were missing and were not always correct. Additionally, Compustat records their tickers not as they appear on the exchanges but by their stock characteristics, such as non-conventional voting rights or a delisting. The ticker symbol that would normally appear on an exchange, such as IBM, would receive a ticker symbol listing as IBM.Z if it is delisted, and to search for the security information IBM.Z would have to be used. These odd occurrences would inhibit the databases to have a full one to one matching. But the most notable ticker symbol alterations that Compustat uses is when a ticker symbol is used for both a U.S. and Canadian exchange, the Canadian ticker symbol is appended with a '.'. Additionally, the unit trusts were not recorded the same. Within Fund Data they were recorded with '.U' whereas the Compustat Data recorded it with a '.UN'. This became a major problem for the way that mapping needed to be conducted.

The Fund Data ticker symbols were used in conjunction with the security name to find the applicable ticker symbol and security name within the Compustat database. The remaining identifiers that were not found by using the standardized join approach was searched for directly by ticker symbol within the Compustat database to find the applicable symbol. If the ticker symbol could not be found by searching within the Compustat database, the ticker was found through a Google finance search. There were many company names that have been changed or companies that were acquired by other companies and the current name was found through Google search. Such companies' ticker symbols were pulled out of the Compustat security name search. These security prices were then cross-checked on Google Finance to ensure that the price accurately reflected that security price at that point in time.

After completing the steps to find the ticker symbol corresponding to the security name, if a historical price was not found, it was determined that it was best to leave the constituent on that date out of the data set, rather than to add it with the incorrect price. To ensure that the constituents would minimally affect the overall index the percentage holdings were totaled. In Table 4-4 below, the number of constituents and the percentage of the market total was calculated. The market total is out of 200% due to the factors that i) the weighting of each ETF totaled 100% and ii) this is the two ETF's combined. Although this calculation is inaccurate, it was used primarily as an approximation of how much of the S&P/TSX Composite market portfolio would be missing. The dates from 09/30/10-12/31/2010 have more than 20 companies and were thought to be unrepresentative of the S&P Composite Index.

Table 4-4: Number of Missing Constituents

Date	# of Companies Missing Information	Market % total	Date	# of Companies Missing Information	Market % total
1/31/11	14	6.65	7/31/12	2	0.86
2/28/11	9	4.69	8/31/12	3	0.4
3/31/11	2	0.92	9/30/12	4	0.91
4/30/11	4	2.07	10/31/12	4	2.49
5/31/11	1	0.3	11/30/12	3	0.41
6/30/11	1	0.19	12/31/12	3	0.41
7/31/11	1	0.19	1/31/13	3	0.4
8/31/11	1	0.18	2/28/13	2	0.21
9/30/11	3	0.43	3/31/13	2	0.55
10/31/11	3	0.43	4/30/13	1	0.23
12/31/11	4	2.36	5/31/13	1	0.23
1/31/12	2	1.18	6/30/13	1	0.23
2/29/12	2	1.18	7/31/13	1	0.23
3/31/12	3	1.55	8/31/13	1	0.22
4/30/12	3	1.25	9/30/13	1	0.23
5/31/12	5	1.99	10/31/13	1	0.25
6/30/12	3	1	11/30/13	1	0.27
7/31/12	2	0.86	3/31/14	1	0.22
8/31/12	3	0.4	4/30/14	2	0.41
9/30/12	4	0.91	5/31/14	1	0.2
10/31/12	4	2.49	6/30/14	1	0.14
11/30/12	3	0.41	12/31/14	1	0.68
12/31/12	3	0.41	8/31/15	1	0.27

4.4.2 Coverage Issues: Carbon Data

The greenhouse gas data provided by CDP had coverage issues given the voluntary nature of the data, which is why another source, Bloomberg, was sought out and used in conjunction with CDP. Table 4-5 outlines the number of reporting disclosures for CDP, which justifies seeking out another data provider was useful for greater coverage. As displayed, the coverage increased on average by 8.8%.

Table 4-5 Company Disclosures and Coverage

	2014	2013	2012	2011	2010
# of CDP Data	84	80	74	73	61
# of CDP + Bloomberg*	91	96	109	95	86
# of S&P/TSX Constituents**	247	241	232	252	241
% Coverage (CDP)	34%	33%	32%	30%	25%
% Coverage (CDP + Bloomberg)	37%	40%	47%	38%	36%

* The number of constituents for the fiscal year end.

** The number of constituents at March end of the following year.

To avoid a look-ahead bias when understanding the investment returns from a portfolio management perspective, the carbon data needed to be resampled to appear at a time when the data would be reasonably available to the public. Therefore, the number of constituents within the S&P/TSX Composite, which represents when the carbon data is available for investment purposes, is for the end of March of the year after the fiscal year. For example, for the fiscal year 2011, the coverage for the carbon emissions data against the number of constituents in the index are for March 2012. A three-month time lag was chosen because it is a standard industry approach, used within the U.S. markets. Since the SEC deadline for filing out the 10-K form is 90 days (SPCapital IQ, 2015) and many Canadian companies trade on United States exchanges, this approach was taken. This approach was also used for the total revenue data that will be incorporated into the low carbon portfolios investment process (this will be explained in greater length below).

4.4.3 Resampling Data: Carbon Emissions

Standardization on how companies report are rising; the Greenhouse Gas Protocol for 15 years has provided guidance to companies on how to homogenize the way they calculate their GHG emissions. Most companies in 2014 that reported to CDP use this approach, allowing CDP to estimate and compare the carbon footprint for companies and their value chains (Greenhouse Gas Protocol, 2014). These GHG emission accounting standards allow for metric matching across methodology providers and are not concerning as long as one controls for external factors such as currency of portfolio, time of reporting, and scope (Greenhouse Gas Protocol, 2015; IIGCC, 2015). As noted previously, both data providers used scope 1 and scope 2 and all currency is in CAD. The remaining issue of the time of reporting will be discussed here.

CDP's reporting year is reflective of the current reporting year and is the latest/most recent 12-month period for which the data is reported. This data does not have to be aligned to a company's fiscal year (CDP, 2016). For example, CDP requests companies to report their emissions for the 2015 calendar year. The Bloomberg data, received from Corporate Knights, accounts for their data by fiscal period. For example, the data could be from March 2014-February 2015 for the 2014 fiscal year. The period end difference amongst the two providers causes two problems: lag issues and reporting versus fiscal year end issue.

Lag issues: As noted above, when understanding return data from a portfolio management perspective, both the revenue and GHG data for a fiscal year period will have a lag of 3 months (at a minimum) to show when the data would have been available to investors in real-time (preventing look-ahead bias). Fiscal month end varies; for the fiscal year 2010 a company can have a fiscal year end anywhere from July 1st 2010 – June 30th 2011. Therefore, if Bloomberg data were to be used, any company that had a fiscal year ending in January to June would need to be resampled to reflect the following fiscal year. For example, Open Text Corporation reports their fiscal year end in June so the fiscal period 2010 ending in June 2011, will be resampled to March 2012. Given that Bloomberg's methodology more accurately reflects how the revenue is reported (it follows the same methodology on how the revenue is recorded for fiscal year ends), Bloomberg data has been used as the primary source and CDP has been used to fill in any missing data. Although, only 6 companies of the 120 that disclosed GHG emissions over the five-year period had a fiscal period that ended in January to June, both the GHG data and the revenue data were resampled to represent this approach for the carbon emission portfolio analysis.

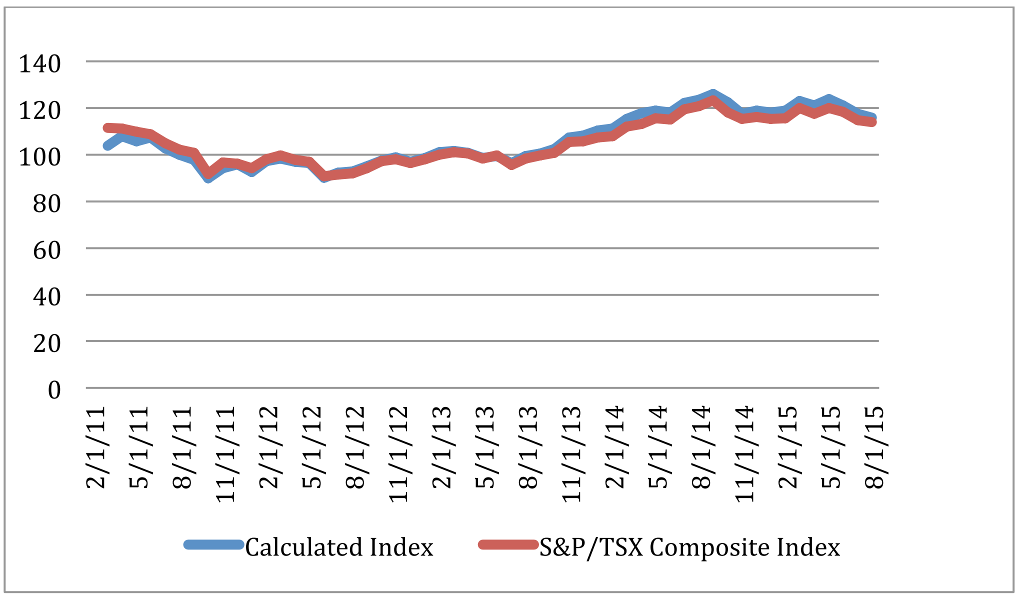
Reporting versus fiscal year end issue: A total of 17 of the 120 companies that submitted GHG data had a fiscal year end other December. Bloomberg data was always chosen first because total revenue is also calculated with the fiscal year approach. Therefore, the emissions data would still be aligned to the period in which the revenue was generated from the emissions output. The Bloomberg dataset had information for the 17 companies.

By adjusting for both the lag issues and the reporting year versus fiscal year end issues all emissions and revenues were aligned and have been lagged 3 months to prevent look ahead bias.

4.5 Step 4: Divestment - Portfolio Creation Calculation

Prior to creating the sub-index portfolios, to verify that the pricing data retrieved through the Compustat database corresponded to the correct tickers and that the missing data did not create an index overall price return difference that was statistically significant, the price levels (float shares outstanding * price) were summated and the cumulative returns were calculated. In Figure 4-4 the cumulative returns had a correlation of .98% (where equation 4-1 was used for the calculation of cumulative returns). Therefore, the differences amongst the calculated benchmark versus the real benchmark are statistically insignificant and the prices retrieved from the Compustat database were accurate.

Figure 4-4: Calculated Index versus S&P/TSX Composite Index



(S&P Dow Jones Indices, 2016).

Equation 4-1: Cumulative Returns were calculates as:

$$\frac{(FMCAP_n - FMCAP_{(n-1)})}{FMCAP_{(n-1)}} - .0001$$

Where FMCAP equals the total float shares outstanding on date n multiplied by price at date n and .001 is the index deflator.

This price return calculation used the same approach of S&P Dow Jones Indices but within this calculation a deflator was used instead of an index divisor since the index divisor is proprietary information of the company. "Continuity in index values is maintained by adjusting the divisor for all changes in the constituents' share capital after the base date. This includes additions and deletions to the index, right issues, share buybacks and issuances, and spin-offs. The divisor's time series is, in effect, a chronological summary of all changes affecting the base capital of the index." (SP Dow Jones Indices, 2016). Additionally, the divisor allows the price value of the index to have a value that is reasonable to articulate to day-to-day traders (i.e., 12,483 versus 1,093,314). Given these limitations, the index divisor was not calculated as no formula could be found and rather an index deflator of .001 was used.

It is worthwhile to note that an alternative way to calculate portfolio returns, which is the most common approach for portfolio investors, is to find the unit price return of the security and multiply it by the weight (MCAP weight) of that constituent in the portfolio, then summate these values for all the constituents within the portfolio. This calculation is another robust way to calculate portfolio returns. As with the calculation of the index divisor, however, this methodology becomes erroneous when trying to smooth out and account for all share buybacks, new releases and stock splits. If a granular portfolio attribution analysis was needed, such as which stocks outperformed versus underperformed versus the benchmark, then these calculations would be required, however, it is sufficient to have one calculation. The CFA Institute is an association of investment professionals that offers a CFA designation, which is a standardized measurement of your investment knowledge. They provide the following calculation, (Equation 4-2 and Equation 4-3) that proves that the price return of the index is the same as that of the sum of the price return of the individual securities, market capped weighted.

Equation 4-2: Calculation of Single-Period Price Return

$$\mathrm{PR}_I = \frac{\mathrm{V}_{\mathrm{PR}I1} - \mathrm{V}_{\mathrm{PR}I0}}{\mathrm{V}_{\mathrm{PR}I0}} = \sum_{i=1}^{N} \mathrm{w}_i \mathrm{PR}_i = \sum_{i=1}^{N} \mathrm{w}_i \left(\frac{\mathrm{P}_{i1} - \mathrm{P}_{i0}}{\mathrm{P}_{i0}} \right)$$

(CFA Institute, 2015)

Where PR_I = the price return of index portfolio *I*, PR_i = the price return of constituent security I, w_i = the weight of security *I*, P_{i1}= the price of constituent security *i* at the end of the period, P_{i0}= the price of constituent security *i* at the beginning of the period.

Equation 4-3: Value of Price Index

$$\mathrm{V}_{\mathrm{PRI}} = \frac{\sum_{i=1}^{N} n(i)P(i)}{D}$$

(CFA Institute, 2015)

Where V_{PRI} = the value of the price return index, n_i = the number of units of constituent securities in the index, N = the number of constituent securities in the index, P_i = the unit price of constituent security I and D = the value of the divisor.

The prices level of each portfolio will be used going forward for the calculation of the portfolio returns. Additionally, the synthetic benchmark will be used and be called the S&P/TSX Composite Index going forward to offer consistency of portfolio statistics against the benchmark, such as active return and active risk.

4.5.1 Sub Index Portfolios

The varying approaches to divestment were applied. Six sub-index portfolios were created an are as follows:

1. *Coal Divestment:* Divestment from the companies with the categorization of coal sub-industry classification. This encompasses companies that are primarily involved in the production and mining of coal, related products, and other consumable fuels related to the generation of energy.
2. *Coal + Energy Equipment and Services Divestment:* Using portfolio 1 as the investment universe, divestment from companies with the energy equipment and services industry classification.
3. *Coal + divestment from Carbon Underground 200:* Using portfolio 1 as the investment universe, divestment from the Canadian based companies listed on the Carbon Underground's Top 2015 List (Fossil Fuel Free Indexes, 2015). A list of these companies and their total reserves can be found in Appendix A. These companies account for 8.008 Gt CO_2 total coal, gas and oil reserve emissions potential.
4. *Coal + Oil Gas and Consumable Fuels:* Divestment from the companies with coal and oil, gas and consumable fuels industry classification.
5. *Energy Sector Divestment:* Divestment from the companies with the energy sector classification.
6. *Energy + Utilities Divestment:* Divestment from the companies with the energy or utilities sector classification, excluding companies with the renewable energy GICS sub-industry classification.

The sub-index portfolios were used to demonstrate the comparable return and risk profile of a step-by-step divestment approach to the energy and utility sector. The first case assumes a 100 percent equal re-investment into the companies remaining within the portfolio. The second case assumes a re-investment into companies that are considered to have a core business that is the development of green technologies and sustainable infrastructure solutions, which was done by investing into the S&P/TSX Renewable Energy and Clean Tech Index (S&P Dow Jones Indices, 2016). These constituents are chosen by Sustainalytics, a global responsible investment research firm (Sustainalytics, 2016). Both of these classifications are very limiting within the GICS sector classification standards. Only companies that engage in the generation and distribution of electricity using renewable sources or companies that provide environmental and facilities maintenance services such as waste management and pollution control services receive a classification that differentiates their core business amongst others. Companies that manufacture capital equipment used to generate electricity using renewable sources or companies that provide environmental data tracking and management services do not have a different classification from their non-renewable manufacturing competitors. The stocks are selected from the TSX investible universe and include many small cap stocks within the industrial and utilities sector, as displayed within Table 4-6.

Table 4-6: Sector Breakdown of Clean Index vs. Composite Index

	Weight		
	S&P/TSX Composite	S&P/TSX Renewable Energy and Clean Tech Index	Over/ Under Weight
Consumer Discretionary	6.9%	-	-
Consumer Staples	4.5%	3.6%	-0.9%
Energy	18.5%	1.4%	-17.1%
Financials	38.3%	-	-
Health Care	3.2%		-3.2%
Industrials	8.3%	22.8%	14.5%
Information Technology	3.2%	2.1%	-1.1%
Materials	9.5%	6.8%	-2.7%
Telecom. Services	5.4%	-	-
Utilities	2.3%	63.2%	-0.8%

*As of January 29th 2016.

This index comprises 20 companies that have a strategic commitment to five environmental themes: i) renewable energy for production and distribution; ii) renewable energy for manufacturing and technologies; iii) energy efficiency; iv) waste reduction; and, v) water management, and low impact materials and products (ie. organic foods). It focuses on companies that reduce the throughput pressures on the ecological system when providing goods or services to global markets. The constituents throughout the time period chosen were unavailable for free, only the current constituents were available. A cross-reference of stocks was completed to note the overlap with constituents that were being divested or are remaining in the portfolio (i.e., that are within the S&P/TSX Composite index). Of the constituents held on February 25th, 2016, seven were within the S&P/TSX Composite, four being companies that were divested from within the sub portfolios (to note: three were within the independent power producers, and energy traders sub-industry). This demonstrates that this GICS classification needs be divided amongst environmentally responsible and non-responsible business types and would have not be divested from in the first place if the GICS were clearer. Lastly, the S&P/TSX Renewable and Clean Tech index will be referred to as the green index, and will act as an ETF (exchange traded fund) in the way that re-investment will only occur within how the index is created, mimicking the overall return.

Taking the value of what was divested, and re-investing that capital into the green index each month accomplished the re-investment into the green index. For example, if the energy sector divestment for January was 24% of the overall TSX Composite index, 24% of portfolio return would be generated from the green index return and 76% would be generated from the energy divestment portfolio. It is similar to 76% of the holdings being invested into the "energy sector divestment portfolio" and 24% being invested in the green index. The formula is displayed below.

Equation 4-4: Divested and Re-invested Portfolio Return

$$Monthly\ return_{t=n} = r_1 w_1 + r_2 w_2$$

Where r_1 is the return of the divested portfolio, w_1 is the weight of the divested portfolio against the benchmark portfolio, r_2 is the return of the green index, and w_2 is the weight of the benchmark portfolio less the divested portfolio. $w_1+w_2=100\%$, and is the month n=1,…..,55.

4.6 Step 5: Model Creation

4.6.1 Carhart Model

As discussed earlier, capital asset pricing models are renowned for asset pricing of theoretical returns of a security or portfolio; a way to measure the systematic and unsystematic risk. Before describing the model creation and the how each factor within the model is defined, a brief explanation for the chosen model was needed.

To review, the capital asset pricing model created, established by William Sharpe and Linter in the 1960's, was arguably the first asset-pricing model used at a large scale. It states that one factor, the risk premium, is sufficient to explain the cross-section of expected returns. Later, Kenneth French and Eugene Fama contended the validity of this model, stating that in fact, two more factors, SMB and HML, are needed to reliably explain the returns (Fama and French 1993). Lastly, the Carhart 4-factor model was created, adding one more factor: 12-month price momentum, MOM.

Carhart demonstrates that persistence in mutual funds within the US markets does not reflect superior stock-picking skill, but common factors in stock returns and differences amongst the expenses and transaction costs (another reason why expenses and transaction costs are omitted from this analysis). The most well-known study collected all available mutual fund data from 1962 to 1993. For comparison, the mean absolute errors from the CAPM, 3-factor, and 4-factor models were .35%, .31%, 14%, respectively (Carhart, 1997). This demonstrates that using the 4-factor model helps explain a significant amount more of the mutual fund returns of this period than that of the other models and was attested to be the new model for investment managers deploying style investment strategies. There are two underlying issues of this study that does not make it applicable for investment managers to use worldwide today. First, the sample is comprised of mutual funds within the US, so it is country specific. Second, if a large amount of investment managers implemented this strategy in the US or elsewhere, this model would not be as effective. But nonetheless, it is useful to use within the analysis to use so investors can have an interpretation of the attribution of the portfolio returns. Both the CAPM and Carhart model will be created and tested to further understand the return attribution and predictably of the portfolio returns.

The Carhart model was calculated as:

Risk premium: The excess market return. The benchmark return less the risk free rate. The risk free rate is measured by the 1 month Treasury bill issued by the Government of Canada.

SML: The return of the small cap portfolio less the return of the large cap portfolio. The small cap portfolio is calculated by the bottom 20% of stock as ranked by their total market capitalization. The large cap portfolio is the remaining stocks within the benchmark universe.

HMB: The return of the value stock portfolio less the return of the growth stock portfolio. The value stock portfolio is created by taking the top 30% of stocks within the benchmark universe ranked by their corresponding book to market ratio. The growth stock portfolio is the remaining stocks within the universe. The book to market ratio is calculated by the book value (total assets less total liabilities and total preferred shares) divided by market capitalization (total common shares outstanding multiplied by the price per share).

MOM: The return of the winner portfolio less the return of the loser portfolio. The winner portfolio is calculated as the top 30% of stocks within the benchmark universe as ranked by the past 12-month momentum. The loser portfolio is the remaining stocks within the benchmark universe. The 12-month momentum is calculated as the percentage change of the month end price 12 months back to the most current month end price.

The portfolios were rebalanced monthly to reflect the same turnover of the sub-portfolios. The multi linear regression of the four-factor model against the sub-index portfolio was completed within the statistical add-on package in excel. This tool is easy and free to use and automatically calculates all the needed statistical outputs. Additionally the regression was completed in STATA, offering the same results.

4.6.2 Greenhouse Gas Emission Model

The creation of a GHG emission model was looked at to solve the coverage issues of Bloomberg and CDP. No academic research has prescribed a well thought-out methodology on how to approach this problem and industry providers tend to hold their model creation methodology proprietary. Therefore, after reviewing the broad approaches used within the industry (input/output, regression models, financial statement, sector averaging, and EEIO) it was decided that unless a rigorous multi-tiered approach was taken, the model would not accurately approximate the emissions output of the non-disclosing companies. The companies that have disclosed their emissions are used to understand the impact of investing in the best performers in an industry in terms of carbon footprinting, known as carbon tilting. The objective is to understand in general terms the link between climate change and financial performance for portfolio management; how an investor can mitigate their financial risks associated with climate mitigation policies and technological or economic trends (for example, carbon pricing or stranded assets). The Greenhouse Gas Protocol (2014) also advises that when using carbon tilting in the portfolio construction process it can be complemented with green/brown exposure metrics in some sectors such as utilities and transportation. As discussed within the literature review section, this will require additional data that is not readily available through data providers and therefore, creates a laborious task and is outside the scope of this analysis.

4.7 Step 6: Carbon Emissions - Portfolio Creation

4.7.1 Benchmark Portfolio

By carbonizing companies and portfolios as mentioned above, the objective is to understand the risk, but also that it may be a moral objective to contribute to the transition to a lower carbon society. This would provide evidence to investors that it is possible to invest into a lower carbon portfolio without suffering a loss in returns. As discussed within the literature review, there are two main approaches used for “carbonizing” a portfolio: total emissions/million (ownership) or total emissions/sales (efficiency). Both of these approaches will be explored. Prior to discussing how the portfolios were created (formulas used), it is important to discuss the universe in which these portfolios will be chosen from.

Given that an estimation model was not created, it is important to understand the sector allocation of the baseline portfolio; the initial universe that will be used for stock selection. Table 4-7 demonstrates the sector allocation of the universe for those companies that disclosed versus the S&P/TSX Composite index. As demonstrated, the universe will be largely overweight in the financial and industrial sector. Therefore, this is not a true representation of the S&P/TSX Composite index but rather a representation of firms that are willing to communicate openly to their shareholders on their GHG inventory for their investment process.

Table 4-7: Sector Allocation Comparison: Carbon Emission Universe vs. S&P/TSX Composite

Sectors	Carbon Emissions Universe	S&P/TSX Composite	Over/Under Weight
Consumer Discretionary	6.3%	6.9%	-0.61%
Consumer Staples	2.1%	4.5%	-2.44%
Energy	17.6%	18.5%	-0.87%
Financials	44.4%	38.3%	6.12%
Industrials	10.4%	3.2%	7.17%
Information Technology	0.6%	8.3%	-7.69%
Materials	10.8%	9.5%	1.28%
Telecom. Services	7.1%	5.4%	1.69%
Utilities	0.7%	2.3%	-1.56%
Health Care	0%	2.3%	-2.30%

*Sector allocation is by MCAP.

** Data is used for Carbon universe: March 31st, 2015. Composite: January 29th, 2016. (S&P Dow Jones Indices, 2016).

4.7.2 High/Low Emissions Portfolios

There are two approaches that were taken for portfolio selection, ownership and efficiency method, to differentiate the firms between the best and worse in-class with the metric that is of interest.

Ownership method (balance sheet): The initial universe was broken up into two portfolios, entitled high carbon emissions and low carbon emissions. The high carbon emissions portfolio is comprised of the stocks that were the top half of stocks by carbon ownership within an industry classification. The low carbon emission portfolio is comprised of the stocks that were the bottom half of stocks by carbon ownership within an industry classification. If there were an odd number of firms within an industry, firms having a higher carbon ownership then average in the industry were included the high carbon emissions portfolio and vice versa. If there was only one firm within an industry, the average of the industry group was used. Carbon ownership is calculated as: total carbon emissions/total float market capitalization. The portfolios are market cap weighted.

Efficiency method (income statement): The initial universe was broken up into two portfolios, entitled high carbon intensity and low carbon intensity. The high carbon intensity portfolio is comprised of the stocks that were the top half of stocks by carbon intensity within an industry classification. The low carbon intensity portfolio is comprised of the bottom half of stocks by carbon intensity within an industry classification. If there were an odd number of firms within an industry, firms having a higher intensity then average in the industry were included in the high carbon intensity portfolio and vice versa. If there was only one firm within an industry, the average of the industry group was used. Carbon intensity was calculated as: total carbon emissions of firm/total sales of firm. The sales and carbon emissions were calculated for the same fiscal year, this was ensured by a thorough process of identifying fiscal year end dates (as noted previously). The portfolios are market cap weighted.

Two metrics to 'carbonize' the baseline portfolio (universe), and best and worst in-class portfolios to demonstrate how investing in the best in-class can reduce the carbon footprint of a portfolio by one of the methods above. Similar to the approaches for portfolio construction these metrics explain the total carbon emissions per million dollars invested (Equation 4-5) and the total carbon efficiency (Equation 4-6) of the portfolios, but are normalized statistics, allowing for comparison, regardless of portfolio size (normalized by million dollars invested).

Equation 4-5: Portfolio Carbon Emissions (per million dollars invested):

$$\sum_{n=1}^{n} \frac{Ownership\ \%\ X\ Company\ Carbon\ Emissions}{amount\ of\ dollars\ invested\ (per\ mill.)}$$

Where: n = the number of stocks within a portfolio

And Ownership % = $\frac{portfolio\ position\ (amount\ of\ \$\ invested\ in\ firm)}{total\ MCAP\ of\ firm}$

Equation 4-6: Portfolio Carbon Intensity:

$$\frac{\sum_{n=1}^{n} Portfolio\ Carbon\ Emissions}{\sum_{n=1}^{n} Company\ Sales\ X\ Ownership\ \%}$$

(Frankel et al., 2015)

Where company sales are the total sales from the same fiscal year as the carbon emissions.

Lastly, given that these portfolios were fully re-evaluated each year, the turnover rate of these portfolios and the number of constituents within the portfolios at each turnover date (March of every year) could vary significantly. Therefore, the cumulative returns at these dates had to be normalized. Calculating the return of the portfolio from the start of the month to the end of the month solved this problem. For example, a best in class portfolio had a turnover of many constituents on March 31st, 2011, some companies fell into the worst class portfolio and new companies disclosed their carbon footprints, becoming best in-class. Therefore, the total float market capitalization varied significantly from the previous month and if using the cumulative return calculation, it would create a largely inaccurate return. The old portfolio float market capitalization was calculated for March 31st, 2011 as well and used in the return calculation for the portfolio return on March 31, 2011, and the float market capitalization of the new portfolio was used to calculate the return of the portfolio for April 30th 2011, reflecting an accurate return of the changes made in the portfolio.

5 Results

5.1 Tiered Divestment Strategies

The tiered divestment return statistics are listed in Table 5-1 below; Figure 5-1 displays the cumulative performance of the divestment portfolios. As demonstrated, the return performance continued to increase when taking a more aggressive divestment approach, excluding divestment from the utilities sector. Given that the classifications for the utilities sector are poorly categorized (i.e., renewable power generators are within this category), a higher level of return would not necessarily be what a climate friendly investor would want. As well, the annualized risk continued to be relatively constant through each stage of the divestment. Therefore, an investor would only be further compensated for the investment at each stage of divestment, as shown by the Sharpe ratios. For example, the Sharpe ratio for the coal + energy equipment and services divestment was .27, whereas the Shape ratio for the energy sector divestment was .47. The information ratio, a measure of the excess return to the excess risk, informs an investor whether their excess return to the benchmark is also constant. This means that the high and low period of returns are correlated to the benchmark rather than being random. The information ratio is fairly moderate, showing that the volatility slowly increases as the tiered portfolio divest stocks and become less correlated to the benchmark, which is completely expected.

The energy sector divestment portfolio performed the best overall, producing an annualized active return of 1.92% with an annualized volatility of 9.05%, which is less volatile that the benchmark. The energy sector comprised 24.80% of the benchmark on average over the five years, which is higher than average, compared the other seven sectors. As demonstrated by the average # of constituents per month, there were 51 out of 62 energy sector firms considered under the industry categorization of oil, gas and consumable fuels. 19 companies were considered either a coal company (which was two on average) or on the Carbon Underground 200 list (17 companies on average). When divesting from these firms, the resulting portfolio had an overall return performance close to the full energy sector divestment (19.01% compared to 21.40%). This means that a majority of the excess return came from divesting from the companies that are considered to have the largest fossil fuel reserves in Canada.

Overall, the use of a divestment strategy over the period of January 2011 to August 2015 financially outperformed on a risk/return basis and mitigated the perceived risks of stranded assets of the energy and utility sectors. Therefore, the null hypothesis (or hypothesis one) was rejected, and the alternative hypothesis: “Divesting from Canada’s S&P/TSX Composite index as an investment strategy financially outperforms relative to the S&P/TSX Composite benchmark” was accepted.

Table 5-1: Return Statistics for Divestment Portfolios

Index Statistics	*S&P/TSX Composite Benchmark	Coal Divest.	Coal + Energy Equip. & Services Divest.	Coal + Divest. From Carbon Underground 200	Coal + Oil, Gas Consumable Fuels	Energy Sector Divest.	Energy + Utilities Divest.
Total Return	11.30%	12.35%	12.89%	19.01%	20.56%	21.40%	21.28%
Annualized Return[1]	2.36%	2.57%	2.68%	3.87%	4.16%	4.32%	4.30%
Annualized Risk[2]	9.91%	10.10%	9.89%	9.69%	9.12%	9.05%	9.19%
Sharpe Ratio[3]	0.23	0.25	0.27	0.39	0.45	0.47	0.46
Active Return[4]	N/A	0.20%	0.31%	1.48%	1.76%	1.92%	1.90%
Annualized Active Risk[5]	N/A	0.44%	.37%	1.66%	3.04%	3.26%	3.21%
Information Ratio	N/A	0.45	0.85	0.89	0.58	0.59	0.59
Average # of Constituents/ Month	244	242	231	225	193	182	175
Weight of Energy Sector[6]	24.80%	24.43%	23.70%	16.50%	1.24%	0	0
Weight Dist. Increase/ Stock[7]		1.013	1.021	1.203	1.351	1.351	1.386

*January 2011- August 2015

[1]The annualized return is based on the geometric average. Dividends, management fees, and transaction costs were not included.

[2]Annualized risk is calculating on the on price returns using monthly values and is the annualized standard deviation of monthly returns.

[3] Sharpe ratio does not include risk free rate

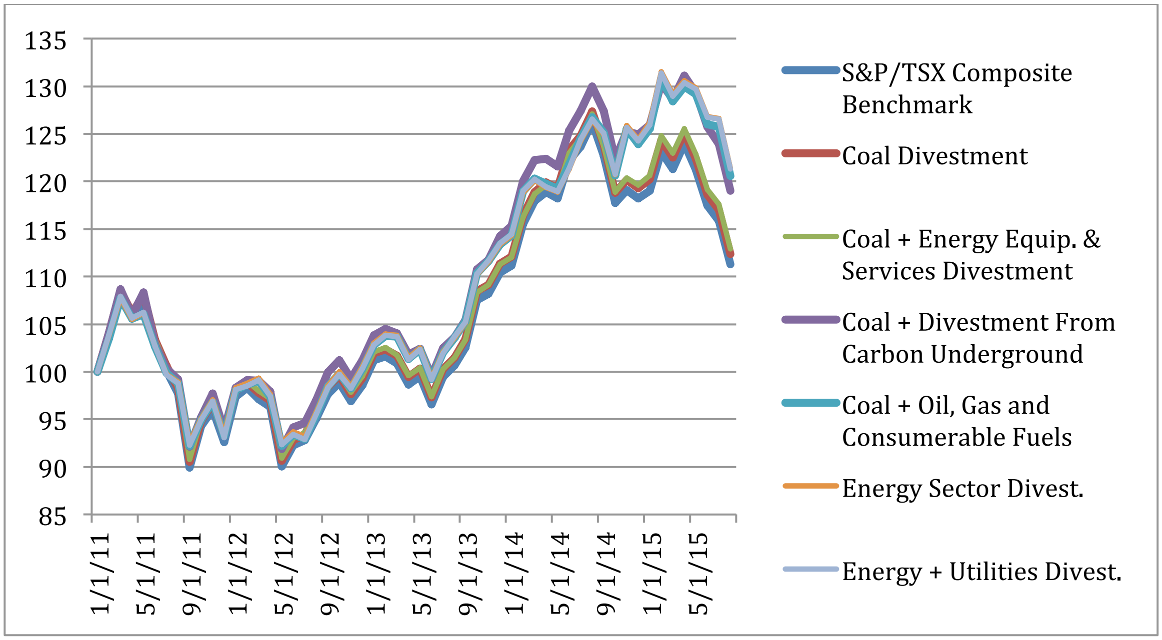
[4]Active Return= Ann. Benchmark Return – Ann. Portfolio Return

[5]Annualized active risk is the annualized standard deviation of the active monthly returns.

[6]The weight of the energy sector is the arithmetic average of the float MCAP

[7]The weight distribution increase for 01/31/2011 each stock varies throughout the time period due to relative weight of the divestment portfolio against the index

Figure 5-1: Cumulative Returns of Divestment Portfolios



5.2 Re-investment within the S&P/TSX Renewable Energy and Clean Technology Index

Table 5-2 displays the return statistics for the divestment strategies with a re-investment within the S&P/TSX renewable energy and clean technology index (green index) and Figure 5-2 displays the cumulative return performance graph. As clearly shown within the cumulative returns graph, the green index unperformed greatly over the past five years (figure 5-2). Therefore, any significant investment within this index would have lowered returns of the existing portfolio. Divesting away only from the Canadian firms within the Carbon Underground 200 and re-investing that money within the green index was a more beneficial strategy than that of divesting completely away from the energy sector and re-investing into the green index. This is a great example of a situation where an investor, albeit if able to predict the future, would have chosen the strategy that would have suited his moral background. For example, if an investor is willing to trade off some financial return to reallocate their capital to companies whose core business practices are aligned to a lower carbon future than they would fully divest and re-invest into this index. Otherwise, the former approach would be taken. Both strategies did outperform the S&P/TSX Composite index and offered slightly less volatility then the benchmark making them better investments than the index from a risk/return perspective. A correlation between both the returns of the divested portfolios and the green index was taken to ensure that price movements were not highly correlated, hedging the downside risk. As shown, the return correlations between the sub-index and the green index are moderate, therefore adding this index will diversify the portfolio in terms of sector allocations and returns. These strategies worked well and could be adapted by any investor going forward who is seeking to mitigate their risks within the energy sector and wanting to re-invest that capital in more climate change minded companies.

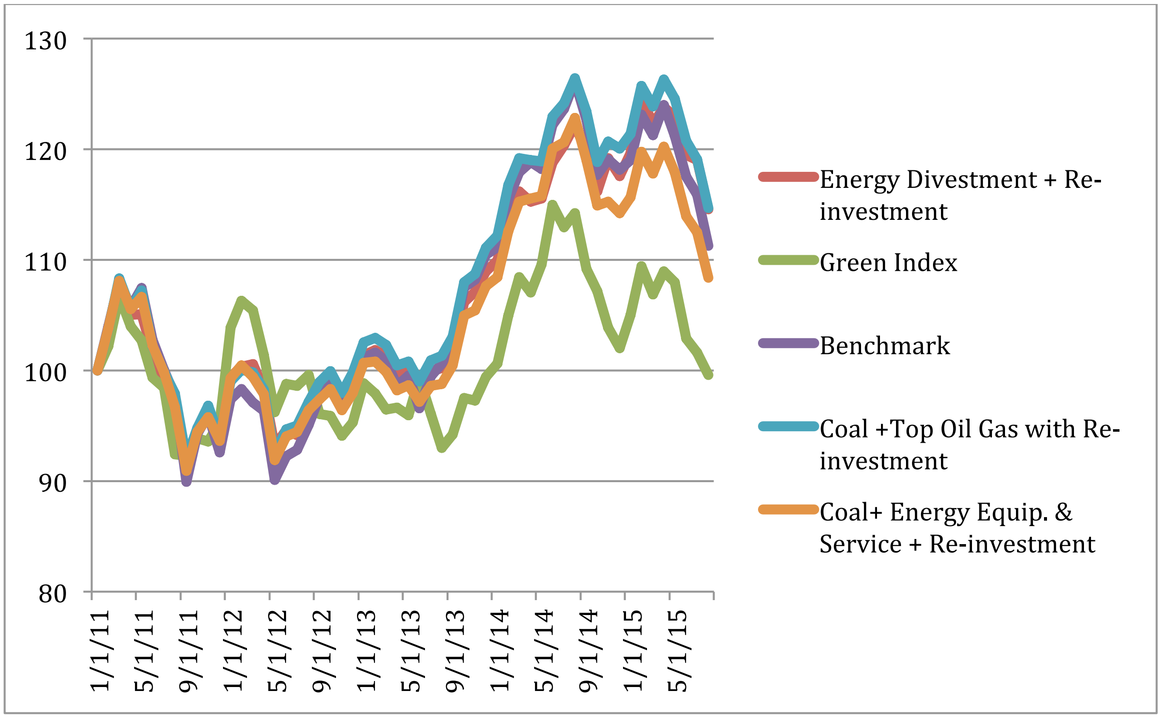
Table 5-2: Return Statistics for Divestment + Re-investment Strategies

Statistics	S&P/TSX Composite	Coal + Energy Equipment & Services Divestment	Divestment From Carbon Underground 200	Energy Sector Divestment
Total Return	11.30%	8.37%	14.67%	14.60%
Annualized Return	2.32%	1.77%	3.03%	3.02%
Annualized Risk	9.91%	9.18%	9.15%	8.40%
Sharpe Ratio	0.23	0.19	0.33	0.36
Active Return	N/A	0.55%	0.71%	0.70%
Tracking Error	N/A	2.23%	1.97%	3.45%
Information Ratio		0.25	0.36	0.203
Correlation (Sub Index vs. Green Index)		0.742	0.540	0.500

* January 2011- August 2015

** All statistics are calculated in the same manner as the tiered divestment statistics

Figure 5-2: Cumulative Returns of Divestment + Re-investment Strategies



5.3 Return Attribution using Carhart Four Factor Model

The following are the results from the multi-linear regression Carhart models. For simplicity, each portfolio will be labeled as follows:

Portfolio A: Coal + energy equipment & services divestment

Portfolio B: Coal + divestment from the Carbon Underground 200

Portfolio C: Energy sector divestment

Portfolio D: Coal + energy equip. & services divestment w/ re-investment into green index

Portfolio E: Coal + divestment from the Carbon Underground 200 w/ re-investment into green index

Portfolio F: Energy Sector divestment w/ re-investment into green index

Table 5-3 provides the single linear regression results for the CAPM model and Table 5-4 provides the results for the multi-linear regression for the Carhart model. As displayed in the CAPM model the beta for the risk premium, the correlation of the risk premium return to the portfolio returns, is highly correlated and explained the majority of the returns, with significance values (p values) of less than .0001. This means it is highly likely that the regression model predicts the correct returns. Additionally, the R^2 can also be used to demonstrate how correlated the data fits the model, also know as the regression line or line of best fit. The R^2 are highly correlated for all portfolios, stating the regression models can be used as an accurate prediction model.

Table 5-3: Single Linear Regression (CAPM Model)

	$r^{2\,(1)}$	Adjusted r^2	Root MSE[2]	Risk Premium[3]	Alpha[4]	P-value[5]
Portfolio A	0.99871	0.99861	0.00106	0.98894	.00018	<.0001
Portfolio B	0.9722	.9717	0.00467	0.9562174	.0019	<.0001
Portfolio C	0.89359	0.89158	0.00855	.85657	.0016	<.0001
Portfolio D	0.959	0.9582	0.00534	0.896796	-.009	<.0001
Portfolio E	0.9650	0.9643	0.000495	0.899308	-.0001	<.0001
Portfolio F	.8892	.8871	.00811	.7947346	-.0008	<.0001

*Number of data points is 55

[1] R^2 is a measure of how close the data is to the fitted regression. In this case, of a simple linear regression, it mimics a correlation co-efficient.

[2] Root MSE=Root mean squared error. It measures the average of squares of the deviations between the linear of best fit and what is estimated.

[3] The risk premium is the beta for the independent variable, it the coefficient to the return of the market in excess of the risk free rate.

[4] The alpha is the abnormal rate of return of the portfolios in excess of what would be predicted

[5] The p-value determines the significance of the results. A p-value less than .05 typically means that the model is significant and can accurately be used for prediction.

Table 5-4 provides the results of the Carhart four-factor model. The results demonstrate that when adding the three additional factors (SML, HML, and MOM) the risk premium is still highly correlated to all of the portfolios at high significance levels, demonstrating that the three additional factors do not further explain the returns of the portfolios analyzed. These results demonstrate that one factor, risk premium, was sufficient enough to explain the cross-section of expected returns, within this time period and sample set. Additionally, evidence that the returns of the portfolios are mainly driven by systemic (market) risk and the idiosyncratic (stock specific) risk is almost non-existent, meaning the portfolios are well diversified. Given that the return performance is higher than the benchmark relative to the risk (the Sharpe ratio), investors are being compensated for this systemic risk.

Fama and French's results demonstrated that by adding the three additional factors a more reliable model for portfolio return would result, but as demonstrated these results show no increase in reliability of returns given that risk premium beta is highly correlated. This is not surprising given that these portfolios are quite large and are largely comprised of the S&P/TSX

Composite universe. What is interesting is that, albeit very small, the alphas were all positive for the divested portfolios (A,B,C) and negative for the re-invested portfolio (D,E,F) in both models. This means that the abnormal return in excess of what is predicted is positive for the divested portfolios and negative for the portfolios with a re-investment into the green index. Further research needs to be done to see if there is significance with negative alphas and green stocks, portfolios, and indices.

Table 5-4: Multifactor Regression Results (Carhart Model)

	R^2	Adjusted R^2	Root MSE	Risk Prem.	SML	HML	MOM	Alpha	P-value
Portfolio A	.99871	.99861	.00106	.98894	- .0013	.0010	.00085	.0002	<.0001
Portfolio B	.97494	.97294	.00457	.96286	- .0010	- .012	- .0021	.00184	<.0001
Portfolio C	.91348	.90656	.00794	.89408	- .0072	- .0287	.00761	.00149	<.0001
Portfolio D	.96119	.95808	.00534	.89294	- .0027	- .0073	- .0046	- .00976	<.0001
Portfolio E	.96681	.96416	.00496	.89867	- .0022	- .0064	- .0045	- .00019	<.0001
Portfolio F	.89602	.8877	.00809	.81336	- .0072	- .0171	.0018	- .00091	<.0001

*Number of data points is 55
** Root MSE= root mean standard error (see table 5-3 footnotes for the explanations of statistics)

5.4 Carbon Footprinting Investing

As aforementioned, establishing a baseline is essential for the approaches that are taken when using a carbon footprinting approach for portfolio selection. As discovered through the literature review and articulated in the methodology section, a balance sheet and income statement approach was used. The market capitalization, referring to both the allocation of ownership and sales, referring to the efficiency of carbon use, will be used to demonstrate the characteristics of the universe prior to dividing the universe in two portfolios (the best and worst in class). As shown in Table 5-5 below these figures are normalized to be comparable to other portfolios.

Table 5-5: Carbon Intensity and Total Carbon Metrics

	Total Carbon Intensity	Total Carbon Emissions of Portfolio (ownership)

	(efficiency) (t CO2 e/ $M)	(t CO2e/ $M)
2011	440.62	210.421
2012	270.82	189.21
2013	265.83	220.57
2014	362.40	244.33
2015	197.87	173.54
Average	307.50	207.61

* Carbon Metrics are for March of every year.
** The Carbon intensity is calculated by equation 4-6 and total carbon emissions of portfolio is calculated by equation 4-5

The average carbon intensity of the universe portfolio over the five-years was 307.51 and the average carbon emissions of the portfolio (ownership) were 207.62. Although the intensity did decrease throughout the years and the carbon emissions by ownership did vary, this can be due to a multitude of factors such as different constituents entering into the universe, increased efficiency, or more share releases, therefore, no conclusions can be made.

It is also important to understand the sector dynamics of the benchmark universe, used for both methods in portfolio selection. This will also aid in providing some insight into if the divestment portfolios would also have a lower carbon portfolio per million dollars invested or a lower carbon intense portfolio from divesting away from the energy sector or the utilities sector. As demonstrated in Table 5-6 the utility sector is the most carbon emissions per million invested and the most carbon intense industry. The energy, equipment and services industry group is second most intensive. Therefore, divesting from the oil, gas, & consumable fuels industry group and the utilities sector would mitigate an investor's exposure to carbon risks in this sample.

Table 5-6: Average Carbon Intensity (per million) and Emissions/Million Invested

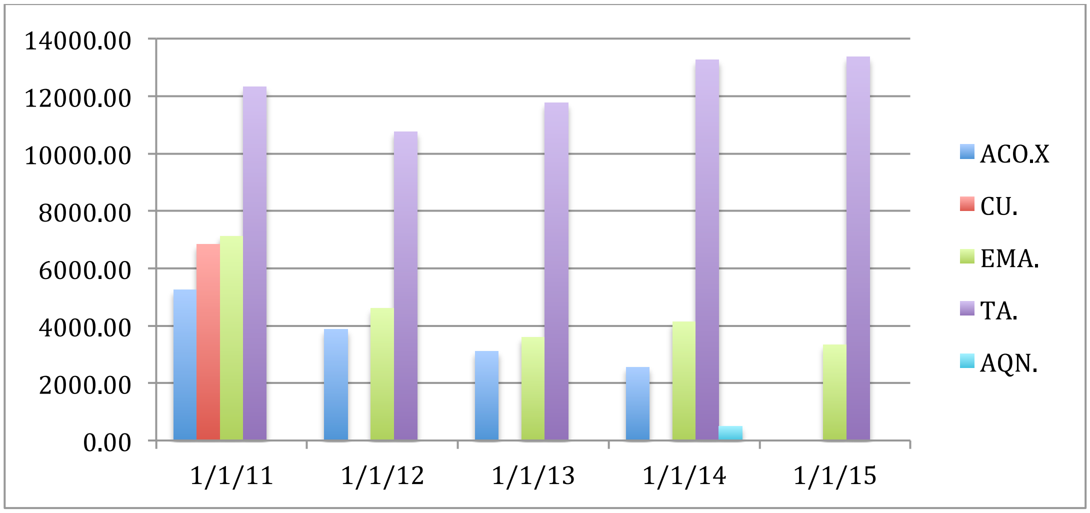
	2014		2013		2012		2011		2010	
Sector/ Industry	Avg. Int.	Avg. Em./ $M	Avg. Int.	Avg. Em./$ M	Avg. Int.	Avg. Em./$ M	Avg. Int.	Avg. Em./ $M	Avg. Int.	Avg. Em./$ M
Energy Equipment & Services	124	30	1507	1283	118	118	128	23	139	29
Oil, Gas & Cons. Fuels	1582	3988	1636	1091	1683	815	1567	960	1770	747

Materials	430	476	757	479	391	705	334	350	410	276
Industrials	232	191	184	141	255	227	205	291	142	130
Consumer Discret.	128	67	66	36	140	117	126	50	66	48
Consumer Staples	27	60	37	79	39	247	43	110	81	418
Financials	4	14	39	16	25	12	30	16	62	18
Info. Tech.	11	15	22	39	17	16	13	13	N/A	N/A
Telecom. Services	22	10	13	44	88	11	96	13	18	15
Utilities	8354	1751	6656	4804	4743	3976	6416	4528	7885	7586

* Both average intensity and average emission/million dollars invested were calculated using the portfolio construction equations ie. Total carbon emissions/total sales (per million) and total carbon emissions/ total FMCAP (per million)

It is also useful to look at the range of the individual constituents within the utilities sector to ensure that there are not any outliers skewing the average. As an example, Figure 5-3 displays the companies within the utility sector and their associated carbon intensity. TransAlta (TA.) is an outlier within the utilities sector, and is among the most carbon intense companies in the entire benchmark universe (TransAlta is alongside Enbridge, Trican, and Canadian Oil Sands as the most intensive). This is not surprising given that this utility provider operates coal-fired power plants that comprise 41% of their net generating capacity (TransAlta, 2016). If more renewable electricity producers disclosed their carbon footprints, surely the sector average would go down and TransAlta would be driven out further as an outlier. This is not the case, however, for this data set. Any investments made within the utility sector, aside from Algonquin Power and Utilities (AQN.), is above the average of the entire benchmark universe and would increase the carbon footprint of the portfolio, increasing exposure to the perceived risks of regulatory and carbon pricing mechanisms. Additionally, two interesting conclusions can be made out of this example. Firstly, this is an explicit example of how the GICS need to be revised to embrace more core business practices within their broad categorization. The industry is seeking out new ways of categorizing companies and GICS will fall short if they do not update their classifications or create new ones. Second, TransAlta, although being the most intense, is listed on the Jantzi Social Index. The Jantzi social index screens companies to find 50 companies that pass a set of broadly based ESG criteria (Sustainalytics, 2016). TransAlta has a mix of hydro, wind and solar generation (31% of net capacity). This demonstrates that green/brown metrics could aid in differentiating this company as a best or worst in class against its industry peers.

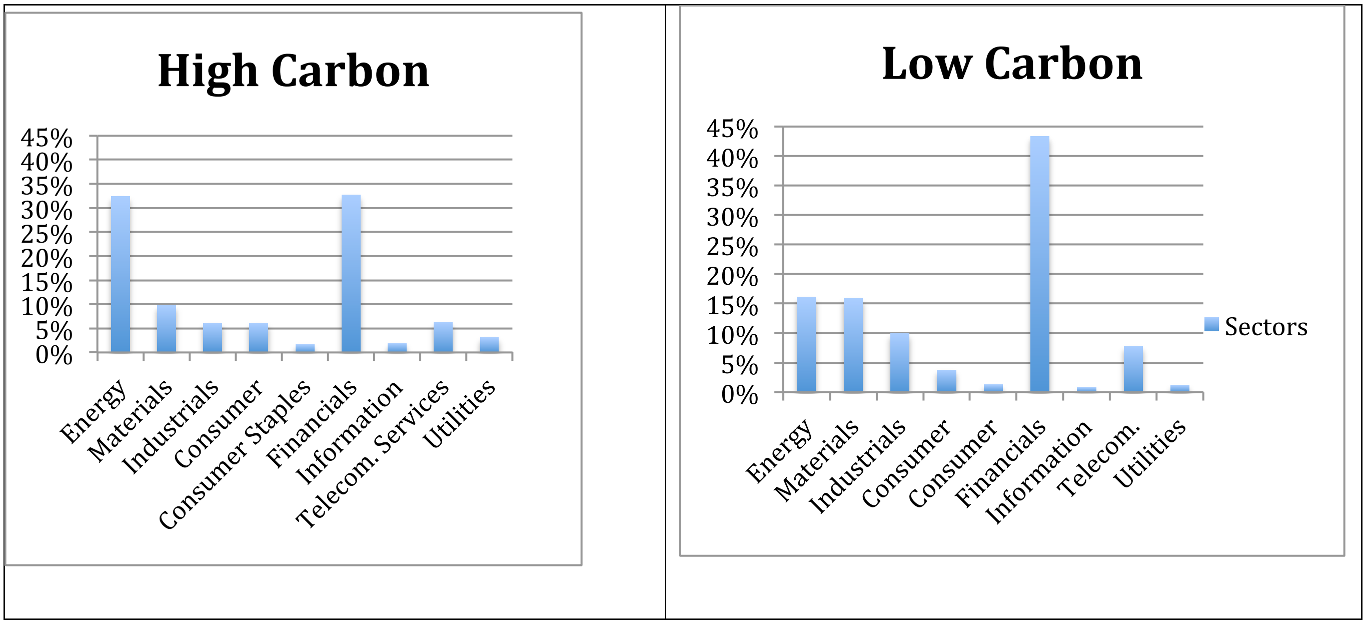
Figure 5-3: Carbon Intensity of Companies in Utility Sector



5.4.1 Portfolio Returns Results for Low Carbon Emissions versus High Carbon Emissions Portfolios (Investing Best & Worst In-Class, Ownership Method)

Using the ownership methodology for investing, the results for the two portfolios are displayed below. First, however, it was useful to understand how the market capitalization of the sectors varied between the two portfolios. More specifically, it was useful to understand if dividing the companies amongst their sub-industry peers created a difference in sector weighting of the resulting portfolios. It is obvious that this is unrealistic due to the nature of the each company's market capitalization being different and the way in which the portfolio construction process took place. For example, some companies, such as Gildan Activewear, were the only ones within their sub-industry classification and thus always fell into the high carbon portfolio due to carbon efficient business types of the consumer discretionary industry group peers. For industry groups that did have many companies disclose their carbon footprint, such as financials, materials and energy, it was very important to use the sub-industry classification to distinguish between their business types. Figure 5-4 below demonstrates that both the high and low carbon portfolios had a relatively highly weighted financial sector, due to 20 financial companies disclosing their carbon footprint and having large FMCAPs. By dividing the companies up among their industry group peers, the portfolio weightings for the resulting two portfolios are different. If an overall sector did have poor performance throughout this five-year period, this would affect the portfolio differently.

Figure 5-4: Sector weighting for the High and Low Carbon Portfolios (by Float MCAP)



*based on a five year average

The statistical results for the two portfolios are displayed in Table 5-7 below, with the cumulative return performance displayed in Figure 5-5. Given that the benchmark portfolio return for the ownership approach is negative, -1.38%, whereas the benchmark portfolio return for the divestment portfolios was largely positive, 11.30 %, it is difficult to demonstrate overall positive performance of any sub-universe portfolio for the carbon footprint approaches. As shown in Table 4-7 the industrial and financial sectors were overweight in this benchmark universe, therefore, underweighting slightly most other sectors. The reason for this poor return could lie within the companies that chose to disclose their footprint, the weighting methodology or not incorporating the total return (ie. dividends). No conclusions can be made and further analysis is needed because the poor benchmark return does not support asset managers well in Canada when wanting to choose solely a carbon footprint approach for investing.

The low carbon portfolio did outperform the benchmark, and therefore also the high carbon portfolio. Although the low carbon portfolio did not minimize risk compared to the benchmark, it is better from a risk/return perspective, as shown when comparing the Sharpe ratios. The Sharpe ratio in general (annualized return/ annualized risk) is poor compared to industry standards, understanding that it is the amount of return given for every unit of risk. No investment manager would think that this is a reasonable strategy since government issued investments would generally have a higher return and no perceived risk. In Table 5-8 the carbon footprint statistics are illustrated. Given that the portfolios were created based upon the ownership method, it is important to look at whether the total carbon emissions decreased for the low carbon portfolio. As demonstrated, the total carbon emissions decreased by 85.79 tCo_2/ $Million on average over the period. This means that the low carbon emissions portfolio decreased their exposure to carbon emissions by 41% on average. The ownership method strategy from a carbon footprint reductions perspective performed well. Given that the low carbon portfolio did still outperform the benchmark, this strategy should definitely not be dismissed, rather the issues of this approach should be identified and investigated.

Two issues of this approach, sector allocations and the chosen market capitalization weighting, are important to discuss. For example, the low carbon portfolio has over a 40% weighting in the financial sector. Financial institutions are exposed to carbon through the investments they make and are not calculated within their carbon footprint. If regulations or carbon pricing do come into place and negatively affect the energy sector, surely some of the loans that the banks have provided this sector will feel these affects. Using a weighting cap for the portfolios construction process or different weighting approach overall, could have changed the results. If a different weighting approach, such as an equally weighted universe, the sector allocation and perhaps the benchmark return would have been quite different. A non-market capitalization weighted approach might be good to investigate as well. Additionally, dividends should be incorporated to provide reward for the investors who invest in more value firms (firms that have a stable share price but offer a higher and consistent dividend) that do not receive great price returns. Further ideas for research will be discussed within the conclusions.

Table 5-7: Return Statistics: High Carbon/ $Million invested vs. Low Carbon/$Million invested

Statistics	Initial Index Portfolio	High Carbon Portfolio	Low Carbon Portfolio
Total Return	-1.38%	-2.01%	1.45%
Annualized Return	-0.31%	-0.46%	0.33%
Annualized Risk	9.76%	10.92%	9.80%
Sharpe Ratio	-0.03	-0.04	0.03
Active Return	N/A	-0.15%	0.64%
Tracking Error	N/A	3.30%	3.67%
Information Ratio	N/A	-0.04	0.17
# of Constituents on Average	86	42	44

*March 2011-August 2015.
** All statistics are created using the formulas for the statistics within section 5.1

Overall both the ownership and efficiency methods for carbon footprinting created best in-class portfolios that performed better relative to the universe benchmark. These portfolios also lowered the carbon footprint of the universe portfolio significantly. Therefore, the null hypothesis was rejected, and the alternative hypothesis: "Using a carbon emission metric as an investment strategy financially outperforms the universe benchmark" was accepted.

Figure 5-5: Cumulative Returns for Emissions/$Million Strategies

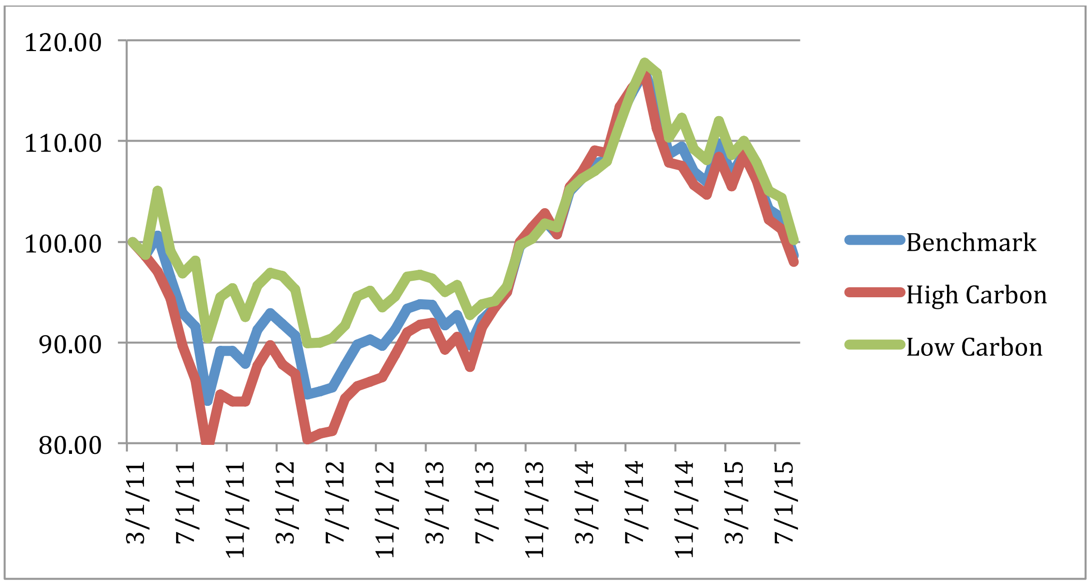


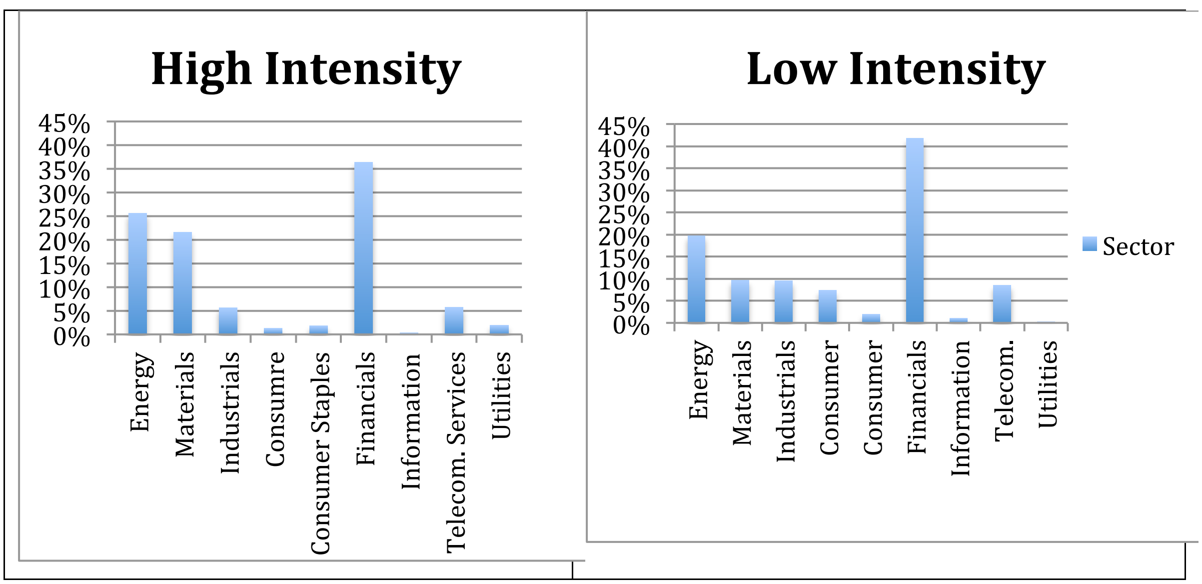
Table 5-8: Carbon Footprint Statistics

	High Carbon		Low Carbon	
	Total Carbon Intensity (t CO2 e/ $M)	Total Carbon Emissions of Portfolio (t CO2e/ $M)	Total Carbon Intensity (t CO2 e/ $M)	Total Carbon Emissions of Portfolio (t CO2e/ $M)
2011	477.69	210.42	374.18	164.27
2012	321.46	189.21	205.66	126.871
2013	456.98	220.57	158.84	105.64
2014	454.14	244.33	194.73	115.34
2015	228.13	173.54	159.03	96.98
Aver.	387.68	207.61	218.48	121.82

5.4.2 Portfolio Return Results for Low Carbon Intensity versus High Carbon Intensity Portfolios (Investing Best & Worst In-Class, Efficiency Method)

Using the efficiency method, the results for the best and worst in-class portfolios are displayed below. Again, it was useful to understand how the market capitalization of the industry groups varied between the two portfolios. As demonstrated in Figure 5-6 below the weightings of the two portfolios do vary slightly, but not as great as in the ownership method. Therefore, if a sector had an overall positive or negative performance due to an external variable, such as a changing currency, then it would impact the portfolios more evenly than that of the ownership approach. Within investment management, external factors are always prone to affect the performance of portfolios and this analysis draws attention to how the external variable, carbon, affects portfolio performance.

Figure 5-6: Sector Weightings for High and Low Carbon Intensity Portfolios (by Float MCAP)



* Based on the five-year average.

The statistics for the return performance of the high and low carbon intense portfolios are listed in Table 5-9 below and the cumulative return graph is Figure 5-7. The benchmark statistics for this method are different than that of the previous method due to missing sales data, but still offers a negative total return of -3.7% The low carbon portfolio did outperform the benchmark (hence the high carbon portfolio) with an annualized active return of 1.10%. As with the previous method, this is a very slim margin with no transaction costs and management fees taken into account. Additionally, the annualized risk and tracking error are quite high. The poor sharpe ratio (.02), a measure of return for every unit of volatility, demonstrates low correlated stocks are needed to decrease the volatility and perhaps to increase the return. Even when analyzing the volatility relative to the benchmark, the low carbon intensity portfolio is still volatile, showing that the excess returns of the portfolio fluctuate and that the portfolio is perhaps not rewarded enough financially for this increased risk. Although the efficiency method for investment did provide increased returns, the greater risk might not be worth it to any investor. Table 5-10 below displays the carbon footprints for the portfolios. Given that this is the carbon efficiency approach, it is important to look at whether the carbon efficiency of the portfolio increased. As demonstrated, the carbon efficiency did increase by 211.1 tCO_2/$Millions on average over the period. This means that the low carbons emissions portfolio decreased the exposure to carbon emissions by 68% on average. The efficiency method strategy from a carbon reductions perspective worked well. Similar to the method above, this method should not be dismissed and further research is needed to demonstrate what other components can be blended into this approach to offer an investor a risk/return profile that they are comfortable with.

Table 5-9: Return Statistics for High Carbon Intensity vs. Low Carbon Intensity

Statistics	Initial Index benchmark (portfolio)	High Carbon Portfolio	Low Carbon Portfolio
Total Return	-3.7%	-9%	1.40%
Annualized Return	-0.80%	-2%	0.30%
Annualized Risk	12.68%	12%	17.70%
Sharpe Ratio	-0.07	-0.18	0.02
Annualized Active Return	N/A	-1.20%	1.10%
Tracking Error	N/A	5.64%	8.50%
Information Ratio	N/A	-.21	0.13
# of Constituents on Average	86	39	47

* March 2011- August 2015.

** All the statistics are calculation using the equation in section 5.1

Figure 5-7: Cumulative Return for Carbon Intensity Strategies

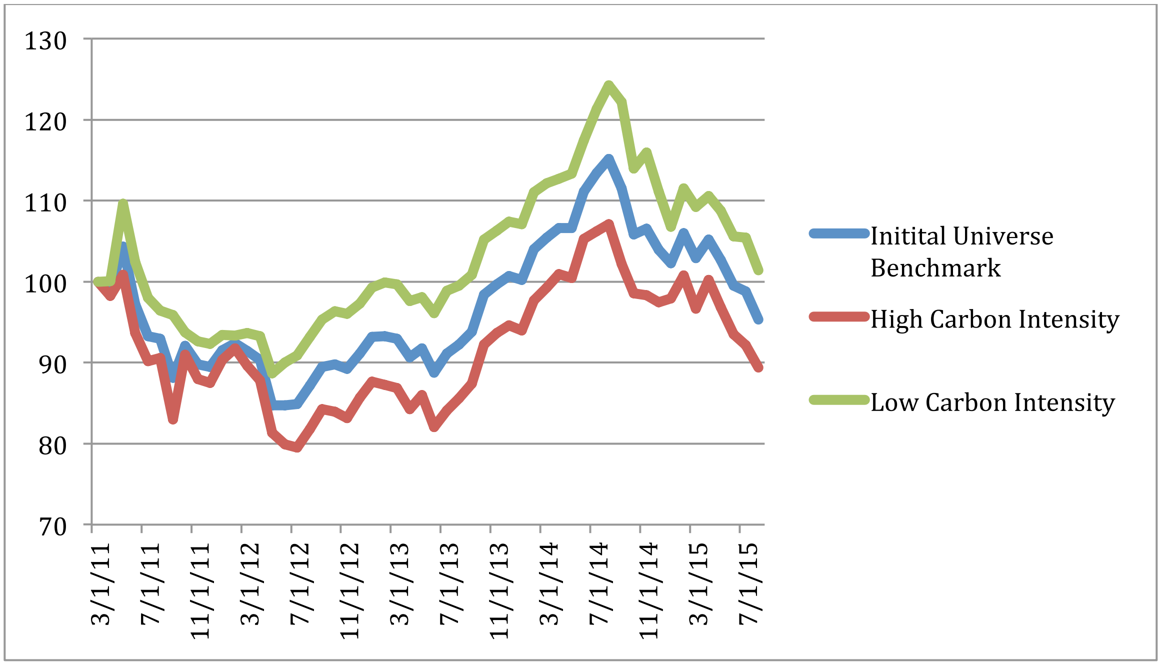


Table 5-10: Carbon Footprints Statistics

	High Intensity		Low Intensity	
	Total Carbon Intensity (t CO2 e/ $M)	Total Carbon Emissions of Portfolio (t CO2e/ $M)	Total Carbon Intensity (t CO2 e/ $M)	Total Carbon Emissions of Portfolio (t CO2e/ $M)
2011	737.29	73.72	179.41	113.53
2012	450.00	44.99	130.61	101.14
2013	435.10	43.51	123.82	97.65
2014	593.27	59.32	134.18	86.34
2015	331.85	33.18	107.94	83.37
Aver.	509.50	50.94	135.19	96.40

6 Conclusions

Whether Canada chooses to adhere to its responsibilities to meet its climate change targets or not, investors in Canada have a lot to be concerned about. The imminent threat of human induced climate change will have the global community reacting in ways that will affect Canada and their investors. Therefore, these investors need to be aware of financial mitigation and adaptation techniques. Although, there are a multitude of public and private financial techniques, this thesis specifically looked at techniques within the Canadian equity markets. Given that greenhouse gases (equivalent carbon emissions, referred to as carbon emissions with this thesis) are directly linked to climate change, the ways in which an investor can mitigate their exposure to carbon related risks and re-allocate their capital to support a lower carbon society was analyzed. This paper tested the financial performance of two strategies that mitigate against carbon related exposure in respect to climate change, fossil fuel divestment and carbon footprinting. Before discussing the results of these two strategies, and the ideas for future research, a brief summary of how the literature review aided in the analysis will be discussed.

The statistics and models that came out of the modern portfolio theorists' work aided investors in having quantitative approaches for understanding and predicting portfolio returns and risks. The efficient frontier and the asset pricing models were explained within the literature review and methodology and were shown within the results for the two strategies within this paper; mainly, the risk/return profile of the investments compared to a benchmark, and the capital asset pricing and Carhart models. As aforementioned, modern portfolio theory contrasts behavioral theory, which demonstrates that investors cannot implement these quantitative approaches successfully due to cognitive biases and human errors. Behavioral theory alludes to human emotion as an element of the investment process that should not be dismissed as readily as modern portfolio theory seems to do. Investors fall within the spectrum of the beliefs and implementations of the modern portfolio and behavioral theorists' work (known as conventional and SRI investors). Due to the growing concerns of a carbon bubble, there is a need to implement non-financial criterion to the investment process. Therefore, the techniques that were used in this paper for portfolio construction stem from behavioral theory and are within the growing field of socially responsible investing. As discussed, the predominant two techniques that address climate change which were used are fossil fuel free divestment and carbon footprinting for portfolio selection using a best in-class technique.

This analysis demonstrates that the paradigms of both modern portfolio theory and behavioral theory collide when addressing the concerns of a carbon-constrained society; mainly that divestment and carbon footprinting strategies are implemented because of both risk and returns concerns and moral and ethical ideologies. Conventional investors are concerned about the issue of stranded assets in regards to the energy and utilities sector while SRI investors want to divest from a moral and ethical standpoint because it is unjust to support fossil fuel extraction. The carbon footprinting approach appeals to conventional investors who see end use policy and regulations of carbon as an imminent risk, such as a limit of emissions for a company or a price on carbon. Furthermore, it appeals to SRI investors because they are reallocating their capital to support a lower carbon society. Therefore, within the spectrum of conventional to socially responsible types, investors are wanting to test out strategies that address the pending climate charge targets, checking whether the performance of such strategies maintain their risk/return profile and if there are investment opportunities to support a lower carbon society.

The results demonstrated that over the period January 2011-August 2015 from a risk/return perspective, it was beneficial to divest from the energy sector within Canada at any degree. Therefore, the null hypothesis was rejected and the alternative hypothesis was accepted. The carbon footprint results were more complicated due to the overall benchmark having an overall negative return but both of the best in-class portfolios, (the low carbon emissions portfolio and the carbon efficient portfolio) did perform better on risk/return basis and both decreased the carbon footprint substantially. Therefore, the null hypothesis was rejected and the alternative hypothesis was accepted.

Markowitz (1959) explains that the utility maxim, point of optimality for investments are the portfolios that lie on the efficient frontier where one cannot receive a greater level of return for a given level of risk. As shown in the tiered divestment results, the S&P/TSX Composite index is not an efficient portfolio, and the divested portfolios received a greater return for a similar or lower level of risk. This means that any index investor type, should diversify their holdings across all sectors but the energy sector and utilities sector, finding indices and exchange traded funds that are fossil free. Additionally, the tiered divestment results demonstrated that when divesting away from the firms listed on the Carbon Underground 200 (the firms with the largest about of fossil fuel reserves), the return increased most dramatically over the five-year period. As Fischer (2015) notes, stranded assets are an evitable part of climate change policy. It cannot be determined that this above average performance was derived solely because the market is understanding stranded assets risk, perhaps discounting these assets, but it is a relationship nonetheless. The change in oil price could have just as easily affected the earnings of these firms. This is an important concern when addressing how applicable this investment model is for future use. The decrease in oil price, dropping from around $100 dollars (2011-2014) to under $50 a barrel in (2014-2015) (Macrotrends, 2016), marked a rapid change in the commodity price. The commodity price of oil directly affects the entire supply chain for oil. The extractors, producers, and transporters would be affected as well as the end us consumers. Given the lower oil price companies at the beginning of the supply chain, such as all companies marked as an oil company within the energy sector, would need to accept decreased revenues until the global supply of oil increased. Whereas, end consumer would receive the benefits of this decreased price by saving more per barrel purchased. Given that the commodity price directly affects the revenues and the savings of the companies within the supply chain, this could lead to share price changes of these firms as well. Therefore, this investment model should be used alongside the tracking of oil prices and is best suited for a low oil price.

The CAPM and Carhart model results demonstrate that CAPM is sufficient to explain the attribution of returns for the time period. These results go against Fama and French (1993) claims that the risk premium only explains 70% of the return. Fama and French's research was only tested within the US and for a longer and different time period. To demonstrate if the Carhart model could be applied to the Canadian markets, more portfolios that are further diversified away from the market would have to be studied, and for longer period of time. Lastly, to re-instate, some believe that the SRI portfolios under-perform conventional portfolios as the investment opportunity is constrained by the non-financial criterion and mean-variance efficient portfolios are not achievable (Tippet, 2001; Kahn et al. 1997; Geczy et al. 2005; Gregory et al. 1997). These results shown contradictory evidence of this and these results further support Bauer, Derwall, & Otten (2007) in studing the how SRI funds performance within the Canadian markets.

The carbon footprinting portfolio results supported Statman (2000) claims that a firm can "do well by doing good" by demonstrating over performance of portfolios relative to the universe benchmark, that were created by selecting the top firms by a carbon footprinting metric against their sub-industry peers. These results complement the body of literature that support the link of SRI to positive financial performance. Through the discussions within the results, examples such as TransAlta being a top emitter but utilizing renewable power capacity, demonstrates the need, as 2 Degrees Investing Initiative (2013) suggested, to implement a blended approach of carbon footprinting investment strategies. Thaler's (2010) claims of investors are not rational but are normal and that risk should be more than volatility is shown with socially responsible investing and within this overall analysis. Investors are seeking ways to invest with more perspectives that incorporate climate change and creating their own subjective utility maxim. Unfortunately, the firms that an investor within Canadian equities can invest within while utilizing an SRI approach and maintaining their risk/return profile, only goes as far as the large cap S&P/TSX Composite index. The green index, which is comprised of many small caps firms not within the S&P/TSX Composite index, has yet to be rewarded for their climate friendly core business practices. This issue will be discussed further in the following paragraph.

The systemic problems of the overall market are shown with the re-investment potential. It was important to understand if an investor can hedge their carbon related risk, however, understanding the opportunities for where an investor can reallocate their capital needs to be addressed further. As this research has demonstrated, the S&P/TSX Renewable and Clean Tech index does not offer competitive returns relative to other Canadian indices. The market capitalization of the companies within the non-renewable sector is huge (348,604 million as of August 31, 2015) in comparison to the companies that are offering renewable and clean tech solutions (5,432 million (maximum)) (S&P Dow Jones Indices, 2016). If all investors, therefore, were wanting to divest from the non-renewable energy sector and re-invest into green companies, or invest in best in-class companies within the broad market index and diversify through green companies, it would not be feasible and non-public market financing opportunities would have to be sought out. The financial and non-renewable energy sector are heavily weighted in the overall equity market, and their linkage needs to be analyzed further to understand the implications and the fear of divesting from the energy sector and further investing into the financial sector. Indices such as the Jantzi social index heavily weigh financial institutions (Blackrock, 2016), which is a misleading approach for sustainable investing. Mutual funds within Canada comprise 31% of Canadians overall wealth (The Investment Funds Institute of Canada, 2016), and if the public markets within Canada do not provide companies that Canadians are wanting to invest within, other country markets or private investment would have to be sought out. This would only occur if Canadians speak out to their associated asset managers and put their capital where their moral and ethical ideologies lie. Therefore, the issue of the Canadian equity markets currently not providing enough capital opportunities for Canadians to support a lower carbon society is a tangled issue and needs to be further analyzed. The closing paragraphs, will discuss other limitations and ideas for future research.

There are seven limitations that will be discussed. First, home bias is inherently a limitation. Although it is known that it is useful to diversify a portfolio across countries, it would have not been an accurate portrayal of the Canadian markets, supporting the societal need to transition to a lower carbon society. Second, the Global Industry Classification Standards (GICS) does not accurately categorize companies based upon their core business practices. This brought forth complications when divesting, specifically away from the utilities sector. Third, only using the stock price for calculating the return (price return) offered lower return than the total return would have. Total returns incorporate dividends and other distribution realizations. Many indices use both return methodologies to demonstrate performance. Given that total return demonstrates higher performance throughout the period, this would have enhanced the poor performing carbon footprint universe and resulting portfolios. The big banks are renowned dividend payers in Canada (Tattersall, 2016) and the heavily weighted financial sector could have provided more significant returns. Fourth, the coverage offered by the carbon data providers was not robust and the inability to receive an available estimation model made the carbon emissions universe not representative of the S&P/TSX Composite index. Fifth, by only using the carbon footprint approach, it was difficult to differentiate amongst companies within a certain sector that could have green exposure (such as renewable power or research in advancing cleaner technologies) that is not encapsulated in the carbon footprint metric. Additionally, the annualized carbon footprint doesn’t incorporate firms who are improving their efficiency and becoming proactive to change their core business practices to more climate-friendly practices. Sixth, the inability of being able to constrain by sector exposure or tracking error from the benchmark created difficulties in being able to provide portfolios are similar to the overall broad market for the carbon footprint strategies. Lastly, a major overall issue of both approaches was not being able to control the change in oil price.

The following are five ideas (topics) for further research. First, given the issues of being able to differentiate industry peers based upon their carbon emissions improvements and their involvement with green energy or technology, analyzing investment strategies in the Canadian equity markets that encompass blended carbon footprinting strategies is of interest. Additionally, non-market capped weighted approaches to carbon footprinting and/or constraints to investments (such as sector constraints or benchmark volatility constraints) would be interesting. Second, understanding that the green indices within Canada are not performing well and there is a minimal amount of capital to invest into, investigating private investment opportunities in Canada for investors who are uninterested in providing all of their capital to the Canadian equity markets but would like to keep their money in Canada. Different financing opportunities need to be embraced to support the transition to a lower carbon society if these companies cannot be competitive on the public markets. Third, analyzing linkages between financial institutions and the non-renewable energy sector in Canada. The big five banks in Canada are seen as a risk adverse and socially responsible investment. Further analysis might demonstrate some causes for concern. Fourth, analyzing the sector allocation of the carbon footprint portfolios to see the performance for the sectors. This would provide more insight into which sectors it was more beneficial to invest by a carbon footprint methodology and it would provide a sector specific approach to the link of carbon and financial performance. Lastly, it would be very useful to analyze how much carbon allocation an investor is able to have if they would want to remain within the climate change targets. Drawing a link across the spectrum from firms to investor to provinces to provinces up to Canada, how much capital is able to finance the continuing carbon emissions outputs and how much capital needs to be reallocated. This is broader analysis is much broader than that of the equity markets and needs a systems analysis approach.

This thesis, Divesting and Re-investing into a Greener Future for Canada, outlined how an investor can utilize two carbon-related strategies that should be of interest for any investor, ranging from conventional to SRI. This topic is of great importance due to the Canada's and the world's climate change targets. Any investor should not readily dismiss the imminent threats of climate change, the world is changing and the way investors perceive the market should change as well.

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Appendix

Appendix A: List of companies within the Carbon Underground 200

Oil, Gas, and Coal Companies	Oil Gt CO_2	Gas Gt CO_2	Total Reserves
Canadian Natural Resources	0.788	0.208	0.996
Imperial Oil	0.527	0.025	0.552
Cenovus Energy	0.326	0.048	0.374
Husky Energy	0.215	0.128	0.343
Crescent Point Energy	0.146	0.011	0.157
Suncor Energy	0.713	0.003	0.716
Pacific Rubiales Energy	0.124	0.030	0.154
Penn West Petroleum	0.100	0.036	0.136
ARC Resources	0.046	0.066	0.112
Canadian Oil Sands	0.102	0.000	0.102
Tourmaline Oil	0.014	0.079	0.093
Enerplus	0.043	0.037	0.080
Peyto E&D	0.008	0.079	0.087
Encana	0.081	0.467	0.548
Teck Resources	2.603		2.603
Capital Power	0.367		0.367
MEG Energy	0.173	0.000	0.173
Mitsui & Co	0.048	0.095	0.143
Prophecy Coal	0.272		0.272
Total			8.008