Fall 12-12-2022

The Effect of Climate Change on Firm Level Costs with Focus on MENA Region

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الجامعة الأمريكية بالقاهرة
Graduate Studies

The Effect of Climate Change on Firm Level Costs with Focus on MENA Region

A Thesis Submitted by
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to the
Master of Science in Finance
Graduate Program

12th December 2022

In partial fulfillment of the requirements for the degree of

Master of Science in Finance

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Abstract

This paper has a main objective of identifying the relationship between environmental factors and climate change on operating costs incurred by firms. This paper also attempts to compare the direction and intensity of the effect on different sectors in order to analyze whether climate change effect differs based on the nature of the business operations. Several papers have previously addressed the relationship between climate change factors ad profits. This literature will add to previous studies by observing the effect on the cost rather than the profits. In addition to providing results that minimize endogeneity, which is found in a large scale in this particular relationship. This will enable us to test whether some sectors are positively affected (incur lower costs) by the deterioration in the environment and the worsening of climate conditions and climate change severity. Our initial hypothesis predicts that in general, overall firms will incur higher costs due to climate change disruptions and the need to adjust operations accordingly. The study results can be summarized as following: Overall climate change conditions result in a direct increase in costs on firms operating in the MENA region. When observing sectors, we have found that sectors which are most linked and dependent on natural resources and land quality are those highly impacted by the variable changes. Meanwhile, firms with less dependency on natural resources and are rather more technologically built, have a weaker relationship and significance with climate changes. This study encourages firms' and the MENA region as a whole to reconsider regulations and measures taken to overcome or rather to manage the increasing climate change threats imposed due to the severity of their consequences.

Introduction

Climate change has gained a lot of attention due to its criticality and world-changing effect on the economy. This phenomenon is not newly introduced; in fact, it has been gaining huge momentum for decades. Global warming has been the topic of the hour since the beginning of the Industrial Revolution around 300 years ago. This rise in momentum is mainly driven by the fact that we, as humans and our human activity, have become one of the main drivers and triggers for this issue. Humans have largely impacted world temperatures by contributing in additional industrial gas emissions that lead to trapped sun heat. This phenomenon is known as the greenhouse effect (Curley 2021). This effect is amongst many other measures that help observe the worsening climate situation on Earth. Climate change can be measured by comparing weather patterns in different regions. It can additionally be measured using different tools and observations such as wind, soil formation, temperature change and precipitation. Identifying climate change can only be identified by observing climate movements through the years (Cunningham 2019). Focusing on this topic is crucial as human-interference has become one of the main triggers of worsening climate conditions, therefore understanding the implications of those changes could possibly lead to increased awareness and needed precautionary measures. Previous studies have tested and assumed that climate change leads to lower running revenues on firms and businesses, this paper aims to test the accuracy of those findings and measuring the severity of the effect assumed but from the cost perspective and by comparing different sectors. Attempting to measure this relationship is a challenging task due to the high level of endogeneity in the most-frequently used models. This concept has also become more prominent as most countries have started introducing measures and regulations in an attempt to restrict or minimize human-induced climate damage. This is an attempt by regulators to boost awareness and measures taken by firms to minimize gas emissions and polluting activities. As a concept, climate change is relatively volatile and reacts to several factors, which researchers have long been attempting to explain and identify the effects that are resulting from it, this paper will focus on the direct effect on firm level costs. To demonstrate more reliable findings, this study will be conducted on several distinct countries with different backgrounds across the MENA region. Data observations will be retrieved starting from a historical time interval starting 1980 in order to be able to observe several decades, the observations will continue to include the most recent figures available in 2021. This research will use several environmental measures to test the effect

of climate change on the operating cost of MENA region companies. Moreover, this time-period will cover a large span thus would allow us to observe how changes in climate change, which have evolved drastically during later times and environmental awareness and social responsibility have become a main target for investors, and how this affected investment choices and company accrued operating costs. This research paper will be divided into five sections. The first section will focus on the literature review and mention some of the previous contributions related to the subject. The second section will demonstrate the research question being tackled. The third section will explain the methodology and the model used to test the hypothesis, as well as explaining the research design and sample selection. The fourth section will include the model results and the analysis of the outcomes. Finally, the fifth section will include the conclusion.

The literature available related to the topic focuses mainly on the relationship between climate change and profits. Moreover, previous literature mentions costs within the scope of motivation, meaning that they attempt to prove how following regulations and being environmentally aware would help firms minimize long-term costs. Majority of the research focus on how mitigations taken by countries and companies, help them become more productive. An example of the most prominent research models used is testing one environmental variable that shows climate change and testing its' relationship and effect on financial indicators such as ROI, ROA, and ROE. Most of which have produced and assumed a positive relationship between being environmentally cautious and taking precautionary measures and financial performance (Castihlo 2022).

This paper will attempt to add value to previous literature by introducing a different measure to represent firm performance and efficiency, which will be the operating cost rather than revenue/profit analysis. Moreover, this paper will divide the relationships identified based on sectors in order to identify similarities and differences. The most important factor this paper will add, is the attempt to minimize the endogeneity in such testing by using a model that attempts to reduce the relationship between variables in the model and how the variables used as inputs themselves can have a direct effect on each other, as long as how the output variable can simultaneously affect the future inputs.

Justification of Selection

This research will be applied on the MENA region in specific during a 42 years' time interval. This is a significant study as climate change and environmental factors relationship with company performance has been growing extensively and has become embedded in most financial and economic considerations. Moreover, climate change and environmental awareness has received great focus recently not only by governments, but also by entities, firms and individual investors. This research will help provide literature on whether operating costs incurred by businesses are directly affected by negative changes in climate and in the environment as a whole, the testing will also identify the intensity and nature of the relationship (positive or negative).

The MENA region in specific includes several developing markets, which are heavily affected by global economic shifts, therefore it is of great importance to address the matter in the countries which are heavily effected, and which include a concentration of climate and environmental awareness. The period of study has been selected to compliment the objective, therefore, to be able to compare, the research must initially include the period before the increased awareness on climate change as a topic of interest and continuing to include the most recent figures where climate change has become the center of attention for most of, if not all the world.

The whole globe has been focusing on being more environmentally cautious and aware of the effect of their investment decisions on the overall soundness of the economy. This has severely affected the consumer buyer behavior, stock market movements and returns, business profitability measures, costs in all forms and the overall economy. If climate change is found to affect operating costs, this could lead to justifying some of the unexplained company performances.

Literature Review

The first introduction and awareness of climate change according to Bolin in his book titled "A History of the Science and Politics of Climate Change" can be considered from the beginning of 1987. This was during the UN General Assembly opening where the report named Our Common Future was being discussed. The focus of the report was on the rapid change of environmental soundness and the increase in natural resource exploitation. This topic included a broad range of sub-topics to be discussed such as illiteracy, poverty, safe water availability, wood fuel availability, increase of unusable damaged dry-land, precipitation and CO2 emissions. The report also focused on the greenhouse effect. This topic was of great importance because it was seen to lead to deterioration of the environment and would change the planet and put several species existences under threat. The main purpose of such awareness is to put people on the right track and highlight the importance of cautious activities and establish policies that would sustain the scarce environmental resources. The highlight of this publication is that it mentions that only 28 countries responded to the meeting to discuss climate change, these countries only included 11 developing countries. This indicated that developing countries were behind on awareness and readiness to work on such matter, which as referred by Bolin indicated that Climate Change was not a topic that was high in priority in the political agenda for most countries. (Bolin 2007).

According to Castilho, in his paper titled "The relationship between climate change mitigation strategies and the financial performance of Brazilian companies", human activities heavily affect climate change. Therefore, companies should be fully aware of their negative climate change and environmental contribution and should take mitigating actions towards reducing emissions. This further on led to the development of several regulations and government restrictions that guide and monitor business activity. Not only does this help reduce the negative impact on the environment, but also, according to Castilho, climate change strategies implemented by businesses can help them achieve leadership in their sector and leads to a positive financial performance. Agreeing with this research, previous research mainly focuses on investigating developed countries. Meanwhile, developing countries have lacked extensive studies on this topic. Based on Busch and Lewandowksi, out of 32 studies on climate change, only one study focused on developing countries.

A recent newly published literature that tests the relationship between climate change and costs was titled “The impact of climate vulnerability on firms’ cost of capital and access to finance” written by Kling in 2019. This literature notes that it is the first to investigate the effect of climate vulnerability on firms’ cost of capital and finance resources. This paper created a climate index to include in the model which would represent climate change. The scope of this paper was focused on the private sector companies worldwide. It also attempts to reduce endogeneity by using the panel variable regression model. This paper includes worldwide firms and uses a timespan from 1997 till 2017. This means that it lacks inclusion of the most recent awareness post-pandemic and inclining environmental damage and hazards. The results of testing show, according to Kling that only 0.63% direct effect of climate vulnerability leads to increase in cost of debt for firms. In conclusion, this research shows that climate change leads to higher corporate financing cost and increases cost of capital for firms.

This sets ground to the next major aspect of this research, the choice of the MENA region as an area of focus for the purpose of this study. According to a publication by Thompson titled “Climate Change in the Middle East and North Africa: 15,000 Years of Crises, Setbacks, and Adaptation”, MENA region is one of the most fragile regions worldwide, which means that it could become virtually uninhabitable due to continuous climate and environmental pressure and deterioration. Thompson predicts that the recurring unfavorable climate changes in the long term could disrupt the development and enhancement of the MENA region. Climate change as an event has occurred in the region several times historically. There were major climate shifts that occurred such as the Younger Dryas, which goes back as early as 12,000 years ago. Adding on to the importance of the MENA region as an area of focus, it is assumed that global warming will hit this region in particular, as it will lead to increase in temperatures by up to 7.5 degrees, decrease in water availability, increase in number of drought days by 50% by 2070-2099, damage of coastal areas due to rising sea levels, with the UAE, Qatar being areas of focus. In addition to those impacts, there is also expected to be lower rainfall, which would lead to decline in crop production and agriculture disruptions. This is a major factor as according to Thompson, over a third of the regions’ population work in the agricultural sector and thus GDP is heavily dependent on the performance of agriculture and any disruption could directly negatively affect the economy as a whole. It is mentioned that it is only very recent where climate change has

gained focus in this region specifically, as previously most topics related to this region focused on heritance, culture and dynasties (Thompson 2021). A result of this lack of awareness in the region, leads to the assumption that there are also minimal regulatory measures put in place to manage or contain the spiraling disruptions. This concludes that focusing on this area for the purpose of this study is integral and is of great importance and added value to literature.

A firm level operating expense also known as "OPEX" consists of the costs which are incurred by a firm in order to enable them to operate their business activity. These costs enable the company to run day-to-day operational business normally without disruption. This makes OPEX a main cost indicator of firm as they help analyze identify the company's overall operational performance and also give an insight on efficiency. Operating expense differs depending on the industry or sector, because each industry has different components or inputs which enable them to operate. Generally, this cost category includes supplies, administration fees, wages, utility costs and rent (if applicable). Our main focus for the purpose of this research is to identify the variable costs accurately to understand how costs vary as a result of negative environmental conditions. This cost was chosen due to its criticality and importance. Analyzing the trend of this cost/expense will help observe the company's costs needed to generate revenues, higher costs as a percentage of revenues indicate lower efficiency (Corporate Finance Institute 2022).

Climate change is considered to be one of the main topics currently being considered worldwide. This increase in awareness is mainly driven by the obvious increase in natural hazards, according to Salehi. To indicate how major and disruptive this concept has become, we can see that only in 2017, 318 natural disasters occurred leading to 122 countries affected. 9503 deaths, and as for the economic effect it was observed that a damage valued at $314 billion was incurred. Moreover, costs were seen to rise due to flood-affected damage and economic disruptions. It is also expected according to Salehi that by 2050, average temperature will rise on average by 2.5-3.7 degrees Celsius. This would accordingly lead to an increase in heat duration and drought. Finally, one must note that the one of the seven goals in the sustainable development is working against climate change (Salehi 2019).

Terra Climate, the data source used to retrieve climate related data using different methods and sources, including Terra Climate which is a dataset of monthly climate data and water balance

for global surfaces from 1958-2020. In order to extract such data, high spatial resolution was required along with time-varying data. The temporal resolution for the provided data is at a 4km spatial resolution. Terra Climate uses interpolated time-varying anomalies, in order to combine between high spatial resolution climatological normal retrieved from the WorldClim dataset, along with time-varying data retrieved from Japanese 55-year Reanalysis (JRA55) and CRU Ts4.0.

According to a journal publication by Oliver Deschenes and Michael Greenstone titled "The Economic Impacts of Climate Change: Evidence from Agricultural Output and Random Fluctuations in Weather", climate change will have an overall effect on the economic wellbeing. This is mainly driven by the fact that precipitation, rainfall ad temperature levels directly impact the production level of the agricultural sector in specific. According to Deschenes, farmers tend to alter their farm activities due to the change in climate, they start using fertilizers differently, attempt to change the crops mix used and can even use their land in activities other than crop production. This paper attempts to test the effect of climate change on crop production by using county-level panel data extracted from the Census of Agriculture. This data will help estimate the effect of climate change on the agriculture sector in terms of profits. The conclusion of this research predicts that there will be an increase in agricultural sector profits which is mainly driven by adjusting crops and fertilizer use according to the available resources. Moreover, farmers tend to switch their crop production to those that actually benefit from higher temperatures, making it cheaper and easier for them to produce these specific crops in large quantities, therefore they predict that the increase in profits is not only due to the fact that farmers will increase their prices in the short-run, but rather long-run adjustments to production (Deschenes 2017).

Addressing climate change cannot pass without considering how we can control and adapt to those changes. An article by Fussel named "Adaptation planning for climate change: concepts, assessment, approaches, and key lessons", observes how human interference can help combat and reduce the effect of climate damages. Fussel notes that we can either mitigate or adapt to those changes. Adaptation relates to focusing on the vulnerable system in order to attempt to moderate the harms occurring. Meanwhile, mitigation related to eliminating the changes by controlling our emissions of gases and damages. Mitigation is considered more important due to

its ability to actually minimize the impact on the long run as it actually targets reducing the root cause. Additionally, adaptation is unable to avoid or target all impacts of climate change, due to practical constraints and thus adaptation cannot substitute or replace mitigating procedures. This highlights the importance of educating humans and firms of ways to mitigate and adapt to climate changes, in order to limit or minimize the negative impacts forecasted to occur in the near future (Fussel 2007).

After considering adaptation and mitigation, we can focus on how one of the sectors considered are attempting to adjust to climate change. A publication titled "World trade as the adjustment mechanism of agriculture to climate change" by Roxana Julia and Faye Duchin focuses on the adaptation measures by trade sector in order to combat climate change. This paper considers that as climate change significantly reduces crop production and yields, workers and governments usually attend to adjust production and consumption patterns in order to control and minimize the global overall impact. This is mainly driven by the importance of agricultural production in food sufficiency and supply. This paper addresses a very important factor to be considered which is the location, where Julia and Duchin argue that an efficiently functioning trade system, helps shift production to different regions depending on the location and competitive advantage of regions which benefit from weather disruptions in a way that enables them to produce more. This, as a global outcome helps compensate the potential losses of other regions of the world. This point shows the importance of understanding and analyzing each region separately as climate change impacts cannot be generalized. For this reason, this paper focuses on the MENA region which is an already high temperature region, with low expected precipitation volume (Julia & Duchin 2007).

Research Question

As indicated earlier, this research paper is focusing on the effect of environmental factors and climate change worsening trends on the performance of firms in the MENA region. The performance of firms will be observed using operating costs incurred. The main research question is whether worsening environmental conditions will actually negatively affect costs and will lead to higher operating expense costs due to tougher business' operating environments and increased demand and pressure to keep business activity constant and unaffected. This question

is due to the assumed relevance between climate conditions and the ability to perform operational activities with the same force due to activity disruptions, damaged goods, shutdowns and unavailable or endangered labor force.

Research Methodology

The goal is to estimate the effect of Climate change on the firm costs. A simple regression for this case will lead to biased parameters due to the endogeneity problem. For instance, firms bearing high costs may adversely affect climate change. On the other hand, significant changes in the climate might affect the firms' cost function. Following Love and Zicchino (2006), this empirical framework will be based on the Panel Vector Autoregressive model that considers the endogeneity problem that might result in significant covariance between the regressors and the error term. Following (Holtz-Eakin et al.1988), we assume q variate panel VAR as in the linear equation below:

$$Cost_{its} = Cost_{its-1}A_1 + Cost_{its-2}A_2 + \cdots + Y_{its-q}A_q + X_t\beta + \phi_i + \gamma_s + \varepsilon_{it} \rightarrow$$

$$Where\ i\ corresponds\ for\ the\ firm\ i \in \{1,2,..,N\},$$

$$While\ \ t\ represents\ the\ time\ t \in \{1,2,..,T\}$$

To define the Variables in equation (1), first $Cost_{its}$ is the firm i cost at time t operating in sector s. While X_t is a matrix of explanatory variables representing climate change. ϕ_i and γ_s are the firm and sector fixed effects respectively. ε_{it} is the Error term assumed uncorrelated with X. The matrices $A_1, A_2, \dots, A_q, and\ \beta$ are the parameters to be estimated. This model minimizes biasness at large T, as derived by Judson and Owen (1999). This thesis chooses the optimal number of lags based on Bayesian information criteria (BIC), Hannan–Quinn information criteria (HQIC), and Akaike information criteria (AIC).The Levin–Lin–Chu (2002) test for stationarity in Panel data is applied as moment conditions are inefficient when the Panel has nonstationary series. Considering the autoregressive structure of the Panel VAR model, this thesis presents impulse response functions (IRF). The stability conditions (invertibility and infinite order of

Vector Moving Averages) for those IRFs were test for the model (Lütkepohl, 2005). The following matrix presents the companion matrix necessary for the IRF where it reflects the k variate panel VAR.

$$\bar{A} = \begin{pmatrix} A_1 & A_2 & .. & A_{p-1} \\ I_k & O_k & .. & 0_k \\ .. & .. & .. & 0_k \\ 0_k & 0_k & I_k & 0_k \end{pmatrix}$$

The empirical model which will be used to assess the time interval will be as following:

$$LOPEX_{i,t} = \beta_0 + X1_{i,t} + \beta_2 X2_{i,t} + \beta_3 X3_{i,t} + \beta_4 X4_{i,t} + \beta_5 X5_{i,t} + + \beta_6 X6_{i,t} + \beta_7 X7_{i,t} + + \beta_8 X8_{i,t} + \varepsilon_{\iota,\tau}$$

The methodology of this research will be based on panel data regression with firm-level data retrieved from Reuters Eikon and climate change measures retrieved from Climate Northwest Knowledge (Climatology Lab). For the purpose of this research, we will run a panel instrumental variable regression model, the purpose and reason for this regression choice is in order to prevent having the clear endogeneity relationship found within the variables included in the model. in this test. Panel regression model uses specific lags This model will test the significance and measure of the relationship between firm level costs and climate change indicators. Results will be divided based on the sector activities of the firms under testing in order to analyze whether there's a difference in the relationship based on the sector of activity and nature of business operations. This research will be conducted by recognizing trends in the cost structure by analyzing financial statements and comparing them to climate change disruptions.

Data and Variables

In order to be able to run and come up with results that represent the MENA region, we chose the 10 biggest and most influential countries in the region to extract private operating firms. The countries under study were as follows, Saudi Arabia, United Arab Emirates, Morocco, Bahrain, Israel, Egypt, Kuwait, Qatar, Jordan, and Oman. Through this country choice, we retrieved pa total of 1,792 privately listed companies. Results were retrieved within a 41-year time interval initiating in 1980 and ending in 2021. For the purpose of the econometrics analysis, we will be

using firm-level data extracted from Thomson Reuters Refinitiv Eikon. Through this database, we extracted the firms' operating expense, as per Refinitiv Eikon, this represents the total operating expense as it is reported by the firm. This expense is reported in the gross profit/operating expense format. This excludes any extraordinary or non-recurring items. Total operating expense includes selling, general and administrative expenses, which is applicable on all industries. As for Financial companies, they additionally include cost of financing-related operations, underwriting expense and insurance reserves or claims (Refinitiv Eikon n.d.) Based on these firm-level indicators, we retrieve the impact of climate change and vulnerability on the total operating expense cost by running a panel data regression. In this research, we observe climate change and economic disruptions direct affect on a firm's cost of operating expense.

Climate change related data is obtained from the Climate Northwest Knowledge (Climatology Lab). Terra Climate dataset includes the following variables used in our study, windspeed, precipitation, vapor pressure, and downward surface shortwave radiation. Our dependent variable includes measures of cost of operating expense. In addition, we derive country-level measures of expenses incurred by country in total using GDP as an indicator of country overall performance during the period, which conceptually should correlate with firm-level performance of the same country. This variable also helps provide an indicator as to which countries are most vulnerable or well-prepared to handle environmental and climate challenges and risks, this can also be analyzed to observe whether location plays a factor on the intensity of the effect.

	Symbol	Variable	Description
Dependent Variables	OPEX	Operating Expense	Expense Performance Indicator
Independent Variables	X1	GDP	Gross Domestic Product
	X2	Surface Land Level	Land components which are physically visible and present
	X3	Wind Speed	How fast air moves past a specific defined point
	X4	Vapor Pressure	Quantity of water found in the air
	X5	Soil Moisture	Quantity of water, including water vapor, found in unsaturated land soil
	X6	Water Deficit	Available water resources and human activity/requirements.
	X7	PDSI	Palmer Drought Severity Index - Long-term drought
	X8	Precipitation	Water released from clouds

Definition of Variables

The variables which will be used as the dependent variables to measure costs will be the OPEX. The independent variables will be GDP, which will represent the macro-indicator in the model. As for the independent variables, these will include Surface Level, Wind Speed, Vapor Pressure, Soil Moisture, Water Deficit, PDSI (Palmer Drought Severity Index), and Precipitation. These figures are retrieved on a monthly basis per country. The first variable considered is GDP which is by definition the goods and services produced during a specific time period for a specific country. For the purpose of this paper, GDP will be observed on an annual basis per country. GDP helps provide an insight on whether the country under study is shrinking or growing, it also shows the size of the economy and quality of performance. This is a main attribute in this model because it is directly related to company performance, where increased GDP indicates better performing companies and better production. On the other side, if GDP is found to be shrinking this would also indicate that global disruptions led to affecting the quality and ability of firms to produce and hire within their normal levels (IMF).

Moving on to the climate measures, the first independent variable is surface land cover, this represents land components which are physically visible and present. A change in land cover can be triggered by different factors such as climate drivers and human activity. This can be illustrated as following, increased demand for urbanization and buildings results in loss of natural and farming lands. This accordingly affects temperature, weather patterns and precipitation. These mentioned effects have influenced the global climate by altering circulation patterns, changing albedo of Earth's surface, and manipulating amount of carbon dioxide emissions in the atmosphere (The National Climate Assessment).

The second independent variable used to measure climate change is Wind Speed. Wind speed describes how fast air moves past a specific defined point. Usually, research related to climate change tends to focus on temperature, but it's worth noting that climate change implications go far beyond that. The most recent report by the UN's Intergovernmental Panel on Climate Change expects the mean wind speed will decrease as a result of climate change (Halm 2021). From 1979 to 2018, mean land wind speed was seen to have a reduction of 0.063m/second each decade. This can be interpreted as following, when wind speed is high, this demonstrates that temperature is simultaneously increasing while humidity is decreasing. This indicator helps us monitor and predict temperature patterns as well as global climate. Not only does wind speed indicate weather changes, it also impacts surface water, which in turn affects evaporation, and seiches development and storm surges (Zakaria 2020).

The third climate measurement is Vapor Pressure, where pressure can be described as the quantity of water found in the air; therefore, this indicates that the more water in the air, the higher exerted pressure at the surface (Climate Signals). This can help us define the relationship between vapor pressure and temperature as following; as temperature increases, vapor pressure also increases. Meanwhile, as vapor pressure decreases temperature accordingly decreases.

The fourth variable included is Soil Moisture, which represents an estimate to the quantity of water, including water vapor, found in unsaturated land soil. This means that the higher the soil water, the lower the temperature will be because this would mean that lands are less dry and accordingly moisture (National Integrated Drought Information System).

The fifth variable being observed is Water Deficit, this happens when water demand exceeds water supply. This is a result of the profound disparity between available water resources and human activity/requirements. This disparity has resulted in several recurring incidences of global water crises and mismatch. From a technical perspective, this shortage in supply is driven by the difference, at a given time, between evapotranspiration and precipitation, where a shortage in precipitation is found in such a scenario. This is one of the main indices used to describe climate change as any change in climate is primarily reflected on change in water. The relationship can be described as inverse, where increased temperatures lead to dryness and water shortage (decrease in water supply). (United Nations n.d.)

The sixth independent variable in the model is PDSI, this can be considered as one of the most integral, PDSI is an abbreviation for an index called Palmer Drought Severity Index. - It is a standardized index that quantifying long-term drought, describing it as either wet or dry. PDSI uses data on temperature along with a physical water balance model, in order to be able to capture the basic effect of global warming on drought by observing changes in evapotranspiration (Climate Data Guide 2014). PDSI is most efficient and descriptive when used to describe those impacted by soil moisture conditions, for this case this can mainly be considered agriculture production. PDSI magnitude is used as an indicator to represent the severity of the disruption from normal drought conditions; where a PDSI value that is greater than 4 indicates very wet conditions, while a PDSI less than -4 indicates extreme drought (National Integrated Drought Information System).

The final independent variable included in the model is Precipitation. Precipitation represents the water released from clouds in any form such as rain, snow, or even hail. The amount of water that evaporates in the air is linked to warmer oceans. When increased moisture air moves across the land or into a storm system, this accordingly produces increased intense precipitation. Precipitation is also linked to dryness, where a lack of precipitation would lead to severe dryness and can turn land into desert (NOAA 2021)

Results and Interpretation

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. pvar lopex2 lgdp lsurface WindSpeed2 VaporPressure24 SoilMoisture2 WaterDeficit2 PDSI2 Percipitation2

Panel vector autoregresssion


GMM Estimation

Final GMM Criterion Q(b) =  3.79e-32
Initial weight matrix: Identity
GMM weight matrix:     Robust
                                                No. of obs      =     67154
                                                No. of panels   =      1583
                                                Ave. no. of T   =    42.422
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lopex2						
lopex2						
L1.	.9105868	.013912	65.45	0.000	.8833197	.9378539
lgdp						
L1.	.0413113	.0157831	2.62	0.009	.010377	.0722456
lsurface						
L1.	.0103302	.0089271	1.16	0.247	-.0071665	.027827
WindSpeed2						
L1.	-.0201358	.0039611	-5.08	0.000	-.0278993	-.0123722
VaporPressure24						
L1.	.0288617	.0082038	3.52	0.000	.0127826	.0449407
SoilMoisture2						
L1.	-.000259	.0005429	-0.48	0.633	-.001323	.0008051
WaterDeficit2						
L1.	-.0002086	.0000382	-5.46	0.000	-.0002836	-.0001337
PDSI2						
L1.	.0000283	4.98e-06	5.68	0.000	.0000186	.0000381
Percipitation2						
L1.	-.0001524	.0000384	-3.97	0.000	-.0002276	-.0000772

First of all, the first model was run on all observations without dividing into sectors. The purpose of this generalization was to establish an initial understanding of the relationship and compare to see whether there are specific sectors that led to these results, or whether there were major deviations amongst sectors. It can be concluded from the results that GDP has a negative correlation with operating expense, which means the more efficiently productive a country is the less cost it incurs, this is mainly driven by efficiency in operations. As for climate variables, we can identify that there is a negative relationship between operating expense and surface land, where the smaller the surface land becomes, indicating worsening climate conditions, the more costs are incurred by firms in order to operate, this can be justified as a result of having to put extra costs and more labor in order to establish a feasible land for operations, which has been disrupted due to the diminishment of available surface land.

Moving to the next observation, it is evident that there is a negative relationship between wind speed and operating expenses. As described earlier, the lower the wind speed, the higher the temperature and thus this also indicates that as wind speed decreases, temperature increases, resulting in worsening climate change and as a result higher operating expense on firms. As for vapor pressure, a positive correlation was observed. The higher the vapor pressure meant that temperature is also rising, this also matches the earlier findings proving that pressure on temperature leads to higher costs. Moving on to soil moisture, we can observe a negative relationship, which means that the less moist and more dryness there is in moisture, the more firms' have to spend to produce. This also can be justified due to having to incur higher operating expenses in order to make the land feasible for work. Moreover, temperature disruptions and land distortions can lead to a decrease in production efficiency, where a land that once produced a certain quantity at a specific cost amount, would produce less quantity for the same cost.

Another variable is water deficit, a negative correlation is also evident in the results. This relationship means that the higher the water deficit, the lower the costs incurred, this measure does not correlate with our previous findings as much. This can be explained by the lack of demand for water in certain sectors, thus may not be influenced by such environmental shortage. Moving to PDSI, we can observe a positive correlation, this means that when drought increases, land becomes drier, temperature worsens, and accordingly higher costs incurred by firms.

Finally, precipitation also flows with previous findings and measures, as it shows a negative relationship. This relationship means that the lower the precipitation, the dryer the surface is, the less rain fall observed and therefore higher costs incurred. This can be due to the lower rainfall, which as a result can lead to having shortage in certain production and flows. The dryness of land is also a major aspect to be considered as a disruption for business' operations as this dryness will have to be sorted by human interference, which leads to higher incurred costs, more labor needed, less time for production and inefficient overall operations.

Agriculture, Finance and Insurance –

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. pvar lopex2 lgdp lsurface WindSpeed2 VaporPressure24 SoilMoisture2 WaterDeficit2 PDSI2 Percipitation2 if gsec2==1

Panel vector autoregresssion



GMM Estimation

Final GMM Criterion Q(b) =  1.70e-31
Initial weight matrix: Identity
GMM weight matrix:     Robust
                                                No. of obs      =     19561
                                                No. of panels   =       418
                                                Ave. no. of T   =    46.797
```
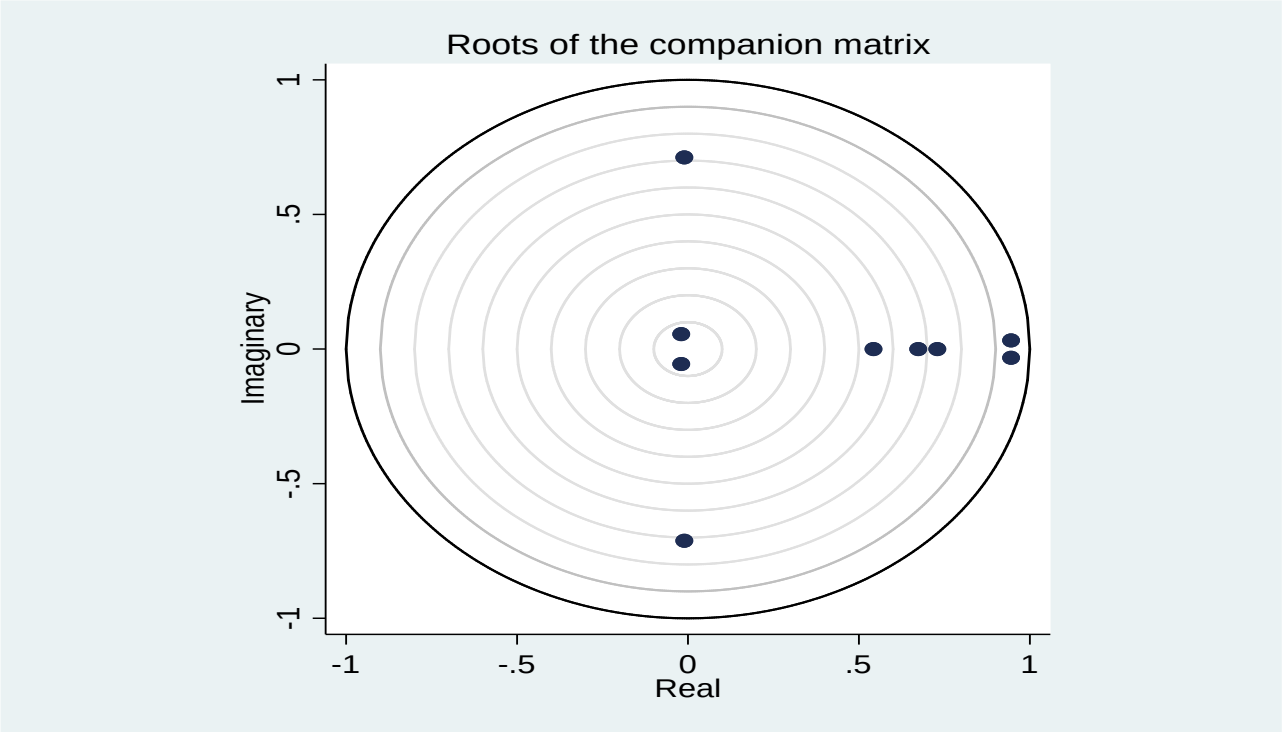

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lopex2						
lopex2						
L1.	.8843605	.0268266	32.97	0.000	.8317813	.9369397
lgdp						
L1.	.150722	.0432951	3.48	0.000	.0658652	.2355789
lsurface						
L1.	-.0504738	.0186127	-2.71	0.007	-.086954	-.0139937
WindSpeed2						
L1.	-.0173656	.0087885	-1.98	0.048	-.0345907	-.0001405
VaporPressure24						
L1.	.0616505	.0168988	3.65	0.000	.0285295	.0947715
SoilMoisture2						
L1.	-.0006415	.0010026	-0.64	0.522	-.0026066	.0013237
WaterDeficit2						
L1.	-.0003666	.0000851	-4.31	0.000	-.0005334	-.0001997
PDSI2						
L1.	.0000194	8.61e-06	2.25	0.024	2.50e-06	.0000363
Percipitation2						
L1.	-.0002047	.000046	-4.45	0.000	-.0002949	-.0001145

```
. pvarstable, graph
```

Eigenvalue stability condition

Eigenvalue		
Real	Imaginary	Modulus
.9451277	-.0322292	.945677
.9451277	.0322292	.945677
.7292796	0	.7292796
-.0107721	-.7120077	.7120892
-.0107721	.7120077	.7120892
.6735388	0	.6735388
.542574	0	.542574
-.0196814	-.055489	.058876
-.0196814	.055489	.058876

All the eigenvalues lie inside the unit circle.
pVAR satisfies stability condition.



The first sector distribution considered will be a combination of Agriculture, Finance and Insurance companies. The agriculture sector focuses mainly on crop production, animal breeding and fish harvesting. This sector consists of labor workers who are farmers, Overall, agriculture sector accounts for around one-fifth of total nation economic activity. This accordingly means that this sector is highly dependent on water availability and resources. Agriculture needs to have an efficient water system in order to have processed water and clean irrigation. Additionally, this sector requires active transportation systems for moving livestock. Finally, they need chemical fertilizers for crop production and energy for food processing (Cybersecurity & Infrastructure Security Agency). All of the mentioned factors, represent how agriculture theoretically should be strongly linked to climate change disruptions, water resources and land conditions. According to Karimi, in the publication "Climate change and agriculture: Impacts and adaptive responses in Iran", changes in rainfall, represented as precipitation, water resources will have significant impacts on crops and the sector. The extent or severity of the effect on yield is dependent on crop type, CO2 fertilization effect, climate change trends and ability of farmers and producers to adapt. Karimi expects high negative impacts on rainfed production as a result of the long term ongoing global climate change (Karimi 2018). As for finance and insurance sector, these can be seen to be less directly impacted, but in theory can also face increased costs due to work disruptions, higher insurance costs due to more failed businesses, damaged cars due to pollution and thus higher incurred overall operating costs. Analyzing the extracted results, we can observe that there is a negative correlation between surface land and costs. This supports the initial hypothesis that this sector is negatively impacted by worsening climate conditions. As surface land shrinks and worsens, higher costs are incurred to recover land and resume operations. As for wind speed, we can also observe a negative correlation, which also indicates the same findings. The result that does not support our hypothesis is vapor pressure as it shows a positive correlation, this can be justified due to the nature of the crops, some of which might requires lower vapor pressure and thus this would reduce costs on agriculture farmers. Moving to the soil moisture and water deficit, a negative relationship is found. This also supports the same conclusion, where a decrease in soil moisture would make it more challenging for crops to grow, would require human interference to manually add moisture to the soil to make it adequate for crops to grow. As for the water deficit, the more deficit there is the higher costs are incurred. This is supported by the previous mentioned fact that this sector requires adequate water

resources to achieve smooth workflow. As for the PDSI, we can observe a positive relationship, which means that the higher the drought the less the costs, this might seem a bit out of scope but can be influenced by the companies which are operating in the financial and insurance sector. Finally, looking at precipitation we can observe a negative relationship, which is perfectly justified by the importance of rainfall and natural water supply and therefore the lower the precipitation, the higher costs are incurred to create an adaptable environment for agriculture. To ensure significance of the previously explained results, we looked at the significance of the p value, where all of them showed significance except for the PDSI and soil moisture, where actually according to most results the PDSI was actually unrepresentative of the relationship. We then further ran a companion matrix to ensure that all results are unbiased and are representative. The result successfully indicated that the panel regression model is a true representative of the actual relationship and that the results are significant. The pvarstable test showed that all results within this test are stable as they all lie within the unit circle as represented above.

Construction, Manufacturing, and Transportation –

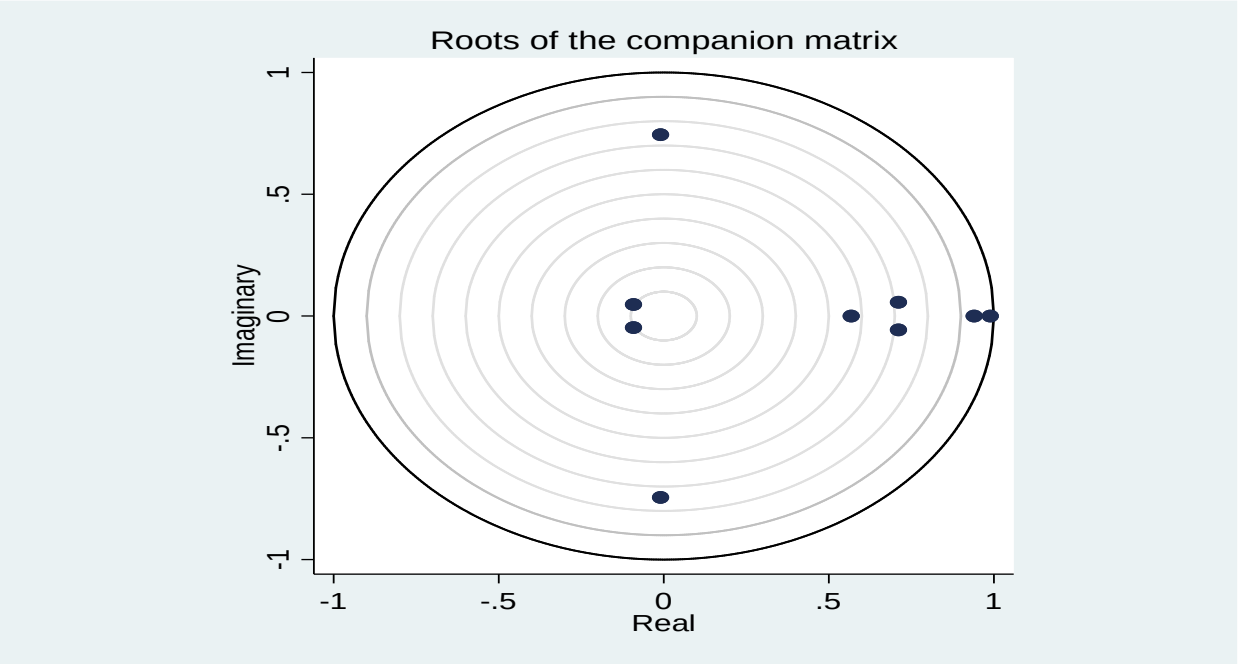
```
. pvar lopex2 lgdp lsurface WindSpeed2 VaporPressure24 SoilMoisture2 WaterDeficit2 PDSI2 Percipitation2 if gsec2==2

Panel vector autoregresssion



GMM Estimation

Final GMM Criterion Q(b) =  2.40e-32
Initial weight matrix: Identity
GMM weight matrix:     Robust
                                                No. of obs      =     24701
                                                No. of panels   =       590
                                                Ave. no. of T   =    41.866

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lopex2       |
      lopex2 |
        L1.  |    .951858   .0175707    54.17   0.000       .91742     .986296
             |
        lgdp |
        L1.  |  -.0116627   .0188417    -0.62   0.536    -.0485917    .0252663
             |
    lsurface |
        L1.  |    .014213   .0138115     1.03   0.303     -.012857    .0412829
             |
  WindSpeed2 |
        L1.  |  -.0196123   .0063552    -3.09   0.002    -.0320682   -.0071564
             |
VaporPressure24 |
        L1.  |   .0192102   .0122557     1.57   0.117    -.0048104    .0432309
             |
SoilMoisture2 |
        L1.  |  -.0004643   .0006797    -0.68   0.495    -.0017964    .0008678
             |
WaterDeficit2 |
        L1.  |  -.0001401   .0000568    -2.47   0.014    -.0002514   -.0000287
             |
       PDSI2 |
        L1.  |   .0000367   8.11e-06     4.53   0.000     .0000208    .0000526
             |
 Percipitation2 |
        L1.  |  -.0001088   .0000383    -2.84   0.005     -.000184   -.0000337
```

```
. pvarstable, graph
```

Eigenvalue stability condition

Eigenvalue		Modulus
Real	Imaginary	
.9890582	0	.9890582
.9401209	0	.9401209
-.009724	-.7445701	.7446336
-.009724	.7445701	.7446336
.7109343	-.0567421	.7131951
.7109343	.0567421	.7131951
.5677089	0	.5677089
-.091788	-.0474106	.1033093
-.091788	.0474106	.1033093

All the eigenvalues lie inside the unit circle.
pVAR satisfies stability condition.



The second sector classified is Construction, Manufacturing and Transportation. Construction relates to building cities, buildings, and factories. It is a critical sector to be tested as it heavily contributes to climate change worldwide and therefore is in return theoretically heavily affected by changes in climate change. According to a paper published by Hurilmann titled "Climate change preparedness across sectors of the built environment", constructors are one of the main contributors to climate change, where they are found to be responsible for 70% of CO2 emissions from energy use globally. This leads to understanding that this sector should have a significant relationship with climate change indices and have a major responsibility to limit global warming effects. However, given that poor policies are currently in place in many nations, greenhouse gas emissions have been on a trajectory inclining trend. This is observed through the increasing vulnerability to climate change impacts such as droughts, floods, heat pressure, extreme weather events and significant sea level rise (Hurilmann, 2022). These risks are all expected to continue to increase as climate change conditions worsen, which accordingly should result in a problematic and more difficult environment for construction, transportation, and manufacturing sectors. Climate change also plays a role on the transportation sector, as according to Prwose in his article "Implications of Climate Change for Economic Development in Northern Canada: Energy, Resource, and Transportation Sectors", the sunder shipping season will lengthen in duration, while the sea-ice duration is expected to shorten by 20-30 days by 2080. It is also likely to observe an increased numbers of transits by large ships, due to sea-level disruptions and weather conditions. Additionally, changes in sea and water levels could negatively impact flat-bottomed barges due to the shallow river system. This indicates that we should observe an inverse relationship between climate change and costs as large investments in land-based roads might be required and long-term adapting techniques to enable access to towns and industrial areas that rely on networks of streams and lakes (Prwose 2009). After understanding the nature of this sector and looking at the results obtained, according to the P-Value, surface level, vapor pressure, and soil moisture are insignificant to this sector. Observing the remaining findings, we can see a negative relationship between operating costs and wind speed, this is an accurate finding as it indicates that the higher the wind speed, the better the climate condition is, the less disruption there is to normal operations. Adequate wind speed would also indicate that marine transportation has a good water flow and is accessible without the need for additional effort. Moreover, looking at PDSI we find a positive relationship which

means that the higher the drought severity, the higher costs incurred. This makes a lot of sense as extensive dryness would need human interference to moisture the land and make it adequate for construction, manufacturing and exporting from underground utilities. As for transportation, to ensure smooth transport and commuting for either individuals, marines, ships or wholesale transport we must ensure smooth roads which would thus require higher costs for maintenance due to increased drought. Moving on to the last factor for this sector, precipitation is found to have a negative relationship, this also goes with the expected relationship between overall climate change and the sector understudy, as lower precipitation means worsening or tougher climate conditions and accordingly higher costs are incurred to adapt and neutralize negative climate change effects.

Observing the reliability test, we can also see that all points are within range and that the stability condition is met. This indicates that the results retrieved are representative and are unbiased and can be used to make further assumptions and analysis. This test checks for eigenvalue stability condition after estimating parameters of the vector regression run. The circle above shows the distance between each eigenvalue and the unit circle. Interpreting a VAR model requires a strict stability condition to be met. If it is found to be stable, this means that the VAR is invertible and has infinite order vector moving-average representation. Moreover, stable results show that forecast error variance and impulse response functions can be correctly interpreted (Stata).

Education and Healthcare –

```
. pvar lopex2 lgdp lsurface WindSpeed2 VaporPressure24 SoilMoisture2 WaterDeficit2 PDSI2 Percipitation2 if gsec2==3

Panel vector autoregresssion



GMM Estimation

Final GMM Criterion Q(b) =  6.06e-32
Initial weight matrix: Identity
GMM weight matrix:     Robust
                                                No. of obs      =      3277
                                                No. of panels   =        95
                                                Ave. no. of T   =    34.495
```

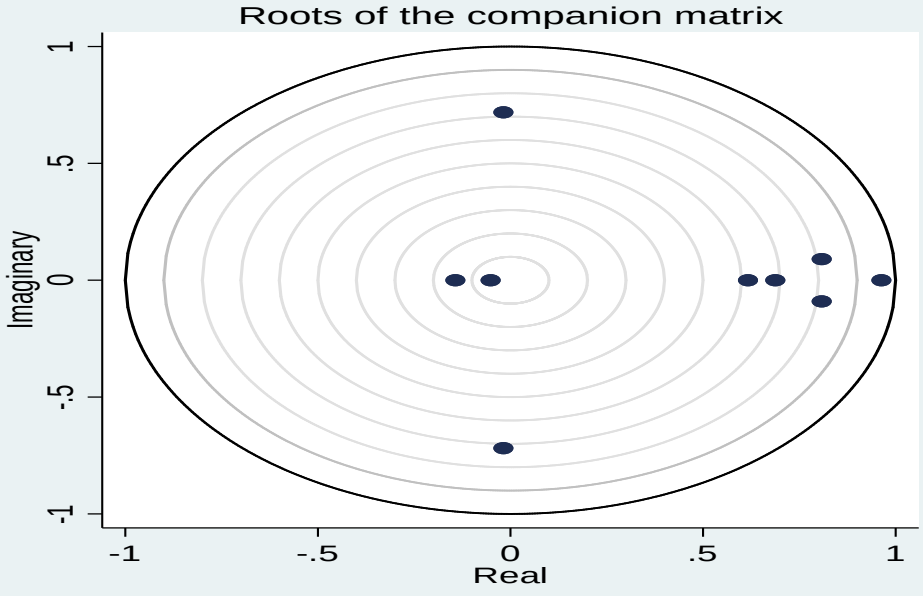
	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lopex2						
lopex2						
L1.	.8694479	.072074	12.06	0.000	.7281855	1.01071
lgdp						
L1.	.1757448	.1335999	1.32	0.188	-.0861062	.4375957
lsurface						
L1.	-.0827226	.0841612	-0.98	0.326	-.2476754	.0822303
WindSpeed2						
L1.	-.0000644	.0147683	-0.00	0.997	-.0290098	.028881
VaporPressure24						
L1.	.1684336	.0782555	2.15	0.031	.0150556	.3218116
SoilMoisture2						
L1.	.0127241	.0082047	1.55	0.121	-.0033567	.0288049
WaterDeficit2						
L1.	-.0006858	.000327	-2.10	0.036	-.0013268	-.0000449
PDSI2						
L1.	.0000647	.0000445	1.45	0.147	-.0000226	.000152
Percipitation2						
L1.	-.0001226	.0001411	-0.87	0.385	-.0003993	.000154

```
. pvarstable, graph
```

Eigenvalue stability condition

Eigenvalue		
Real	Imaginary	Modulus
.9630311	0	.9630311
.807973	-.0903265	.8130063
.807973	.0903265	.8130063
-.018335	.7185488	.7187827
-.018335	-.7185488	.7187827
.6875844	0	.6875844
.6165806	0	.6165806
-.1430902	0	.1430902
-.0515273	0	.0515273

All the eigenvalues lie inside the unit circle.
pVAR satisfies stability condition.



The third sector was a combination of education and healthcare institutions, including schools and hospitals. Initially, this sector when classified was in order to distinguish how some sectors might be less related to climate change adverse effects. When considering this sector, we were expecting to observe a weaker relationship between climate change and sector incurred costs as the operations of these firms' does not heavily depend on climate conditions and therefore would be less affected by disruptions.

The importance of this sector actually comes not in the role of cost management, but in raising awareness in order to establish and develop individuals who are fully aware of the challenges caused by climate change and therefore come up and introduce innovative ideas and new technologies to limit the negative effect of other sectors' operations and production mechanisms. Moreover, it is expected that the higher climate change implications occur, the higher costs are incurred on education simultaneously to provide more awareness on precautions needed.

Looking at the results, we can analyze that most of the results are insignificant, signifying that there is a low relationship between climate change and this sector. Surface level, wind speed, soil moisture, PDSI and precipitation have all extracted insignificant results showing a weak or unrepresentative relationship between these metrics and operating costs.

Nevertheless, we can still observe the significant results which area positive relationship between costs and vapor pressure, signifying that the hotter the weather and more vapor pressure there is, higher costs are incurred by educational and medical institutions. This can be due to the stress coming from increased vapor levels and the need to neutralize the pressure through additional electricity and technology for machinery and equipment usage. As for water deficit, there is a negative relationship meaning that the lower the water deficit the higher the costs incurred are, this is difficult to justify and can only be explained through noting that this should be ineffective on this sector as water supply does not pose a major threat on operations.

To summarize, we can notice that there is a weak link in this classification and thus this can help justify our initial assumption that the severity or intensity of climate change depends on the nature of the sector under study and cannot be generalized throughout all operations. The higher the sector uses natural resources and depends on water, land and rainfall, the more intense and rigorous the relationship will be.

Looking at the results from the stability test, we can also see that all values have a distance at most at 1, which indicates that the results are stable and can be used for further interpretation and

testing. We can also check our results from the table on the side, where can see that all real eigenvalues are less than one, which is another method to test and check stability.

Information, Rental and Leasing

```
. pvar lopex2 lgdp lsurface WindSpeed2 VaporPressure24 SoilMoisture2 WaterDeficit2 PDSI2 Percipitation2 if gsec2==4

Panel vector autoregresssion



GMM Estimation

Final GMM Criterion Q(b) =  9.78e-32
Initial weight matrix: Identity
GMM weight matrix:     Robust
                                                No. of obs      =      9795
                                                No. of panels   =       234
                                                Ave. no. of T   =    41.859
```

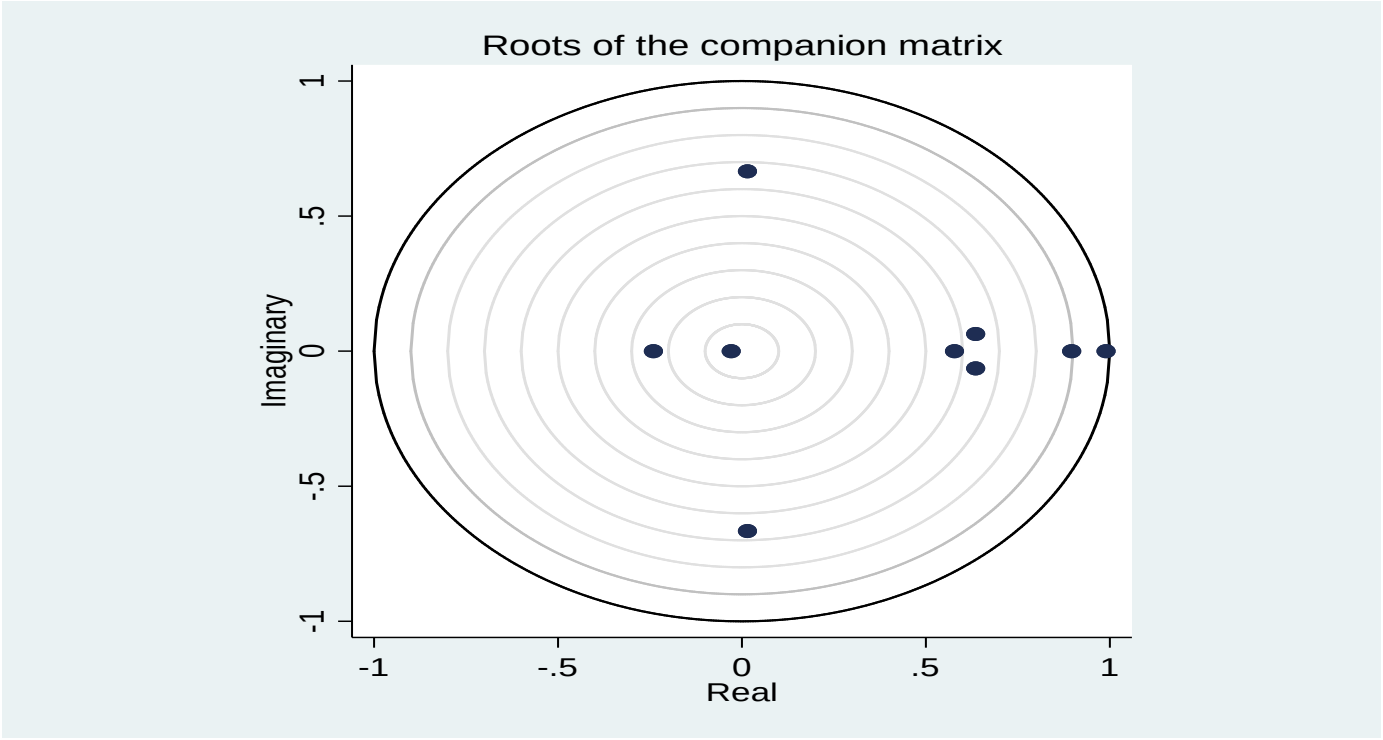
	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lopex2						
lopex2						
L1.	.8638558	.0555455	15.55	0.000	.7549886	.9727231
lgdp						
L1.	-.0462429	.0240494	-1.92	0.055	-.0933789	.000893
lsurface						
L1.	.1051984	.0517163	2.03	0.042	.0038364	.2065605
WindSpeed2						
L1.	-.0126579	.0082839	-1.53	0.127	-.028894	.0035782
VaporPressure24						
L1.	-.0561461	.0254105	-2.21	0.027	-.1059498	-.0063425
SoilMoisture2						
L1.	-.0033967	.0016813	-2.02	0.043	-.0066921	-.0001014
WaterDeficit2						
L1.	.0000289	.0000692	0.42	0.676	-.0001067	.0001646
PDSI2						
L1.	.0000318	.0000143	2.22	0.027	3.71e-06	.0000599
Percipitation2						
L1.	-.0002307	.0001893	-1.22	0.223	-.0006017	.0001403

```
. pvarstable, graph
```

Eigenvalue stability condition

Eigenvalue		Modulus
Real	Imaginary	
.9897724	0	.9897724
.8963047	0	.8963047
.0150533	-.6657883	.6659585
.0150533	.6657883	.6659585
.6352764	-.0636888	.6384609
.6352764	.0636888	.6384609
.5776423	0	.5776423
-.2406353	0	.2406353
-.0291389	0	.0291389

All the eigenvalues lie inside the unit circle.
pVAR satisfies stability condition.



The fourth sector classified is Information, Rental and Leasing. Information sector comprises of companies which mainly operate in distributing information, creating databases that enable people to communicate and transmit data remotely, and finally processing data. These include companies that work in software publishing and development, it can also include motion picture broadcasting, and telecommunications industries. Moving on to the other category, rental and leasing are closely related to non-banking financial institutions. Leasing proved businesses and people with alternatives for debt other than bank loans.

The majority of this sector are establishments where renting, leasing allows the use of firms' owned assets by others. These assets can either be tangible or intangible, such as equipment, machinery, and real estate or otherwise patents and trademarks (US Bureau of Labor Statistics). Previous studies have lacked any evidence of a relationship between climate change and the operating costs of this sector. What we can theoretically predict is a similar situation to the financial and healthcare sector as the main operations of this sector does not heavily rely on any climate or environmental aspects to operate. Therefore, disruptions in climate conditions or weather trends are not expected to have a fierce or significant effect on the business costs incurred to operate. In this case, all variable results are found to be significant and thus can be interpreted.

The results show that there is a positive relationship between surface level, PDSI and water deficit, which means that when any of those variables increases, the costs incurred in operations also increase. This positive relationship means that the higher the surface level the higher costs incurred, this could be due to the fact that higher surface levels could make it harder to establish buildings that could be leased or rented and require additional costs to make the land appropriate for the business needs. Meanwhile, the other two positive relationships signify that the higher the PDSI index, representing the drought levels, the higher costs are incurred. Also, the higher the more there is water deficit, the higher costs are also incurred. This could signify that this sector relies on water supply and can be negatively affected or find the need to resource external water supply in order to continue operations.

Moving on to the remaining factors which are wind speed, vapor pressure, precipitation, and soil moisture, these have been found to have a negative relationship with costs. This indicates that the

lower the wind speed, the more disruptions there are to the operations of the firms' and thus higher costs to manage and increase the flow and pressure of the wind. Moreover, higher vapor pressure and precipitation both indicate more rainfall, this also leads to lower costs incurred in this case. This could be primarily due to the ease of work due to having better water supply from rainfall. This perfectly correlates with the previous positive relationship found between water deficit and PDSI, where both demonstrate dryness and led to higher costs thus it would only be likely to have lower costs when water supply is adequate.

Finally, testing for stability, we can observe from the above results that they all follow the threshold, and all values are within an acceptable unit distance. This can be observed from the root comparison matrix in addition to the pvarstable table. All observed eigenvalues are below one. This supports the validity of the findings for this sector and helps strengthen the research results.

Retail and Wholesale Trade –

```
. pvar lopex2 lgdp lsurface WindSpeed2 VaporPressure24 SoilMoisture2 WaterDeficit2 PDSI2 Percipitation2 if gsec2==5

Panel vector autoregresssion


GMM Estimation

Final GMM Criterion Q(b) =  4.26e-32
Initial weight matrix: Identity
GMM weight matrix:     Robust
                                                No. of obs      =      7914
                                                No. of panels   =       203
                                                Ave. no. of T   =    38.985
```

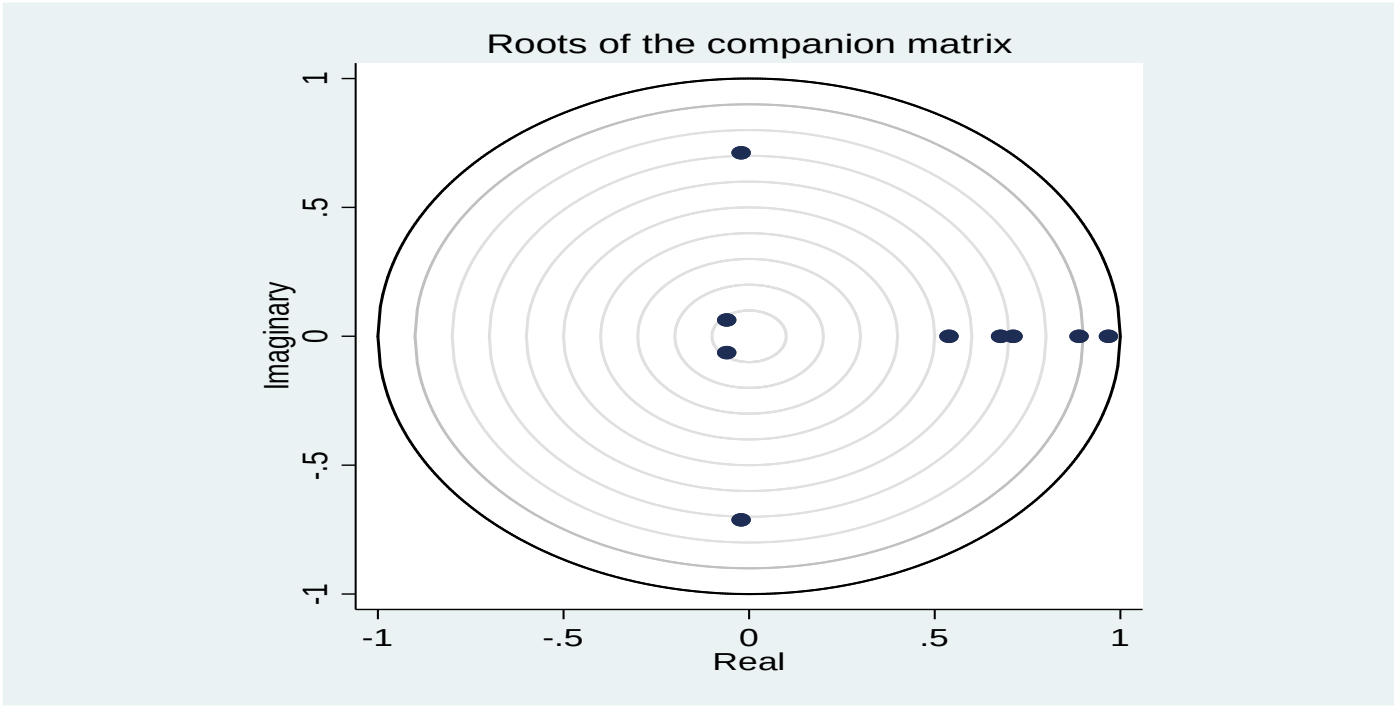
	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lopex2						
lopex2 L1.	.8799604	.0449554	19.57	0.000	.7918494	.9680715
lgdp L1.	.0668245	.0565142	1.18	0.237	-.0439413	.1775904
lsurface L1.	.0369481	.0254161	1.45	0.146	-.0128666	.0867628
WindSpeed2 L1.	-.0061101	.010211	-0.60	0.550	-.0261234	.0139031
VaporPressure24 L1.	.0742038	.0349332	2.12	0.034	.0057359	.1426717
SoilMoisture2 L1.	-.0003184	.0020849	-0.15	0.879	-.0044047	.0037678
WaterDeficit2 L1.	-.0003942	.0001289	-3.06	0.002	-.0006468	-.0001416
PDSI2 L1.	-9.76e-07	.0000132	-0.07	0.941	-.0000269	.0000249
Percipitation2 L1.	-.0003134	.0000655	-4.78	0.000	-.0004418	-.000185

```
. pvarstable, graph
```

Eigenvalue stability condition

Eigenvalue		Modulus
Real	Imaginary	
.9679483	0	.9679483
.8888277	0	.8888277
-.0215839	-.7119402	.7122673
-.0215839	.7119402	.7122673
.7110778	0	.7110778
.6771363	0	.6771363
.538384	0	.538384
-.0603098	-.0633076	.0874364
-.0603098	.0633076	.0874364

All the eigenvalues lie inside the unit circle.
pVAR satisfies stability condition.



The last sector cluster is related to retail and wholesale trade. This consists of the business of reselling final goods to end consumers. This can include the purchase of food, clothing, necessities, and other goods. This industry is considered one of the top employers providing several jobs in the economy and positively contributing to growing GDP. These goods being sold can either be locally produced or imported from other specified foreign countries. Therefore, this can help us understand that this sector can partially depend on the availability of smooth transportation of goods across borders. Wholesalers are considered "middlemen" who supply products to business customers. These can include restaurants, retailers, and manufacturers. Additionally, they can also provide big tickets for farm machinery, vehicles, and heavy equipment. Wholesalers are also responsible for supplying and distributing quantities of fertilizers, seeds and food and beverage. This point is worth noting because this also indicates that the quantity they can supply is strongly related to the land quality, structure, precipitation to be able to supply seeds and fertilizers. Their workspace is usually through a warehouse and does not usually attract walk in customers. The warehouses or outlets are usually located around industrial areas, to be able to deliver, load and transport bulk equipment and supplies (BC Economy and Labor Markets).

On the other side, retail trade consists of exchanging retail merchandise and services to end consumers. This is considered the last step of merchandise; therefore, they are usually found to sell small quantities of final goods. There are types of retail trade, stores are those responsible for serving walk in customers. They depend on displays and advertising to promote their products. This service can also include the final stages of delivery and installation (US Bureau of Local Statistics n.d.).

After understanding the operations of this sector, we can now look at the test results and find only vapor pressure and water deficit have significant findings. This indicates that this sector is not highly affected by the climate change disruptions, mainly because they are not directly responsible for the actual raw material manufacturing process. This makes them less exposed to the risk of manufacturing disruptions. Observing the only three significant variables in this case, vapor pressure is found to have a positive correlation, where the higher the vapor, the higher the costs. This could be explained by the fact that the higher the vapor, the more likely it is to rain and therefore could lead to damages in display, merchandise and could make it harder for walk

in clients to access stores. Another variable is precipitation which is found to have a negative relationship, which means that the lower the precipitation levels the higher the costs. This indicates a negative relationship between overall climate change and costs and thus indicates that worsening climate conditions lead to higher costs incurred. This could be due to the fact that precipitation might make it less accessible for walk-in clients and could disrupt supply delivery and transportation of goods. This sector is not an accurate representative of the effect of climate change on costs as this sector is also considered a middle man between the actual operations and end-clients. Therefore, their costs are not expected to be highly affected by such change in variables. In order to verify our given results, the stability test was run and the results obtained showed stability. All eigenvalues were below one and within an acceptable unit distance.

Conclusion

To conclude, this research has contributed in identifying the relationship between climate change and firm level operating expense. This report has successfully managed to retrieve results while minimizing endogeneity, which was a factor that was evident in most previously published literature. It was evident that in most cases, climate change disruptions have led to negative impacts on costs, where firms have mainly experienced evident increase in operating expense in order to reduce the impact of environmental challenges on production volumes, quality and efficiency. This has pressured firms to increase costs, labor force, restructure and recover lost resources. The worsening quality of land, soil and water supply, the more there is need for human interference in order to readjust and substitute the shortage in natural resources.

The main aspect observed throughout this research is that the extent of the effect of each environmental factor differs highly based on the sector of activity. It was analyzed that depending on the sectors' main function and the level of dependency and need for natural resources, the higher the negative effect is evident and higher costs are incurred. For example, agriculture, transportation, construction and manufacturing are found to be the most effected. This is mainly due to the dependency of their activities on land quality, precipitation, rainfall level and temperature levels in general. Meanwhile, other sectors can also be seen to be negatively affected but with a lower magnitude. This can also be supported by the significance of the results where all the closely related sectors had all variables significant, meanwhile sectors

which are not closely linked to climate change factors had several insignificant variables and results.

This conclusion helps us highlight the importance of climate change awareness and the integral role of global initiatives to control those negative changes, as they do not only lead to less profits, they also add additional cost pressures on operating firms. The MENA region is one of the world hubs for agriculture and trade but is still lacking behind in climate change preventative measures actions. This report aims to enhance one's understanding of the repercussions of not defying the environmental disruptions and downfalls as these effects are expected to bloat further as environmental pressures simultaneously increase. Further research could be conducted in the future to include more firms and could also test different cost measures incurred by firms. This additional research would help literature to identify the difference in performance based on regions, which could be another way to compare the effect. Moreover, costs could be observed from different perspectives to include measures such as cost of debt and cost of capital rather than operating expenses. Climate change could also be tested using different measures and indices.

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