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The Sustainable Communication of Canadian Mining Companies and their Corporate Financial Actions

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Résumé

Cette thèse étudie la relation entre la communication en matière environnementale des sociétés minières canadiennes cotées sur l'indice composite S&P/TSX et leurs décisions financières futures. Ce processus comprend une analyse textuelle appliquée aux annonces de nouvelles relatives aux émissions à l'aide de FinBERT, qui est introduite dans l'analyse de l'étude d'événements. La fenêtre d'événement sélectionnée est [t+1, t+16] tandis que les rendements anormaux cumulés sont calculés sur trois fenêtres. La fenêtre la plus significative, [t +1, t 11], a été sélectionnée pour l'analyse de régression en utilisant les changements dans les émissions, les dépenses d'investissement et l'effet de levier comme variable dépendante. Les résultats indiquent que les changements dans le cadre 1 des émissions, les dépenses d'investissement, et l'effet de levier peuvent être expliqués par le modèle au niveau de 5 % de confiance, ce qui signifie que les entreprises améliorent ces facteurs à la suite de leur communication.

Mots clés : environnement, exploitation minière, actions d'entreprise, émissions

Méthodes de recherche : analyse des sentiments, analyse de régression, étude des événements,

Factiva, Trucost, Compustat

Abstract

This thesis investigates the relationship between the communication of Canadian mining companies listed on the S&P/TSX composite index and their financial actions. It questions whether their communication regarding the environment had an impact on their actual actions in the future. This process includes a sentiment analysis applied on news announcements related to emissions using FinBERT, which is inputted into the event study analysis. The event window selected is [t+1, t+16] whereas the cumulative abnormal returns are computed over three windows. The most significant window, [t +1, t +11], was selected for the regression analysis to explain the variability in emissions, capital expenditure, and leverage. The results indicate that the changes in scope one of emissions, the capital expenditure, and the leverage can be explained by the model at the 5% significance level, meaning the firms improve these factors following their communication.

Keywords: environment, mining, corporate actions, emissions

Research methods: sentiment analysis, regression analysis, event study, Factiva, Trucost, Compustat

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1. Introduction

The threat of climate change and the emphasis of carbon emissions were not yet noticeable concerns in the 1990's (Bolton & Kacperczyk, 2021), and it is not until recently that the Securities and Exchange Commission (SEC) made it mandatory for firms in the United States of America to report their direct and indirect carbon emissions in the fiscal year 2022. Prior to this change in regulations, firms were reporting voluntarily their emissions. Canada is a leading nation in the mining industry with its production valued at $43.9 billion in 2020 with a total contribution to the gross domestic product (GDP) being 5%. Québec is in fact the largest producer in Canada followed by Ontario and British Columbia (Natural Resources Canada, 2022). The Canadian mines have been directly affected by climate change with an increase in hazards threatening their production (Pearce, et al., 2011). It is therefore of primary interest to address this issue as well as investigate the transition to a greener mining operation, which will lead to a sustainable growth of the companies as well as a healthier environment.

The term "corporate social responsibility" (CSR) emerged in the 1950's but CSR activities and the need for sustainable development in mining companies has grown considerably in the last decade. Mining companies employ CSR to conduct responsible business venture by decreasing the possible risks that may arise from safety issues as well as the negative environmental impact. This will in turn help attract and maintain employees as well as increase their social reputation (Wirth, Kulczycka, Hausner, & Konski, 2016). The literature on CSR proves that it is related to increasing shareholder value, improving financial performance as well as the brand of the firm. The goal of environmental, social, and governance (ESG) metrics is to measure a firm's performance in these issues and act as an indicator to investors and companies. However, the ESG information is subject to data inconsistency and imputation, disagreement within data providers, and distortions in the selection of a benchmark (Kotsantonis, Advisors, & Serafeim, 2019). It is an indicator for investors especially during the ongoing risk of climate change, which will affect investment opportunities by creating more stranded assets and shifting towards low-carbon investments. This will enable

investors to manage their exposure to the risks imposed and changes in regulations, as well as become more competitive in the carbon markets (Jagannathan, Ashwin, & Sammon, 2018).

The communication of companies on CSR is lacking, although it is an important factor and indicator for investors. It is an important tool for financial analysis that is capable of providing important information for major corporate decisions of the firm and their financial performance. It is of primary interest therefore to distinguish between a syntactical valuation of the announcements and the market reaction in the short run, as well as long run. This paper questions whether the communication concerning the environment had an impact on the actual actions of the firm in the future and is constructed as follows. Section 2 presents previous research addressing this topic. Section 3 is devoted for the data gathering, while section 4 focuses on the baseline methodology. Section 5 presents the results. Section 6 concludes.

2. Literature Review

2.1 Green Transition

The first section of the literature review will focus on defining the green transition and its effect on firm economic value. It aims to examine whether firms that implement a green transition exhibit an improved financial performance. Duncan and Petry (2019) study the financial sustainability in the mining sector which contributes to 11% of the global energy use and causes deforestation, pollution, as well as the depletion of water and land resources. It is thus crucial to transition to a low carbon economy through sustainable mining and recycling of those metals and minerals, which are present in the renewable energy sources such as solar panels, electric cars, and wind turbines. The challenge lies not only in the transition to green energy, but also in decreasing the emissions and negative environmental impact throughout the entire supply chain procedure. The development of standards for reporting emissions is an ongoing process as consumers, investors and government require more transparency. This will in turn lead to a lower financing cost as well as an increase in need for green metals and materials.

Bolton and Kacperczyk (2021) assess the carbon transition risk for 14,400 firms in 77 countries to which investors will be exposed to as countries attempt to achieve net-zero emissions by 2050. They find that firms with higher emissions seem to take on more leverage due to a decrease in future profitability and have a higher cost of equity. Whereas recent evidence suggests a negative relation between leverage and exposure to climate risk (Nguyen & Phan, 2020). The results also suggest that the carbon premium is linked to the percentage change and the level of emissions. In their later work, Bolton and Kacperczyk (2021) study various firm-level variables and test their explanatory power for the emissions such as the logarithmic of size, book-to-market ratio, return on equity, leverage, the ratio of capital expenditure to book value of assets, the HHI which is the Herfindahl index of business segments, logarithm of high tangible capital (PPE), the ratio of the dollar change in annual revenue to the market capitalization, and dollar change in annual earnings per share. They find that the emission levels and changes in scope one and scope two of emissions are associated to the size of the firm and is smaller for companies having a high capital expenditure. The carbon premium is in fact related to the level of emissions and the growth of emissions, but

not to the emissions intensity. They also find that firms with higher leverage, lower book-to-market ration, and a larger size are most likely to report their emissions.

Dialga (2017) describes the types of efforts that can be done for the green transition and attempts to obtain an index of sustainable mining countries of natural resources using a top down/ bottom-up approach by identifying five relevant dimensions, namely an economic, social, environmental, governance, and a transverse dimension. Each dimension is then respectively attributed measurable indicators which are in turn weighted and summed. Dialga (2017) applies sensitivity and robustness analysis of this index which indicates is success.

Cheung (2011) examines whether corporate sustainability actions are valued by investors through understanding the effects on returns, risk, and liquidity of US stocks following their inclusion or exclusion in the Dow Jones Sustainability World Index (DJSWI). Whereas Çimen (2019) finds that firms experience superior abnormal returns after their inclusion in the Borsa Istanbul Sustainability Index. This is accomplished by studying the impact of positive news announcements 3 days after the event.

2.2 Market Perception About Green Transition

The second section of the literature review examines whether environmental efforts impact economic and financial value differently. Climate change concerns are relatively recent with little attention paid to it prior to 2010, therefore, news on emissions or climate would not be reflected by the market (Alekseev, Giglio, Maingi, Selgard, & Stroebel, 2021). With the rise of climate change concerns, investors are searching for new methods and techniques to hedge their investment portfolios (Krueger, Sautner, & Stark, 2020). Alekseev, Giglio, Maingi, Selgard, and Stroebel (2021) show how mutual funds adjust their portfolios following local heat shocks. They also demonstrate an efficient methodology to hedge climate change risks following an extreme heat event over a five-year period ranging from 2015 until 2019. Subsequent to climate news shocks, their quantitative hedging strategy outperforms other traditional methods. They define extreme heat shocks as having extreme temperatures, as well as property damage and individual injuries. The results indicate that stocks belonging to the energy sector are bought by mutual funds

investors following heat shocks, which could be justified by their belief of developing green sources of energy. Instead of developing their own climate risk news, they employ various methods such as Engle, Giglio, Kelly, Lee, and Stroebel (2020) and Faccini, Matin, and Skiadopoulos (2021) while comparing the hedging performance. Their findings confirm that the performance of the hedging strategy is inconsistent across methodologies and that it is very difficult to achieve. This is due to the fact that the risks arising from climate change are complex and could be either physical risk such as changes in temperature or transition risks such as regulatory consequences.

Previous literature found that green bonds outperform when there is negative news about climate change, they trade at lower yields which implies lower expected returns compared to brown bonds. This indicates that investors are willing to accept a lower return in exchange for holding an environmentally friendly asset (Pastor, Stambaugh, & Taylor, 2021). On the other hand, Pastor, Stambaugh, and Taylor (2019) find that green assets exhibit lower expected returns as they act as a hedge for climate risk.

Bolton and Kacperczyk (2021) study whether carbon emissions are related to US stock returns and question whether investors require compensation for the carbon risks foretaken. They find that firms with higher carbon dioxide emissions experience higher returns, and that returns are affected by fossil fuel energy prices and commodity price risk. In their previous work Bolton and Kacperczyk (2021) regress the logarithm of total emissions, the percentage change in emissions, as well as the intensity of emissions on the logarithm of size, book to market value, return on equity, leverage, capital expenditures, logarithm of the firm's physical capital, the presence of the company in the MSCI world index, and the Herfindahl concentration index of the company. The results indicate that companies with higher carbon emissions experience higher returns and that this is risk is larger for less developed countries.

Bansal, Wu, and Yaron (2021) investigate the variability of returns through time of socially responsible investment (SRI). Their findings confirm that highly rated SRI stocks will have a superior alpha compared to the low rated SRI stock during good economic times but will underperform during recessions. The negative ESG incidents were constructed on Reprisk, and the results show that firms who didn't suffer from an ESG incident will tend to have abnormal returns

than firms with negative ESG incidents during good economic times only. This could be explained by the fact that during good economic times, consumer is more financially stable and would be able to afford socially responsible stocks. The market reactions following these announcements are studied in the short term, since firms continuously make such announcement throughout the year. This will also help isolate these announcements from other noises and have more precise effects.

The analysis of a company's sustainable performance is crucial to evaluate the financial and economic condition. Castro and Chousa (2006) address the absence of fundamental approaches regarding the implementation of sustainable development. They employ an integrated model which considers the environmental, social, and economic performance of firms in order to create sustainable value.

Endrikat (2016) shows that the market perception towards green transition can be measured by event studies in the short run. Endrikat (2016) analyses the relationship between stock market reactions and corporate environmental performance (CEP) and find a positive relation for positive events, and a negative reaction to negative events, which means that the markets reflect news announcements in the stock prices. The results indicate an asymmetry of information, meaning positive events induce a stronger market reaction than negative events. To compute the abnormal returns for the event study, returns are measure on the event date, and then accumulated over a three-day event window to obtain the cumulative abnormal return (CAR).

Anderson-Weir (2010) employs an event study to examine the relationship between company value and the environmental decisions of the firm which results in an adverse market reaction following environmental news. The market and risk adjusted models are used with an estimation period of 230 trading days and is regressed against the S&P500 index. The results indicate that investors react negatively following the release of positive environmental news, which is explained by higher operating cost to reduce emissions.

Deák and Karali (2015) analyze the relation between environmental news and the financial performance of firms in the food industry, given that their one of the largest polluters of greenhouse

gasses. They find that positive events that are internal to the company result in higher predicted returns, whereas negative events lead to negative returns. They find that the market reaction to environmental news is altered by firm-level financials and non-financials apart from leverage and return on equity. Therefore, negative environmental action and news is penalized by investors.

Oberndorfer, Schmidt, Wagner, and Ziegler (2013) use a three-factor Farma and French event study to examine the stock performance of German firms following their inclusion in the Dow Jones STOXX Sustainability Index (DJSI STOXX). The estimation window is 100 trading days and find a significant negative CAR for the event windows [0,5]. They find the markets have a negative reaction following the addition of a stock in the Sustainability Index, indicating the firm's engagement in environmental activities, therefore, corporate environmental activities are not rewarded.

2.3 Communication and Disclosure Policy

The final section examines the disclosure policy of firms, namely how do firms communicate about their green transition and what impacts does this commination have. Miklosik and Evans (2021) study the disclosures of Australian mining companies contained in their annual reports since it is perceived as a method of communicating their sustainability goals. The mining industry is a major contributor to Australia's economic growth and is responsible for providing the materials stored in the Technosphere, which is why mining companies in Australia should be prompt in reducing their environmental impact and actively disclose their emissions (Baker, 2008). The 100 companies with the largest market capitalization listed on the Australian Stock Exchange (ASX) are included in the sample. By distinguishing environmental keywork occurrences which are part of the Global Reporting Initiative (GRI) Sustainability Reporting Framework (G3) checklist such as carbon footprint, emissions, and climate change, Miklosik and Evans (2021) study the relevance and intensity of each company's communication. The results reveal that the dedication for the protection of the environment and prevention of climate change is related to company size; however, they don't provide any indication on the company's contribution to decrease their environmental impact. Moreover, textual analysis has limitations namely, it is a

time-consuming task and could lead to misinterpret of the sentences in isolation or lead to uncertain explanations.

There are many reporting initiatives to encourage companies to disclose their environmental performance, such as the GRI-Global Report initiative (Global Reporting Initiative, 2015). Bodea, Pérez-Belis, Torca-Adell, and Ibáñez-Forés (2020) based their study on corporate reports to analyse how firms communicate their sustainability performance through non-financial information, namely graphical representations. They find no consistent patterns in communicating their sustainability, which reinforces the fact that there is no coherent way of reporting environmental performance. In order to facilitate and encourage companies to report, a cluster of icons is needed which will in turn standardize corporate communication to stakeholders.

Natural language processing (NPL) methods have been employed to help in the analysis of the disclosures of the companies. Wujec (2021) uses textual analysis of financial reports and studies the communication of companies and the corresponding market reaction. The results of the event study indicate that the sentiment analysis calculated by the model can explain the reaction of the market by a 1% significance level following the reports published. Moreover, sentiment analysis on financial news allows us to obtain an estimate on how the market will react. In 2019, the Google Artificial Intelligence Language team developed a trained NPL model “BERT” (Devlin, Chang, Lee, & Toutanova, 2019). BERT has been trained to notice the ambiguity of words and the different meanings they could potentially have. The model FinBERT is based on BERT; however, it has been trained in financial analysis to be able to contribute sentiment scores to financial communication (Aract, 2019).

3. Data Gathering

This section presents the data gathering process which includes the sample construction of firms and the retrieval of the relevant environmental news articles from the Factiva database on which the event study and sentiment analysis will be based. The last two segments are devoted for the collection and preparation of emissions data from Trucost, and annual financials using Compustat.

3.1 Sample Construction

The selection of sampling size is crucial to prevent an inefficient analysis of the data (Kim & Kuljis, 2010). Miklosik and Evans (2021) select the Australian Mining Exchange which contains 625 companies and restrict their focus to the mining sector of 100 companies with the largest market capitalisation. This metric reflects the size of the company without the consideration of sales and assets. Similarly, since the area of interest of this paper is Canadian mining companies, the sample consisted of the companies with the largest market capitalisation that constitute the materials sector of the S&P composite index of Toronto Stock Exchange (TSX) as a standard procedure in the literature. The initial sample size consists of 55 firms with their revenues totalling 109.29 B. The list of companies and their respective market capitalisation are shown in Table A1 in Appendix A.

3.2 Dow Jones Factiva

To obtain the announcement published by the firms, the Factiva by the Dow Jones Database was utilized. A sample of keywords was first constructed which contained potential filters for the data gathering. News announcements ranging from 1990 until 2022 were obtained for the firms by applying the filter of “emissions”. As a robustness check, other filters such as “climate change”, “environment”, “carbon”, and “net zero” were applied, however, failed to render successful results as much as the former. In order to verify the accuracy of the database search, random articles were

selected for individual reading and the results obtained confirm that the information acquired is consisted with the filters selected. The choice of filter is also backed by Miklosik and Evans (2021), which indicate that "emissions" and "environment" are part of the Global Reporting Initiative (GRI) G3 disclosure checklist. However, since "environment" could be used in various context such as work environment and factory environment, the filter selected was "emissions". Not all news announcement obtained through the filter were relevant to environmental events, which is why manual filters were applied to remove any irrelevant findings from the data. Announcements containing non environmental keywords such as "earnings", "earns", "profit", and "industry snapshots" were deleted to avoid the risk of contamination. This can also be justified by the fact that these announcements obtained a sentiment score of "neutral" while applying the textual analysis subsequently, meaning they will not affect the results obtained. Moreover, a few companies rendered irrelevant results and did not publish any news regarding their environmental action, hence they were removed from the sample. This happens to coincide with those failing to report their emissions. The 16 companies with unavailable data were removed from the sample and can be found in the Table A2 of Appendix A. On one hand, a maximal number of observations is desired, however, the data will be very noisy if it includes the firms who did not actively communicate about the environment. Those firms may not be voluntarily communicating about the environment and may be subject to regulatory or government constraints. Moreover, other forms of communication may have been missed such as blogs, investor roadshows, etc. Thus, the sample does not necessarily reflect those firms that actually chose to release announcements, and the decision to communicate is difficult to control for.

3.3 Emissions Data

To obtain the emissions data of the companies selected, the Trucost Environmental Dataset by the S&P Global Marketplace was employed, since it is the most trusted platform for ESG information and widely used in research while merging data from many sources (Bolton & Kacperczyk, 2021). However, one of its limitations is the availability of early data which is why a timeframe of 2002 until 2020 was first chosen. Emissions data can be categorized into three scopes, namely scope one which reflects direct emissions of the company, scope two which indicates

indirect emissions and electricity usage, and scope three which reflects upstream, downstream, and investment activities (Raynaud, 2015). The lack of data regarding scope three results from the fact that scope one and two are nowadays mandatory to report whereas scope three is voluntary, which is why the study will focus primarily on the direct and indirect emissions. The incomplete findings of the emissions were complemented with data from Bloomberg, as well as individual sustainability reports of each firm. However, after thorough research, Trucost appeared to be reflecting all available data of firms which do report sustainability reports. Due to the heterogeneous and inconsistent emissions data across firms, the timeframe was constrained to 2016 until 2020. The purpose of this analysis is to estimate a change in emissions which needs at least two observations, while maintaining the highest number of firms as possible. However, some compromises had to be made since not all firms report their emissions every year. For comparison purpose, this change in emissions needs to be calculated over the same period for all firms. For the starting period, the maximum number of observations is perceived in 2016, which justifies its selection as a reference. Regarding the end date, the year 2020 was selected since it is a common reporting date for the firms. Considering the firms that report before or after 2016, a constant evolution in emissions was assumed and therefore the data was either extrapolated or interpolated. In fact, by using this methodology, 11 firms were spared which leads to a comprehensive sample for the regression including 49 firms in total. The relative change in scope one and two were studied to emphasize the evolution of emissions, which is defined as the following:

$$\frac{emissions_{end\ period} - emissions_{start\ period}}{emissions_{start\ period}} \qquad \textit{(Eq1.1)}$$

As a sensitivity analysis, the timeframe was adjusted to include the earlier years of 2013 until 2020. The exhaustive Tables A3 and A4 of emissions of both periods can be found in Appendix A. Moreover, the firms which failed to report were removed from the sample, which also coincided with the firms who did not publish any relevant news regarding environmental change during that period. A summary of the descriptive statistics of the changes in the scopes of each sample period can be found in Table 1 below.

Table 1 Descriptive Statistics of Emissions from Trucost in Tonnes of CO_2

Panel A Sample Period 2013-2020

	Mean	***Median***	***Standard Deviation***	***Minimum***	***Maximum***
Scope 1	1.01266225	0.36660167	2.10082129	-0.986569	7.95880928
Scope 2	6.06654039	0.38254762	27.3410074	-0.9966536	179.338124

Panel B Sample Period 2016-2020

	Mean	***Median***	***Standard Deviation***	***Minimum***	***Maximum***
Scope 1	1.09937158	0.25408452	2.22002978	-0.7591171	9.48278655
Scope 2	3.25803971	0.18366936	18.3598625	-0.8839693	124.767209

3.4 Compustat Capital IQ

Due to the imperfect data on emissions, other metrics had to be considered which will give an explanatory power to the long-term reaction of the firms following the news announcements, and in turn will provide insight regarding the investment and financing dimensions of the firm. Further detail is provided in Section 4.3. In contrast to standard literature which focuses on the events, this section aims to focus on the financials of the companies and their corporate actions following the announcement. Based on the literature review, the following variables were selected: assets, long term debt, capital expenditure, book value per share, market value, sales, and size which is the logarithm of assets (Castro & Chousa, 2006), (Deák & Karali, 2015), (Bolton & Kacperczyk, 2021), (Skiera, Bayer, & Schöler, 2016). Other variables such as current income tax and in research and development expense were considered, however, failed to render any consistent results due to the unavailability of data. The dependent financial variables selected are capital expenditure and leverage, which were normalized across firms as such:

$$\frac{capital\ expenditure_{2020} - capital\ expenditure_{2016}}{total\ assets_{2016}} \quad \textit{(Eq 2.2)}$$

$$leverage_{2020} - leverage_{2016} \quad \textit{(Eq 2.3)}$$

where leverage is defined as the ratio of long-term debt to total assets. Since it is already a ratio, the variable is interpreted as the leverage change in percentage points. The remaining variables were considered as controls, and their value at the beginning of the period was employed with the exception of sales and market value which was normalized by dividing by total assets.

4. Methodology

This section is devoted to the construction of the model, which first consists of a sentiment analysis of the news headlines obtained, followed by an event study to verify if there exists a relationship between the news headlines and the performance of the firm, and finally an ordinary least squares (OLS) regression analysis. The purpose of this section is to distinguish between a linguistic assessment of the communication and the market assessment in the short run, as well as long run.

4.1 Sentiment Analysis

It is important to attribute a sentiment to the news announcement previously obtained from Factiva which will be able to distinguish between negative environmental action and positive environmental action. This will allow the construction of a variable that will measure how active the company was regarding the environment and will be used to study the long-term market reaction. In order to accomplish this task, the FinBERT model (Aract, 2019) was employed to study sentiment analysis on Python. The sentiment analysis examines the titles of the news announcements and attributes a magnitude for each positive, negative, and neutral scores. As indicated in Table 2 below, the average number of communications per firm is 16, whereas the average number per year is 63.

Table 2 Descriptive Statistics of Announcements

Year	Count of Announcements
2013	25
2014	25
2015	16
2016	44
2017	76
2018	60
2019	87
2020	172
Average	63.125
Average per firm	16.13

A threshold of 0.1 was selected, meaning that if a score was greater than 0.1, the sentiment would be positive, and on the contrary if the score was < - 0.1, it would be considered negative. An exhaustive summary providing the results of the sentiment analysis can be found in Table A5 of Appendix A which represents the weighted average score, the overall sentiment, as well as the corresponding count for positive and negative news. The weighted average of each announcement was computed by summing up the corresponding magnitudes of the positive, negative, and neutral scores as shown in the equation below.

$$weighted\ average = 1 \times positive\ score - 1 \times negative\ score + 0 \times neutral\ score \qquad (Eq1.3)$$

To construct the variable for the regression, the sentiment score was aggregated since certain firms failed to publish sufficient news announcements. The communication of the firm is in fact a sporadic event spread over time, and it would be unreasonable to claim that one communication in the past years could explain the change in emissions. The purpose is instead to examine whether their overall communication and policy since 1990 had any impact on the firm changes, and what is the overall sentiment. To examine the effect of these announcement, the aggregate score was translated into a dummy variable to be used as a control in the regression which gives a non-linear

effect instead of a finer information with minimal changes. The descriptive statistics of the sentiment analysis are found in Table 3 below.

Table 3 Descriptive Statistics of Sentiment Score

Count Positive	Count Negative	Count Neutral	Average Score	Minimum Score	Maximum Score
33	7	7	0.17049149	-0.3068	0.9169

Both controls were used for the regression, however, the weighted score format of the sentiment score was found to have a greater explanatory power than the dummy variable as discussed further in Section 5.3. A value of 1 was be attributed to a positive sentiment, and 0 otherwise. The magnitude of the threshold did not affect the sentiment score since there is no ambiguity in attributing a sentiment given the way the distribution of the scores as shown in Figure B1 of Appendix B, which represents the sentiment analysis of the news published by Barrick Gold Corp.

4.2 Event Study

An event study is a statistical methodology which aims to relate stock prices to certain economic events (Dyckman, Philbrick, & Stephen, 1984). In order to study whether the market reflects all available information, the software program Eventus was employed for two periods ranging from 2013 until 2020 and 2016 until 2020. The estimation period consists of 120 trading days in order to compute the stock's beta which is a standard procedure in the literature as suggested by Brown and Warner (1985). In this case, the estimation period ranges from [t-125, t-5], where t is the event date and the event window in this case ranged from [t+1, t+16]. The market model returns are defined as follows:

$$R_{jt} = \alpha_j + \beta_j R_{mt} + \epsilon_{jt} \qquad \textit{(Eq 3.2.1)}$$

where R_{jt} is the return of the stock of firm *j* on day *t;* R_{mt} is the market return; ϵ_{jt} is a random variable uncorrelated with the market return, homoscedastic, and with an expected value of zero;

β_j measures the sensitivity of the return of the firm to the market index (Brown & Warner, 1985).

In the market model, the market portfolio is used, in which case the S&P TSX 60 is employed as a proxy of a value weighted index. Abnormal returns are defined as the difference between the return after the event window and the normal return during the event window, and are given by the following equation:

$$A_{jt} = R_{jt} - (\hat{\alpha}_j + \hat{\beta}_{jt} R_{mt}) \quad \textit{(Eq 3.2.2)}$$

where $\hat{\alpha}_j$ and $\hat{\beta}_j$ are the OLS estimates of α_j and β_j.

Whereas the cumulative abnormal returns (CAR) are defined as:

$$CAR_{it} = \sum_{t=0}^{T} A_{it} \quad \textit{(Eq 3.2.3)}$$

4.3 Regression Analysis

The purpose of this section is to examine if the major corporate decisions of the firms have been affected by previous communication that they have made. The primary dependent variables are the changes in scope one and two of emissions which is ultimately the purpose. The literature in finance also indicates that if the emissions cannot be directly observed, the firm changes will be indirectly reflected in their investment policy and their financing policy. Through the lens of corporate investments and capital structure, additional information could be obtained as an indication to whether firms are incorporating any actions by examining the changes in capital expenditure and the changes in leverage. A change in capital expenditure doesn't necessary indicate that the firm is shifting to green investments, but it is a necessary condition if it was the case. It is not a sufficient condition since an absence of change would prohibit the firm from pretending to incorporate changes to its investments. Similarly, firms with an enhanced environmental performance exhibit a lower cost of equity capital and they tend to transition from

equity to debt financing (Sharfman & Fernando, 2008), whereas heavy polluting firms and those exposed to carbon risk decrease their financial leverage (Nguyen & Phan, 2020). An increase in the leverage of a firm is therefore consistent with the idea of a green transition because they would be recovering part of their debt capacity. This increase in leverage is therefore not a guaranteed condition for the firm to be greener, but it is a necessary condition as well. The additional regressions can therefore be viewed as tests for the results in emissions and are able to examine a larger sample of firms given that more data is available. There is no need to account for time because everything is instantaneous and is regressed on variables in some point of time.

The controlling conditions were selected at the beginning of the period and include, the sentiment score, the CARs, the interaction term, which is the multiplication of the two latter terms, the size of the firm, which is the logarithm of assets, the book value per share, the ratio of market value to assets, and the ratio of sales to assets. The summary statistics can be found in the Table 4 below, which represents the number of observations for each variable, the mean, the standard deviation, and the maximum and minimum of the values. The term size represents the logarithmic of assets, whereas the interaction terms represent the product of the weighted sentiment score with each CAR window respectively.

Table 4 Descriptive Statistics of the Regression

Variable	Observation	Mean	Standard deviation	Minimum	Maximum
Change CAPEX	44	2.583861	16.4091	-0.8711563	108.8007
Change Leverage	44	0.385121	2.934733	-1	18.51319
Changes Emissions Scope 1	45	1.15834	2.301389	-0.7591171	9.482787
Changes Emissions Scope 2	42	3.576192	19.20231	-0.8839693	124.7672
Sentiment Analysis	45	0.1717613	0.2166481	-0.3068138	0.9168715
Dummy	43	0.7209302	0.4538503	0	1
CAR1	34	0.1437173	0.8329705	-0.3561728	4.763585
CAR2	34	0.4467	2.8673	-0.8050273	16.52846
CAR3	34	0.2791953	1.827968	-0.6113257	10.4987
Interaction 1	44	0.0074641	0.081682	-0.089661	0.494241
Interaction 2	44	0.0538458	0.2670728	-0.1733574	1.714894
Interaction 3	44	0.0299071	0.170647	-0.1431314	1.089282
Size	43	3.336047	0.6103145	1.784054	4.551804
Book Value Per Share	43	8.377619	7.194136	0.1887	30.2341
Sales	43	1575.189	2103.794	0	9300
Market Value	42	3427.762	4389.753	92.4517	18625.87

5. Results and Discussion

5.1 Event Study

The output collected from the event study was the cumulative abnormal returns (CARs), which will be used further in the regression analysis. A positive return means market participants have a positive anticipation about the stocks, whereas negative return means they have a negative anticipation. The result of the CARs gives a sense on how the market incorporated the news. Three different CARs were computed to study different possible market reactions for robustness purposes and consisted of CAR_5 from $[t+1, t+6]$, CAR_10 from $[t+1, t+10]$, and CAR_15 from $[t+1, t+16]$. The distribution of the three different CAR's results are shown in the Figures 2 to 7 below for each of the sampling period 2013-2020 and 2016-2020 respectively.

Figure 1 Distribution of CARs [t+1, t+6] for 2013-2020

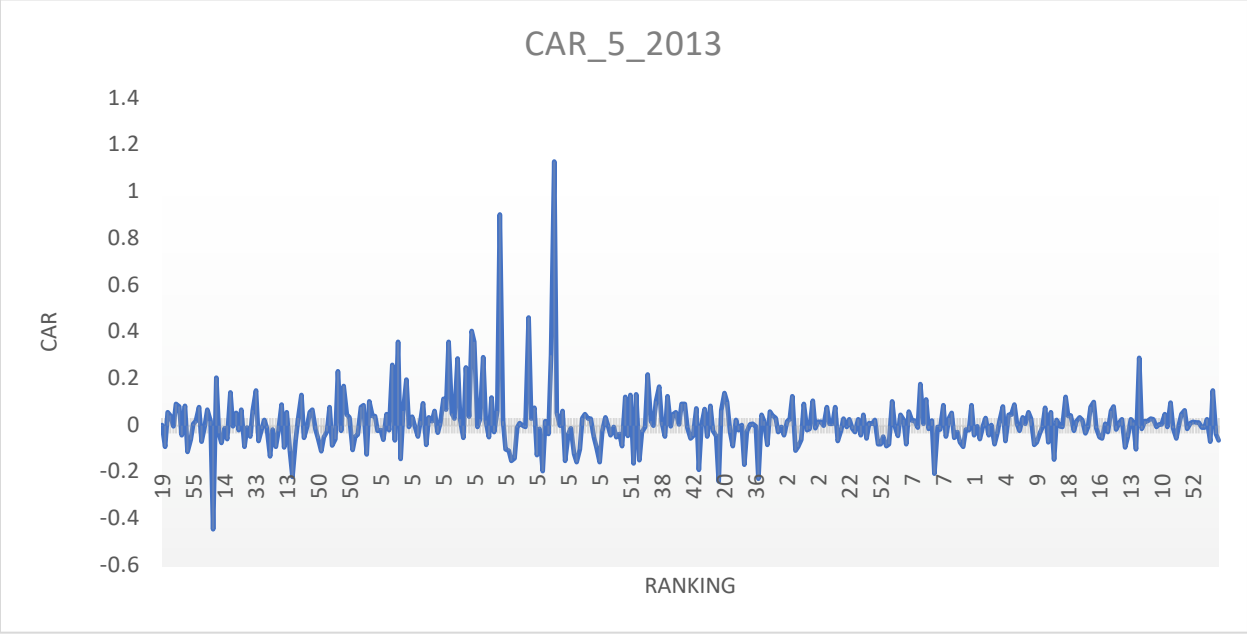


Figure 2 Distribution of CARs [t+1, t+10] for 2013-2020

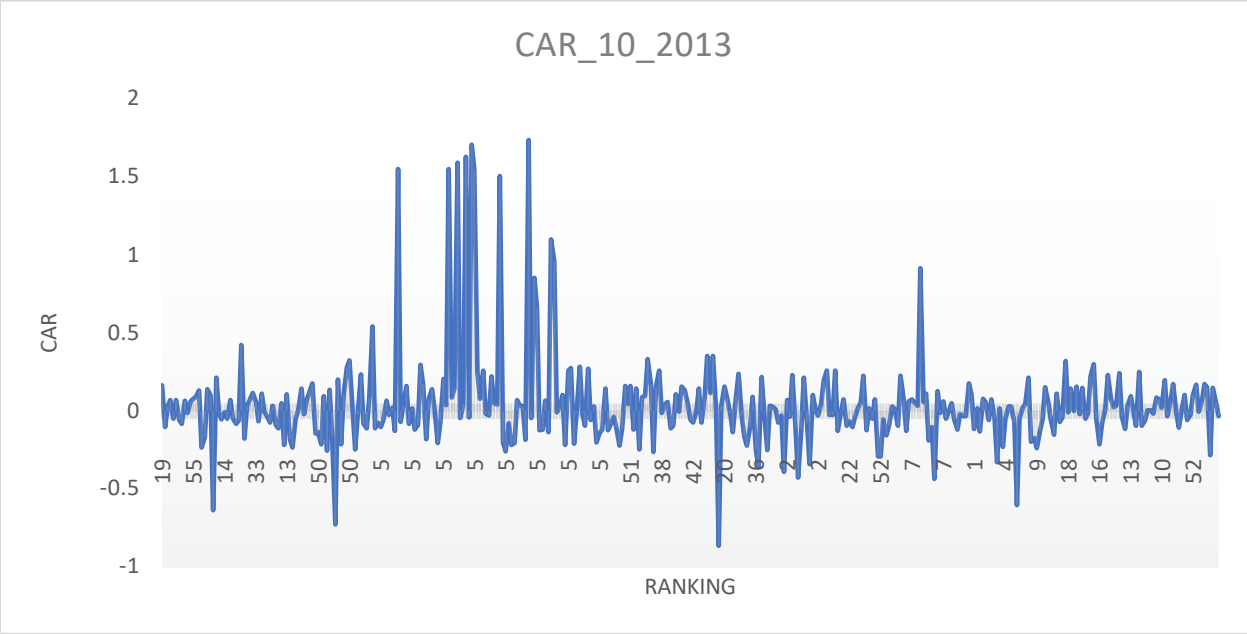


Figure 3 Distribution of CARs [t+1, t+15] for 2013-2020

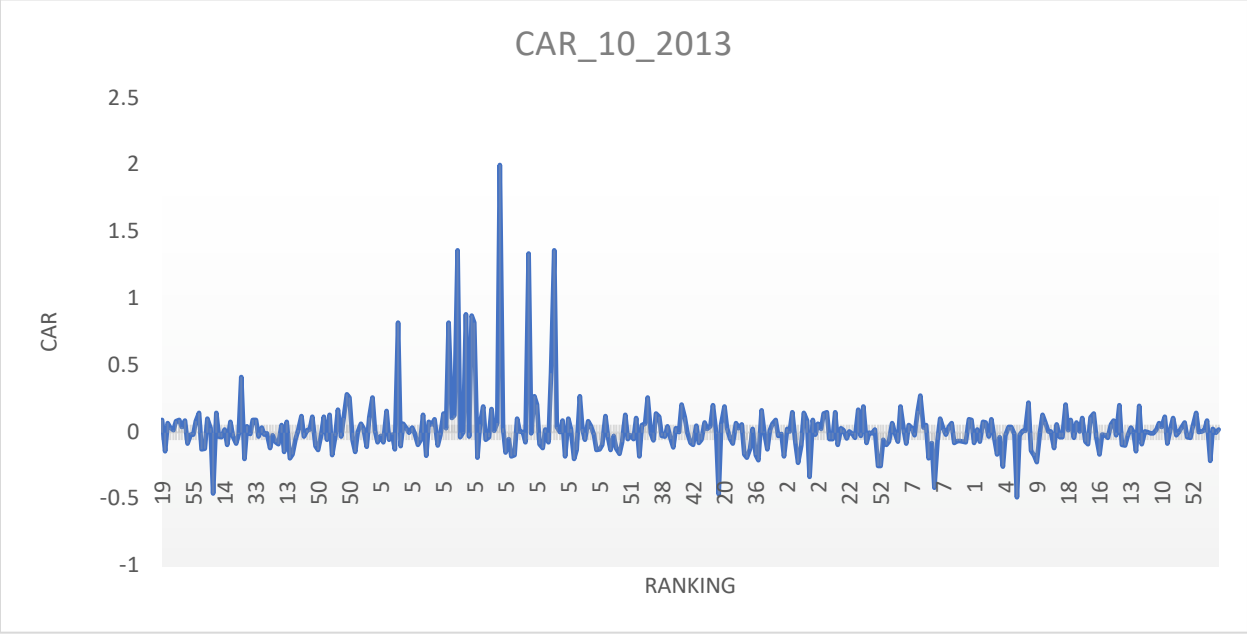


Figure 4 Distribution of CARs [t+1, t+6] for 2016-2020

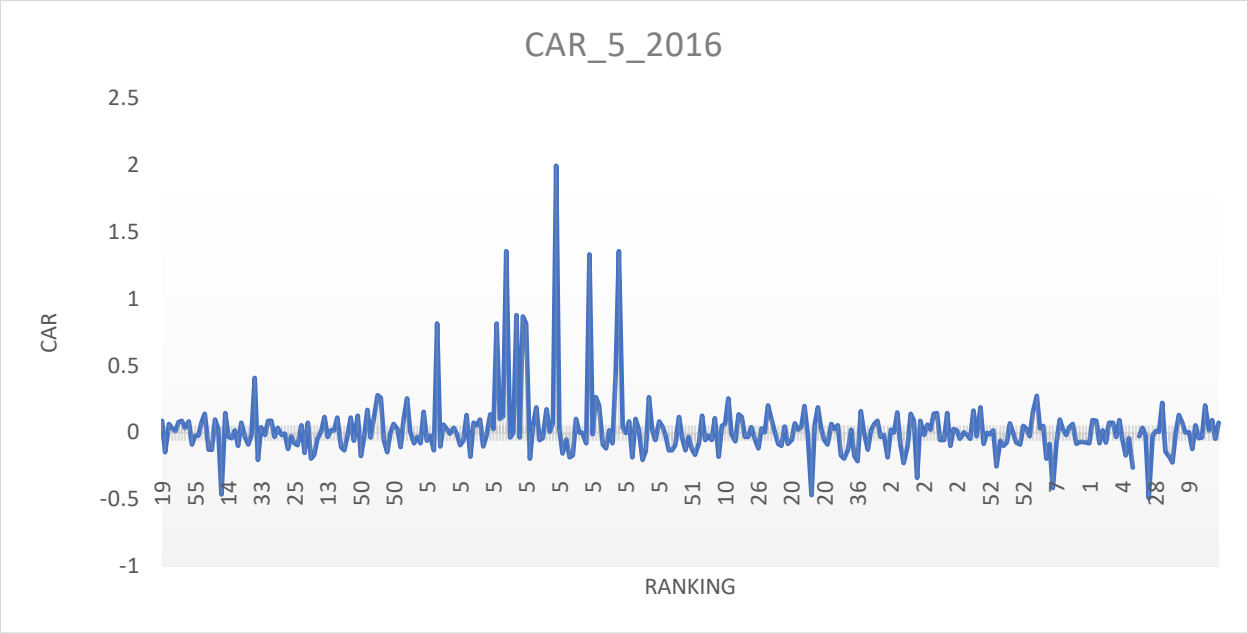


Figure 5 Distribution of CARs [t+1, t+10] for 2016-2020

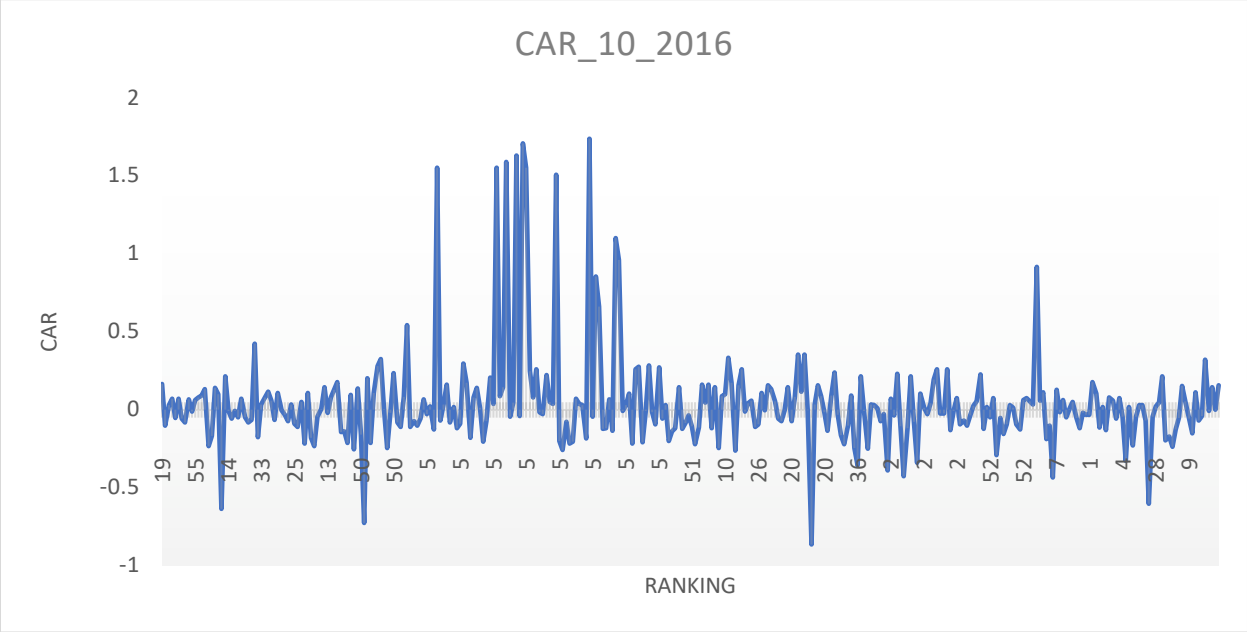
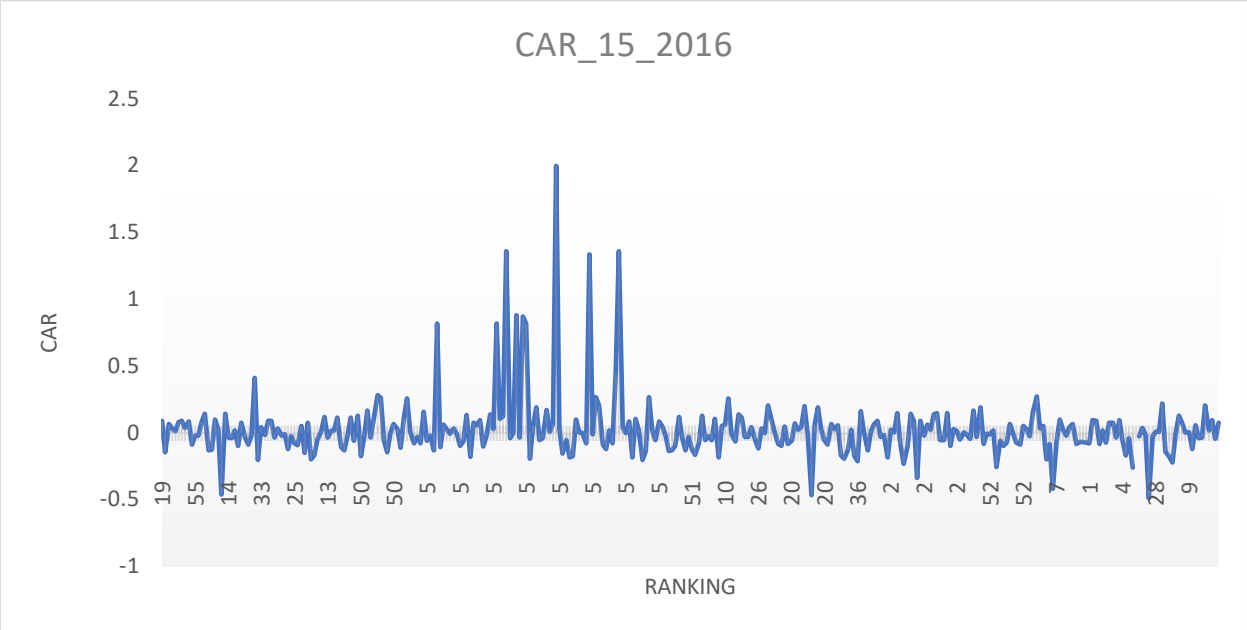


Figure 6 Distribution of CARs [t+1, t+15] for 2016-2020



Tables 5 and 6 below display the descriptive statistics which indicate that the mean cumulative returns are positive for all event windows in both sampling periods, which signifies that the firm is exhibiting greater returns than the market following these announcements and is therefore experiencing superior performance.

The Patell Z test is a generalized sign test which estimates a standard error for each firm event and adopts a cross-sectional independence (Patell, 1976). The results indicate that for the sampling period beginning in 2013, the first window (+1, +6) is significant at the 10% level, whereas the longer market windows of (+1, +11) and (+1, +16) are significant at the 1% level. On the other hand, for the 2016-2020 period, the test is significant at the 5% level for the (+1, +16) window, and significant at the 1% level for (+1, +11).

Regarding the cross-sectional standard deviation test, CSectErr t, the results are significant at the 1% level for all windows in the 2013-2020 period and shows that the first window is less significant than the others in the 2016-2020 period.

The last column displays the generalized sign test, which is a nonparametric test hypothesising that the estimation period contains the exact ratio of positive returns as found in the event date (Sanger & Peterson, 1990). The results indicate that for both periods, the first shorter window is significant at the 5% level, whereas the longer two are significant at the 10% level.

The findings are consistent with previous literature which also find that the market is slow to react regarding information about emissions, but the stock prices eventually integrate all the new information (Bolton & Kacperczyk, 2021).

Table 5 Descriptive Statistics for the Event Study 2013-2020

Days	N	Mean Cumulative Abnormal Return	Precision Weighted CAAR	Positive: Negative	Patell Z	CSectErr t	Generalized Sign Z
(+1, +6)	536	1.10%	0.73%	286:250 >	0.836	1.370$	1.852*
(+1, +16)	536	3.18%	2.89%	281:255)	1.736*	2.462**	1.579$
(+1, +11)	536	2.15%	1.92%	277:259)	2.580**	2.469**	1.397$

The symbols $, *, **, and *** denote statistical significance at the 0.10, 0.05, 0.01 and 0.01 levels, respectively, using a generic one-tail test. The symbols (, < or), > etc. Correspond to $, * and shoe the direction of significance of a generic one-tail generalized sign test

Table 6 Descriptive Statistics for the Event Study 2016-2020

Days	N	Mean Cumulative Abnormal Return	Precision Weighted CAAR	Positive: Negative	Patell Z	CSectErr t	Generalized Sign Z
(+1, +6)	483	1.06%	0.66%	253:230 >	0.836	2.098*	2.294*
(+1, +16)	483	3.08%	2.85%	250:233)	1.736*	2.452**	1.862*
(+1, +11)	483	2.26%	2.03%	248:235)	2.375**	2.469**	1.516$

The symbols $, *, **, and *** denote statistical significance at the 0.10, 0.05, 0.01 and 0.01 levels, respectively, using a generic one-tail test. The symbols (, < or), > etc. Correspond to $, * and shoe the direction of significance of a generic one-tail generalized sign test

5.2 Market Reaction

In order to analyse to what extent do the CARs coincide with the sentiment, and whether there is agreement or is disagreement, the interaction term of the two variables was computed and the results are shown in Tables A6 and A7 of Appendix A. Similarly, the correlation coefficient of the entire sample, the positive sub sample, and the negative sub sample was computed for the two period and can be found in Table 7 below.

Table 7 Correlation Coefficient Between Sentiment Scores and CARS

Panel A Sample Period 2013-2020

	Correlation 1	Correlation 2	Correlation 3
Entire Sample	0.13169863	0.1211237	0.09841703
Positive Sub Sample	0.16088885	0.10641519	0.02805289
Negative Sub Sample	-0.7098023	0.18725842	0.07980706

Panel B Sample Period 2016-2020

	Correlation 1	Correlation 2	Correlation 3
Entire Sample	0.0602755	0.01961718	0.00558373
Positive Sub Sample	0.0615233	0.01073389	-0.0349733
Negative Sub Sample	-0.0663712	0.01961718	0.00558373

The correlation coefficient of the CARs with the sentiment analysis score addresses the question how a certain piece of information translates into concrete actions and will measure if it has any impact on the corporate long-term decisions. From the financial perspective, it's interesting to question the financial market, whose basic job is to process information. Beyond the mere sentiment analysis which tries to objectify the news, the market information is also obtained. Following an announcement that the company has made and its sentiment analysis, the market will either translate it into good or bad environmental action. The CARs provide additional information concerning how this announcement is perceived by the financial markets and indicate if the firm is getting more profitable. The efficient market hypothesis suggests that in efficient markets, all information is reflected in the stock prices and therefore any change in information will be accessible to market participants (Simoes, Macedo-Soares, Klotzle, & Pinto, 2012). The CARs however will be able to assess the temporary market reaction which provides a valuation of the company at a certain point in time given the announcement. It is therefore viewed as the contemporaneous reaction of the market which will validate the sentiment analysis if its positive or contradict the sentiment analysis otherwise, therefore either reinforcing the analysis or mitigating it. As shown in the two Panels above, the correlation coefficient is the strongest with the first CAR window which corresponds to the short-term market reaction. It is most significant in the negative sub sample of the 2013-2020 period, with a magnitude of 0.71.

Given that the news receives positive support from the market, the goal is to test whether it translates into concrete action in the future. It will provide insight regarding the reaction of the managers of this industry and whether they are listening to the message sent by the market. Or the opposite conclusion that the long-term action of the managers is that they're not precautious about the contemporaneous market reaction.

The interaction term of 17 firms in the sample period 2016-2020, and 24 in the earlier period, is positive, resulting from a positive sentiment announcement and positive short market reaction. This signifies that it means that managers not only listen to what they say but they reinforce their actions because the market gave them the incentive to do so and are implementing concrete actions towards their green transition.

The results indicate that 3 firms in the sample period 2016-2020 have a negative sentiment associated with a positive CAR, and 6 firms in the sample period 2013-2020 obtain such an opposition. This signifies that the CARs on their own reflect that the firm is getting more profitable, but it doesn't not provide any information regarding environmental action and therefore the event didn't affect the green transition of firms.

5.3 Regression Analysis

This section aims to explain whether the communication regarding environmental action affects the long-term performance of the firm and constitutes the results of the regression analysis. The analysis constitutes how the performance of the firms is affected by these announcements, controlling for the contemporaneous market reaction. The results indicate that the weighted score has a stronger correlation with the dependant variables instead of the dummy associated, and therefore was used as a control in the regression. Moreover, the cumulative returns from [t+1, t+6] have a greater explanatory power than [t+1, t+10] and [t+1, t+15], and were selected as controls throughout the regression. The following regression model was estimated:

$$Changes\ in\ Scope_{1i} = a_0 + a_1 SENTIMENT_i + a_2 CAR_i + a_3\, INTERACTION_i + a_4\, SIZE_i + a_5 SALES_i + a_6\, BOOK_i + a_7 MARKET + \epsilon_i \quad \textit{(Eq. 5.3.1)}$$

where *i*= 1, …, N, *SIZE* is the logarithmic of assets, *SALES* is the ratio of sales to assets, *BOOK* is the book value per share, *MARKET* is the ratio of market value to total assets, and ϵ is the error term. The first regression analysis consists of testing the changes in the scope one of emissions against the independent variables, and the results are found in Table 8 below.

Table 8 Regression Analysis for Changes in Scope 1 of Emissions

The dependant variable is changes in scope one of emissions. The coefficients are reported with the p-values reported in parentheses. ***1%; **5%, *10% significance.

	1	2	3	4	5	6	7	8
Constant	1.0868***	1.2219*	0.7975*	0.8278*	3.9707	3.8441	6.1499*	6.3492*
	(0.002)	(0.09)	(0.065)	(0.060)	(0.131)	(0.159)	(0.086)	(0.092)
Sentiment		-0.4738	1.1253	1.2238	0.2480	0.2320	-0.5882	-0.5537
		(0.772)	(0.527)	(0.497)	(0.899)	(0.907)	(0.783)	(0.80)
CAR			1.7787***	0.9509	0.6500	0.7509	0.0692	0.0918
			(0.00)	(0.529)	(0.641)	(0.612)	(0.966)	(0.956)
Interaction				7.7761	12.3201	11.8217	15.8842	15.6776
				(0.491)	(0.339)	(0.373)	(0.253)	(0.163)
Size					-0.8562	-0.7864	-1.5347	-1.6084
					(0.231)	(0.315)	(0.155)	(0.697)
Book Value						-0.1379	-0.0221	-0.0234
						(-0.812)	(0.706)	(0.697)
Sales							0.0003	0.0003
							(0.305)	(0.419)
Market Value								0.0000
								(0.827)
Observations	48	45	34	34	33	33	33	33
R^2	0	0.002	0.3849	0.3931	0.4296	0.4309	0.4539	0.4549

The coefficient of each specification shows the nature of the relationship between the independent and dependent variables. The null hypothesis of the t-test is that the R^2 is equal to 0, and the model is found to not have explanatory power regarding the dependent variable. The p-values of the t-test which are greater than 0.1, 0.05, and 0.01 need to be verified and correspond to the 90%, 95%, and 99% significance level respectively. The coefficient of the CAR signifies that an increase of 1.7787 in the CAR leads to a one unit increase in the scope one of emissions. The p-value of the CAR is significant at the 1% level, meaning that we are 99% confident that we can reject the null hypothesis. The coefficient of determination, R^2, indicates that the final model can explain 45.49% of the changes in the scope one of emissions.

The regressions studying the variability in the scope two of emissions follows the same model as the equation above and renders insignificant results as shown in Table 9 below. Therefore, we cannot reject the null hypothesis and the coefficient of determination, R^2, has indeed a value of 0. The model fails to explain any variation in the scope two of emissions, and thus the firms do not improve their scope two emissions following environmental communication.

Table 9 Regression Analysis for Changes in Scope 2 of Emissions

The dependant variable is changes in scope two of emissions. The coefficients are reported with the p-values reported in parentheses. ***1%; **5%, *10% significance.

	1	2	3	4	5	6	7	8
Constant	3.3464	4.3930	5.2941	5.2812	38.7631	43.0551	68.0740	59.6576
	(0.233)	(0.245)	(0.288)	(0.302)	(0.252)	(0.217)	(0.138)	(0.218)
Sentiment		-5.2704	-4.8851	-4.9413	-13.489	-13.327	-21.941	-22.593
		(0.711)	(0.818)	(0.821)	(0.566)	(0.574)	(0.397)	(0.390)
CAR			-0.3551	-0.3837	-4.972	-8.3053	-16.207	-16.317
			(0.941)	(0.988)	(0.777)	(0.652)	(0.433)	(0.260)
Interaction				-2.9812	62.041	78.3977	129.7086	130.648
				(0.984)	(0.706)	(0.641)	(0.470)	(0.473)
Size					-9.2140	-11.589	-19.5996	-16.616
					(0.315)	(0.502)	(0.155)	(0.260)
Book Value						0.4653	0.3975	0.4441
						(0.502)	(0.570)	(0.63)
Sales							0.0028	0.0037
							(0.387)	(0.312)
Market Value								-0.0009
								(0.533)
Observations	45	42	32	32	32	32	32	32
R^2	0	0.0035	0.002	0.002	0.0393	0.0561	0.0845	0.0981

The regression for the changes in CAPEX estimates the following model:

$$Changes\ in\ CAPEX_i = a_0 + a_1 SENTIMENT_i + a_2 CAR_i + a_3\, INTERACTION_i + a_4\, SIZE_i + a_5 SALES_i + a_6\, BOOK_i + a_7 MARKET + \epsilon_i \quad \textit{(Eq. 5.3.2)}$$

The results of the regression indicate that the size of the firm has a negative relationship with the capital expenditure of magnitude 0.8136, and the results are significant at the 5% level with a p-

value of 0.024 as shown in Table 10 below. Therefore, we can reject the null hypothesis which means that the overall model is capable of explaining 23.04% of the changes in capital expenditure.

Table 10 Regression Analysis for Changes in CAPEX

The dependant variable is changes in capital expenditure. The coefficients are reported with the p-values reported in parentheses. ***1%; **5%, *10% significance.

	1	2	3	4	5	6	7	8
Constant	2.2950	1.9004	0.0926	-0.0881	2.9749	2.9621**	4.3069**	4.5774**
	(0.297)	(0.519)	(0.681)	(0.702)	(0.023)	(0.028)	(0.013)	(0.012)
Sentiment		3.3972	0.5531	0.5547	-0.2145	-0.2170	-0.6960	-0.6573
		(0.759)	(0.572)	(0.547)	(0.829)	(0.830)	(0.514)	(0.544)
CAR			0.0623	-0.2495	-0.3764	-0.3653	-0.7894	-0.7644
			(0.783)	(0.723)	(0.603)	(0.634)	(0.340)	(0.363)
Interaction				0.4830	5.7843	5.7309	8.1507	7.9133
				(0.939)	(0.386)	(0.404)	(0.248)	(0.269)
Size					-0.8136**	-0.8610**	-1.2479**	-1.3483**
					(0.024)	(0.041)	(0.018)	(0.018)
Book Value						-0.0016	-0.0070	-0.0088
						(0.959)	(0.817)	(0.774)
Sales							0.0002	0.0001
							(0.192)	(0.335)
Market Value								0.0004
								(0.588)
Observations	50	47	36	34	35	35	35	35
R^2	0	0.0021	0.0115	0.1097	0.1721	0.1722	0.2219	0.2304

The regression for the change in leverage follows the same model in equation above and shows that the model does have explanatory power. This is first reflected by the coefficient of the sentiment score, which is positive of magnitude 5.0204 and significant at the 5% level with a p-

value of 0.088, as shown in Table 11 below. This signifies that an increase in 5.0204 of sentiment score leads to an increase of one unit for the change in leverage. Similarly, the results indicate a positive interaction term of magnitude -3.764 and identical p-value. The variable referring to the size of the firm is found to have explanatory power across all models, with a negative magnitude and significance level of 5%. Therefore, a decrease in size, which is the logarithmic of assets, as well as a decrease in the interaction term, lead to an increase in leverage. The null hypothesis can be rejected, meaning that the overall model explains 36.23% of the changes in leverage. This indicates that the environmental communication leads to a change in leverage, and the managers of the firms are incorporating actions regarding their assets by a magnitude of -2 to -4 approximately.

Table 11 Regression Analysis for Changes in Leverage

The dependant variable is changes in leverage. The coefficients are reported with the p-values reported in parentheses. ***1%; **5%, *10% significance.

	1	2	3	4	5	6	7	8
Constant	1.4541	2.3046	-0.2933	-0.4112	7.3941**	7.6120**	10.5697**	12.5754**
	(0.207)	(0.134)	(0.661)	(0.527)	(0.047)	(0.048)	(0.033)	(0.015)
Sentiment		-5.1091	5.0204**	4.5683	2.3549	2.3978	1.3445	1.6316
		(0.373)	(0.088)	(0.111)	(0.413)	(0.413)	(0.655)	(0.593)
CAR			-0.2107	3.3810	2.7260	2.5375	1.6047	1.7904
			(0.752)	(0.124)	(0.197)	(0.255)	(0.504)	(0.449)
Interaction				-3.764**	-23.1246	-22.2184	-16.8963	-18.6573
				(0.088)	(0.231)	(0.263)	(0.408)	(0.365)
Size					-2.1764**	-2.3041**	-3.2758**	-4.0203**
					(0.034)	(0.042)	(0.032)	(0.013)
Book Value						0.0264	0.0145	0.0008
						(0.762)	(0.321)	(0.994)
Sales							0.0004	0.0001
							(0.321)	(0.729)
Market Value								0.0003
								(0.162)
Observations	50	47	36	36	35	35	35	35
R^2	0	0.0176	0.09	0.1704	0.2861	0.2884	0.3135	0.3623

6. Conclusion

This paper studies the environmental communication of Canadian mining firms belonging to the Materials sector of the S&P TSX index and whether it translates into improvement in their pollution or financial policy. The firms were found to have superior returns, and the results are significant at the 1% level in [t+1, t+11] following the announcements, which is accompanied by various short term market reactions. We cannot consistently conclude that the communication of the firms does in fact imply their transition to sustainability. The regression analysis confirms that only the variability in the scope one of emissions, capital expenditure, and leverage are explained by the model and are significant at the 5% level.

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Appendix A

Table A 1 Market Capitalisation of the Materials Sector

Ranking #	Ticker	Company Name	Market Capitalisation
1	NTR CT Equity	Nutrien Ltd	75.52B
2	ABX CT Equity	Barrick Gold Corp	52.22B
3	FNV CT Equity	Franco-Nevada Corp	38.11B
4	AEM CT Equity	Agnico Eagle Mines Ltd	34.67B
5	TECK/B CT Equity	Teck Resources Ltd	29.40B
6	WPM CT Equity	Wheaton Precious Metals Corp	26.35B
7	FM CT Equity	First Quantum Minerals Ltd	25.23B
8	KL CT Equity	Kirkland Lake Gold Ltd	13.11B
9	IVN CT Equity	Ivanhoe Mines Ltd	12.49B
10	WFG CT Equity	West Fraser Timber Co Ltd	12.30B
11	CCL/B CT Equity	CCL Industries Inc	10.36B
12	LUN CT Equity	Lundin Mining Corp	9.15B
13	K CT Equity	Kinross Gold Corp	8.53B
14	TRQ CT Equity	Turquoise Hill Resources Ltd	7.19B
15	PAAS CT Equity	Pan American Silver Corp	6.94B
16	YRI CT Equity	Yamana Gold Inc	6.85B
17	SSRM CT Equity	SSR Mining Inc	6.32B
18	BTO CT Equity	B2Gold Corp	6.02B
19	MX CT Equity	Methanex Corp	5.09B
20	LAC CT Equity	Lithium Americas Corp	4.87B
21	CS CT Equity	Capstone Copper Corp	4.05B
22	AGI CT Equity	Alamos Gold Inc	3.96 B
23	PVG CT Equity	Pretium Resources Inc	3.61 B
24	FR CT Equity	First Majestic Silver Corp	3.54B
25	CG CT Equity	Centerra Gold Inc	3.40B
26	STLC CT Equity	Stelco Holdings Inc	3.33B
27	CFP CT Equity	Canfor Corp	3.27B
28	OR CT Equity	Osisko Gold Royalties Ltd	2.98B
29	WPK CT Equity	Winpak Ltd	2.89B
30	NG CT Equity	Novagold Resources Inc	2.71B
31	EQX CT Equity	Equinox Gold Corp	2.39B
32	ITP CT Equity	Intertape Polymer Group Inc	2.36B
33	OGC CT Equity	OceanaGold Corp	2.35B
34	SJ CT Equity	Stella-Jones Inc	2.28B
35	LIF CT Equity	Labrador Iron Ore Royalty Corp	2.27B
36	ELD CT Equity	Eldorado Gold Corp	2.26B
37	KNT CT Equity	K92 Mining Inc	2.19B

38	IFP CT Equity	Interfor Corp	2.19B
39	HBM CT Equity	Hudbay Minerals Inc	2.17B
40	WDO CT Equity	Wesdome Gold Mines Ltd	2.00B
41	MAG CT Equity	MAG Silver Corp	1.95B
42	SEA CT Equity	Seabridge Gold Inc	1.85B
43	SSL CT Equity	Sandstorm Gold Ltd	1.76B
44	ERO CT Equity	ERO Copper Corp	1.55B
45	DPM CT Equity	Dundee Precious Metals Inc	1.51B
46	SIL CT Equity	SilverCrest Metals Inc	1.50B
47	OSK CT Equity	Osisko Mining Inc	1.45B
48	TCL/A CT Equity	Transcontinental Inc	1.41B
49	FVI CT Equity	Fortuna Silver Mines Inc	1.36B
50	IMG CT Equity	IAMGOLD Corp	1.30B
51	NGD CT Equity	New Gold Inc	1.29B
52	CAS CT Equity	Cascades Inc	1.28B
53	TXG CT Equity	Torex Gold Resources Inc	1.25B
54	EDR CT Equity	Endeavour Silver Corp	0.91B
55	SVM CT Equity	Silvercorp Metals	0.60B

Table A 2 Firms with Missing Data

Sentiment Analysis	Emissions	Event study
MAG Silver Corp	Seabridge Gold Inc	Winpak Ltd
ERO Copper Corp	NovaGold Resources Ltd	Torex Gold Resources Inc
Labrador Iron Ore Royalty Corp	CCL Industries Inc	Stella-Jones Inc
Winpak Ltd	Capstone Mining	ERO Copper Corp
Wesdome Gold Mines Ltd		Labrador Iron Ore Royalty Corp
K92 Mining Inc		Endeavour Silver Corp
		Hudbay Minerals Inc
		First Majestic Silver Corp
		NovaGold Resources Ltd
		Transcontinental Inc
		CCL Industries
		Capstone Mining Inc

Table A 3 Emissions Result for the Sample Period 2013-2020

Company 2013 2020	Scope 1	Scope 2
Lithium Americas Corp	5.477	4.595
Osisko Mining Inc	-0.123	
Canfor Corp	7.251	-0.340
Stelco Holdings Inc	-0.348	-0.337
Torex Gold Resources Inc	1.304	0.694
Interfor Corp	0.388	179.338
West Fraser Timber Co Ltd	-0.093	2.875
Dundee Precious Metals Inc	-0.155	0.755
B2Gold Corp	5.492	2.513
ERO Copper Corp	0.876	-0.713
New Gold Inc	-0.241	-0.698
Lundin Mining Corp	0.007	1.896
Fortuna Silver Mines Inc	0.922	0.285
Centerra Gold Inc	-0.169	-0.572
Capstone Mining Corp	1.001	1.342
OceanaGold Corp	-0.416	
Eldorado Gold Corp	-0.205	-0.608
SSR Mining Inc	-0.759	-0.829
Teck Resources Ltd	7.959	-0.420
IAMGOLD Corp	0.321	-0.890
Turquoise Hill Resources Ltd	2.546	62.666
Kinross Gold Corp	0.363	0.467
Yamana Gold Inc	-0.763	-0.647
Hudbay Minerals Inc	0.474	26.899
Silvercorp Metals Inc	-0.245	0.031
Kirkland Lake Gold Ltd	0.088	0.195
Methanex Corp	0.402	0.888
Transcontinental Inc	0.748	0.516
Equinox Gold Corp	5.651	-0.506
Labrador Iron Ore Royalty Corp	-0.977	-0.887
Alamos Gold Inc	1.898	-0.774
Pan American Silver Corp	0.325	0.298
Barrick Gold Corp	0.367	-0.396
Cascades Inc	-0.382	0.126
First Quantum Minerals Ltd	2.263	1.105
Nutrien Ltd	0.217	0.525
Intertape Polymer Group Inc	0.436	3.360
Agnico Eagle Mines Ltd	0.557	0.924
Stella-Jones Inc	4.634	0.927
Winpak Ltd	-0.640	0.846
Wesdome Gold Mines Ltd	1.066	-0.853
Pretium Resources Inc	0.698	0.876
CCL Industries Inc	0.001	0.021
Sandstorm Gold Ltd	0.467	0.665
Endeavour Silver Corp	-0.733	0.075
First Majestic Silver Corp	-0.129	0.484
Osisko Gold Royalties Ltd	-0.987	4.102
Franco-Nevada Corp	0.882	1.712
Ivanhoe Mines Ltd	1.903	-0.343

Table A 4 Emissions Result for the Sample Period 2016-2020

Company 2016 2020	Scope 1	Scope 2
Lithium Americas Corp	5.477	4.595
Osisko Mining Inc	-0.123	
Canfor Corp	5.483	-0.585
Stelco Holdings Inc	-0.348	
Torex Gold Resources Inc	1.304	0.694
Interfor Corp	0.159	124.767
West Fraser Timber Co Ltd	-0.032	2.503
Dundee Precious Metals Inc	0.100	0.622
B2Gold Corp	6.954	1.461
ERO Copper Corp	0.876	-0.713
New Gold Inc	0.291	-0.645
Lundin Mining Corp	0.355	-0.025
Fortuna Silver Mines Inc	0.159	0.087
Centerra Gold Inc	-0.021	0.696
Capstone Mining Corp	-0.196	-0.328
OceanaGold Corp	-0.337	
Eldorado Gold Corp	0.335	0.276
SSR Mining Inc	-0.759	
Teck Resources Ltd	9.483	-0.430
IAMGOLD Corp	-0.210	-0.603
Turquoise Hill Resources Ltd	2.208	2.260
Kinross Gold Corp	0.132	0.140
Yamana Gold Inc	-0.598	-0.570
Hudbay Minerals Inc	-0.141	-0.581
Silvercorp Metals Inc	-0.245	0.031
Kirkland Lake Gold Ltd	0.088	0.195
Methanex Corp	-0.058	-0.285
Transcontinental Inc	0.690	1.205
Equinox Gold Corp	5.651	-0.506
Labrador Iron Ore Royalty Corp	0.606	0.633
Alamos Gold Inc	-0.174	-0.884
Pan American Silver Corp	0.426	0.041
Barrick Gold Corp	1.086	1.033
Cascades Inc	-0.382	0.126
First Quantum Minerals Ltd	1.666	2.114
Nutrien Ltd	0.357	0.960
Intertape Polymer Group Inc	0.419	3.517
Agnico Eagle Mines Ltd	0.143	-0.248
Stella-Jones Inc	4.634	0.927
Winpak Ltd	-0.640	0.846
Wesdome Gold Mines Ltd	1.066	-0.853
Pretium Resources Inc	0.698	0.876
CCL Industries Inc	0.001	0.021
Sandstorm Gold Ltd	0.467	0.665
Endeavour Silver Corp	-0.303	0.134
First Majestic Silver Corp	0.122	0.173
Osisko Gold Royalties Ltd	4.840	5.059
Franco-Nevada Corp	0.254	0.567
Ivanhoe Mines Ltd	1.903	-0.343

Table A 5 Sentiment Analysis of the Firms

Company Name	Weighted Score	Sentiment	Dummy	Positive Count	Negative Count	Total Count
Lithium Americas Corp	0.4072	Positive	1	25	0	38
Seabridge Gold Inc	0.0274	Neutral	0	0	0	8
Novagold Resources Inc	0.2098	Negative	0	0	0	2
Osisko Mining Inc	0.3008	Positive	1	2	1	6
Canfor Corp	-0.1423	Negative	0	1	4	9
Stelco Holdings Inc	0.1001	Positive	1	3	1	7
Torex Gold Resources Inc	0.1896	Positive	1	7	1	9
Interfor Corp	0.0579	Neutral	0	1	0	3
West Fraser Timber Co Ltd	0.2717	Positive	1	2	0	5
Dundee Precious Metals Inc	0.3519	Positive	1	12	1	20
B2Gold Corp	0.3164	Positive	1	8	0	14
New Gold Inc	0.1940	Positive	1	13	2	21
Lundin Mining Corp	0.1092	Positive	1	4	1	9
Fortuna Silver Mines Inc	0.1230	Positive	1	5	1	11
Centerra Gold Inc	-0.1792	Negative	0	8	4	10
Capstone Mining Corp	0.3896	Positive	1	3	0	5
OceanaGold Corp	0.2971	Positive	1	7	1	12
Eldorado Gold Corp	0.0885	Neutral	0	4	2	11
SSR Mining Inc	0.5370	Positive	1	7	0	10
Teck Resources Ltd	0.1038	Positive	1	85	30	172
IAMGOLD Corp	0.0234	Neutral	0	9	4	28
Turquoise Hill Resources Ltd	-0.1319	Negative	0	7	10	21
Kinross Gold Corp	0.1153	Positive	1	12	4	31
Yamana Gold Inc	0.1383	Positive	1	13	6	42
Hudbay Minerals Inc	0.1067	Positive	1	2	1	4
Silvercorp Metals Inc	0.5512	Positive	1	3	0	4
Kirkland Lake Gold Ltd	0.9169	Positive	1	2	0	2
Methanex Corp	0.2171	Positive	1	7	3	6
Transcontinental Inc	0.1176	Positive	1	1	0	2
Equinox Gold Corp	0.2165	Positive	1	15	1	30
Alamos Gold Inc	-0.0893	Negative	0	2	2	8
Pan American Silver Corp	0.0282	Neutral	0	0	0	7
Barrick Gold Corp	0.1268	Positive	1	23	6	57
Cascades Inc	0.3564	Positive	1	38	0	49
First Quantum Minerals Ltd	0.1521	Positive	1	12	6	29
Nutrien Ltd	0.1512	Positive	1	18	5	37
Intertape Polymer Group Inc	0.3842	Positive	1	10	0	17
Agnico Eagle Mines Ltd	0.1309	Positive	1	14	5	28
Stella-Jones Inc	0.1288	Positive	1	11	0	27
Pretium Resources Inc	-0.3068	Negative	0	1	3	8
Sandstorm Gold Ltd	0.0832	Neutral	0	2	0	3

Endeavour Silver Corp	0.3637	Positive	1	6	0	7
First Majestic Silver Corp	0.1505	Positive	1	1	0	5
Osisko Gold Royalties Ltd	0.3246	Positive	1	2	0	6
Wheaton Precious Metals Corp	0.0876	Neutral	0	2	1	6
Franco-Nevada Corp	-0.2229	Negative	0	0	2	2
Ivanhoe Mines Ltd	0.1393	Positive	1	22	5	43

Table A 6 Market Reaction Sample Period 2013-2020

Company Name	Sentiment Analysis	CAR 1	CAR 2	CAR 3	Interaction 1	Interaction 2	Interaction 3
Kinross Gold Corp	0.1153	4.9577	15.6483	9.4111	0.5717	1.8045	1.0853
Teck Resources Ltd	0.1038	5.2560	15.9564	8.8714	0.5453	1.6555	0.9204
Methanex Corp	0.2171	4.7026	14.9108	9.3237	1.0211	3.2376	2.0244
Canfor Corp	-0.1423	0.0634	0.1045	0.0373	-0.0090	-0.0149	-0.0053
Cascades Inc	0.3564	0.5091	0.7807	-0.7134	0.1814	0.2782	-0.2542
West Frser Tmbr Co Ltd	0.2717	0.8068	0.2089	-1.0360	0.2192	0.0568	-0.2814
Interfor Corp	0.0579	0.1391	0.2921	0.0634	0.0081	0.0169	0.0037
Ivanhoe Mines Ltd	0.1393	0.6968	1.8083	0.4122	0.0970	0.2518	0.0574
Nutrien Ltd	0.1512	-0.2051	-0.1329	-0.1754	-0.0310	-0.0201	-0.0265
Dundee Precious Metls -Cl A	0.3519	-0.1741	-0.2183	-0.1184	-0.0613	-0.0768	-0.0417
Osisko Mining Inc	0.3008	0.1811	0.3479	0.3205	0.0545	0.1046	0.0964
Pan American Silver Corp	0.0282	0.3561	0.5165	-0.8285	0.0100	0.0146	-0.0234
Intertape Polymer Group Inc	0.3842	0.8350	1.0514	0.1018	0.3208	0.4039	0.0391
Eldorado Gold Corp	0.0885	0.2965	-1.2118	-1.6007	0.0262	-0.1072	-0.1416
Ssr Mining Inc	0.5370	0.8887	0.2173	-1.0377	0.4773	0.1167	-0.5573
Yamana Gold Inc	0.1383	4.8081	15.2189	9.1647	0.6652	2.1055	1.2679
Stelco Holdings Inc	0.1001	0.1722	-0.1444	-0.1165	0.0172	-0.0145	-0.0117
Iamgold Corp	0.0234	0.1518	-0.2596	0.7076	0.0036	-0.0061	0.0166
Turquoise Hill Resources Ltd	-0.1319	4.7015	15.3868	9.2587	-0.6203	-2.0301	-1.2216
Wheaton Precious Metals Corp	0.0876	0.0090	0.0456	0.0098	0.0008	0.0040	0.0009
New Gold Inc	0.1940	0.6687	-0.0987	-1.4963	0.1297	-0.0191	-0.2903
Seabridge Gold Inc	0.0274	-0.0130	-0.8211	-1.7581	-0.0004	-0.0225	-0.0482
First Quantum Minerals Ltd	0.1521	0.7595	1.4277	-0.2559	0.1155	0.2171	-0.0389
Fortuna Silver Mines Inc	0.1230	0.1749	0.0168	0.1765	0.0215	0.0021	0.0217
Osisko Gold Royalties	0.3246	0.0140	-0.0217	-0.0061	0.0045	-0.0070	-0.0020
Lundin Mining Corp	0.1092	-0.0080	-0.0958	-0.0721	-0.0009	-0.0105	-0.0079
Silvercorp Metals Inc	0.5512	4.6957	15.3012	9.3294	2.5880	8.4333	5.1419
Centerra Gold Inc	-0.1792	-0.0414	-0.1092	-0.1289	0.0074	0.0196	0.0231
Sandstorm Gold Ltd	0.0832	0.1519	0.1515	0.0258	0.0126	0.0126	0.0021

Franco-Nevada Corp	-0.2229	0.0580	0.2159	0.2241	-0.0129	-0.0481	-0.0499
B2Gold Corp	0.3164	0.8758	2.5540	0.8610	0.2771	0.8082	0.2724
Lithium Americas Corp	0.4072	-0.1884	0.5804	-0.0004	-0.0767	0.2364	-0.0001
Pretium Resources Inc	-0.3068	0.8518	1.2363	0.2008	-0.2613	-0.3793	-0.0616
Oceanagold Corp	0.2971	4.8723	15.8850	9.5708	1.4475	4.7193	2.8434
Agnico Eagle Mines Ltd	0.1309	-0.0754	-0.5481	-0.4401	-0.0099	-0.0718	-0.0576
Alamos Gold Inc	-0.0893	0.4180	0.2664	-0.8574	-0.0373	-0.0238	0.0765
Barrick Gold Corp	0.1268	0.2250	-0.4979	-0.0218	0.0285	-0.0631	-0.0028

Table A 7 Market Reaction Sample Period 2016-2020

Company Name	Sentiment Analysis	CAR 1	CAR 2	CAR 3	Interaction 1	Interaction 2	Interaction 3
Kinross Gold Corp	0.1153	-0.1833	-0.0391	-0.2043	-0.0211	-0.0045	-0.0236
Teck Resources Ltd	0.1038	4.7636	16.5285	10.4987	0.4942	1.7149	1.0893
Methanex Corp	0.2171	0.0134	0.1169	0.0684	0.0029	0.0254	0.0149
Canfor Corp	-0.1423	0.0634	0.1045	0.0373	-0.0090	-0.0149	-0.0053
Cascades Inc	0.3564	-0.2516	-0.4865	-0.4016	-0.0897	-0.1734	-0.1431
West Frser Tmbr Co Ltd	0.2717	-0.0321	0.1902	0.1214	-0.0087	0.0517	0.0330
Interfor Corp	0.0579	0.1391	0.2921	0.0634	0.0081	0.0169	0.0037
Ivanhoe Mines Ltd	0.1393	-0.2409	-0.7765	-0.4265	-0.0335	-0.1081	-0.0594
Nutrien Ltd	0.1512	-0.2051	-0.1329	-0.1754	-0.0310	-0.0201	-0.0265
Dundee Precious Metls -Cl A	0.3519	-0.1741	-0.2183	-0.1184	-0.0613	-0.0768	-0.0417
Osisko Mining Inc	0.3008	0.1811	0.3479	0.3205	0.0545	0.1046	0.0964
Pan American Silver Corp	0.0282	0.0015	-0.0098	0.1258	0.0000	-0.0003	0.0035
Intertape Polymer Group Inc	0.3842	-0.0089	0.0813	0.1265	-0.0034	0.0312	0.0486
Eldorado Gold Corp	0.0885	-0.3562	-0.8050	-0.6113	-0.0315	-0.0712	-0.0541
Torex Gold Resources Inc	0.1896	0.3399	0.4063	0.3335	0.0644	0.0770	0.0632
Yamana Gold Inc	0.1383	0.1202	0.0744	0.1079	0.0166	0.0103	0.0149
Stelco Holdings Inc	0.1001	0.1722	-0.1444	-0.1165	0.0172	-0.0145	-0.0117
Iamgold Corp	0.0234	0.1518	-0.2596	0.7076	0.0036	-0.0061	0.0166
Turquoise Hill Resources Ltd	-0.1319	-0.2363	-0.6494	-0.5014	0.0312	0.0857	0.0662
Wheaton Precious Metals Corp	0.0876	0.0090	0.0456	0.0098	0.0008	0.0040	0.0009
New Gold Inc	0.1940	0.0424	-0.0686	-0.2998	0.0082	-0.0133	-0.0582
Seabridge Gold Inc	0.0274	-0.0221	-0.1281	-0.1268	-0.0006	-0.0035	-0.0035
First Quantum Minerals Ltd	0.1521	0.1585	0.6623	-0.0931	0.0241	0.1007	-0.0142
Fortuna Silver Mines Inc	0.1230	0.1749	0.0168	0.1765	0.0215	0.0021	0.0217
Osisko Gold Royalties	0.3246	0.0140	-0.0217	-0.0061	0.0045	-0.0070	-0.0020
Lundin Mining Corp	0.1092	-0.0080	-0.0958	-0.0721	-0.0009	-0.0105	-0.0079
Silvercorp Metals Inc	0.5512	-0.1171	0.1245	0.0063	-0.0645	0.0686	0.0035
Centerra Gold Inc	-0.1792	-0.0414	-0.1092	-0.1289	0.0074	0.0196	0.0231
Franco-Nevada Corp	-0.2229	0.0580	0.2159	0.2241	-0.0129	-0.0481	-0.0499

B2Gold Corp	0.3164	0.2238	0.6270	0.3465	0.0708	0.1984	0.1096
Lithium Americas Corp	0.4072	-0.1853	0.5479	0.0600	-0.0755	0.2231	0.0244
Pretium Resources Inc	-0.3068	0.1910	-0.6063	-0.4809	-0.0586	0.1860	0.1476
Oceanagold Corp	0.2971	-0.0536	0.4796	0.3038	-0.0159	0.1425	0.0903
Agnico Eagle Mines Ltd	0.1309	-0.0754	-0.5481	-0.4401	-0.0099	-0.0718	-0.0576
Alamos Gold Inc	-0.0893	0.0219	-0.1592	-0.0375	-0.0020	0.0142	0.0033
Barrick Gold Corp	0.1268	0.2250	-0.4979	-0.0218	0.0285	-0.0631	-0.0028

Appendix B

Figure B 1 Sentiment Distribution for Barrick Gold Corp