Prosperity Under Threat, Climate Change and Forestry Firms

ABSTRACT

We are driven to investigate how climate change impacts the prosperity of forestry firms. We propose that there are interconnected links between climate change, forest ecosystems, forest economies, and forestry firms. Our research shows that global warming leads to the destruction of forests due to droughts, pests, and wildfires. These climate events prompt government policies regarding harvesting, which in turn affect firms by increasing production costs, leading to a decline in profitability and fluctuations in stock market performance. Our findings establish causal connections between rising global temperatures and both cash flows in firms and industry stock market returns. Given these concerning negative trends, the challenging effects of climate change on the forestry sector are likely to worsen, posing serious risks to the sustainability of firms, individuals, and communities that rely on forests. The implications for life in the forestry sector are nothing short of existential.

1. Introduction

In Canada, climate change is having a detrimental impact on the forestry industry, particularly affecting the forests of British Columbia and threatening the industry's long-term viability. Forestry companies are increasingly pressed to adapt to climate change, facing challenges that impact their operations, profitability, attractiveness to investors, and strategic responses. Factors such as rising temperatures and altered precipitation patterns negatively affect forest health, leading to issues like drought, insect outbreaks, wildfires, and fungal diseases. Consequently, wood supply is diminishing, and the forestry sector is grappling with supply shortages, which further destabilize the supply chain (García-Jácome et al., 2025). Projected forest fire areas in France are expected to increase by 55% by the end of the century (Riviere et al., 2022).

Studies have indicated that the spread of pine beetles inflicts greater environmental damage by elevating greenhouse gas levels in the atmosphere. Over recent decades, climate change has significantly contributed to the decline of forests globally. In British Columbia, the mountain pine beetle has devastated an estimated 54% of the province's pine volume[i].

The forestry supply chains are facing disruptions, as tree harvesting operations become increasingly challenging. For instance, warmer temperatures are shortening winter logging seasons, leading to reduced wood harvesting in Siberia. Additionally, rising temperatures hinder forest growth, resulting in smaller trees at harvest time. These factors lead to increased costs and reduced productivity for forest firms due to smaller harvests (Acuna & Strandgard, 2017).

Furthermore, climate models project that softwood supply could decrease by 16-73%, while hardwood supply may fluctuate between -2% and +4% by the year 2150 in New Brunswick, Canada (McMonagle et al., 2024). This decline is anticipated to result in a loss of 0.08-0.88% of yearly GDP over the course of 40 years. Additionally, climate change is projected to reduce wood production for species like birch, pine, and spruce by up to 0.3% (Kotlarz & Bejger, 2024). In Quebec, climate change could lead to losses as high as $300 million, representing 0.12% of GDP in Canada (Boccanfuso et al., 2013, 2018).

Over the past century, the average temperatures in British Columbia have increased by 1.1°C in summer and 2.1°C in winter, resulting in 24 fewer frost-free days each year. According to the Fraser Basin Council, "Under a moderate greenhouse gas (GHG) emissions scenario, B.C. is projected to warm by an additional 2.4°C in summer and 2.9°C in winter on average by the year 2100."

Gillett et al. (2004) noted that "In many parts of B.C., snowpacks are projected to continue to decrease. Less snow means less snowmelt in the spring and reduced runoff in the summer. These declining water levels impact natural resource industries, including hydropower, agriculture, and fisheries."

> We already have examples of the effects of reduced snowfall, as seen in the seasonal droughts of 2003 and 2009. These events illustrate the vulnerability of community and irrigation water supplies and highlight potential future challenges. The droughts, combined with high-density urban interface forests, contributed to the Okanagan forest fire of 2003. Additionally, increased temperatures have exacerbated the mountain pine beetle infestation. Over the past four decades, the area burned by forest fires has grown alongside rising temperatures.

British Columbia is the leading contributor to Canada's forestry sector, accounting for 42% of the country's roundwood harvested by volume. Following British Columbia are Quebec and Alberta. Forestry is a cornerstone of British Columbia's economy, generating significant revenue and providing 60,000 direct jobs. In fact, one in every four people employed in manufacturing in the province works in the forestry industry, which supports 140 mostly rural communities. In 2019, twelve sawmills in the Kamloops region closed to restore the balance between timber supply and demand[ii]. Over the past 60 years, the number of firms in the Canadian forestry sector has decreased by 42%. Many firms have been acquired, shut down, or merged with competitors, all of which have increased the industry's vulnerability to climatic disturbances. As a result, residents of forestry-dependent towns are deeply concerned about losing their livelihoods in what has historically been a stable industry with well-paying jobs. They are calling for research into actions that could prevent further shutdowns of sawmills and pulp and paper mills. The long-term consequences of a struggling forestry industry could be devastating for small towns, impacting not only ecological aspects but also economic factors, such as disrupted timber supply to mills, and social issues, including unemployment and increased crime rates.

Progress has been made in studying the impacts of climate change on forest ecosystems (Riviere et al., 2022; Gillett et al., 2004; Abatzoglou and Williams, 2016). These studies establish an adverse relationship between anthropogenic climate change and forest viability. Additionally, several studies indicate that climate change negatively affects the forestry industry (McMonagle et al., 2024; Kotlarz & Bejger, 2024; Boccanfuso et al., 2013, 2018; et al., 2016; Roos, 2023). Roos (2023) presents a literature review examining 23 studies on the global impacts of climate change on forestry, particularly focusing on the economic losses within supply chains. These studies effectively link climate change, forestry populations, and the economics of the forestry industry.

This relationship is further examined to reveal its business-level impacts (Acuna & Strandgard, 2017; Roos, 2023). Acuna and Strandgaard (2017) use economic modeling to investigate the effects of climate change on forest operations in Australia. They find that climate change increases the risk of wildfires, which shortens the harvesting period and raises supply chain costs by up to 10.9%.

However, there is a gap in the literature regarding how climate change specifically affects forestry firms, beyond its impacts on forests and the broader industry. While numerous studies have used modeling approaches to examine economic impacts, there has yet to be an empirical analysis of how climate change affects the business performance of forestry companies. Therefore, we aim to investigate the financial well-being of forest firms in Canada concerning climate change. To date, no studies have specifically explored the relationship between climate change and business-level performance in this context. We will collect panel data that integrates and models climate change effects, forestry firm performance, government harvest allocations, and the impacts of fire and insects, covering a period of over 30 years.

Murtaza et al. (2016) highlight the need for future research to develop more comprehensive models that examine the impacts of climate change on forest ecosystems and the related industries. They emphasize the importance of cross-disciplinary research that integrates natural sciences, economics, and business to create effective adaptation strategies.

In a significant contribution to the emerging field of Climate Finance, Dietz et al. (2016) develop a theoretical model to assess the risk of value loss in global assets. Their research seeks to identify the causal relationships between trends in global temperatures and the cash flows of various firms or industries. A critical implication of this study is whether the stock market reflects the risks and impacts of climate change in the valuations of these companies. However, studies addressing this issue in the business literature are scarce (Linnenluecke et al., 2013). While some business studies do explore how firms adapt to changing market conditions, they often overlook the environmental changes that influence these adaptations (Linnenluecke et al., 2013).

Our study is both unique and necessary, as it aims to address the gap in research concerning the effects of climate change on the prosperity of forest firms. Additionally, it analyzes how climate change impacts the cash flows, risks, and market valuations of these firms. The challenges posed by climate change to the forestry sector are expected to intensify, which will have significant implications for the sustainability of the forest industry.

2. Literature Review

Climate change presents a major challenge to forests, governments, and forestry companies. This literature review examines how climate change affects forest businesses, disrupts supply chains, and influences adaptation strategies.

Climate change is damaging forest ecosystems through rising temperatures, altered rainfall patterns, and increased CO2 concentrations. These changes are reshaping forests and impacting the forestry industry both directly and indirectly (Murtaza et al., 2016). For instance, climate change has led to a surge in pine beetle populations in British Columbia, Canada, as winters are no longer cold enough to control their spread[iii] (Fredeen, 2007). Research on forest responses to environmental change has utilized gap models to simulate succession interactions in forest stands (Bray, 1956) and biogeographical models to evaluate responses to nutrient and water availability (Neilson and Marks, 1994). Consequently, changing environmental conditions are affecting tree growth rates, species composition, and the availability of forest products, which in turn influences government harvesting policies regarding allowable annual cuts and the economic viability of forestry companies. As noted by Roos (2023), climate change is increasing forest disturbances such as wildfires, storms, and insect infestations. Forest companies depend on stable forestry conditions, making them highly vulnerable to economic risks resulting from these changes. These risks lead to poorer wood quality, delayed harvesting, and increased costs.

A critical area of research is the impact of climate change on forest supply chains. The frequency and severity of fires and insect infestations are growing, resulting in supply chain disruptions (Roos, 2023) and affecting communities reliant on stable forestry industries. Fires destroy wood stocks, while insect infestations degrade the quantity and quality of sellable wood (Roos, 2023). Additionally, dead forests become more prone to flooding, further disrupting the lives of people in these forestry-dependent communities. Abatzoglou and Williams (2016) demonstrate that climate change contributes to an increase in wildfires across western U.S. forests. These fires release particulate matter, a mixture of smoke, dust, and other toxic gases, with particle sizes ranging from 2.5 to 10 micrometers. This particulate matter is linked to various chronic illnesses, including lung infections, cardiovascular issues, bronchitis, asthma, and severe respiratory disorders.

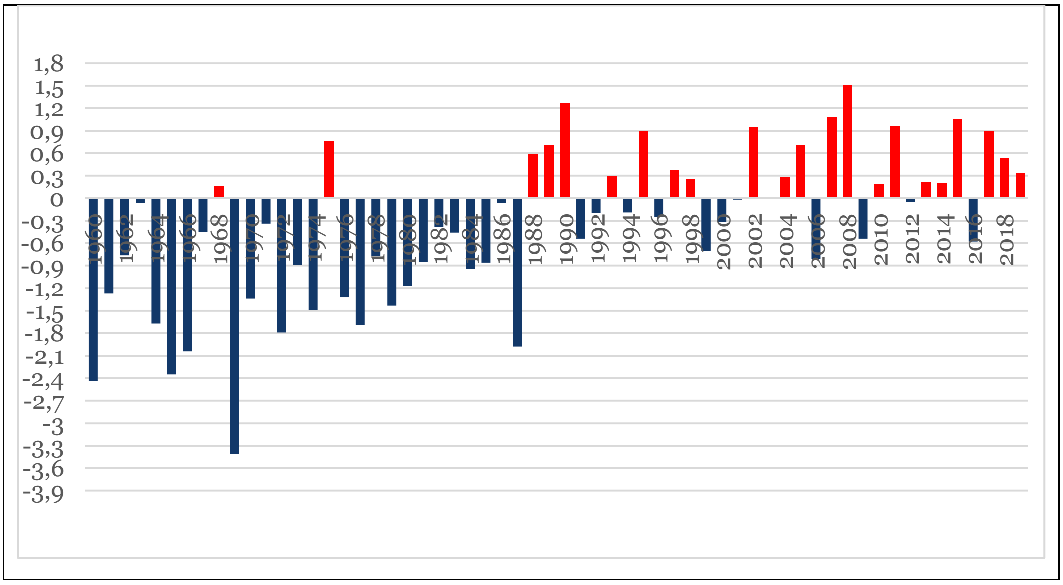
To address these challenges, researchers propose management options to help forestry companies adapt to supply chain disruptions. These options include diversifying wood sources, forecasting and planning for potential disruptions, and implementing optimization strategies to minimize losses (Roos, 2023). In recent years, collaborations among a broader range of stakeholders—including governments, industry, Indigenous communities, scientists, and firms—have been initiated to create a more resilient supply chain. Forest companies have the opportunity to derive economic value from carbon storage by implementing policies that promote it, providing an adaptation strategy. However, climate change creates a conflict between the wood production goals of forest firms and their role in carbon storage. Specifically, companies aiming to increase timber production and profitability often face a dilemma between economic and environmental objectives, as enhancing wood output may reduce their capacity for carbon storage (Vaguet, 2023).

3. Background Climate Change and Forests

Since the Industrial Revolution, global ambient temperatures and atmospheric concentrations of carbon dioxide (CO_2) have been on the rise (Schneider, 1989). In Canada, annual land temperatures have increased by 1.7 °C since 1948, with even higher increases observed in northern British Columbia[iv]. Additionally, analysis of borehole data indicates temperature increases ranging from 0.8°C to 1.5°C, starting as early as 1860 and as late as 1948, across different regions of Canada (Deming, 1995).

Figure 1 illustrates temperature anomalies—deviations from normal temperatures—in Canada over the past 60 years. Prior to 1988, there were numerous years with colder-than-normal temperatures. However, after 1988, there has been a notable increase in the frequency of abnormally warm years.

Figure 1: Temperature Anomaly for British Columbia, Canada from 1960 – 2018

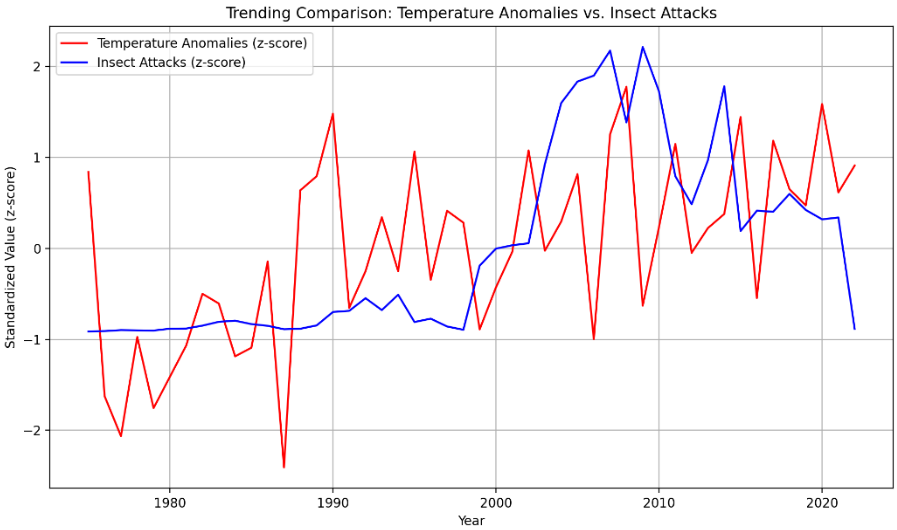


Climate warming is directly harming tree health through heat and hydration stress. As a result, Canadian forests are becoming less productive due to warmer climates and drier summers, which are not conducive to tree growth. The warming temperatures in Canada have led to a noticeable decrease in the vitality of trees, undermining their resilience against insect pathogens. Ultimately, these pathogens and bark beetles can lead to tree mortality. Forest insect epidemics severely impact ecosystem dynamics by causing tree deaths and hindering the growth of millions of trees across vast areas. Both native insects and invasive alien species affect managed and natural forests alike. However, the impact of these insects on carbon (C) dynamics and the global climate is not well-documented (Nature, 2008).

Over the past 50 years, climate change has resulted in drier, warmer summers and milder winters. This shift has triggered a reproduction surge among many harmful insect species, particularly the Mountain Pine Beetle. This native insect of the pine forests in western North America periodically experiences large-scale outbreaks. During these outbreaks, widespread tree mortality decreases forest carbon uptake, leading to increased emissions of carbon dioxide and other warming gases from the decay of dead trees. Unfortunately, the effects of insects on forest carbon dynamics are often overlooked in large-scale modeling analyses.

Since 1990, the Mountain Pine Beetle has primarily targeted forests in British Columbia, capturing the attention of foresters and economists alike. The current outbreak in British Columbia is significantly larger in both area and severity than all previously recorded outbreaks. Moreover, the surge in pine attacks has attracted other invasive species that are threatening other commercially important forests, such as Fir.

Figure 2. Long Term Trends: Global Warming and Forest Destruction by Insects



The area of trees affected by insect damage has increased rapidly over the last 60 years, reaching as high as 12 million hectares, as shown in Figure 2. Rising temperature anomalies indicate a global warming trend that aligns with the increasing destruction of forests by insects. This insect outbreak has transformed forests from being a small net carbon sink into a significant net carbon source both during and immediately after the infestation. Climate change has played a crucial role in the unprecedented extent and severity of this outbreak. Insect infestations represent a significant way in which climate change may reduce forests' ability to absorb and store atmospheric carbon. Such impacts must be included in large-scale modeling analyses (Kurz et al., 2008).

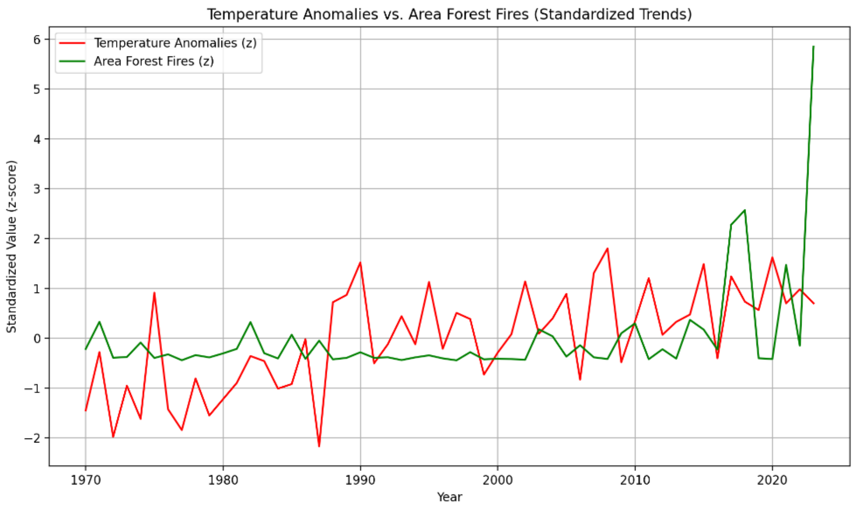
After insects destroy forests, the dead trees dry out, becoming highly flammable and increasing the risk of massive wildfires. This drying effect is an indirect consequence of climate change on forest destruction. Figure 3 illustrates the rising impact of climate change on forest fires, based on the area burned since 1970. Interestingly, the number of fires in Canada has decreased by more than 40% since 1970, likely due to advances in technology, improved forest management practices, and effective gas policies. However, the concern lies in the fact that fire intensity has escalated significantly; recent wildfires are much larger and more destructive than ever before.

The consequences of these fires on the local forest industry are particularly striking. In Kamloops, BC, several sawmills have shut down in recent years due to the combined effects of climate change and wildfires[ii]. The forest industry is a vital component of the Canadian economy, and climate warming is extending fire seasons. Wotton and Flannigan (1993) estimated that the average length of the fire season in Canada could increase by 22%, or about 30 days, in a world with twice the current levels of carbon dioxide (Flannigan, 2003).

Additionally, lightning significantly contributes to forest fires. Wotton et al. (2005) investigated the relationship between lightning fires and various fire weather and fuel moisture scenarios. They projected a 24% increase in lightning fire activity by 2040 and an 80% increase by the end of the 21st century (Flannigan, 2003).

As shown in Figure 3, the area of forests destroyed by fires has increased significantly over the last decade. Before 2015, the area affected by forest fires had remained relatively stable. This aligns with the global warming trend, which correlates with the growing incidence of forest fires.

Figure 3. 60-year Trends: Global Warming and Forest Destruction by Forest Fires



Consequently, climate change has led to a decline in harvest yields over the past few decades, posing challenges to government harvesting policies in managing forests and the forest industry. Provincial governments prescribe the estimated Annual Allowable Cut (AAC), which represents the volume of industrial roundwood that can be sustainably harvested each year from provincial Crown lands, as determined by professional foresters. Timber supply measures, such as allowable annual cuts and long-term sustainable yield, are not static; they are modified and updated based on new information and changes in land use, resource priorities, unexpected disturbance losses, productivity changes, and accessibility (e.g., new roads).

Furthermore, factors such as climate change impacts on forest land area, growth rates, disturbance patterns, management inputs, regulatory constraints, regeneration success, and species composition also influence these measures (Williamson et al., 2007). For instance, the mountain pine beetle infestations in British Columbia have led to significant changes in timber supply over time. Specifically, "the allowable annual cut of the Vanderhoof Forest District in the Prince George Timber Supply Area has increased from its traditional level of around 2 million cubic meters (approximately the year 2000) to its current level of around 6.5 million cubic meters to facilitate the salvage of beetle-killed pine" (Pederson, 2004).

In response to these challenges, the government has raised its AAC to encourage the forestry industry to harvest more trees, clear forests more quickly, and maximize wood value from damaged forest lands. This approach also aims to remove tree debris to prevent further fires. Conversely, a reduction in wood supply typically leads to increased lumber prices. "Such large fluctuations in local timber supply and the associated changes in production and employment, compressed within a relatively short time frame, can result in significant challenges for communities and forestry companies" (Williamson et al., 2007).

To examine the impact of climate change on the prosperity of forestry firms, it is essential to understand how global warming degrades forest ecosystems. However, the dynamics of how climate change affects the prosperity of forestry firms have not been thoroughly studied. This process is illustrated in Figure 4 as a linear process. It is likely to involve non-linear and concucrrent interactions.

Figure 4. The Process of Climate Change Effecting Forestry Firms

Climate change disrupts average temperature patterns.

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Climate change hurts forest health by increasing the frequency of natural disasters, insect infestations and forest fires.

↓

Based on their assessments of forest health, the government responds with harvesting policies (AAC), forest health management, and forest protection.

↓

The AAC influences the harvesting plans of the forestry industry.

↓

Climate change, forest health, AAC, and total harvest collectively impact on forest firm prosperity

4. Hypothesis

Whether climate change affects the prosperity or poverty of forestry businesses remains to be studied. Despite numerous studies showing the harm that climate change has on the forest industry economics, how it affects the business performance of these firms is not well understood. Hence, we are motivated to study the financial soundness of Canadian forest firms which were listed since the 1990s. As their main forestry operations are in British Columbia, which has the largest wood production in Canada, we examine climate change in this province.

Insufficient research is being conducted on the business impacts of climate change on forestry firms. The impact of climate change on the firms' asset values has finally begun to receive attention. Dietz et al. (2016) examine the potential impact of climate change on the asset values of firms globally. Their work is a significant contribution to the emerging topic of Climate Finance. The research of climate finance seeks to: "identify the causal links from trends in global temperatures to firm or industry cash flows." The important implication is whether the stock market imputes the risks and impacts of climate change into the value of companies.

We aim to establish a causal relationship between global warming and the financial performance, cash flows, and value of forestry firms. Our empirical design of a panel study models this process, showing how climate change affects the biology, the economics and the business to test our hypotheses:

H1A: Climate change has an increasing effect on the production costs of forestry firms.

H2A: Climate change hurts the profitability of forestry firms.

H3A: Climate change hurts the market valuation of forestry firms.

We explicitly recognize forest variables, such as harvesting, insect damage, fire damage, as well as government harvesting policy, in our empirical modelling to show their climate change impacts on forestry firms.

5. Data and Methodology

We study climate change trends on the forestry firms' performance using time series environmental-econometric methods.

We collect data across different domains and data sources as follows:

1. Climate data is obtained from NOAA, the US National Ocean and Atmospheric Administration (53.7 Degrees N, 127.7 Degrees E), 1990 – 2023. (https://www.noaa.gov)
2. Forest ecosystem and government harvesting policy data is obtained from the Canadian National Forestry Database (http://nfdp.ccfm.org), 1990 – 2023.
3. Business financial data on forestry firms is collected from Capital IQ database published by Standard and Poor (https://www.capitaliq.com).

In line with our three hypotheses, we test these models on the effects of climate change on forestry firm prosperity in terms of operational costs, profits and stock returns.

H1A: Climate change has an increasing effect on the production costs of forestry firms.

Firm Property = B_1 (Climate Change) + B_2 (Climate Change x Insect Damage) + B_3 (Government Harvesting Policy) + B_4 (Forest Fires) + B_5 (Insect Damage) + B_6 (Wood Harvested) + B_7 (Lumber Price) + B_8 (Firm Factors) (1)

This is specified further as follows:

Cost of Goods Sold, COGS = B_1 + B_2 (Temp Anomalies) + B_3 (Temp Anomalies x Insect Damage) + B_4 (Annual Allowable Cut) + B_5 (Forest Fires Area) + B_6 (Wood Volume Harvested) + B_7 (Lumber Price) + B_8 (Firm leverage) + B_9 (Firm Assets) (2)

H2A: Climate change has a negative effect on the profitability of forestry firms.

Return on Assets, ROA = B_1 + B_2 (Temp Anomalies) + B_3 (Temp Anomalies x Insect Damage) + B_4 (Annual Allowable Cut) + B_5 (Forest Fires Area) + B_6 (Wood Volume Harvested) + B_7 (Lumber Price) + B_8 (Firm leverage) + B_9 (Firm Assets) (3)

H3A: Climate change has a negative effect on the market valuation of forestry firms.

Stock Returns = B_1 + B_2 (Temp Anomalies Lag one year) + B_3 (Temp Anomalies x Insect Damage) + B_4 (Annual Allowable Cut) + B_5 (Forest Fires Area) + B_6 (Wood Volume Harvested) + B_7 (Lumber Price) + B_8 (Firm COGS) + B_9 (Firm leverage) + B_{10} (Firm Assets) (4)

We give the definitions for each variable in Table 1 below. Of note, temperature anomaly is the "departure from a reference value or long-term average. A positive anomaly indicates that the observed temperature was warmer than the reference value, while a negative anomaly indicates that the observed temperature was cooler than the reference value" (National Centers for Environmental Information).

Table 1: Variable Definitions and Data Sources

Elements	**Definition**	**Source**
Temperature Anomaly (1960 – 2023)	Difference from average temperature. Measured in ℃ or °F.	National Centers for Environmental Information (https://www.ncei.noaa.gov)
Annual Allowable Cut (1960 – 2023)	The volume of industrial roundwood that can be harvested sustainably each year set by the provincial government. It is measured in cubic meters.	Government of Canada – Ministry of Forest website.
Total wood harvested (1960 – 2023)	Volume in cubic meters.	National Forestry Database
Insect attacks (1975 – 2022)	Insect infestation damage in hectares.	National Forestry Database
Number of wildfires (1970 – 2023)	Number of wild fires	National Forestry Database
Area burnt by forest fires (1970 – 2023)	Area burnt in hectares.	National Forestry Database.
Lumber prices (1972 – 2023)	Market Price of lumber per board feet	Macrotrends https://www.macrotrends.net/2637/lumber-prices-historical-chart-data
Cost of Goods Sold/Sales (1990-2023)	Operational costs measure of cost of goods expense / sales	Capital IQ
ROA (1990-2023)	Operational profitability measure, Return on Assets - net income / total assets	Capital IQ
ROE (1990-2023)	Operational profitability measure, net income / equity.	Capital IQ
Stock Return (1990-2023)	Annual stock returns including dividends	Capital IQ
Debt/Equity (1990-2023)	Displays long term debt borrowing, leverage.	Capital IQ
Total Assets (1990-2023)	measures firm size in dollars	Capital IQ

We collect the population of publicly listed Canadian Forest firms; there are 26 firms. Many corporations in the forest industry have either merged, given up ownership, or liquidated their business since its inception. More than ten firms have gone out of business towards the end of 2019 which is concerning many Canadian forest communities. The government is pursuing policies to mitigate these effects of climate change and to restore economic vitality to the forest economies for the past decade.

Table 2. Descriptive Statistics on Climate Change Effects on Forest Firms

Variable	count	mean	std	min	25%	50%	75%	max
ReturnsMean_lag1	27	0.12	0.4	-0.52	-0.15	0.1	0.31	1.36
COGS (mill)	64	576.31	953.55	0.13	0.50	1.08	1059.25	3519.96
ROA	52	0.05	0.04	-0.04	0.02	0.04	0.08	0.19
Temp Anomalies	64	-0.58	1.06	-3.78	-1.2	-0.48	0.25	1.23
TempAnomXInsect 000's	49	2310	3226	3	200	733	3959	12831
Area Forest Fires 000's	54	203	455	3	20	49	177	2841
Insect Attacks 000's	48	3772	4142	30	275	1606	5878	12850
Harvested 000's	34	68313	11232	36200	64608	69251	75382	86998
Lumber Price	52	280.15	139.36	132.18	186.94	260.8	341.27	872.89
D/E	64	0.93	0.3	0.17	0.74	0.97	1.13	1.53
Total Assets	64	2111	2375	226	552	888	3850	10445

We present descriptive statistics on our study variables here in Table 2. The dependant variable, mean stock returns has a mean of around 0.12 and standard deviation around 0.40 indicate relatively volatile year‑ over‑ year stock performance. As well, Cost of goods sold, COGS has a mean of 576 with a standard deviation of 953 also shows high volatility in costs. The Cost of Goods, COGS, statistics are very dispersed (from near zero to >3,500). The wide spread captures multiple regimes (lean vs intensive cost periods). That volatility gives the model room to find signal from drivers; however, with only ~27 usable observations (due to lagging and missingness), inference is population size constrained. Thus, our estimated coefficients can be sensitive to outliers and collinearity. However, the strong signals that persist (Temperature Anomalies, TempAnomXInsect2, Insect Attacks, Harvested) are therefore notable. With respect to our variable of interest, climate change (temperature Anomalies) has a slightly negative mean and a fairly wide dispersion (std ~1.06) spanning cold to warm years. Quartiles from roughly −1.2 to +0.25 show warming episodes that can coincide with stress on forests. Climate stress and the pest–temperature interaction are systematically linked to lower next‑ year returns. Profitability ROA appears relatively stable with a mean of 5.0 percent and standard deviation of 4 percent.

As for climate disturbances, Area Forest Fires statistics appear to be highly skewed: low 25th/50th percentiles with a very large 75th percentile and max. This indicates occasional extreme fire seasons. Second, Insect Attacks has a median in the low millions with a long right tail (max > 12M). This variable showed a strong and positive association with next‑ year returns in Stage‑ 1 regression (Table 5).

Looking at the forest industry variable, Harvested, summary statistics show large scale (tens of millions), moderate dispersion, and relatively tight quartiles compared to the mean. In Stage‑ 1, higher harvested levels foreshadow lower next‑ year returns (negative and significant), consistent with near‑ term inventory drawdown or mean reversion after strong operating years. Operational intensity (Harvested) appears to anticipate some near‑ term mean reversion in returns.

Figure 5 displays graphs of all our variables over a 50-year period. The trends highlight these realities: 1) temperature anomalies are increasing indicating global warming; 2) forestry firm operational costs (COGS) are rising steeply; 3) firms have falling profits, ROA; 4) the area of forest fires burning has steeply risen in the last twenty years; 5) harvesting volume of trees is in steep decline; 6) lumber prices are rising steeply, and 7) forest firm assets are increasing showing concentration. This strong rise in the total assets of forest firms is a result of the industry consolidating through mergers and acquisitions, creating much larger forest firms. There are far fewer forest companies today than there were twenty years ago.

Figure 5. Trend Graphs for Selected Variables on Climate Change and Forestry

6. Results

Global Warming and Operational Costs

We present results in Table 3 showing the impact of climate change, as measured by Temperature Anomalies, on forest firms' operational costs. Here, temperature anomalies consistently demonstrate significant positive associations with Cost of Goods Sold, COGS across all 8 specifications (standardized beta coefficients ranging from 0.1389 to 0.491, $p < 0.01$), suggesting higher operational costs in years experiencing abnormal climatic conditions. This relationship likely arises from intensified production demands or logistical complexities induced by climatic change.

***************************INSERT TABLE 3 HERE*************************

Further, the interaction between temperature anomalies and insect damage area (TempAnomXInsect) significantly predicts increased COGS (standardized beta coefficients between 0.2522 and 0.5632, significant at least at $p < 0.10$), especially in models with ecological and market controls. These findings imply that ecological disturbances, amplified by warmer climatic conditions, substantially increase production costs, possibly reflecting additional expenditures on timber salvage, pest management, and operational adjustments.

The allowable annual cut (AAC), indicative of permitted logging intensity, emerges consistently as negatively related to COGS, with coefficients significantly negative across multiple models (β ranging from -0.3688 to -1.0406, $p < 0.01$). This negative relationship suggests economies of scale or cost efficiencies when firms engage in higher volume logging permitted by regulatory adjustments. The increased AAC greatly influences the scale of harvesting operations and incentivizes the forestry industry to pursue larger economies of scale, higher efficiency in its supply chain, and realize salvageable value from damaged timber. Therefore, climate change disruptions influence the AAC and impact the supply of lumber through costs. Indeed, the harvested volume similarly shows a negative and significant relationship (β ranging from -0.1405 to -0.2995, $p < 0.01$ to 0.10), consistent with potential economies of scale during high-volume logging periods.

The government increases AAC significantly within a year of large forest fires in the region affected. Hence, we find that the area damaged by forest fires significantly impacts COGS, mostly negatively (β from -0.1756 to -0.7633, $p < 0.01$) indicating potential short-term cost reductions. This result is consistent with the forest industry harvesting more with the increased AAC possibly due to salvage logging incentives, compensatory mechanisms, or reduced operational complexity post-fire.

Even stronger results appear with Insect attacks, representing areas of infestation, significantly and positively correlate with COGS (standardized beta coefficients ranging from

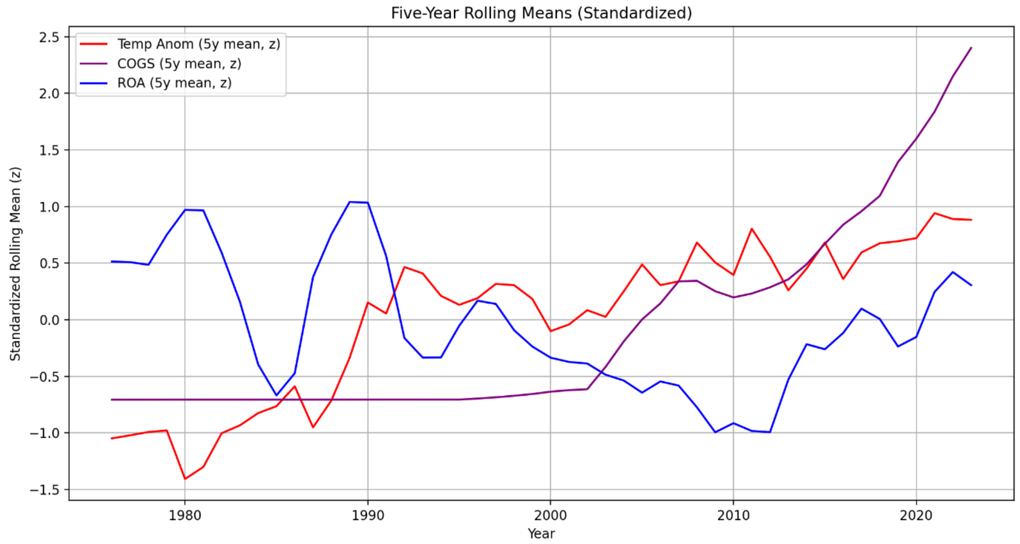
0.3762 to 0.814, $p < 0.01$), affirming substantial operational cost increases related with biological disruptions. The economic rationale includes increased poor lumber yields, management expenditures, harvesting inefficiencies, and losses from damaged timber resources.

Lumber prices show a significant positive impact on COGS (standardized beta coefficients between 0.3688 and 0.4909, $p < 0.01$), reflecting the direct transmission of market conditions into firms' operational expenditures.

The Debt-to-Equity ratio exhibits negligible influence on COGS, indicating operational cost independence from financial leverage considerations. Conversely, total assets significantly and positively predict COGS in the comprehensive model ($\beta = 0.3899$, $p < 0.01$), suggesting increased operational expenditures linked to firm scale, asset complexity, or broader production bases. That is, forestry firms with such broader production bases would have larger mass and more spread-out forestry land tenure. This means that these firms harvest their timber from larger and further away timber stands and thus raises their costs.

Figure 6 shows historical trend of climate change and the firm operational costs, COGS. Here, both climate change and COGS trends are rising higher. The rising operational cost trend has accelerated dramatically since 2003.

Figure 6. Fifty Year Trends of Global Warming and Firms Firms Operational Costs and Profitability



In sum, climate change and its biological disruption, insect infestation, harm the costs of production for forestry firms. The government responds by managing harvesting quota, AAC in the short term which appears helpful to mitigate the increased costs from climate change.

Global Warming and Profitability

Figure 6 (above) also shows historical trends of climate change and firm profitability. Here, as climate change trend rises, the firm's profitability, ROA shows a falling trend. Therefore, climate change appears to relate to diminishing profitability explained by rising operational costs. We test our hypothesis with results in Table 4 showing the adverse impact of climate change on forest firms' profitability. The return on assets, ROA effects are lagged by two years.

*************************INSERT TABLE 4 HERE************************

Climate change induced insect damage to forests by area, consistently yield significant negative impacts on ROA across all relevant specifications, with standardized beta coefficients ranging from -0.605 to -1.009 ($p < 0.01$). A one-standard-deviation increase in insect-damaged areas substantially reduces profitability, highlighting the significant economic implications of biological disruptions on corporate financial outcomes. Such severe impacts likely arise from direct timber losses, increased salvage and operational costs, and consequent production disruptions. The increased operational costs (COGS) from temperature anomalies found previously explain losses in profitability.

Temperature anomalies alone show no significant direct relationship with firm ROAs, exhibiting relatively small coefficients (e.g., 0.0102 to 0.195) without statistical significance. However, the interaction between temperature anomalies and insect damage area (TempAnom X Insect) reveals significant complexity, with standardized beta coefficients ranging from 0.284 to 0.359 ($p < 0.05$) in mid-range models.

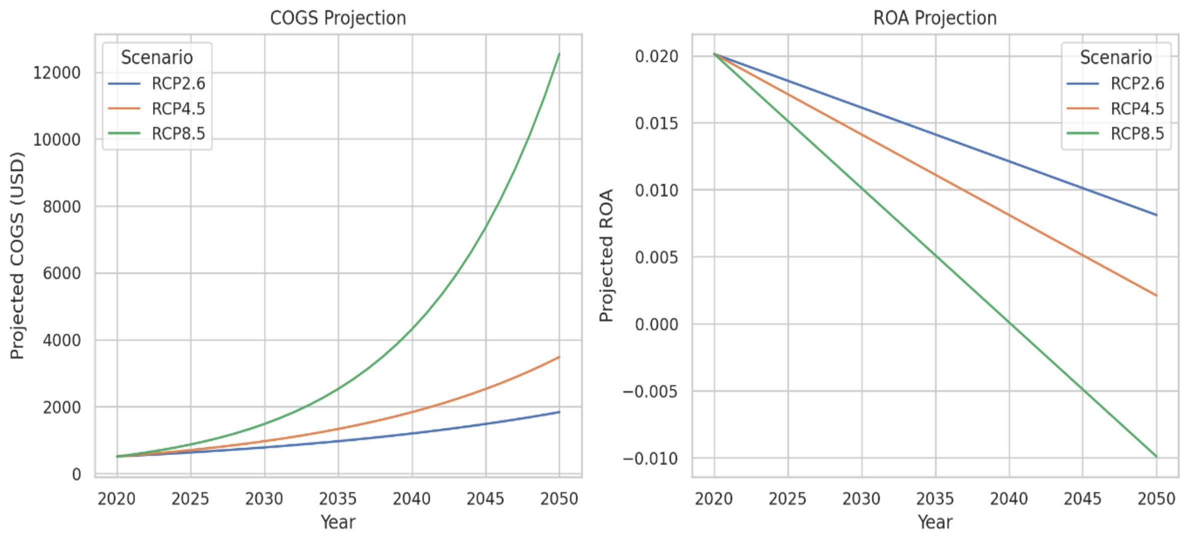
Allowable Annual Cut (AAC), initially exhibits negative impacts on profitability, particularly in simpler models, with standardized beta coefficients around -0.423 ($p < 0.05$). The relationship suggests short-term profit sacrifices, possibly associated with strategic long-term growth initiatives or proactive ecological risk management strategies like AAC. However, the significance of AAC diminishes once ecological disturbances are explicitly controlled, suggesting reactive policy adjustments in harvest quotas that respond to anticipated ecological stressors rather than proactive profit management. Here, government efforts to help the forest industry by increasing AAC lose their effectiveness in protecting profitability.

Severe forest fire seasons negatively affect profitability significantly in the most comprehensive model ($\beta = -0.3374$, $p < 0.01$), though less dramatically than insect attacks. Higher harvested volumes ($\beta = -0.2739$, $p < 0.10$) and extreme lumber prices ($\beta = -0.4179$, $p < 0.05$) correlate negatively with ROA, reflecting margin compression during intensive logging years and hedging or inventory cost impacts at lumber price extremes. As with the operational cost results previously, a firm's financial structure, its leverage (DE), appears largely inconsequential once operational risks are taken into account.

In sum, climate change secondary effects of insect infestation and fires harm the profitability after two years for forestry firms. During such biological disruptions, the government responds by increasing harvesting quota, AAC; however, it appears to have limited effect on forest firm profitability.

We further use our models on climate change effects to forecast future operational costs and profitability into 2050. Incorporating all of the variables, our model produces three accepted IPCC (International Panel on Climate Change) scenarios of global warming: best case at 2.6C, do nothing case at 4.5, and worst case 8.5C. Figure 7 shows the projections of rising operational costs, as well as falling profitability scenarios. These future projections suggest that the forestry firms are at high risk of failing to thrive or prosper in the next 25 years. Indeed, the profitability shows all three ROAs falling below 2 percent which is unviable for raising capital investment.

Figure 7. Projections on Firm Operations Cost and Profitability Based on IPCC Scenarios on Global Warming



Global Warming and Market Valuation

How does the financial market respond to forestry firm valuations relating to climate change? Figure 8 shows historical trends of climate change and firm stock returns. Here, as the climate change trend is rising, the firm's returns appear flat (trend line) over these 25 years. Investors face low returns without growth and would seek more attractive returns in stocks from other industries and countries, such as the United States, which is a very concerning issue for this industry. Interestingly, Figure 8 shows that temperature anomalies and forestry firm returns appear to move together, synchronizing with the peaks and troughs. However, the market capitalizations exhibit a rising trend, in line with the growth trend of temperature anomalies in Figure 9.

Figure 8. Trends of Global Warming and Forestry Firms' Stock Return

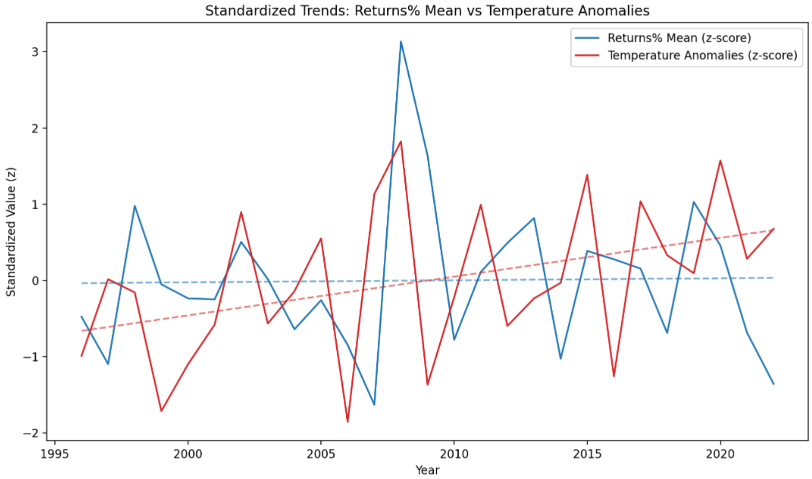
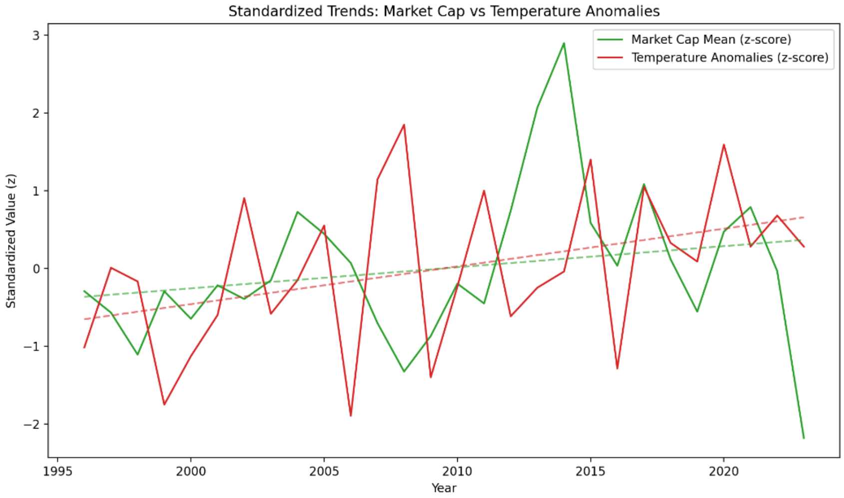


Figure 9. Trends of Global Warming and Forestry Firms' Market Capitalization



We test our hypothesis using the results in Table 5, which indicate that climate change hurts the market performance of forest firms. Here, we employ a two-stage panel regression model (utilizing the same drivers), with the forest firm stock returns (lagged by one year) as the dependent variable.

The highlight of this analysis is the direct and indirect impacts that climate change has on the stock returns of forestry firms. Notably, these return effects are not observed in the current year, but rather in the year that follows. First, Temperature Anomalies alone have a negative (-0.457, $p \approx 0.01$) effect on stock performance. Second, hot years combined with insects (TempAnom X Insect) and Harvested volume both reduce future returns (-0.304 and 0.654, $p \approx 0.03$ and 0.01). Interestingly, Insect Attacks (+0.594, $p < 0.01$) strongly raises next-year returns, a positive effect. Our model fitness yields an R-squared of 0.65, indicating that the set explains almost two-thirds of the lagged-return variation. The climate-and-operations block is genuinely predictive for future returns.

Next, in the second-stage regression, we use the fitted (expected) returns to value the firm. We append the lagged returns as an additional input and regress Market Cap Mean (standardized) on the standard deviation of these lagged returns, using the same nine drivers. Here, we find that the expected-return factor itself (LagRet_hat_std) is small and insignificant (-0.033, $p \approx 0.75$). This result implies that market value does not directly respond to the one-year-ahead return forecast once other fundamentals are taken into account. Other findings show that the TempAnomXInsect remains materially negative (-0.507, $p \approx 0.03$), which continues to affect returns as it did in the first stage. Harvested volume switches to positive and significant (+0.453, $p \approx 0.004$) for market cap. Insect Attacks (+0.555, $p \approx 0.063$) and COGS (+0.739, $p \approx 0.075$) are marginally significant. Our model fit drops to an R-squared of 0.513, compared to the earlier single-stage valuation. Thus, this extra fitted-return variable does not add explanatory power; in fact, it slightly dilutes the fit after adjustment. However, investors appear to price market-cap levels based on current operational and climate signals directly, rather than via the one-year expected-return channel.

Table 5. Two-Stage Regression Summary on Climate Change Effects on Firm Returns and Market Capitalization.

Stage 1: Predict next-year Returns % Mean

Dependent variable: standardized ReturnsMean_lag1

Variable	**Coef**	**StdErr**	**t**	**P>|t|**
const	0.0	0.074	0.0	1.0
Temperature Anomalies	**-0.457**	**0.179**	**-2.546**	**0.011**
TempAnomXInsect	**-0.304**	**0.141**	**-2.154**	**0.031**
Area Forest Fires	0.153	0.107	1.433	0.152
Insect Attacks	**0.594**	**0.141**	**4.218**	**0.0**
Harvested	**-0.654**	**0.252**	**-2.597**	**0.009**
Lumber Price 2	0.182	0.214	0.851	0.395
COGS (mill)	-0.378	0.279	-1.357	0.175
D/E	-0.039	0.168	-0.233	0.816
Total Assets	0.008	0.209	0.039	0.969
R-squared: 0.65, Adjusted R-squared: 0.453				

Stage 2: Market Cap Mean with expected returns

Dependent variable: standardized Market Cap Mean; includes fitted LagRet_hat_std

Variable	**Coef**	**StdErr**	**t**	**P>|t|**
const	-0.0	0.162	-0.0	1.0
LagRet_hat_std	-0.033	0.104	-0.313	0.754
Temperature Anomalies	-0.076	0.138	-0.548	0.584
TempAnomXInsect	**-0.507**	**0.231**	**-2.194**	**0.028**
Area Forest Fires	0.064	0.136	0.467	0.64
Insect Attacks	**0.555**	**0.299**	**1.857**	**0.063**
Harvested	**0.453**	**0.156**	**2.906**	**0.004**
Lumber Price 2	0.098	0.208	0.468	0.64
COGS (mill)	0.739	0.415	1.782	0.075
D/E	-0.162	0.178	-0.911	0.362
Total Assets	-0.314	0.304	-1.032	0.302
R-squared: 0.513, Adjusted R-squared: 0.239				

7. Discussion

Our study makes significant contributions to the existing literature on climate change and forestry firms. While previous research has explored the impacts of global warming on forests and the economic consequences for the forestry industry, it lacks an in-depth empirical analysis of how climate change specifically affects the prosperity of forestry firms. As highlighted by Murtaza et al. (2016), future research requires models that integrate knowledge from the natural sciences, economics, and business. Our study provides such a model, combining factors related to climate change, the business operations of forestry firms, government harvest allocations, and the impacts of fire and insect infestations over the past 50 years.

Our findings indicate that climate change, along with its secondary effects—such as insect attacks and wildfires—threatens the prosperity of forestry firms by increasing operating costs, reducing profitability, and lowering stock returns. Additionally, our research contributes to the emerging field of Climate Finance, which aims to identify causal links between trends in global temperatures and the cash flows of firms or industries (Dietz et al., 2016). Our study may be the first to investigate whether the stock market reflects the risks and impacts of climate change in the valuation of these companies. We found that the stock market does account for this risk approximately one year after a climate change risk event, such as a wildfire. This observation aligns with the data presented in Figure 5, where the peaks and troughs of temperature anomalies suggest predictable stock returns in the following year.

Robustness

We conduct robustness checks to validate our findings. First, we assess whether our models are affected by multicollinearity among the main independent variables. Table 6 indicates that the Variance Inflation Factor (VIF) for all variables is below 10, which is the acceptable threshold for multicollinearity. Therefore, our panel models do not exhibit multicollinearity issues.

Table 6. Robustness Test for Multicollinearity for Models

	Variable	VIF
0	Temperature Anomalies	1.32
1	TempAnomalies X Insect	2.02
2	Total AAC	7.37
3	Area Forest Fires	1.96
4	Insect Attacks	7.07
5	Harvested	2.57
6	Lumber Price 2	2.91
7	D/E	1.62
8	Total Assets	3.1

We begin by examining the robustness of coefficient estimates and model fit. Specifically, we conduct five robustness checks on the operational cost models: three Newey-West bandwidths, a heteroskedasticity-robust HC3 adjustment, and a Huber robust regression to account for outliers. All variables are z-scored, resulting in standardized beta coefficients.

In Table 7, we observe that the results from HAC0, HAC4, HAC8, and HC3 yield identical point estimates, although the standard error matrices differ. The Huber robust fit, which reduces the weights of high-leverage observations, slightly adjusts the beta values: it shows lower coefficients for Lumber Price and Temperature, while increasing the coefficients for Harvested and Total Assets.

Notably, the estimated coefficients' direction and relative magnitudes remain consistent. Our primary findings suggest that Temperature Anomalies are associated with an approximate increase of 0.14 standard deviations (σ) in Cost of Goods Sold (COGS) for every 1 σ increase in warming. Conversely, the major cost offsets are observed from Total Allowable Cut (≈ -0.52 σ) and Harvested (≈ -0.30 σ). Insect Attacks, Lumber Price, and Total Assets continue to exert positive pressure on COGS. Interestingly, the fire area still indicates a slight negative association, suggesting that our earlier findings are not merely an artifact of outliers.

Table 7. Robustness Test of Coefficient Estimates in Models

HAC0	HAC4	HAC8	HC3	Huber
-0.098	-0.098	-0.098	-0.098	-0.085
0.077	0.077	0.077	0.077	0.054
-0.3	-0.3	-0.3	-0.3	-0.365
0.376	0.376	0.376	0.376	0.368
0.256	0.256	0.256	0.256	0.198
0.068	0.068	0.068	0.068	0.088
0.139	0.139	0.139	0.139	0.103
-0.52	-0.52	-0.52	-0.52	-0.504
0.39	0.39	0.39	0.39	0.406
0	0	0	0	0.014

In summary, the estimates of the cost drivers are robust against reasonable choices of serial correlation bandwidth and adjustments for outliers.

8. Conclusion

We are driven to address the need for research examining how climate change affects the business performance of forestry firms. Our findings clearly indicate that climate change adversely impacts both the prosperity and sustainability of these firms. Specifically, global warming leads to the destruction of forests, provokes government harvesting policy responses, and increases production costs for these companies. As a result, they face reduced profitability and decreased market valuation. Given the alarming trends associated with climate change, the challenges it poses to the forestry sector are expected to intensify, resulting in negative consequences for the sustainability of the industry. This, in turn, poses significant risks to the firms, communities, and individuals that rely on forests.

One limitation of our research is the small population of forestry firms in Canada, which has been declining in recent decades. Many companies in the industry have either merged, relinquished ownership, or liquidated since their establishment. Despite this limited population, our study produces robust results and models with high significance.

For future research, we see a valuable opportunity for scholars to investigate the business impacts of adaptation efforts undertaken by forestry firms in response to climate change.

Our findings establish causal links between trends in global temperatures and not only the cash flows of firms or the industry but also their stock market returns. These implications for forestry firms are significant and warrant further exploration.

REFERENCES

1. Abatzoglou, J. T., and A. P. Williams. 2016. "Impact of Anthropogenic Climate Change on Wildfire across Western U.S. Forests." *Proceedings of the National Academy of Sciences USA* 113 (42): 11,770–11,775. https://doi.org/10.1073/pnas.1607171113.

2. Acuna, M., and M. Strandgard. 2017. "Impact of Climate Change on Australian Forest Operations." *Australian Forestry* 80 (5): 299–308. https://doi.org/10.1080/00049158.2017.1395762.

3. Boccanfuso, D., V. Bernier Gosselin, J. Goyette, L. Savard, and C. Tanekou Mangoua. 2013. "An Impact Analysis of Climate Change and Adaptation Policies on the Forestry Sector in Quebec: A Dynamic Macro-Micro Framework." http://gredi.recherche.usherbrooke.ca/wpapers/GREDI-1404.pdf.

4. Boccanfuso, D., L. Savard, J. Goyette, V. Bernier Gosselin, and C. Tanekou Mangoua. 2018. "An Impact Analysis of Climate Change on the Forestry Industry in Quebec: A Dynamic CGE Model." *Canadian Journal of Forest Research* 48 (2): 216–226. https://doi.org/10.1139/CJFR-2017-0220.

5. Bray, J. R. 1956. "Gap Phase Replacement in a Maple-Basswood Forest." *Ecology* 37: 598–600.

6. Deming, D., and R. A. Borel. 1995. "Evidence for Climatic Warming in North-Central Oklahoma from Analysis of Borehole Temperatures." *Journal of Geophysical Research* 100 (B11): 22017–22032. https://doi.org/10.1029/95JB02625.

7. Dietz, S., A. Bowen, C. Dixon, et al. 2016. "Climate Value at Risk of Global Financial Assets." *Nature Climate Change* 6: 676–679. https://doi.org/10.1038/nclimate2972.

8. Flannigan, M., B. Stocks, and M. Weber. 2003. "Fire Regimes and Climatic Change in Canadian Forests." In *Fire and Climatic Change in Forests of North America*, edited by T. T. Veblen, W. L. Baker, G. Montenegro, and T. W. Swetnam, 3–17.

9. García-Jácome, S. P., M. Jankovský, A. D. Hoeben, M. Lindner, S. Uzquiano, T. Stern, O. Nuhlíček, et al. 2025. "Forest Value Chain Resilience from a Local Perspective in Five European Countries: Analysis of Predictors and Co-Drivers." *Frontiers in Forests and Global Change* 7. https://doi.org/10.3389/ffgc2024.1461932.

10. Gillette, N. P., A. J. Weaver, and M. D. Zwiers. 2004. "Detecting the Effect of Climate Change on Canadian Forest Fires." *Geophysical Research Letters.* https://doi.org/10.1029/2004GL020876.

11. Kirilenko, A. P., and S. E. Sedjo. 2007. "Climate Change Impacts on Forestry." *Proceedings of the National Academy of Sciences of the United States of America.* https://www.pnas.org/content/104/50/19697.short#abstract-1.

12. Kotlarz, J., and S. Bejger. 2024. "Estimation of the Short-Term Impact of Climate-Change-Related Factors on Wood Supply in Poland in 2023–2025." *Forests* 15 (1). https://doi.org/10.3390/f15010108.

13. Linnenluecke, M. K., A. Griffiths, and M. I. Winn. 2013. "Firm and Industry Adaptation to Climate Change: A Review of Climate Adaptation Studies in the Business and Management Field." *WIREs Climate Change* 4: 397–416. https://doi.org/10.1002/wcc.214.

14. McGlinchey, D. 2019. "Capital Markets at Risk from Climate Change." *Woods Hole Research Center.* http://whrc.org/capital-markets-at-risk-from-climate-change/.

15. McMonagle, G., V. A. Lantz, A. R. Taylor, Y. Boulanger, C. Sharma, P. Withey, and C. R. Hennigar. 2024. "Economic Impacts of Climate Change on Forests: A PICUS-LANDIS-CGE Modelling Approach." *Canadian Journal of Forest Research.* https://doi.org/10.1139/cjfr-2024-0089.

16. Murtaza, Ghulam, Faiz Rasool, Rab Nawaz, Tariq Javed, Amna Rasool, Muhammad Shahzad, Muhammad Ahsin Ayub, Muhammad Mohsin Ayub, and Hasnain Irshad. "A Comprehensive Review of Climate Change Deadly Impacts on Forest and Forestry." *Crops* 9 (10).

17. Neilson, R. P., and D. Marks. 1994. "A Global Perspective of Regional Vegetation and Hydrologic Sensitivities from Climatic Change." *Journal of Vegetation Science* 5: 715–730. https://doi.org/10.2307/3235885.

18. Pedersen, L. 2004. “How serious is the mountain pine beetle problem? From a timber supply perspective. In Mountain pine beetle symposium: Challenges and solutions.” October 30–31, 2003, Kelowna, B.C. T.L. Shore, J.E. Brooks, and J.E. Stone (editors). Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria, B.C. Information Report bc-x-399. Victoria, B.C. pp. 10–18.

19. Riviere, M., F. Pimont, P. Delacote, S. Caurla, J. Ruffault, A. Lobianco, T. Opitz, and J.-L. Dupuy. 2022. "A Bioeconomic Projection of Climate-Induced Wildfire Risk in the Forest Sector." *Earth's Future* 10. https://doi.org/10.1029/2021EF002433.

20. Roos, A. 2023. "Forest Damage and Forest Supply Chains: A Literature Review and Reflections." *International Journal of Forest Engineering* 34 (3): 330–339. https://doi.org/10.1080/14942119.2023.2240607.

21. Schneider, Stephen H. 1989. "The Changing Climate." *Scientific American* 261 (3): 70–79. http://www.jstor.org/stable/24987396.

22. Wotton, B. M., and M. D. Flannigan. 1993. "Length of the Fire Season in a Changing Climate." *The Forestry Chronicle* 69 (2): 187–192. https://doi.org/10.5558/tfc69187-2.

23. Kurz, W., C. Dymond, G. Stinson, et al. 2008. "Mountain Pine Beetle and Forest Carbon Feedback to Climate Change." *Nature* 452: 987–990. https://doi.org/10.1038/nature06777.

Table 3. The Effect of Climate Change on Forestry Firm Operational Costs

This table presents the baseline regression results of temperature anomalies (climate change) on firm level cost of goods sold. Estimated Beta coefficients are standardized. T-statistics are in parentheses and significant levels are denoted by *** p<0.01, ** p<0.05, * p<0.1

Dep Variable: Cost of Goods Sold

Variable	1. Beta	2. Beta	3. Beta	4. Beta	5. Beta	6. Beta	7. Beta	8. Beta	9. Beta
Temperature	**0.491** ***	**0.355** ***	**0.429** ***	**0.371** ***	**0.388** ***	**0.273** ***	**0.242** ***	**0.238** ***	**0.139** ***
Anomalies	**(3.74)**	**(3.02)**	**(0.42)**	**(3.19)**	**(3.62)**	**(3.35)**	**(4.05)**	**(4.21)**	**(2.75)**
Temp Anom		0.339	0.563 ***	0.457 ***	0.252 *	0.207 *	0.121	0.116	0.068
X Insect		(1.93) *	(3.95)	(2.87)	(1.68)	(1.93)	(1.54)	(1.47)	(1.08)
Total AAC			-0.532 ***	-0.369 *	-0.889 ***	-1.041 ***	-0.798 ***	-0.763 ***	-0.520 ***
			(-3.28)	(-1.75)	(-4.28)	(8.38)	(-9.41)	(-8.37)	(-6.51)
Area Forest Fires				0.274 *	0.008	-0.140 *	-0.186 ***	-0.176 ***	-0.098 ***
				(1.94)	(0.08)	(1.93)	(-4.08)	(-3.58)	(-2.73)
Insect Attacks					**0.814** ***	**0.849** ***	**0.801** ***	**0.777** ***	**0.376** ***
					(4.67)	**(6.72)**	**(8.45)**	**(8.32)**	**(4.63)**
Harvested						-0.141	-0.114	-0.122 *	-0.300 ***
						(-1.01)	(-1.53)	(-1.79)	(-3.80)
Lumber Price							0.369 ***	0.398 ***	-0.256 ***
							(5.16)	(4.70)	(3.40)
Debt / Equity								0.044	0.077
								(0.72)	(1.39)
Total Assets									0.390 ***
									(5.25)
Intercept	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	64	49	49	49	48	33	33	33	33
R_squared	0.241	0.317	0.533	0.584	0.714	0.819	0.895	0.896	0.945
Adj R-squared	0.229	0.287	0.502	0.546	0.68	0.778	0.866	0.862	0.924

Table 4. The Effect of Climate Change on Forestry Firm Profitability

This table presents the baseline regression results of temperature anomalies (climate change) on a firm's profitability, Return on Assets. Estimated Beta coefficients are standardized. T-statistics are in parentheses and significant levels are denoted by *** p<0.01, ** p<0.05, * p<0.1

Dependant Variable: Return on Assets ROA Lag 2 years

Variable	1. Beta	2. Beta	3. Beta	4. Beta	5. Beta	6. Beta	7. Beta	8. Beta	9. Beta	10. Beta
Temp Anom	**0.010**	**0.105**	**0.164**	**0.162**	**0.195**	**0.134**	**0.161**	**0.153**	**0.060**	**0.052**
	(0.07)	**(0.62)**	**(1.03)**	**(0.96)**	**(1.22)**	**(1.29)**	**(1.55)**	**(1.33)**	**(0.51)**	**(0.44)**
TempAnom X Insect		**-0.209**	**-0.031**	**-0.034**	**0.129**	**0.284 ***	**0.359 *****	**0.348 *****	**0.304 *****	**-0.407** **
		(-1.64)	(-0.18)	(-0.19)	(0.98)	(1.71)	(2.30)	(2.36)	(1.99)	(-2.31)
Total AAC			-0.423 **	-0.418 **	-0.027	-0.047	-0.260	-0.186	0.041	-0.025
			(-2.58)	(-2.04)	(-0.13)	(-0.18)	(-1.13)	(-0.86)	(0.17)	(-0.07)
Area Forest				0.009	-0.031	0.018	0.059	0.082	0.154	-0.337 ***
Fires				(0.05)	(-0.31)	(0.15)	(0.65)	(0.91)	(1.38)	(-2.74)
Insect					**-0.605 *******	**-0.625 *****	**-0.583 *******	**-0.635 *******	**-1.009 *******	**-0.446 ***
Attacks					**(-3.29)**	**(-2.57)**	**(-2.67)**	**(-2.88)**	**(-3.07)**	**(-1.66)**
Harvested						0.100	0.077	0.058	-0.107	-0.274 *
						(0.67)	(0.46)	(0.36)	(-0.55)	(-1.66)
Lumber Price							-0.324 ***	-0.262	-0.395 **	-0.418 **
							(-2.75)	(-1.36)	(-2.07)	(-2.43)
D/E								0.093	0.124	-0.004
								(0.59)	(0.82)	(-0.02)
Total Assets									0.365 **	0.175
									(2.13)	(0.91)
COGS mill										0.699 *
										(1.79)
Intercept	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Observation	50	49	49	49	48	33	33	33	33	32
R-squared	0.000	0.041	0.178	0.178	0.274	0.309	0.368	0.373	0.416	0.619

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[i] Mountain Pine Beetle. (2019, August 01). Natural resources Canada. Government of Canada. Retrieved from https://www.nrcan.gc.ca/our-natural-resources/forests-forestry/wildland-fires-insect

[ii] Penner, D. (2019, May 21). B.C. forest industry can expect the loss of another 12 sawmills over next decade, analyst estimates. Vancouver Sun. Retrieved from https://vancouversun.com/business/local-business/b-c-forest-industry-can-expect-the-loss-of-another-12-sawmills-over-next-decade-analyst-estimates

[iii] Fredeen, A., (2007). Climate change and the mountain pine beetle. UNBC. Retrieved from https://www.unbc.ca/releases/2007/climate-change-and-mountain-pine-beetle

[iv] Climate Finance Leadership Initiative. (2019). Ensuring sustainable economic growth. Retrieved from https://www.bloomberg.com/cfli/impact/