AN EMPIRICAL ANALYSIS OF CLIMATIC, GEOGRAPHIC, AND CULTURAL DETERMINANTS OF INTERNATIONAL TOURISM

by

Ethan Kranich Strauss

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ABSTRACT

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ADVISOR: Professor Therese A. McCarty

Each year, billions of people visit different countries all around the world. For many of those countries, tourism is their primary industry, leading to millions of jobs and dollars in revenue. It is expected that by 2020 total International Tourism Receipts will reach 2 trillion US dollars annually. Currently, tourism employs an estimated 200 million people around the world. With the continued progression of climate change, the tourism industry is facing a newfound threat. Global temperatures and the seal level are both expected to rise significantly by the end of the century. Additionally, the Intergovernmental Panel on Climate Change has predicted that wildfires, tropical storms, and other natural disasters will increase in size and frequency. In recent years, governments, organizations, and private citizens have increased their efforts to curtail the effects of climate change and better understand the problems associated with it. This paper uses Ordinary Least Squares regressions to identify climatic, geographic, and cultural determinants of international tourism. The results show that the relationships between temperature, precipitation, elevation, and international tourism levels are extremely complex and cannot be evaluated independently. Furthermore, changes in temperature and precipitation over the past 100 years are significant, and are connected to current levels of international tourism. Using this data to better understand seasonality and how climate and geography affects tourism will help add to the existing literature, and hopefully, help governments and organizations prepare for what the future holds.

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CHAPTER ONE

INTRODUCTION

Each year over one billion people visit countries all over the world. The tourism sector accounts for approximately 10% of global GDP and generates over 6 trillion US dollars per year. For some countries, tourism is their number one industry, while for others, it is a smaller component of their economy. Throughout the world, however, the tourism industry provides livelihood to approximately 255 million people.

With the continued progression of climate change, the tourism industry is facing a newfound threat. Global temperatures are expected to rise 2.6 – 4.8 °C, and the sea level is expected to rise .45 – .82 meters by the end of the century. In addition, the Intergovernmental Panel on Climate Change (IPCC) has predicted that wildfires, tropical storms, and other natural disasters will increase in size and frequency. The rising sea level and increasingly acidic oceans will threaten coastal tourism infrastructure, and rising temperatures will change travel patterns, shorten winter sports seasons, and change biodiversity levels affecting eco-tourism.

Many developing countries and small island states have economies that rely on tourism serving as a source of employment for their citizens. For many countries, it is the main source of foreign exchange income. These small and underdeveloped nations will be the ones that are affected the greatest by climate change. Smaller nations typically have fewer resources and less fundamental industries to rely on. As polar sea ice continues to melt at unprecedented rates, sea levels all around the world are beginning to rise. Small island nations will bear the brunt of this change, with some being lost to the sea. We are already seeing the first wave of climate immigrants being forced from their homes due to changes in the environment. Many island nations are situated along the equator, and as temperatures rise, these places may become too hot to sustain tourism. As these nations start to lose their coastal infrastructure, and as their citizens begin to relocate, there will be a profound effect on their economies. It is therefore necessary for us to gain a better understanding of the determinants of tourism, to understand how climate change will impact the economies of these countries and others around the world.

Larger countries and those that are landlocked will still experience significant changes. The IPCC has predicted that precipitation levels are likely to change greatly, with an overall increase. Generally, the climate will warm, causing significant harm to ski and other winter sports industries, and changing seasonal travel patterns. Some countries will pass the temperature threshold and become too hot for travel, while others will see an influx in tourists looking to experience the moderate sun and warm water.

This paper evaluates specific determinants of international tourism using Ordinary Least Squares (OLS) linear and log-linear regressions to gain a better understanding of the complexities surrounding the relationships between climate, geography, and international tourism levels. It provides evidence that pull factors such as World Heritage Sites are significant and can lead to an increase in international tourism. Additionally, using interactive terms, this analysis shows that the relationships between climate and international tourism are extremely complex and dependent on multiple variables such as minimum and maximum elevation. Lastly, the results of this analysis show that noticeable changes in temperature and precipitation over the last 100 years have had an impact on current international tourism levels.

CHAPTER TWO

FUNDAMENTALS OF INTERNATIONAL TOURISM

The following chapter outlines the necessary background information required to fully understand international tourism. The motivations behind travel, the impact seasonality has on tourism levels, and the fundamental differences between tourism and recreation all need to be established in order to evaluate the impacts of climate, geography, and cultural elements on international tourism levels. Additionally, this chapter helps illustrate the expansive economic impact that international tourism has on the global economy.

Section I: Recreation versus Tourism and Motivations

When evaluating relationships with regards to international tourism, there are certain specifications that must be made. Explicitly, the difference between tourism and recreation must be outlined. Current research defines recreation as activities that do not have to span a night outside of an individual’s residence (Amelung et. al. 2007). Recreationists can quickly respond to weather conditions, both precipitation and temperature, and can adjust their plans to match. Tourism is generally characterized by spending at least one night outside of an individual’s usual place of residence (Amelung et. al. 2007). For international tourism, this would mean at least one night in a foreign country. This means that tourists do not have the same level of flexibility as recreationists. They must rely on planning for a longer time frame. Thus, international tourism levels are influenced by climate change on a much greater scale than recreational activity.

In addition to the difference between recreation and tourism, it is also important to identify the different motivations for travel. Individuals travel for business, pleasure, family matters, religious reasons, and more. On a broader scale, all motivations can be separated into push and pull factors. Push factors are generally negative factors surrounding an individual's home location. One example would be escaping the cold of winter. Pull factors are characteristics that make a destination more attractive. An example of a pull factor is a World Heritage Site or another fascinating landmark. For the basis of this analysis, climate variables can be described as both push and pull factors. A bad climate can drive tourists to leave home and travel to foreign locations while at the same time, more forgiving climates can act as attractive drivers for tourists looking to escape.

Section II: Understanding Seasonality

The major distinction between recreation and tourism is time frame. Not only does tourism last longer than one night, but the planning process is much longer and more drawn out. For this reason, seasonality plays an extremely important role in understanding tourism flows and the implications climate change can have on global and regional tourism levels. Seasonality has been described by multiple researchers as "one of the most problematic yet least understood features of the tourism industry" (Amelung et. al. 2007). There are two groups of factors that influence seasonality: natural and institutional. Natural factors are those that are directly impacted by climate and changing temperature and precipitation patterns. Examples of natural factors influencing seasonal variation in tourism include temperature, precipitation, and snow depth. Antithetically, institutional factors are those that indirectly influence seasonal tourism flows. Those include the timing of school breaks, religious holidays, and agricultural and industrial festivals (Hinch and Hickey 1997). Additional research has included social pressures and sports seasons as other factors influencing seasonal tourism flows.

Policy-making and significant marketing campaigns have attempted to alter institutional factors by changing the timing and length of school vacations and influencing societal preferences. On the other hand, tourism planners and developers are currently trying to extend existing tourism seasons by increasing product options and availability to different age groups.

While these ongoing changes are not linked directly to climate change or specific determinants of international tourism, the concept of seasonality is extremely important when understanding tourism flow patterns. Typically, summer vacations are when most tourism occurs. They are the longest periodic break from work or education. Secondarily, winter breaks and holidays in and around December are also extremely popular. Climate change that influences weather patterns during the summer and winter months respectively will have a strong impact on tourism levels. Tourists may seek out different locations as temperatures become too hot in the summer or if snow melts in the winter. They may even opt to travel in narrower windows of time outside of the summer and winter seasonal breaks. Understanding exactly how climate and other geographic and cultural determinants are associated with seasonal tourism levels is crucial in being able to provide data so that countries can adapt and maintain revenue and employment levels. The understanding of climate change on seasonality is still relatively limited, and substantial empirical analysis is yet to be done looking at these relationships.

Section III: Economic Impact

Understanding the complex relationship between climate change and tourism will help countries prepare for changes in their economy, and specifically their workforce. As previously mentioned, not only do billions of people travel the world for leisure and business, but hundreds of millions are employed by the tourism industry. International tourism is the world's largest exporter, and the industry itself has an important role in stimulating new investments and infrastructure, and increasing government revenues. Each year the World Travel and Tourism Council (WTTC) puts out an Economic Impact Review. The most recent article, from 2017, showed that despite the increasing and unpredictable threats of terrorism, disease, natural disasters, and instability, international tourism continued its consistent trend in facilitating the global economy. In 2016, travel and tourism generated 7.6 trillion US dollars to the economy (10.2% of total world GDP). It also generated 292 million jobs over the course of the year. That is equivalent to 1 in 10 jobs in the global economy (WTTC 2017).

Besides its economic impact, international tourism can help stimulate world peace by building cultural bridges between countries and facilitating the flow of both people and goods and services. According to research done by the United States Institute of Peace, tourism has been significant for natural resource conservation and cultural exchange, in addition to its established effects on economic growth and unemployment reduction (Honey and Gilpin 2009). If continued research can help clarify why people travel where, countries can take those factors into consideration when distributing their resources and enacting policies.

By understanding whether climate change will have any impact, countries and organizations can facilitate the decreased use of Greenhouse Gasses (GHGs), buildup infrastructure, and prepare for changes in their economy. Now, more than ever, causal links between climate change and major industries must be established. With the United States leaving the Paris Climate Accord, and countries such as China and India continuing to aggressively invest in infrastructure and technology, any negatives associated with climate change on such a global scale must be made clear, so that countries can come together and act to preserve resources for the future.

CHAPTER THREE

LITERATURE REVIEW

A comprehensive review of all the previous literature on the topic must be considered to fully understand the current conclusions surrounding climate change and tourism. Becoming familiar with the work on tourism demand and the numerous determinants is as important as understanding how climate variables themselves may lead to changing tourism patterns and revenue streams.

As the tourism industry rapidly expanded post World War II, so too did research surrounding it. Initially, literature on tourism lacked mention of climate change. Economists wanted to understand the fundamental demand factors surrounding tourism and why certain countries saw greater revenue streams than others. With the increased understanding of the severity of climate change, and the irreversible consequences we as humans have caused, research into climate change and tourism exploded. Tourism climate indices were created, and climate variables were introduced into tourism demand models.

Section I: Meta-Analyses

In 2015, a meta-analysis based on 195 previous research papers was published by Peng et. al. The article looked at data spanning from 1961-2011 as it tried to paint a clearer picture of tourism demand elasticities and the underlying data characteristics. Peng and his colleagues determined that depending upon the origins, destinations, products, data frequencies, demand variable measures, and modeling techniques, the demand elasticities of tourism varied greatly.

In general, the average income elasticity of tourism was 2.53. Thus, according to 195 studies, international tourism is clearly a luxury good. This has been substantiated in other papers as well. The average *price* elasticity was found to be -1.28. This study was clear to point out that with a larger sample size and more definitive variables, the data could present a different picture. In addition, demand elasticities vary over time.

This paper includes variables mentioned in Peng et. al. (2015), but will not look at tourism from a specific origin country to a comparable destination. Additionally, this paper will not look at elasticities. Since international tourism is a luxury good, it is extremely sensitive to changes in price and other determining factors. Thus, paving the way for climate change to have a strong impact on tourism levels.

A previous meta-analysis was conducted in 1995, but only used 80 data sources. Geoffrey Crouch integrated 80 international tourism demand studies to get a better understanding of the results. Variables including income, exchange rates, transport costs, marketing costs, and even time trend variables meant to reflect changes in tourism trends were all significant, and their elasticities were noted. While Crouch (1995) showed that tourism income elasticities vary greatly across regions, his estimates were right alongside Peng et. al. (2015), at 2, when it came to major destinations.

Meta-analyses such as Crouch's and Peng's helped clarify the discrepancies in tourism demand data sets. By consolidating findings, they made it easier to understand the results and pinpoint which determinants of tourism are most significant. Their work provided a fundamental understanding of tourism demand and income and price elasticities. Acknowledging that international tourism is a luxury good in which elasticities vary greatly across regions helps build a basic understanding of how climatic, geographic, and cultural determinants can impact tourism levels over time.

Section II: International Tourism Analyses

Before specific literature on climate change and tourism is introduced, it is important to take a more precise look at studies that use economic models to evaluate tourism demand trends. Eilat and Einav (2004) used a least square estimate regression to identify and evaluate specific determinants of international tourism. The two economists from Stanford looked at the world as a market of differentiated products, and applied a discrete choice estimation to their data set. To do this, they viewed each destination country as a group of different products supplied, and each origin country as a separate demand market. This method, using both an origin country and a destination country is used in a variety of international tourism literature. Their results showed that political risk, language, and common borders all significantly impacted tourism levels.

Combining these findings with the previous meta-analyses, a clearer picture of tourism demand can be illustrated. It is discernable that in countries where political tensions are high and language provides a barrier to communication, tourism levels would be lower when looking at the world from an origin-destination framework. Since it is understood that tourism is elastic, traveling farther away at a higher cost would be less practical, showing the connection identified by the common border variable. Slowly, by adding more variables and evaluating them within an elasticity framework, international tourism demand becomes clearer.

International tourism, however, is not just studied from an economic viewpoint. Researchers have also looked at international tourism through a socio-psychological framework. Carey Goh, an Assistant Professor at Hong Kong Polytechnic Institute combined these two fields of research. She wanted to assess whether market demand could be derived from factors underpinning both frameworks. To do this, Goh (2012) looked at climate as a socio-psychological variable that could also be identified as an economic determinant. She found that climate played a significant psychological role in tourism demand, thus combining psychological factors with an economic demand model. Using climate as a factor influencing tourism demand follows logically, as temperature and precipitation levels can change moods and alter travel behaviors. This idea forms the fundamental basis of econometric analyses using climate variables to evaluate international tourism demand. As noted previously, climate can act as a push and a pull factor. Thus, climate can cause people to leave a resident country while at the same time pull a tourist to a specific location. Simultaneously, climate is acting as an economic determinant and a psychological factor influencing happiness.

Section III: Climate and International Tourism Demand

Climate change introduces an even greater reason to incorporate climatic variables into tourism demand models. As weather patterns change and global temperatures rise, the tourism industry will see not only a shift in the demand curve, but also in the supply curve. Over the past 20 years, economists have been incorporating climate data into tourism demand models. This was done to better understand how climate impacts tourism patterns. More recently, how the climate is changing has been studied to evaluate its effects on tourism levels.

In 1985, Mieczkowski introduced the Tourism Climate Index (TCI). This index pioneered the way in which climate could be included in economic models, and has since been used in countless research papers. The TCI uses variables such as the daily and daytime comfort indices which account for temperature and humidity. It also incorporates sunlight, wind, and precipitation, with each of the variables receiving a specific weighting. More recent literature has expanded on the original model, incorporating other variables, and changing the mechanics behind it. Combining the data with forecasted weather predictions or looking at historical time-series data has allowed for a deeper understanding of the impacts of climate change on international tourism.

Amelung et. al. (2007) used the TCI for their paper. There, they looked both at current and predicted climate data to evaluate what TCI scores specific areas in the world will have as climate change continues. For both the current and predicted models, TCI scores were calculated for areas all over the world and then plotted on a map so trends could be seen. Current data were calculated using historical time-series measurements up until the present, and future data used climate predictions calculated by the IPCC. The results showed that as of 2007, tourists preferred Mediterranean areas and other moderate climates. As time progresses, and average temperatures increase, tourism to those areas will diminish, and tourists will seek out more polar options. Tourism favorability will rise during the spring and fall seasons respectively. These data show that climate change will indeed impact international tourism patterns, and provide a basic understanding as to why research in this field is both relevant and important. Additionally, the analysis provides substantial evidence to the importance of understanding seasonality regarding both climate change and tourism demand.

In 2014, Rosselló-Nadal reviewed the existing literature on climate change and international tourism. The goal of the paper was to assess the feasibility of the most relevant quantitative approaches evaluating the effects of climate change on tourism. The studies included in the review can be broken down into three sections. The first group considered physical changes in the environment. The second group used climate indices to analyze tourism attractiveness. These are papers such as Amelung et. al. (2007), that used the TCI. Lastly, a third group used tourism demand modeling to evaluate both current and future trends in tourism. Modeling is typically the best at evaluating the effects of climate change on future tourism levels. Rosselló-Nadal (2014) found that almost all studies had both great insight and flaws, and that depending upon the type of approach used, the findings would vary. Most of the articles used in this review used a global data set. The discrepancies shown in the review show that literature in this field is evolving, and a widely-recognized approach to understanding the connection between climate and tourism is yet to be established.

Section IV: A Regional Understanding of Climate and Tourism

While there is a large literature that uses global data sets, many researchers have looked at specific countries and regions. With the span of global variation, it is easier to pinpoint seasonal trends by region. Abidoye and Ayodele (2015) evaluated the effects of climate change on economic growth in Africa. Tourism itself is not mentioned in the article, but due to the size of the tourism industry in many of Africa's nations, it is indirectly implied. A 1°C increase in temperature was shown to reduce GDP by .67%. In South Africa, tourism is expected to account for 9% of the country's GDP over the next five years. Looking at a continental perspective, if temperature is associated with an overall decrease in GDP levels, tourism will be impacted as well. Abidoye and Ayodele (2015) showed that climate change and economics are clearly linked, and not necessarily for the better.

Another study that looks at the impacts of climate change on a specific region is Bigano et. al. (2005). Bigano and her colleagues used an existing data set to evaluate the effects of climate change on tourism levels in Italy. A general conclusion was made that higher domestic temperatures have a positive effect on domestic tourism. Similar conclusions were made in a paper by Hamilton and Tol (2007). In Hamilton and Tol (2007), the relationship between climate change and tourism was explored in Germany, the United Kingdom, and Ireland. The research showed that in general, as the climate warms, all three of the countries will see an increase in domestic tourism (not international). Citizens will not need to travel out of their countries to find the levels of warmth they seek. Both the United Kingdom and Ireland exhibited a tourism shift towards the North, whereas in Germany it was the opposite. This was due to the overall climate differences in the countries and the position of coastlines. This article shows that climate change, in the short run, will seek to improve tourism levels in these countries. Hamilton and Tol (2007) concluded that climate change will cause tourists to travel domestically within these three countries, and eventually, international tourism will increase as tourists from southern European countries try to escape the hotter climate. This does not show what the global trends would be. Southern European countries would see a decrease in tourism revenue as individuals look to areas farther north. Similar results were shown in Amelung et. al (2004) when using the TCI and predicted temperatures. The patterns and trends predicted for international tourism are much clearer when looked at regionally. Tourism will begin to shift away from popular destinations and towards the poles as climates become unsuitable.

Section V: IPCC and WTTC Reports

The best way to fully understand the scope of how much of an impact international tourism has on world economies is by looking at institutional reports. Furthermore, climate change reports typically illustrate how specific industries and areas will be impacted as temperatures increase and natural weather patterns and disasters change both in frequency and location. These reports are the foundation for which empirical analyses are run. The universal standard for climate change information is the Assessment Report released by the IPCC. To date, the IPCC has released 5 reports (1990, 1995, 2001, 2007, 2014) (IPCC). The next report is scheduled to be released in 2022. The fifth Assessment Report released by the IPCC is the source of figures included in this study and many others. It is the fifth Assessment Report that illustrated global temperatures are expected to rise 2.6 – 4.8 °C, and the sea level is expected to rise .45 – .82 meters by the end of the century (Nicholls 2014).

Just as the IPCC is the authoritative body on climate change information. The World Travel and Tourism Council (WTTC) is its counterpart when it comes to tourism. The WTTC comes out with economic reports on travel and tourism annually. Not only do they have international reports, but they also release regional and country specific reports. These reports show the scope of tourism in the past fiscal year as it relates to GDP, unemployment, infrastructure, government expenditures, and other economic indicators (Turner and Freiermuth 2017). When taken together, the Assessment Reports released by the IPCC and the

Economic Reports released by the WTTC provide a great basis for understanding why increased knowledge of the effects of climate change on tourism will be so beneficial. This study uses both reports as sources for fundamental information and referred to them when evaluating which variables would be best to include in the contained regressions.

Section VI: Adding to the Field

Current research has tested indices, models, and different combinations of economics, psychology, and sociology to best understand how climate change and different determinants will impact tourism. The results have varied depending upon what method is used, and which country or region is being evaluated. Winter tourism industries will experience a far different fate than sun and beach tourism industries. Additionally, islands will be impacted by climate change much more than landlocked countries. These variables make it very hard to predict what the future holds.

Determinants for tourism demand have been identified and evaluated for over 30 years. Variables such as political risk, common language, and exchange rates all affect tourism levels. Additionally, income and price elasticities for tourism demand have been studied in depth. International tourism is a luxury good, and price and tourism levels typically have a clear inverse relationship. The above literature has evaluated both economic features of international tourism as well as climate variables. What this paper does is look at new geographic and cultural determinants of international tourism, including temperature and precipitation as climate variables, to help add to the growing literature on tourism demand. This paper claims that the relationships that elevation, winter and summer temperature, and winter precipitation have with international tourism are complex, yet significant.

CHAPTER FOUR

ECONOMETRIC MODEL AND DATA

This chapter includes an overview of the structure of the empirical model used in this analysis. It also introduces each variable, its source, why it is included, and how it is measured. The chapter concludes with a detailed discussion regarding the implications and interpretations of the results.

Section I: Creating the Model

This paper uses an Ordinary Least Squares estimate regression model to evaluate correlations between specific determinants and overall International Tourism Receipt levels (USD, 2014). Various sensitivity tests using different functional forms were run to best interpret the data. These include both linear and log-linear regressions with different combinations of variables. After analyzing the data thoroughly, the relationships between variables fit best within a log-linear framework, and thus the log-linear regression will be analyzed in detail later in this chapter. Specific variables were removed from the equation once it was established that they were neither significant nor were they impacting the other variables. The data itself has been collected for 153 countries, compiled from a variety of sources. The original data set included all 195 sovereign countries, however as more data points were added, countries with no available data for a given variable were taken out to avoid bias created by zero values.

Both cross-sectional and time-series data are used in this analysis. Many of the variables used in this analysis do not change at a continuous rate. The size of a country (total square km), minimum and maximum elevation levels (m), and the number of UNESCO World Heritage Sites, for example, tend to stay relatively constant. Coastline is expected to change significantly as climate change increases; however, the current data do not provide enough fluctuation to cause time-series data to be necessary. This is not to say that a new World Heritage Site will not be proclaimed, or that political boundaries are not redrawn, but for the sake of this analysis, these variables are relative constants. For that reason, cross-sectional data can be used effectively.

Climate variables have more variation, and when trying to understand climate change, time-series data is necessary to evaluate change over time. To account for temporal variation not attributed to climate change, time-series data for the climate variables was created by taking the mean values for two time periods. The first is from 1901-1930 and the second is from 1991-2015. Looking at yearly data could allow for outliers that alter the data and using the change in annual temperature and precipitation for the entire time frame would have the same effect as comparing the early and later periods.

Section II: The Variables

All variables that were used within regressions are illustrated in Tables 1,2, and 3 within the Appendix, however many were not included in the final specification that is discussed in detail further along in this chapter. Table 1 shows all individual non-climatic variables, Table 2 shows all individual climatic variables, and Table 3 shows all the interactive terms that were created. Interactive terms were created to better understand how different variables interact under different climatic and geographic conditions. They are created by multiplying individual variables together and are used to test complex relationships.

Each variable was chosen on the understanding that it should influence tourism. Some are climate variables that will indirectly affect tourism levels. The dependent variable used to estimate international tourism is International Tourism Receipts per dollar of GDP (ITR), measured in US dollars from 2014. Initially International Tourism Receipts was used as the dependent variable. Without accounting for country size, either by population or by economy, outliers existed in the data. In earlier regressions, International Tourism Receipts per capita was also used. This variable was eventually discarded again due to outliers such as the Maldives and Luxembourg. Finally, International Tourism Receipts per dollar of GDP was created to account for the broad range of global economies. For the regression analyzed in this chapter, the natural log of the variable is used. International Tourism Receipts are the expenditures by international inbound visitors. Each time a visitor from a foreign country makes a purchase it is included in the receipts. Thus, a larger value of International Tourism Receipts should imply a larger influx of international tourists.

The area of each country was measured in square kilometers. Each country's area does not include the area of any of its legal territories. For example, the United States' area does not include that of Puerto Rico. One would not count tourism to Puerto Rico as tourism to the United States. Area is a variable that should present a clear relationship with tourism revenues. As evaluated later in this chapter, total area is negatively correlated with ITR, most likely because the dependent variable is with respect to GDP. Area, along with coastline, is something that may change because of climate change. The United States itself has already seen its first wave of climate change migrants having to leave their coastal homes. Small island nations will especially see their total area change as sea levels rise and flood the coasts.

The sole cultural variable included in this study is the number of World Heritage Sites, as designated by UNESCO. World Heritage Sites can fall into different categories, however; they all provide a certain level of interest for the country in which they are located. For that reason, I use the total number of sites for my data. By calculating how many total World Heritage Sites are within each country, the analysis can quantitatively evaluate both cultural and geographic landmarks within the nation's borders. It is my understanding that with more cultural and geographically significant landmarks in a country, more tourists would want to travel there. Since international tourism has been established as a luxury good, more World Heritage Sites should increase the demand for travel to that country.

Coastline was measured by calculating the total area (km) in contact with oceans, seas, and significantly large lakes and rivers. Small lakes or rivers were not accounted for. The coastline variable was included to capture recreational beach tourism, and thus no smaller bodies of water are included in the measurement. The total number of lakes or rivers and their relative coastlines could prove to have a different and independent effect on tourism. Theoretically, coastline affects the number of beach tourists, but it is also important to infrastructure close to the shoreline. As climate change causes sea levels to rise, coastlines should reach further inland, flooding establishments and causing an increase in spending to fix existing infrastructure. When running earlier regressions, coastline was not significant by itself and showed no interaction with other variables and was thus removed from the later analyses.

The effects of coastline on international tourism may be reflected in minimum elevation measures.

Elevation is another major factor causing variability within countries. By including the maximum and minimum elevations for each country, this analysis can establish whether low lying coastal areas or high altitude mountain ranges have any correlation with tourism revenues. Elevation levels were also used in the interactive terms with temperature and precipitation. The interactive terms are discussed in detail later in this section.

The first true climate variable to be used in the model is temperature. Temperature data was collected from the World Bank's Climate Change Knowledge Portal. For this study, the mean temperature was calculated for two periods. The first period is from 1901-1930, and is the earliest period on record. The second is from 1991-2015, the last calculated period. Once the data was accumulated, seasonal averages were calculated. Temperature levels for both the winter and the summer respectively are included in the model. The two averages are taken for the months of December, January, and February, and June, July, and August respectively, depending upon which hemisphere each country is located. Countries located along the equator were noted. Since this study is evaluating climate change, the change over time for each temperature measurement was calculated between the two periods.

As climate change serves to increase global temperatures, countries all over the world will be impacted. Countries with already high average temperatures may reach a critical point where it gets too hot for year-round tourism. This is already hinted at in studies such as Amelung et. al. (2007). Other countries located more poleward may see an influx of international tourists. Generally, seasonal tourism trends are expected to change, and both the spring and fall seasons will increase in popularity.

The second climate variable that is used in this study is precipitation. The precipitation data comes from the same source as the temperature data, the World Bank's Climate Change Knowledge Portal. Likewise, the data was calculated the same way. Averages for each of the two periods were found, and then seasonal averages were calculated using the same three months as for the temperature data. Once again, the change over time was calculated. Just as climate change is predicted to change temperatures and alter tourism patterns, precipitation levels are also expected to change. There will be a general increase in precipitation across the globe as the climate changes, even though variation will be extreme (Nicholls 2014). The effect of precipitation on tourism is like temperature, as it depends upon the type of tourism in each area. Sun and sand tourism locations thrive in hotter drier climates while ski industries require colder temperatures and higher levels of precipitation. For this reason, interactive variables using both temperature and precipitation were included in this analysis.

The interactive variables were created to investigate the possibility that climate and geography affect ITR in complex ways that vary depending on physical and climatic characteristics. Models containing strategic interaction typically produce conditional hypothesis rather than unconditional ones (Brambor et. al. 2005). These hypotheses, such as: "It is expected that an increase in winter temperature will negatively affect ITR when elevation is high, but not when it is low," are precisely the types of questions that this paper is analyzing. When a conditional hypothesis is involved, and when variables show interactive properties, interactive terms should be included in the model (Brambor et. al. 2005). As illustrated above, both temperature and precipitation can have extremely different effects depending upon the area in which one is assessing. By interacting both minimum and maximum elevations with each temperature and precipitation variable, it is easier to understand these complex relationships. Since there are two time periods of data for each climate variable, one can evaluate historical trends as well.

Lastly, seasonality has already been shown to play a huge role in international tourism. With vacations playing a major role in when people travel, and seasons influencing the type of tourism that is popular, the seasonal climate variables were interacted with elevation as opposed to the overall climate variables. This allowed for a more specified analysis.

Table 4 in the Appendix shows the descriptive statistics of the variables used in the primary log-linear regression. For most of the variables the standard deviation is minimal. There are however, two outliers. Total area and maximum elevation have extremely large standard deviations. This should come as no surprise given this analysis uses a global data set and there is an extreme amount of variation in those two variables around the world. On the flip side, it should be noted that the standard deviations for the seasonal climate variables are relatively small. Temperature and precipitation levels remain cautiously consistent throughout a season compared to their annual measures. This is illustrated in the larger standard deviations for the total annual temperature and precipitation levels for the two periods. Another important takeaway is the increase in both temperature and precipitation over time, as shown by higher mean values in the later period. This will come into play in the following section when interpreting the results of significant variables.

Section III: Discussion of Empirical Results

After evaluating multiple functional forms and sensitivity tests, one specification was created to best illustrate the empirical results of this analysis. Specification 1 as show in Table 5 of the Appendix is a log-linear multiplicative interaction regression where the dependent variable is the natural logarithm of International Tourism Receipts per dollar of GDP (ITR). The independent variables used are listed within Tables 1, 2, and 3, as well as listed within the results in Table 5 of the Appendix.

Significant variables are shown at the 1, 5, and 10 percent levels. The individual variables that were insignificant are maximum elevation, precipitation from 1901-1930, precipitation from 1991-2015, summer temperature from 1901-1930, summer temperature from 1991-2015, summer precipitation from 1901-1930, and summer precipitation from 1991-2015. The interactive variables that were insignificant are maximum elevation * winter temperature for both time periods and minimum elevation * summer temperature for both periods.

Total area is statistically significant with a negative coefficient. This indicates that as total area increases, the ITR will decrease. At first glance one would claim the negative coefficient is the opposite of what is expected; however, with the independent variable in per GDP terms, it makes sense. Around the world, countries with larger total areas tend to also have higher GDP levels. Thus, as total area increases, the denominator for the dependent variable will also increase, causing the negative relationship. If the dependent variable were simply International Tourism Receipts, the coefficient on total area may paint a slightly different picture. When it comes to evaluating the impact of this result, little can be done to change the area of countries. Thus, there are not as many implication surrounding the significance of total area as there are with other climatic or cultural variables.

The number of World Heritage Sites is the second significant variable. If the number of World Heritage Sites were to increase by 1, then the natural log of International Tourism Receipts per dollar of GDP would increase by an average of 4%, holding all other variables constant. World Heritage Sites are a pull factor as identified in previous literature. Thus, an increase in the number of World Heritage Sites should have increased ITR, which this study confirmed, helping to corroborate both other authors, and other analyses.

The overall temperature variables for each period were statistically significant. Since only seasonal temperatures were used in the interactive terms, one can evaluate overall temperature independently. For the later time frame, 1991-2015, the coefficient on temperature is negative. Thus, the higher the temperature, the lower the ITR. Conversely, the coefficient for the earlier period from 1901-1930 is positive. Thus, for two places with the same current temperature, the one with a higher early temperature has a higher ITR. Additionally, more of a rise in temperature is associated with a lower ITR. This result shows that not only does an increase in temperature over time generally harm ITR, but it shows that historical temperatures and the change over time are meaningful and have a lasting impact on current levels.

Total area, World Heritage Sites, and overall temperature measures were not used within interactive terms in the regression, thus it makes sense to evaluate their significance independently. For other significant variables, it only makes sense to evaluate them in the context of their interactive terms. Interactive variables provide an additional level of specificity that can serve to provide a clearer picture of how everything connects. Minimum elevation, winter temperature for 1901-1930 and 1991-2015, and winter precipitation for 1901-1930 and 1991-2015 were all significant independently, but are all included in interactive variables.

The fact that quite a few of the interactive terms are significant indicates that the relationships that elevation, winter temperature, summer temperature, and precipitation have on tourism revenues are complex and interrelated. The results of the regression also show that the change over time in precipitation and temperature are important, as indicated by significant coefficients on variables that include precipitation and temperature from the early 1900s.

To better comprehend the complex relationships between these variables, a closer look at the interaction between summer temperature and maximum elevation can be used as an example. The summer temperature variables for both periods by themselves were insignificant, yet when interacted with maximum elevation, the newly created variables are statistically significant. For the later period, the interactive variable of maximum elevation * summer temperature has a positive coefficient. Thus, summer temperature is associated with higher revenues in places with higher maximum elevations. The interactive term with maximum elevation and summer temperature for the earlier period is significant but with a negative coefficient. So, for two places at the same elevation, the country with a lower early 1900s temperature has a higher revenue.

A second example that helps illustrate the complexities identified by this analysis is the interactive term minimum elevation * winter temperature. The minimum elevation * winter temperature interactive term for the later period, 1991-2015, is statistically significant with a positive coefficient. So, for two places with the same winter temperature, the one with a higher minimum elevation has a higher value for the overall interactive term, and thus is associated with a higher ITR. When evaluating the interactive term with minimum elevation * winter temperature for the earlier period, the coefficient is significant but negative. Thus, the positive influence that minimum elevation has on winter temperature is smaller in places where the winter temperature has risen more.

The two examples outlined above show how temperature and elevation interact to help illustrate the complexities behind international tourism levels. By identifying that a larger positive temperature change between the two periods is associated with less of an increase in ITR depending upon elevation characteristics for both the winter and summer, this analysis provides evidence that climate change, however complex, can be described as a fundamental determinant of international tourism. The same can also be said for precipitation. Since summer temperature was insignificant by itself, but not when interacted with elevation measures, it is clear that there are complex relationships underpinning international tourism levels.

To get a more in depth understanding, one can evaluate the derivatives calculated for the interactive terms with respect to each variable individually. The calculated derivatives are showing the overall effects of the variables in question. There, one can see that for the climate variables of summer and winter temperature and precipitation, maximum elevation seems to be the driving force behind the overall value of the derivative. Thus, it would be incomplete to evaluate climate data and tourism without looking at other geographic indicators. When looking at the global sample used in this analysis, these calculations clearly vary from place to place. This helps validate the conclusion that the factors going into these calculations are sufficiently complex as to make intuitions about the overall effect difficult.

The results of this analysis show that the fundamental determinants of international tourism are extremely complex. It is clear by looking at the descriptive statistics in Table 4 of the Appendix that there has been a change in temperature and precipitation over time, and the results of this analysis show that those changes are significant when evaluated with respect to other variables. It is insufficient to simply evaluate correlations between simple climate characteristics of countries and their ITR. Similarly, it is also insufficient to evaluate the relationships between geographic elements and ITR. To fully grasp the mechanisms at play that are helping facilitate international tourism in certain countries, interactions between the climate, geography, and other factors must all be evaluated simultaneously. World Heritage Sites and other clear pull factors have a strong positive correlation with international tourism, but climate variables and those that have more variation depend upon multiple elements and vary across different countries

Section IV: Possible Discrepancies

There are a few potential changes that could have been made while running the various linear and log-linear regressions. First, using International Tourism Receipts per dollar of GDP may have had an impact on total area and other variables that would have been different if International Tourism Receipts by itself would have been used. The reason the per GDP calculation was used was to account for the wealth of countries without causing a linearity problem. ITR per capita was tested, but created outliers that swayed the data. A second potential change would be to have utilized the change over time for the entire catalogue of climate data instead of the two period model this analysis uses. This should not prove to have any significant effect, as the change over time between periods was included in multiple regressions and was sufficient in accounting for the change over time. Lastly, the use of a cross-sectional sample of ITR could have a different effect than finding substantial ITR time-series data. Time-series data regarding ITR is hard to come by, and many smaller nations do not regularly report such information. Additionally, the format of the above regression helps illustrate how changes over time have an impact on current levels. For these reasons, while it is important to note potential changes in data, the regressions run in this analysis should serve to be a great indicator for the interconnectivity between the climate, geography, and international tourism.

CHAPTER FIVE

CONCLUSION

This analysis provides a strategic way of looking at the impact of climatic, geographic, and cultural elements on international tourism levels. Firstly, the effects of historical increases in temperature and precipitation over the last 100 years are significant and can be seen. Additionally, the results indicate that multiple interactive variables were significant, which helps show how complex the relationships are between the climate, geography, and international tourism. Due to the complexities within the data, no clear conclusion can be made concerning how a country can implement strategies to improve its tourism levels. What this analysis does provide, is a better understanding of the relationships serving as the backbone for international tourism. Lastly, the regression helps to pinpoint at least one specific “pull” factor as described in previous literature and confirm its positive relationship towards ITR. Thus, if countries can register more official landmarks with UNESCO and increase the number of World Heritage Sites within their borders, they should see an increase in international tourism. These results help corroborate previous analyses describing push and pull factors, while they also help paint a clearer picture as to how variable the determinants are for international tourism and how complicated the interactions are between the climate and a country’s tourism level.

This analysis adds to the ever-growing literature surrounding the connections and implications of climate change and tourism. By including climatic variables, geographic variables, and cultural variables, this study took a broad approach at evaluating certain determinants of international tourism. As a result, this paper helps corroborate that climate, and specifically winter and summer seasonality, plays a very large and complex role in international tourism. Specific industries such as the sun and sand industry and the winter ski industry will be impacted on two completely different ends of the spectrum. Climate change has already caused the first round of 21st century weather related migrations. It has made us bear witness to a year with the greatest number and most powerful tropical storms on record. Unprecedented forest fires are occurring at alarming rates, polar sea caps are melting, and the oceans are slowly rising. While these events seem far-fetched, and the timeline seems too long to worry about the immediate future, that is not the case. Even minute changes in climate can result in major changes to the economy.

International tourism directly and indirectly accounts for 1 in 10 jobs in the global economy. Last year over 2 billion people traveled the world, not only fulfilling lifelong dreams for themselves, but providing livelihood to millions more, substantiating government incentives and programs, facilitating trade, and promoting world peace. As the global economy becomes increasingly connected, and as travel is made easier by unprecedented breakthroughs in technology, it will be even more important to understand the complexities behind international tourism and its relationship with the climate.

APPENDIX

Table 1: List of Individual Variables used in Regression Analysis

Individual Variables	Unit of Measure	Data Source
International Tourism Receipts	USD Millions, 2014	The World Bank
International Tourism Receipts Log	Log USD Millions, 2014	Calculated
International Tourism Receipts Per capita	USD Millions, 2014, per capita	Calculated
International Tourism Receipts Per capita Log	Log USD Millions, 2014, per capita	Calculated
International Tourism Receipts Per GDP	USD, 2014	Calculated
International Tourism Receipts Per GDP Log	Log USD, 2014	Calculated
Total Area	Square Kilometers	Nationsonline.org
Total Area Log	Log Square Kilometers	Calculated
UNESCO World Heritage Sites	Number	UNESCO Website
Coastline	Kilometers	World.bymap.org
Maximum Elevation	Meters	CIA World Fact Book
Minimum Elevation	Meters	CIA World Fact Book
Difference in Elevation	Meters	Calculated
GDP	USD Millions, 2014	The World Bank
Population	Millions	The World Bank

Table 2: List of Individual Climate Variables used in Regression Analysis

Climate Variables	Unit of Measure	Data Source
Mean Temperature 1901-1930 °C	Celsius	Climate Change Knowledge Portal (World Bank)
Mean Temperature 1901-1930 °F	Fahrenheit	Climate Change Knowledge Portal (World Bank)
Mean Temperature 1901-1930 Log	Fahrenheit	Calculated
Mean Temperature 1991-2015 °C	Celsius	Climate Change Knowledge Portal (World Bank)
Mean Temperature 1991-2015 °F	Fahrenheit	Climate Change Knowledge Portal (World Bank)
Mean Temperature 1991-2015 Log	Fahrenheit	Calculated
Mean Winter Temperature 1901-1930 °C	Celsius	Climate Change Knowledge Portal (World Bank)
Mean Winter Temperature 1901-1930 °F	Fahrenheit	Climate Change Knowledge Portal (World Bank)
Mean Winter Temperature 1991-2015 °C	Celsius	Climate Change Knowledge Portal (World Bank)
Mean Winter Temperature 1991-2015 °F	Fahrenheit	Climate Change Knowledge Portal (World Bank)
Mean Summer Temperature 1901-1930 °C	Celsius	Climate Change Knowledge Portal (World Bank)
Mean Summer Temperature 1901-1930 °F	Fahrenheit	Climate Change Knowledge Portal (World Bank)
Mean Summer Temperature 1901-1930 Log	Fahrenheit	Calculated
Mean Summer Temperature 1991-2015 °C	Celsius	Climate Change Knowledge Portal (World Bank)
Mean Summer Temperature 1991-2015 °F	Fahrenheit	Climate Change Knowledge Portal (World Bank)
Mean Summer Temperature 1991-2015 Log	Fahrenheit	Calculated
Change in Temperature 1901-2015	Fahrenheit	Climate Change Knowledge Portal (World Bank)
Change in Temperature 1901-2015 Log	Fahrenheit	Calculated
Change in Winter Temperature 1901-2015	Fahrenheit	Climate Change Knowledge Portal (World Bank)
Change in Summer Temperature 1901-2015	Fahrenheit	Climate Change Knowledge Portal (World Bank)
Change in Summer Temperature 1901-2015 Log	Fahrenheit	Calculated
Mean Precipitation 1901-1930	Millimeters	Climate Change Knowledge Portal (World Bank)
Mean Precipitation 1901-1930 Log	Millimeters	Calculated
Mean Precipitation 1991-2015	Millimeters	Climate Change Knowledge Portal (World Bank)
Mean Precipitation 1991-2015 Log	Millimeters	Calculated
Mean Winter Precipitation 1901-1930	Millimeters	Climate Change Knowledge Portal (World Bank)
Mean Winter Precipitation 1901-1930 Log	Millimeters	Calculated
Mean Winter Precipitation 1991-2015	Millimeters	Climate Change Knowledge Portal (World Bank)
Mean Winter Precipitation 1991-2015 Log	Millimeters	Calculated
Mean Summer Precipitation 1901-1930	Millimeters	Climate Change Knowledge Portal (World Bank)
Mean Summer Precipitation 1901-1930 Log	Millimeters	Calculated
Mean Summer Precipitation 1991-2015	Millimeters	Climate Change Knowledge Portal (World Bank)
Mean Summer Precipitation 1991-2015 Log	Millimeters	Calculated

Table 3: List of Interactive Variables used in Regression Analysis

Interactive Variables	Unit of Measure	Data Source
Maximum Elevation * Summer Temperature	Meters*Fahrenheit	Calculated
Maximum Elevation * Summer Temperature Log	Log Meters*Fahrenheit	Calculated
Maximum Elevation * Winter Temperature	Meters*Fahrenheit	Calculated
Maximum Elevation * Winter Temperature Log	Log Meters*Fahrenheit	Calculated
Maximum Elevation * Summer Precipitation	Meters*Millimeters	Calculated
Maximum Elevation * Summer Precipitation Log	Log Meters*Millimeters	Calculated
Maximum Elevation * Winter Precipitation	Meters*Millimeters	Calculated
Maximum Elevation * Winter Precipitation Log	Log Meters*Millimeters	Calculated
Minimum Elevation * Summer Temperature	Meters*Fahrenheit	Calculated
Minimum Elevation * Summer Temperature Log	Log Meters*Fahrenheit	Calculated
Minimum Elevation * Winter Temperature	Meters*Fahrenheit	Calculated
Minimum Elevation * Winter Temperature Log	Log Meters*Fahrenheit	Calculated
Minimum Elevation * Summer Precipitation	Meters*Millimeters	Calculated
Minimum Elevation * Summer Precipitation Log	Log Meters*Millimeters	Calculated
Minimum Elevation * Winter Precipitation	Meters*Millimeters	Calculated
Minimum Elevation * Winter Precipitation Log	Log Meters*Millimeters	Calculated

Table 4: Descriptive Statistics for Independent Observations included in the Log-Linear Regression

Variable	Mean	Median	Maximum	Minimum	Std. Dev.
International Tourism Receipts per GDP	0.06	0.03	0.72	0.00	0.09
Total Area	799769	147181	17075200	261	2143270
World Heritage Sites	6.97	3.00	52.00	0.00	9.97
Maximum Elevation	2932	2629	8848	5	2086
Minimum Elevation	38	0	1400	-431	188
Temperature 1901-1930	63.81	70.11	82.16	18.86	15.37
Temperature 1991-2015	65.44	71.40	84.02	21.26	15.04
Precipitation 1901-1930	94.58	79.16	253.27	3.39	66.43
Precipitation 1991-2015	95.66	79.50	265.42	2.56	67.27
Summer Temperature 1901-1930	4.28	4.32	4.55	3.82	0.14
Summer Temperature 1991-2015	4.30	4.33	4.59	3.85	0.13
Winter Temperature 1901-1930	53.81	60.90	81.44	-14.76	22.25
Winter Temperature 1991-2015	55.41	62.47	82.50	-10.95	21.79
Summer Precipitation 1901-1930	4.18	4.49	6.25	-4.01	1.69
Summer Precipitation 1991-2015	4.17	4.47	6.06	-4.94	1.76
Winter Precipitation 1901-1930	3.49	3.74	5.62	-1.95	1.46
Winter Precipitation 1991-2015	3.49	3.80	5.68	-1.81	1.48

Table 5: Log-Linear Regression Results

Dependent Variable: Log International Tourism Receipts per GDP (USD, 2014)		
Variable	**Coefficient**	**Standard Error**
R – Squared	0.53	N/A
Adjusted R – Squared	0.43	N/A
Intercept	26.367	(14.365)
Total Area (sq. km)	-0.4418	(0.0630) ***
World Heritage Sites (#)	0.0408	(0.0166) **
Maximum Elevation (m)	-0.000309	(0.00223)
Minimum Elevation (m)	-0.132	(0.0580) **
Temperature 1901-1930 (°F)	40.611	(23.276) *
Temperature 1991-2015 (°F)	-47.858	(26.935) *
Precipitation 1901-1930 (mm)	0.0305	(1.684)
Precipitation 1991-2015 (mm)	-0.158	(1.636)
Summer Temperature 1901-1930 (°F)	0.121	(0.308)
Summer Temperature 1991-2015 (°F)	-0.0825	(0.314)
Winter Temperature 1901-1930 (°F)	-0.517	(0.313) *
Winter Temperature 1991-2015 (°F)	0.566	(0.329) *
Summer Precipitation 1901-1930 (mm)	-0.165	(0.802)
Summer Precipitation 1991-2015 (mm)	0.196	(0.748)
Winter Precipitation 1901-1930 (mm)	2.423	(1.356) *
Winter Precipitation 1991-2015 (mm)	-2.272	(1.363) *
Maximum Elevation * Summer Temp 1901-1930 (m*°F)	-0.0137	(0.00457) ***
Maximum Elevation * Summer Temp 1991-2015 (m*°F)	0.0139	(0.00452) ***
Maximum Elevation * Winter Temp 1901-1930 (m*°F)	0.000131	(0.000134)
Maximum Elevation * Winter Temp 1991-2015 (m*°F)	-0.000125	(0.000137)
Minimum Elevation * Summer Temp 1901-1930 (m*°F)	0.0983	(0.0730)
Minimum Elevation * Summer Temp 1991-2015 (m*°F)	-0.0863	(0.0733)
Minimum Elevation * Winter Temp 1901-1930 (m*°F)	-0.00426	(0.00241) *
Minimum Elevation * Winter Temp 1991-2015 (m*°F)	0.00240	(0.00137) *
Maximum Elevation * Winter Precipitation 1901-1930 (m*mm)	-0.00118	(0.000422) ***
Maximum Elevation * Winter Precipitation 1991-2015 (m*mm)	0.00108	(0.000415) ***

Number of observations is 153, standard errors are in parentheses
* significant at 10%
** significant at 5%
*** significant at 1%

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Union College Honor Code

As a student at Union College, I am part of a community that values intellectual effort, curiosity, and discovery. I understand that in order to truly claim my educational and academic achievements, I am obligated to act with academic integrity. Therefore, I affirm that I will carry out my academic endeavors with full academic honesty, and I rely on my fellow students to do the same.

Ethan Kranich Strauss