The Impact of Snowfall on Home Prices: A Study of Northeastern Ski Resort Towns

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The Impact of Snowfall on Home Prices: A Study of Northeastern Ski Resort Towns

By

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This thesis is submitted in partial fulfillment of the requirements for the course Senior Seminar (EC 375) during the Spring Semester of 2019.

While writing this thesis, I have not witnessed any wrongdoing, nor have I personally violated any conditions of the Skidmore College Honor Code.

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XII. References
I. Abstract

As global temperatures continue to rise, it is expected that there will be a reduction in natural snowfall in the mountain regions of North America. Many ski area industry experts warn that snow depth will decline by at least 25% in the next decade. For the 38 states that add value to their state economies through the winter tourism industry and the 191,000 jobs that are supported by the winter sport industry, the concern is real and growing. Lower than average snow years lead to an immediate and significant decrease in skier visits and therefore consumer demand for related goods and services in local communities. One of the most telling factors of an areas’ economic health is home prices, which reflect demand for housing in the area. This study will explore how a decrease in snowfall has will impacted home prices in communities surrounding ski areas.

This study used semi-logarithmic regression analysis on all counties in the 9 Northeastern states from 1996-2019 to determine the impact of ski resort proximity and annual snowfall on home prices. The results of this study show that the number of ski resorts in county \( i \) and winter precipitation have no statistically significant impact on median home prices or average home prices per square foot. In fact, mountain resort presence has a significant negative significant impact on average home prices per square foot, but no statistically significant impact on median home prices. This study shows that in the Northeast, snowfall may have no significant impact on home prices, however the presence of a mountain can have negative effects on average home values per square foot, decreasing values by 10.3%.

As snowfall decreases, demand for ski areas decreases and local ski resorts are often forced to lay off seasonal or full-time workers. This increase in unemployment correlates to a 1.5% decrease in home prices, which may play into the overall decrease in home prices when a mountain is present. Policymakers should be aware of this implication as negative changes in precipitation could largely effect the local economy’s consumer demand, income and unemployment rates and could be cause for tax reforms or budgetary spending changes for the area.
II. Introduction

Since 1970, the global annual temperature has increased at an average rate of .31°F per decade. In 2016, there was a 1.69°F rise over average 20th century temperatures (State of the Climate: Global Climate Report, 2017). As this warming trend continues and potentially accelerates, it can be expected that there will be a reduction in snowpack in the mountainous areas of North America. This will foreseeably have impacts on the winter tourism industry, as Burakowski & Magnusson (2012) found that there is a 17% decrease in skier visits when a low snowfall year occurs and a corresponding $51 million dollar drop in added economic value to the state economy. Many industry experts warn that snow depth will decline by at least 25% in the coming decade and that the ‘snow line’ delineating the latitude at which rainfall turns to snowfall will move northwards through New England and into the higher alpine reaches of the West, Northwest and Southwest, potentially creating unreliable operating schedules and forcing closure of ski areas. For the 38 states that add value to their state economies through the winter tourism industry and the 76,000 jobs that are supported by the industry, the concern is growing. As one of the most telling factors of an areas’ economic health is home prices, which reflect demand for housing in the area, this study begs the question: “How does home proximity to a ski resort, and the amount of snowfall near that resort, impact home prices?”

The consumers and companies in the industry are not the only ones that have a stake in this issue—a decline in ski area visits corresponds to a decrease in spending on goods and services in areas surrounding the mountains. Local businesses, including gas stations, diners, and hotels, are largely supported by the traffic that is brought into the town from these ski areas and will see a drop in income as skiers spend less time on the slopes and in the community. One of the most telling factors of an areas’ economic health is home prices, which reflect demand for housing in the area. Counties with better schools, public transportation, health centers, and a large amount of open spaces see a correlated increase in housing prices and as house prices fall, consumer spending (and related tax revenue) decreases (Hung, n.d.; Pettinger, n.d.). As demand for ski areas decreases, local economies can expect to see a decline in overall income, as well as a potential change in housing prices; this could be cause for tax reforms or budgetary spending changes for the area and therefore requires deeper investigation as this study will provide.

Nelson (2009) and Butsic et. al. (2011) both attempted to place value on ski resorts through hedonic analysis using log and log-log specifications. Nelson (2009) found that ski-
resort proximity increase property values by 23-27% and Butsic et. al. (2011) found that snowfall intensity increases housing prices by 2.2 to 6%. Wheaton (2005) used a two-variable VAR model to find that home prices near ski resorts are prone to overbuild every time positive demand shocks, such as regional income growth or years of heavy snowfall, occur. This study focused on only one area in New Hampshire; Nelson (2009) explores only one resort in Maryland and Butsic et. al. (2011) studies the Northwestern region of the United States.

The purpose of this paper is to determine the impact of snowfall on home prices for all counties in the Northeast from 1996-2019 through the use of semi-logarithmic regression analysis. This study uses four models to determine the impact of snowfall on median home prices but average home prices per square foot as well as the impact of a mountain being present in a county and the number of mountains in a county.

The contributions of this work are not only updating the data from studies done in the early 2000s to data from 2019, but also looking at the importance of a mountain or multiple mountains being in a county, as compared to previous studies that did a hedonic analysis of areas with ski areas.

The results of this study show that the number of mountains in a county have no statistically significant impacts on median home prices. Mountain presence does have a statistically significant negative impact on average home price per square foot, however the number of mountains has no statistically significant impact on average home price per square foot. Precipitation has no statistically significant impacts on both median home prices and average home price per square foot. Unemployment, as expected, has statistically significant negative impacts on both measurements and population and personal income have statistically significant positive impacts on median home value and average home price per square foot.

Previous studies such as Bustic et. al. (2011) prove that home prices increase with increased snowfall intensity and thus argue that as global temperatures warm and snowfall decreases, home prices will decrease as well. This study implies that for the Northeast, the effects of snowfall may not shift the overall range of home prices. While decreased snowfall may not directly impact home prices in this geographical region, the impact of a low snow year can be felt through the local economy as demand for lift tickets decrease, workers are laid off, and in turn home prices decrease in counties where mountains are present.
Section 3 addresses the research question, Section 4 reviews current literature, Section 5 describes data used in the study, and Section 6 explores the methodology used in the study. Section 7 states the results of the study, Section 8 goes into a discussion of the study and examines the limitations and Section 9 concludes the study.

III. Research Question

How does home proximity to a ski resort, and the amount of snowfall near that resort, impact home prices?

IV. Background

While skiing was first used in North America as a mode of transportation to remote villages, it quickly gained popularity once the rope tow was introduced in 1931 and skiers no longer had to hike to the top of the hill carrying heavy equipment (Lippus, 2015). At the end of World War II, over 200 resorts had rope tows.

This culture held strong through the 60s, with advancements in gear and technology creating a more comfortable and reliable experience. Later, snowmaking and improved grooming technologies made it possible to ski during times when natural snowfall was not strong, however these advancements had a pass-through effect of increasing prices at resorts. Despite this, ski participation in the 1950s and 1960s doubled every five to six years and by 1966 there were 662 ski areas in the United States (U.S. Department of Commerce, 1962; Tanler, 1966). Ski resorts soon became the ‘cool culture’ place to be, with the young and upper-class coming together to mold the resorts into destinations. In order to keep up with the influx of consumers, the typical small logging towns and remote posts that housed these resorts soon expanded to fit the needs of middle and upper-class visitors (Lippus, 2015).

In the second half of the 1960’s and continuing today, intentions shifted from developing new resorts to creating larger resorts. For many resorts, this meant expanding terrain and trails or introducing a second peak (such as the addition of Peak 9 at Breckenridge Resort in Colorado, which added 12 trails and two lifts to the existing resort (Vail Resorts Management Company, 2014)). While some resorts expanded through the mid-1970s, many smaller resorts closed or were acquired by larger multi-resort owners (including frontrunners Intrawest, Vail Resorts, and the American Ski Company) as a result of their inability to keep up with the capital and
operating costs of competing with the larger players. This chain of acquisitions is a relatively new phenomenon, and are presumed to occur because acquisitions are the fastest way to gain market share when “barriers to entry, such as environmental regulations and big infrastructure costs make it hard to add destinations” (Clinch, 2018). It also provides resort operators with diversity across North American regions and resort size/demographics, as protection against significant regional variable weather-impacted performance, and capitalizes on certain efficiencies of scale in capital and operational purchasing power, back-office and support functions, and standardized best-practices.

While skiers see benefits from the formation of these large conglomerates, it makes survival more difficult for small, independently-owned resorts as they find it harder to compete not only on price, but on amenities, conditions, and the variety of terrain they can offer (Propst, 2018). Since the 1980’s, roughly 33% of US ski areas have gone out of business and industry experts consider up to 150 more are considered threatened – many of these places were smaller Mom and Pop hills (Clinch, 2018). While these mountains are smaller, with less lifts and terrain, they have a vital individual measure of character and community that is difficult to replicate.

Moving into the late 1970s and 80’s, the sport of snowboarding (founded by Jake Burton, Toms Sims, and Mike Olson) became popular among 18 to 24 year olds that were previously not participating in skiing. In 1985, snowboarding was permitted at only seven percent of American ski resorts; throughout the early 1990s, snowboarding became more widely accepted as the technique and equipment became more advanced (Phillips, 2001). Snowboarding is largely recognized in the industry as the stimulant that revitalized the resort business and led to many improvements in equipment and operations. At the turn of the century, one in every three visitors to ski resorts was a snowboarder (National Ski Areas Association, 2001). Snowboarding was important to the resort real estate business as it captured the all-important family group demographic which was likely to spend long vacations and invest in resort housing.

Separately, it was around his time that environmentalists became concerned with the impact of ski resort development (Fry, 2006). For example, The Sierra Club pointed to ski resorts as one of the leaders in mountain habitat degradation, as construction around these large resorts expanded to create all-inclusive destination vacations in resort villages that included fine dining and shopping (Clifford, 2002). The ski culture has largely faded as the industry is no longer focused on the skiing experience itself, but about the ski resort lifestyle experience. Both actual
skiing and snowboarding, and the attendant leisure lifestyle, reasonably rely on a backdrop of abundant snowfall and active participants.

To combat the decreased snowfall in the past few decades, most resorts across the country have adopted the strategy used mostly in the East and have moved to subsidizing natural snow with manmade snow. In municipalities with ski resorts, 0.5% of municipality energy and 36% of municipality water consumption is put toward snowmaking as it takes between 1.5 and 9 kilowatt hours and 200-500L to make 1 m³ of snow (Rixen et. al., 2011). However as minimum winter temperatures are rising, the efficiency of snowmaking is undermined. With less natural snow and the effectiveness of snowmaking decreasing, the ski season will start to get shorter, no stretching into March and April. Over the past decade, this has cost the industry approximately 1.07 billion in aggregated revenue and will cost billions more as 25% of resort revenues are collected in March (Hagenstad et. al., 2018).

While snowmaking has clear climate change impacts associated with machine costs, energy usage, and water consumption, the grading and grooming of the created snow takes an environmental toll through soil erosion and vegetation degradation as postponing the time of melt-out can ruin plant diversity (Rixen et. al., 2011). In order to subdue public commentary on this matter, many mountains have chosen to take part in sustainability initiatives. Companies that have taken part in voluntary environmental programs (VEPs) have not seen long-term effects, only a decrease in energy usage. This is beneficial in the short-term as it decreases associated energy costs, however it does not mitigate long-term effects of snowmaking and grooming (Rivera et. al., 2006).

As the effectiveness of snowmaking decreases, many resorts are looking to combat demand changes by making capital improvements and investing in 4-season resort activities. However, these ‘green-season’ efforts do little to combat the real issue of natural climate change and are a small token effort in relation to the enormous operating budgets at most resorts. Beaudin and Huang (2014) prove that investment in moving to 4-season resorts does not have any effect on closure rates for mountains; winter still rules. On the other side, snow-covered and open skiing terrain impacts sales as consumers want more diverse types of terrain. This is an unadaptable trait for most mountains, however a large number of trails lowers the closure rate (Beaudin and Huang, 2014).
Despite the criticism of the state and federal environmental interests in and impacts of the ski industry, the industry is still kicking. Hagenstad et. al. (2018) found that in 2015/2016, the ski industry generated over 191,000 jobs (including off-resort and in community jobs), $6.9 billion in wages, and added a total of $11.3 billion in economic value to the economy. Ski visits in 2017/2018 reached 53.27 million, up from the 52.79 million visits in the 2015/2016 season (RRC Associates, 2018) despite increasing temperatures, which eighty-nine percent of ski resorts are combating by using snowmaking to extend their seasons and improve snow quality (Hagenstad et. al., 2018).

V. Literature Review
   a. Climate Change

   The U.S. Government has begun to realize the serious impact that climate change is having not only on the planet but on the economy was well. In a U.S. Congress hearing, Senator Barbara Boxer of California stated that "outdoor recreation is perhaps one of the first and most obvious aspects of our lives that global warming will touch" (The Issue of Potential Impacts of Global Warming on Recreation and the Recreation Industry, 2007). This hearing came to the conclusion that the East Coast will be the first area to see a large impact as ski areas in this region are at “low altitudes, being some of the first to experience rain instead of snow, and the change in winter weather forces tourists to stay away" (The Issue of Potential Impacts of Global Warming on Recreation and the Recreation Industry, 2007). As 97.5% of Americans aged 16 and over participate in some form of outdoor recreation at least once per year, the impacts seen by climate change will not be trivial (The Issue of Potential Impacts of Global Warming on Recreation and the Recreation Industry, 2007). Along with the impact of climate change comes the demographic shifts occurring in society. The large number of snowboarders in the teen population bubble of the 90’s and 2000’s has shrunk, lessening the share of the market in the snowboard versus skier mix and the number of overall participants in the sports, including in the the important family segment. At the same time, older skiers with abundant time and money for (expensive) leisure recreation are aging out. And, there is growing evidence that children are gravitating away from outdoor experiences and towards a virtual indoor reality. This disconnect threatens serious long-term implications for the cognitive, physical, social and emotional well-

As the snow season is becoming shorter and the ability to have good snowpack is decreasing, there has been increasing pressure on winter recreational sports to survive. As snow conditions worsen, consumers are becoming less likely to spend on pricey season passes (Steiger and Mayer, 2008). Smith et al. (2016) found that outdoor recreationists and tourists are not likely to alter their trip-taking behavior during the winter season under warmer conditions if their personal identity is strongly related to that place. This being said, the study found those that do not feel personally associated with the area will change their behavior based on climate changes (Smith et. al., 2016). Industry observers also speculate that as drive and travel times to viable resorts in higher or more Northern regions become necessary to find good snowpack and conditions, the casual and occasional skier and snowboarder may simply abandon the sport altogether.

Since 1970, there has been a 10-20% decrease in snow water equivalent (SWE); SWE measures the amount of water contained in snow packs and can predict snow depth and the time until snow melts (Hagenstad et. al., 2018). Fingerprints show human activity is evident in the loss of snow, as human-induced warming reduced the amount of water available from the snowpack. This has decreased the number of days with snow cover by 1-2 weeks since 1970 (Hagenstad et. al., 2018). These changes have a large effect on resort closure—Beaudin and Huang (2014) found that an increase in temperature by 3%, in conjunction with a 36.5cm decrease in snowfall, increases a mountains likelihood of resort closure by 37%.

While the overall snowfall has been low, the occurrence of large storms is increasing with the effects of climate change. Storms may be beneficial to snowfall, but this does not necessarily correlate to sales. Often storms bring so much snow to the area that highways get shut down, people lose power, and consumers are unable to reach resorts. This leads to a loss of ticket sales even when there is strong snowfall, forcing mountains to increase prices by 3.3-5.1% to stay profitable (Steiger and Mayer, 2008). Even with the increased prices, in low snow years decreased participation led to a loss of over $1 billion dollars in value added and lost 17,400 jobs compared to an average year (Hagenstad et. al., 2018).

Hagenstad et. al. (2018) proves that climate change is shown to have an impact on consumer surplus associated with winter recreation, reducing ski visits and per-day value
perceived by skiers. As consumer surplus shrinks, there is a trend that decreased snow in one year leads to decline in season pass sales (pre-orders) for the next year as well as overall decreased sales in the following year, as demand is significantly more sensitive to snowfall than booking of overnight stays (Steiger and Mayer, 2008). This is largely explained by the backyard hypothesis: that snow in urban backyards can be as important to ski businesses as snow in the mountains (Falk, 2015). Therefore, backyard snowfall can directly impact demand changes. These demand changes are seen by consumers moving to different sports, while other move to different locations—typically, beginner consumers quit and move to other sports, while older consumers will move to overseas skiing.

The historical norm in the ski industry of ‘bad snow years’ followed by ‘good snow years’ is shifting to a trend of continuous low snow years as global temperatures warm and continuous heavy snowfall becomes a thing of the past. The industry seems to be waiting for a “turnaround” that isn’t coming, using snowmaking to try to buffer the impacts of declining snowfall. Snowmaking, however, requires low temperatures and low humidity. As temperatures warm, even this saving grace of the ski industry may become obsolete.

In order to survive, resorts and surrounding towns are coming together to come up with creative ways to bolster long-term revenues by finding other ways to attract people to the town, largely funded by resorts in conjunction with town or state governments.

b. Snowfall

In the field of economic development, rainfall is often used as a variable when studying economic growth. As Miller (2016) stated, “deviations from mean rainfall are commonly used as a source of exogenous and unpredictable variation in household consumption, aggregate consumption, and income” and therefore rainfall is commonly used to deal with problems of endogeneity. Most commonly, these studies are used to study economic growth in developing countries, such as the study by Barrios et al. (2010) that found rainfall has been a determinant of poor economic growth in African nations.

When studying the winter tourism industry and temperatures decrease, rainfall becomes snowfall. Previous literature examines the influence of snowfall on daily ski lift ticket sales (Shih et al., 2008) as well as the economic effects of climate change (i.e. decreased snowfall) on outdoor recreation (Shaw and Loomis, 2008). As climate change continues and temperatures warm, snowfall and snowpack will decrease. In this resource-dependent industry, less snowfall
means less demand for ski resorts (Scott et al, 2006). Many studies have found that “warming is likely to substantially undermine the viability of ski resorts in those areas, with adaptation strategies such as snowmaking providing an uncertain but probably small degree of offset” (Bustic et al., 2011). In almost all studies on skiing, either on demand or the effects of climate change, snowfall is always a significant variable as the industry depends on it to function.

c. Home Prices

Historically, land prices have been used to measure the quality of life in an area the effect of climate on farmland, the impact of water availability on agricultural land, the effect of solar radiation on vineyards and much more (Blomquist et. al., 1988; Mendelsohn et al., 1994; Ashenfelter and Storchmann, 2006). Land prices are used in Hedonic pricing, a method of revealed preferences, which is used to understand consumer perceptions (and willingness to pay) of certain amenities as well as estimate the value of a non-market product or service. For example, hedonnic analysis can be used to discern the value of a lake through the prices of houses near that lake. Revealed preference methods are helpful in making inferences on the effect of certain variables on spending patterns and the importance of said variables to consumers (Apostolakis and Jarry 2009).

In hedonic analysis, price is a function of a house’s structural characteristics, location characteristics, and environmental characteristics. To measure the value of these environmental characteristics, economists will compare the value between homes within the vicinity of that amenity and those that are not near the amenity while holding all other variables, such as number of bedrooms, number of bathrooms, and square footage constant. This difference will show the value in the amenity itself as the sole fluctuation between the properties is the proximity to the amenity.

In summation, land price can be used to estimate the value of nearby amenities. Dipasquale and Wheaton (1996) argue that land must be priced at each site to that consumers are charged for the value of whatever locational advantages exist at that site whether that be the amenities that are nearby or the quality of life that is associated with the area. Clark (2004) states that under the assumption that interregional equilibrium exists, compensating differentials in housing prices can be used to value amenity levels (as the price derived from the differentials represents the marginal value of the amenity).
Within the ski industry, Nelson (2009) and Butsic et al. (2011) both used real estate prices as an estimate for the value of proximity to a ski resort. Butsic et al. (2011) focused on the region of the Southwest and the variability of housing prices with proximity to a ski resort with significant snowfall; finding that while ski area characteristics generally are insignificant and that an increase in temperature by 1.6 to 3.1°C degrees can in some areas correlate to a projected 44% to 55% reduction in home values. Butsic el. al. (2011), the first study to use hedonic pricing to estimate the variability in home prices, uses Census land tract values from 1970-2000 for homes within a 50km radius of ski areas that met their inclusion criteria and a 100km radius of weather stations with a minimum altitude of 4000ft.

d. Relevant Studies

There have been very few studies to discuss the implications of ski areas on real estate prices. The three main studies (Butsic et. al., 2011; Nelson, 2009; Wheaton, 2005) focused on using hedonic analysis to value the proximity to ski resorts and found that ski-resort proximity increases home values by 7.37% (in New Hampshire) and increases weekly rents by 23.6% (in Maryland). Both Wheaton (2005) and Butsic et. al. (2011) studied the impact of snowfall on home prices in these areas and found that in New Hampshire, snowfall intensity increases home prices by 18% and in the Northwest, snowfall intensity increases prices by 2.76%.

To look at each of these studies more in-depth, this study will first start by exploring the the 2005 study by William Wheaton on the purchasing of second homes near ski resorts from 1975-2000 around Loon Mountain in New Hampshire (Wheaton, 2005). Wheaton (2005) provides a detailed analysis on the function of the second-home real estate market, using a two-variable VAR model that predicted condominium stock and price as a function of these variables lagged, as well as interest rates and region-wide skier visits. The study ultimately found that condominium prices and stock behave as if supply were perfectly elastic in real price levels and prone to overbuild every time positive demand shocks, such as regional income growth or years of heavy snowfall, occur (Wheaton, 2005). A trend of average-to-higher snowfall leading to more demand for second home and resort housing may cause optimistic overbuilding, only to find a glut of unused or for-sale units when trends shift. The outcome of heavy snowfall causing a positive demand shock for real estate near ski areas begs the question, does heavy snowfall have an impact on housing prices near ski areas? This study will attempt to answer that question.

Nelson (2009) and Butsic et. al. (2011) both attempted to place a value on ski resorts through
hedonic analysis. Nelson (2009) studied the Wisp Resort in Maryland using a semi-logarithmic hedonic price model for winter rentals and a sample of 577 houses, including 64 slope-access houses and 33 ski-road access houses in the 2007/2008 ski season. This study used structural characteristics (number of bedrooms, number of bathrooms, number of king size beds), quality attributes (fireplace, sauna, extra TVs), and location attributes (ski-slope access, ski-road access) in order to determine the value of proximity to a ski resort (Nelson, 2009). The findings concluded that ski-resort proximity increases property values by 23-27% (Nelson, 2009).

Butsic et. al. (2011) went a step beyond Nelson (2009) by using a hedonic framework to examine the impact of global warming on housing prices near ski resorts. The use of the variable snowfall intensity was used to simulate an increase in temperature through a decrease in snowfall in prime ski months (December through March). This study looked at two different dependent variables—individual home values and Census land tract values from 1970-2000 (Butsic et. al., 2011). One limitation of this study was the manipulation of data – the most influential independent variable in this study, snowfall equivalent to total precipitation (SFE/P), was constructed by the author as current data measurements were not reliable (Butsic et al., 2011). This variable was constricted by following the definition of Knowles, Dettingger and Cayan (2006), who used the rule that any precipitation on a day with a minimum temp below 0°C is measured as snowfall. By using a reduced form of a hedonic price analysis through a log-log specification, the study finds that snowfall intensity increases housing prices by 2.2 to 6% (Butsic et. al., 2011).

Both of these studies (Butsic et. al., 2011; Nelson, 2009) also use a hedonic analysis to research the effect that ski areas have on real estate prices. This study, however, will be using a regression analysis on a county-level to determine the impact of snowfall on real estate surrounding ski areas. This is largely due to the fact that hedonic analysis relies on individual data for homes (number of bedrooms, number of bathrooms, location, square footage) that is not available to the public; this study will instead use median house prices for county \( i \). By using county level data, this study will also be able to do a comparison of house prices between counties with ski resorts and those without as well as looking at the impact of snowfall on median home prices.

A limitation of the current literature is that the geographical scope and time scale are quite limited. Nelson (2009) explores on only one resort and Butsic et. al. (2011) studies the
Northwestern region of the United States; this study will expand the literature by focusing on the Northeast region of the United States. Butsic et. al. (2011) and Wheaton (2005) use data from before 2000 and Nelson (2009) focuses on only period of time— the 2007/2008 winter season; all three studies could be expanded by using a more recent dataset. This study will seek to fill this gap in the literature by focusing on more recent data (1996-2019) and a wider geographical area as well as take a different approach to find the impact of snowfall on real estate prices.

VI. Data

The data for this study is compiled of three main sections: housing prices, weather characteristics, and ski area characteristics. This study will use 97,465 observations to determine the impact of snowfall on home prices. The paper that has had the most weight in this topic area, Butsic et. al. (2011), analyzed the impact of snowfall on housing prices using hedonic analysis by analyzing data of homes within 50km of a ski mountain and 100km of a weather station. While the current study will not be relying on proximity to weather stations, it will follow the guidelines of this general radius by using the county that each ski area is located in. This study will focus on the impact of climate change using multiple regression analysis using panel data compiled by county monthly for years 1996-2019. A dummy variable will be used to indicate whether there is a mountain present in a county. Detailed description of all variables can be found in the appendix in Table 1.

a. Home Prices

This study examines two different dependent variables, the first being median estimated home value— a smoothed, seasonally adjusted measure of the median estimated home value on a county level for all single family homes, condominiums, and co-ops from 1996 to 2019 (Data, n.d.). This variable mimics the median home value data that Butsic et. al. (2011) collected from the Census for their study on Northwestern homes.

The second dependent variable is the average home value per square foot, which follows the same pattern as median estimated home values. While this variable is not directly derived from a previous literature, average home values per square foot give a scaled estimate of the demand for homes in county $i$. While median home values give an idea of the middle value of homes in an area, the average value per square foot allows the fluctuation in home size per county to be accounted for. For example, some counties may have very large homes that are not
in a desirable area, and therefore home prices are lower, while others may have small homes in a very desirable area and therefore home prices are higher—average home price per square foot accounts for that.

The source of this data is the Zillow Home Value Index (ZHVI), which consists of a total of 87.3 million homes. This index is created by first calculating the raw median home estimates, adjusting for any residual systematic errors or seasonality, reducing noise in the data and applying quality control (Zillow Research, 2018). As previously mentioned, there have been no studies done on this topic in the Northeast region. Demand for homes near ski resorts is markedly different in this area than near more luxury, high price resorts in the Northwest. This study will explore these differences by using data from states within the Northeast Region: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.

b. Weather Characteristics

Studies by Nelson (2009) and Wheaton (2005) used inches of snowfall as an independent variable, while Butsic et. al. (2011) questioned the viability of snowfall data, as it is observer dependent and therefore can be unreliable. Butsic et. al. (2011) chose to create a more reliable measure of snowfall—snowfall percentage of total precipitation (SFE/P), which measures the percentage of precipitation that falls as snow while taking into account humidity and wet bulb temperatures. The wet bulb temperature reflects the critical impact of humidity on temperature that defines hospitable conditions for snowmaking—the lower the humidity, the better (when ambient temperatures are greater than 26 degrees Fahrenheit).

In order to determine if snowfall has an impact on housing prices, this study aimed to use the gold standard in regard to measuring snowfall—snowfall percentage of total precipitation (SFE/P). However, both SFE/P and snowfall data were not readily available to the public, and therefore this study used data on precipitation during winter months to approximate snowfall. During the winter months (December – March), average temperatures are below 32°F and therefore precipitation most often falls as snow (National Weather Service, 2019).

Data for precipitation was sourced from Climate Data Online provided by National Oceanic and Atmospheric Administration (Climate at a Glance: National Time Series, 2019). Precipitation is defined in this study as inches of precipitation.
c. Ski Area Characteristics

Butsic et. al. (2011) and Nelson (2009) both conducted studies using hedonic analysis, determining if the presence of a ski area has any effect on home prices. While this study will is not doing hedonic analysis, it will use the basic method of Butsic et. al. (2011) and Nelson (2009) through the independent dummy variable mountain presence (0 if no mountain present, 1 if mountain present) to determine if the presence of a mountain in a county will have any effect on home prices in the area. In order to expand the scope of the study and take the research of Butsic et. al. (2011) and Nelson (2009) further, it will also use number of mountains within the county as an independent variable in order to determine if there is any influence of having more than one mountain in a county.

This study collected background data on ski area characteristics that can help to qualify the results given. The base elevation, peak elevation, and total elevation difference of each mountain, as well as information on where the mountain is located, was collected via the On The Snow reporting website (Ski Resort Statistics, n.d.). This website will also provide data for total number of trails on the mountain, total skiable acres, and amount of lifts which act as general indicators for the size of the mountain. While these ski area characteristics may not be directly involved with the regression analysis, it is important to understand the types of mountains that this study focuses on, and therefore information on each mountain is included in the data set.

d. Control Variables

Butsic et. al. (2011) used population density to account for the size of the county and therefore this study will use both population and population density as control variables. Both Butsic et. al. (2011) and Nelson (2009) do a hedonic analysis and therefore have a set number of homes in their data set. As this study is doing a semi-log regression, it will use number of housing units in a county to capture the size of the county as these previous studies do.

These three variables were obtained from the U.S. Census Bureau in both 2000 and 2010 and used for the entire decade (data for 2000 was used as an estimate for 2000-2009, data for 2010 was used as an estimate for 2010-2019) (Data Access and Dissemination Systems, 2010).

Reichert (1990) found that as unemployment decreases, housing prices for the Northeast increases. As such, this study will use unemployment as a control variable. This data was sourced from the United State Department of Agriculture Economic Research Service and was collected per county for every month from April 1996-January 2019 (U.S. Census Bureau,
Butsic et al. (2011) uses per capita income as a control variable in their study on home prices, however this study will use personal income—income that people get from wages, proprietors' income, dividends, interest, rents and government benefits, as a control variable (Bureau of Economic Analysis, 2017). While household income per capita would be a better, more comprehensive measure, the data was unavailable and therefore this study will lean on the next best thing. This data was collected annually by county for years 2015-2017.

e. Descriptive Statistics

Descriptive statistics for this data set can be found in Table 2. One of the most notable details from this table is the large range of home types that the variable median home value captures as prices range from $18,700 to $1.65 million, with the mean of these values being $175,024. Population density varies within a large range as well, between 2.8 and 69,468 persons per square mile. This large variation shows how the geographic area being studied is demographically diverse.

Table 3 showcases that if county $i$ gets more than an average amount (3.36 inches per month) of precipitation, there will be a higher number of ski mountains in county $i$. Median home value, personal income, and population density are also higher for counties with higher than average precipitation while unemployment rates are lower in areas with less than average precipitation.

Table 4 shows that median home values, as well as average home values per square foot, are lower in areas with ski areas. In these areas, however, the number of housing units is higher. As examined in the discussion section, it is unclear by the variable description whether these home units are occupied or unoccupied, which makes understanding the implications of this variable complicated. Unemployment, personal income, population, and population density are all higher in areas without ski areas. This may be explained by the fact that ski mountains are largely in rural areas, where population and population density are lower than in metropolitan areas, such as New York City.

Of all counties with ski mountains, counties with 4 ski areas have the highest median home values as seen in Table 5. Unemployment is the highest in counties without any ski mountains, and lowest in counties with 6 ski mountains. Population and population density are both highest in counties with two mountains and have a declining trend as the amount of mountains increases, reaching their lower point in counties with six mountains. The number of
housing units is highest in counties with six mountains and is the lowers in counties with four mountains. Personal income is highest in counties with four mountains. However, when comparing counties with mountains to those without, as seen in Table 4, counties without mountains have highest personal income.

VII. Methodology

a. Models

This study will use semi-log regression analysis to determine the impact of snowfall on home prices near Northeastern ski resorts. Butsic et al. (2011) uses a log-log specification and Nelson (2009) relies on a semi-logarithmic hedonic price function; following in the footsteps of these literatures, this study will use a semi-logarithmic regression analysis estimated by OLS to rescale the data and provide more explanatory power to the regression.

Four separate models will be used, the first examining the dependent variable median home price with mountain presence as an independent variable, the second observing the dependent variable median home price with number of mountains as an independent variable, the third observing median home price per square foot with mountain presence as an independent variable and the fourth observing median home price per square foot with number of mountains as an independent variable. The equations of the population regression functions used in this study are as follows:

Model 1

$$\log\ medhomeprice_{it} = B_0 + B_1 precip_{it} + B_2 mountainpres_{it} + B_3 unemployment_{it} + B_4 population_{it} + B_5 popdensity_{it} + B_6 housingunits_{it} + B_7 medianincome_{it} + E_{it}$$

Model 2

$$\log\ medhomeprice_{it} = B_0 + B_1 precip_{it} + B_2 nummount_{it} + B_3 unemployment_{it} + B_4 population_{it} + B_5 popdensity_{it} + B_6 housingunits_{it} + B_7 medianincome_{it} + E_{it}$$

Model 3

$$\log\ avghomepricesqft_{it} = B_0 + B_1 precip_{it} + B_2 mountainpres_{it} + B_3 unemployment_{it} + B_4 population_{it} + B_5 popdensity_{it} + B_6 housingunits_{it} + B_7 medianincome_{it} + E_{it}$$

Model 4

$$\log\ avghomepricesqft_{it} = B_0 + B_1 precip_{it} + B_2 nummount_{it} + B_3 unemployment_{it} + B_4 population_{it} + B_5 popdensity_{it} + B_6 housingunits_{it} + B_7 medianincome_{it} + E_{it}$$
where \( \text{medhomevalue}_{it} \) is the median estimated home value, \( \text{avghomepricesqft}_{it} \) is the median estimated home value per square foot measured in current dollars, \( \text{precip}_{it} \) is precipitation in inches, \( \text{nummount}_{it} \) is the number of mountains present in county \( i \), \( \text{mountainpres}_{it} \) is the measure of the presence of a ski mountain (this is a binary variable; if a mountain is present in this county, \( \text{mountainpres}_{it} = 1 \), if there is no presence \( \text{mountainpres}_{it} = 0 \)). \( \text{Nummount}_{it} \) is the number of ski mountains in the \( i^{th} \) county, \( \text{unemployment}_{it} \) is the measure of unemployment rate in the \( i^{th} \) county, \( \text{population}_{it} \) is the estimate of the resident total population estimate per 100,000 in the \( i^{th} \) county, \( \text{populationdens}_{it} \) is the estimate of the population density per square mile of the \( i^{th} \) county, \( \text{housingunits}_{it} \) is the estimate of the number of housing units per 100,000 people in the \( i^{th} \) county, and \( \text{personalincome}_{it} \) is the income from wages, proprietors' income, dividends, interest, rents and government benefits that residents of the \( i^{th} \) county collect in time \( t \). These variables are displayed in Table 1.

b. Expected Signs

Nelson (2009) found that the presence of a ski mountain near a home will increase the value of a home by 23 to 27%. Therefore, this study predicts that the expected value for \( \text{mountainpres}_{it} \) will be positive. Additionally, with this finding, this study predicts that with more mountains in the vicinity of a home, the value of the home will increase and therefore expects a positive value for \( \text{nummount}_{it} \).

Butsic et. al. (2011) found that a decline in snowfall intensity by one standard deviation can decrease home values by 2.2% to 6.0%, giving this study cause to expect a positive value for \( \text{precip}_{it} \).

Reichert (1990) found that as unemployment decreases, housing prices for the Northeast increase; thus, this study expects a negative value for \( \text{unemployment}_{it} \). Within the Northeast, Reichert (1990) found that a 1% increase in income will increase housing prices by 1.6% during the same period. Similarly, it proves that a 1% increase in population will increase housing prices by 1.9% (Reichert, 1990). Therefore, this study expects a positive value for \( \text{population}_{it} \), \( \text{populationdens}_{it} \), and \( \text{personalincome}_{it} \).

This study predicts a negative value for \( \text{housingunits}_{it} \) as Sanchez and Johansson (2011) found that in the United States, the number of home dwellings in an area has a negative effect on home prices. Expected signs for all variables are displayed in Table 3.
c. Robustness Analysis

When first run, variable inflation factors were above 5 for variables $\text{population}_{it}$ and $\text{housingunits}_{it}$ as they were both size variables, showing that there was correlation between the population of county $i$ and the amount of housing units in county $i$. The regression was then adjusted so that population and housing units were measured for per 100,000 people. After adjustment, VIF was below 5 for all variables and models as seen in Table 7, proving no multicollinearity between independent variables.

When a Hausman test was run, a p-value of less than .05 was found, suggesting that the study should use fixed effects model. However, certain variables (mountain presence, population, and housing units) were omitted in the fixed effects model as they are correlated with alpha$_i$ or county fixed effects. Therefore, this study will not use a Hausman test and use a random effects model for all regressions.

VIII. Results

Regression results using median home price as a dependent variable (Model 1 and 2) are displayed in Table 9; results using average home prices per square foot as a dependent variable (Model 3 and 4) are displayed in Table 10. Models 1 and 2 explain approximately 65% of the variation in the model; Models 3 and 4 explain approximately 69% of the variation in the model. More independent variables or more accurate measurements, such as snowfall equivalent to total precipitation (SFE/P) instead of precipitation, may increase this number.

a. Model 1

The semi-logarithmic regression run by OLS with dependent variable median home price in Model 1 showed that mountain presence was not statistically significant with a negative value of -5.7%. Similarly, as seen in Table 9, precipitation is not statistically significant on median home price (Model 1) with a value of -.1%. In terms of control variables, unemployment, population, housing units and personal income are all statistically significant at the 10% confidence interval. Most of these variables fall in line with expected signs, with unemployment affecting home values by -1.58%, population increasing home values by 5.6% and personal income increasing home values by .0014%. Housing units was the only variable that did not fall in line with expected signs, as they decreased values by .00019%. Population density was not statistically significant with a positive value of .0001%.
b. Model 2

When regressed on median home price, the number of mountains in county $i$ has no statistically significant impacts and a negative value of -1.7%. Precipitation, similar to Model 1, was not statistically significant and showed a negative value of -1.1%, which challenges expected values and the previous literature of by Butsic et. al. (2011) and Wheaton (2005). Unemployment, population, and personal income were all statistically significant falling in line with expected values. Similar to Model 1, housing units had a positive impact on average home price per square foot, with a sign of .0009%, which opposes the expected values of this study as seen in Table 11. Population density had no statistical significance on average home values per square foot, however did fall in line with expected values.

c. Model 3

When regressed on average home price per square foot in Model 3, mountain presence had a significant negative impact, within the 10% confidence interval, as seen in Graph 15. The negative sign of this variables challenge the expected values of this study, as seen in Table 11, and the studies of Wheaton (2005), Nelson (2009) and Butsic et. al. (2011). This will be further examined in the discussion section.

As seen in previous models, unemployment, population, and personal income all fell in line with expected values and were statistically significant. As seen in Table 11, housing units took the opposing sign than previous literature suggested, however was statistically significant. Lastly, population density had no statistical significance in this model.

d. Model 4

Model 4 shows that when regressed on average home value per square foot, the number of mountains in county $i$ has no statistical significant, however takes the opposite sign of the expected value. Precipitation is not statistically significant when regressed on average home price per square foot and takes a negative value (-.09%). Unemployment, population, personal income are all statistically significant and fall in line with expected values. The difference in values between Models 1 / 2 and Models 3 / 4 shows that unemployment has a lesser effect on average home price per square foot (-1.46%) than median home price (-1.58%). Population and personal income also follow this trend. Population density, as in all previous models, is not statistically significant.
e. Overall

Mountain presence was not statistically significant on median home values (Model 1), however when regressed on average home price per square foot, mountain presence was statistically significant, at the 10% confidence interval, and had a negative (-10.3%) impact as seen in Graph 15. The negative sign of this variable challenge the expected values of this study, as seen in Table 11, and the studies of Wheaton (2005), Nelson (2009) and Butsic et. al. (2011). The number of mountains in a county was not statistically significant for either dependent variable (median home price or average home price per square foot). As seen in Table 11, the expected sign, based on literature by Butsic et. al. (2011), for this variable was positive. This study finds a negative value however it is statistically insignificant for all models. This difference in variable signs shows that these studies oppose each other, possibly due to differences in data, geographical area or time period, which will be further explored in the discussion section.

Precipitation was not statistically significant in all models. Graphs 13 and 14 show that there is a negative correlation between precipitation and home values—as precipitation in county \( i \) increases, home values decrease. This opposes findings by Bustin et. al. (2011) and Wheaton (2005). One explanation for this is that while Bustin et. al. (2011) uses data on snowfall percentage of total precipitation (SFE/P) and Wheaton (2005) uses snowfall intensity, this study simply uses precipitation in winter months, which may not be a reliable variable, or comparable across these studies. As this study has proved, this variable captures different aspects of the weather pattern than snowfall does—it can be argued that precipitation is increasing as temperatures increase, decreasing the amount of snowfall and thus explaining the negative correlation between precipitation and home values.

Turning to control variables, population had a significant positive effect on median home value, which falls in line with the literature as an increase in demand for homes as more people live in the area will drive prices up. Population had no statistical significance on average home value per square foot. Population density had no statistical significance in all models. The positive sign of this variable falls in line with relevant literature that shows as the population becomes denser, the demand for homes increases, causing an increase in both median home values and average home price per square foot. This variable having no statistical significance
shows that more research could be done in this area to clarify the importance of population density on home prices.

Housing units and personal income had significant positive effects on all models. While personal income does not drive home costs, a positive correlation between these two variables is logical as the more that a consumer has to spend, the more expensive homes they can buy. The positive association between home prices and housing units in county \( i \), which had a negative expected value, shows that this variable could be better defined—if these housing units are unoccupied and there is a large supply, classical economics defines that price should decrease; if these housing units are occupied and therefore low supply with high demand, price will increase. This proves as a weakness of the study.

The key independent variables of this study, mountain presence, number of mountains, and precipitation, were not statistically significant and no conclusions can be drawn from these results. This will be further explored in the discussion section.

IX. Discussion and Limitations

a. Discussion

While both Butsic et. al. (2011) and Nelson (2009) found that ski mountain presence will increase home prices by 23-27%, this study found that mountain presence decreases average home value per square foot by 10.3%. The impact of mountain presence on median home prices, however, was found to be not statistically significant. The insignificance of this variable clarifies the difference between this study and previous studies. Average home values per square foot may be affected over median home prices largely because of the nature of these two variables. While average home values take into account the lowest and highest home values in county \( i \), the median simply picks the middle value of all home values, with half being above and half being below. If the average price in a county is higher than the median price, the area contains significantly higher priced houses even though in that time \( t \), prices were stronger in the lower range. In the real estate industry, the median price is regarded as the more useful of these two measures. This is because average price can be significantly skewed by sales that are extremely high or extremely low.

The statistical significance of mountain presence on average home prices, while not on median home prices, shows that the presence of a mountain has enough impact to shift the
overall span of home prices. This means that there was a number of homes priced at much lower prices than the majority of homes in county $i$. However, mountain presence does not have enough impact to increase the number of homes sold at a lower price (which would be the case if mountain presence had statistically significant impacts on median home prices). This means that while there was not an increase in the number of homes sold at lower prices, the homes that were sold in time $t$ were at lower prices.

Snowfall, while not a statistically significant in any of the models, shows negative values when regressed on both median home price and average home price per square foot. This opposes the expected values and previous literature of Butsic et. al. (2011) and Wheaton (2005). One explanation for this negative value is that as snowfall decreases, there is less demand for ski tickets and ski areas. With less demand comes less income, and thus ski areas must lay people off—Hagenstad et. al. (2018) proves that 17,400 jobs are lost in low snow years.

As seen in Table 11, there is a statistically significant negative relationship between unemployment and both median home prices and average home prices per square foot. As jobs near ski resorts are lost as snowfall decreases, unemployment will increase and home prices decreases. This connection between low snowfall and high unemployment could explain the negative impact of snowfall on home prices.

As previously stated, Butsic et. al. (2011), Wheaton (2005), and Nelson (2009) all found the presence of a ski mountain to have a positive impact on home prices. This study, as seen in Table 12, found a negative (-10.3%) impact on home prices. The disparity between the magnitude of these variables could be largely due to the fact that the studies are focused in different geographical regions—Nelson (2009) in Maryland, Wheaton (2005) in New Hampshire, Butsic et. al. (2011) in the Northwest US and this study in the Northeast US. All of these geographical regions have different demographics which could largely change the results of the studies. Additionally, these studies focused on different time periods, as seen in Table 12. Consumer demand changes over time, and as such, the demand for ski resorts and homes around them change as well. Over time, the interaction between mountain presence and home prices has changed with the demand changes.

This study found that precipitation decreases property prices by -0.10%, however this variable is not statistically significant. This challenges the findings of Bustic et. Al. (2011) and Wheaton (2005), which found that home prices in the Northwest were increased by 2.2-6% with
heavy snowfall. This difference in signs may be attributed to the nature of ski areas in the Northwest as more ‘destination’ resorts and a larger market for second homes, as opposed to first homes in the Northeast where ski mountains are largely spread throughout the state.

This study may also find differing values than previous literature as this study uses precipitation data in winter months rather than snowfall data as previous studies did. Wheaton (2005) studies snowfall intensive and Butsic et. al. (2011) uses snowfall percentage of total precipitation (SFE/P). This variable may capture different aspects of weather patterns as precipitation increases as snowfall decreases—snow becomes rain when temperatures rise above 32°F. While this study attempted to use snowfall, data unavailability forced the study to use precipitation data during winter months to simulate the variable snowfall. This, however, may have just measured rainfall or sleet during the winter months—this would explain the opposing signs seen between previous literature finding a positive correlation between home values and negative correlation between precipitation and home values. This may also explain the statistical insignificance as the general weather patterns do not largely impact home prices.

While the precipitation variable was not statistically significant, as aforementioned, and therefore it cannot be used to make predictions. The sign of this variable, however, indicates that global warming will cause home prices near ski mountains to continue to decrease in coming years as temperatures warm and more snowfall turns to rain during winter months. Thus, as rainfall increases, the results of this study suggest that home prices will decrease.

b. Limitations

The main limitations of this study arise from data availability. Data was unavailable to the public by county for snowfall and maximum and minimum temperatures. Due to this unavailability, the study relied on precipitation during only winter months to determine the impact of snowfall. While this measurement is reliable in itself, it may not accurately represent snowfall as precipitation (rain) will increase as temperatures warm and actual snowfall decreases. As such, it may not be useful to compare this study with similar literature as the independent variable used in Butsic et. al. (2011) and Nelson (2009) are more clearly defined as snowfall, whereas this study essentially relies on precipitation data. Additionally, population data was unavailable for every year, and therefore Census data for 2000 and 2010 were used as a measurement for all years during each respective decade. This could potentially skew the results for this variable.
As stated in the results section, the variable $housingunits_{it}$, could be better defined. It is defined in this study as an estimate of the number of housing units per 100,000 people in the $i^{th}$ county at time $t$ (Sanchez and Johansson, 2011). The description of this variable is unclear if housing units in county $i$ are occupied or unoccupied housing units. Classical economics argues that if these housing units are unoccupied and there is a large supply, price should decrease; if these housing units are occupied and therefore there is low supply with high demand, price will increase. A clearer definition of this variable would allow for a better understanding of the implication of the results associated with this variable.

The geographical restriction of the study to the Northeast may eliminate interesting interactions that happen across the United States or in other countries as housing markets differ across geographical areas. A widening of the studied area could result in different interpretations regarding the impact of mountain presence and snowfall on housing prices.

c. Future Work

Future work in this area could be done with more accurate data measures to control for the limitations mentioned in the previous section. Specifically, a more accurate measure for snowfall. The use of precipitation as a variable in this study showed that snowfall and precipitation have different impacts on housing prices. This could partially have to do with the fact that as temperatures warm, more snow will fall as rain. Therefore, as snowfall decreases and rainfall increases, there may be opposing signs on the interaction between these variables and a dependent variable. Future work comparing the impacts of precipitation and snowfall (or snowfall equivalent to total precipitation) may give researchers a more robust understanding of the relationship between these variables.

An expansion of the geographical area covered by the study, perhaps to the entire U.S. or other countries, would also prove useful for the area of study to capture interactions that may span a wider area. The use of a small sample area (such as the Northwest in the study by Butsic et. al. (2011) or the Northeast in this study) may only show one part of the story. The use of a larger group of states would allow researchers to look at the interaction at large.

This study found that mountain presence has no statistical significance when regressed on median home prices, however it is statistically significant at the 10% confidence interval and shows a negative value when regressed on average home value per square foot. Future work
exploring why mountain presence has this differing impact on measurements of home prices may help to explain the nature of home pricing around ski resorts.

Lastly, future work including more variables could prove beneficial to the literature, as a wide variety of variables could impact home prices that have not been included currently. For example, maximum temperature, minimum temperature, humidity, tax rates, school ratings, etc. may increase the explanatory power of the model. This study has an adjusted r-squared currently is only 69%, and the addition of more variables could increase this number and give more robust results.

X. Conclusion

As global average temperatures continue to rise, as they have been doing since 1970, it is expected that there will be a reduction in snowpack of the mountainous areas of North America (State of the Climate: Global Climate Report, 2017). The 17% decrease in skier visits when a low snowfall year occurs and a corresponding $51 million dollar drop in added economic value to the state economy bodes trouble for the ski industry and related goods and service providers.

Previous literature, such as Nelson (2009) found that ski-resort proximity increases property values by 23-27% and Butsic et. al. (2011) found that snowfall intensity increases housing prices by 2.2 to 6%. This study found that the number of mountains in county \( i \), and precipitation has no statistically significant impacts on median home prices or average home price per square foot. However, mountain presence did have a negative statistically significant impact on average home prices per square foot.

Butsic et. al. (2011) argues that home prices increase with increased snowfall intensity and therefore infer that as global temperatures warm and snowfall decreases, home prices will decrease as well. This study proves that the impact of a low snow year can be felt through the local economy as demand for lift tickets decrease and workers are laid off. This increase in unemployment correlates to a 1.5% decrease in home prices in counties where mountains are present.

Policymakers should be aware of this implication as changes in snowfall could largely effect the local economy’s consumer demand, income and unemployment rates and could be cause for tax reforms or budgetary spending changes for the area.
XI. Appendices

a. Table 1 - Variable Definitions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$medhomevalue_{it}$</td>
<td>Dependent: The median estimated home value of the $i^{th}$ county measured in current dollars in time $t$ (Butstic et. al., 2011; Nelson, 2009; Wheaton, 2005)</td>
</tr>
<tr>
<td>$avghomepricesqft_{it}$</td>
<td>Dependent: The median estimated home value per square foot of the $i^{th}$ county measured in current dollars in time $t$ (Butstic et. al., 2011; Nelson, 2009; Wheaton, 2005)</td>
</tr>
<tr>
<td>$precip_{it}$</td>
<td>Precipitation in inches in the $i^{th}$ county in time $t$ (Butsic et. al., 2011)</td>
</tr>
<tr>
<td>$mountainpres_{it}$</td>
<td>Measures the presence of a ski mountain in $i^{th}$ county in time $t$. This is a binary variable; if a mountain is present in this county, $mountainpres_{it} = 1$, if there is no presence $mountainpres_{it} = 0$ (Nelson, 2009)</td>
</tr>
<tr>
<td>$nummount_{it}$</td>
<td>The number of ski mountains in the $i^{th}$ county in time $t$ (Nelson, 2009)</td>
</tr>
<tr>
<td>$unemployment_{it}$</td>
<td>Measure of unemployment rate in the $i^{th}$ county at time $t$ (Reichert, 1990)</td>
</tr>
<tr>
<td>$population_{it}$</td>
<td>Estimate of the resident total population estimate per 100,000 in the $i^{th}$ county at time $t$ (Reichert, 1990)</td>
</tr>
<tr>
<td>$populationdens_{it}$</td>
<td>Estimate of the population density per square mile of the $i^{th}$ county at time $t$ (Reichert, 1990)</td>
</tr>
<tr>
<td>$housingunits_{it}$</td>
<td>Estimate of the number of housing units per 100,000 people in the $i^{th}$ county at time $t$ (Sanchez and Johansson, 2011)</td>
</tr>
<tr>
<td>$personalincome_{it}$</td>
<td>Income from wages, proprietors' income, dividends, interest, rents and government benefits that residents of the $i^{th}$ county collect in time $t$ (Reichert, 1990)</td>
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b. Table 2 - Descriptive Statistics

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<th>Std. Dev.</th>
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<th>Max</th>
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### c. Table 3- Descriptive Statistics (Precipitation)

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<td>mountainpres_{it}</td>
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<td>0.34</td>
</tr>
<tr>
<td>nummount_{it}</td>
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<td>medhomevalue_{it}</td>
<td>160352.50</td>
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<tr>
<td>avghomepricesqft_{it}</td>
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<td>132.21</td>
</tr>
<tr>
<td>unemployment_{it}</td>
<td>6.52</td>
<td>6.15</td>
</tr>
<tr>
<td>population_{it}</td>
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<td>2.78</td>
</tr>
<tr>
<td>populationdens_{it}</td>
<td>1147.36</td>
<td>1694.50</td>
</tr>
<tr>
<td>housingunits_{it}</td>
<td>48192.59</td>
<td>48950.77</td>
</tr>
<tr>
<td>personalincome_{it}</td>
<td>47986.14</td>
<td>51346.00</td>
</tr>
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d. Table 4- Descriptive Statistics (Mountain Presence)

<table>
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</tr>
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<td>nummount0</td>
<td>0.00</td>
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<tr>
<td>precip0</td>
<td>3.36</td>
<td>3.36</td>
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<tr>
<td>medhomevalue0</td>
<td>186,154.20</td>
<td>153,261.50</td>
</tr>
<tr>
<td>avghomepricesqft0</td>
<td>129.37</td>
<td>99.31</td>
</tr>
<tr>
<td>unemployment0</td>
<td>6.46</td>
<td>6.14</td>
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<td>population0</td>
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<td>populationdens0</td>
<td>1,931.60</td>
<td>307.72</td>
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<tr>
<td>housingunits0</td>
<td>47,215.34</td>
<td>50,925.77</td>
</tr>
<tr>
<td>personalincome0</td>
<td>50,320.31</td>
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</tbody>
</table>
### Table 5 - Descriptive Statistics (Number of Mountains)

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<th>nummount&lt;sub&gt;_2&lt;/sub&gt;</th>
<th>nummount&lt;sub&gt;_3&lt;/sub&gt;</th>
<th>nummount&lt;sub&gt;_4&lt;/sub&gt;</th>
<th>nummount&lt;sub&gt;_5&lt;/sub&gt;</th>
<th>nummount&lt;sub&gt;_6&lt;/sub&gt;</th>
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</thead>
<tbody>
<tr>
<td>mountainpres&lt;sub&gt;_it&lt;/sub&gt;</td>
<td>0.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>precip&lt;sub&gt;_it&lt;/sub&gt;</td>
<td>3.36</td>
<td>3.32</td>
<td>3.35</td>
<td>3.46</td>
<td>3.66</td>
<td>3.64</td>
<td>3.68</td>
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<tr>
<td>medhomevalue&lt;sub&gt;_it&lt;/sub&gt;</td>
<td>186,154.20</td>
<td>150,432.80</td>
<td>151,560.80</td>
<td>155,879.60</td>
<td>241,875.60</td>
<td>150,778.90</td>
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<td>avghomepricesqft&lt;sub&gt;_it&lt;/sub&gt;</td>
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<td>98.69</td>
<td>92.61</td>
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<td>144.63</td>
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<td>105.34</td>
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<td>6.50</td>
<td>5.89</td>
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<td>-</td>
<td>5.20</td>
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<td>0.97</td>
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<td>1.28</td>
<td>1.43</td>
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<td>populationdens&lt;sub&gt;_it&lt;/sub&gt;</td>
<td>1931.60</td>
<td>376.00</td>
<td>206.72</td>
<td>200.18</td>
<td>206.30</td>
<td>197.63</td>
<td>49.27</td>
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<tr>
<td>housingunits&lt;sub&gt;_it&lt;/sub&gt;</td>
<td>47,215.34</td>
<td>50,997.69</td>
<td>50,568.47</td>
<td>51,104.47</td>
<td>20,626.24</td>
<td>49,285.31</td>
<td>68,215.10</td>
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<tr>
<td>personalincome&lt;sub&gt;_it&lt;/sub&gt;</td>
<td>50,320.31</td>
<td>46,273.53</td>
<td>49,515.52</td>
<td>45,756.95</td>
<td>60,294.00</td>
<td>46,011.67</td>
<td>56,069.00</td>
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f. Table 6 - Expected Signs

<table>
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<tr>
<th>Variable</th>
<th>Expected Sign</th>
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<tbody>
<tr>
<td>nummount$_{it}$</td>
<td>+</td>
</tr>
<tr>
<td>mountainpres$_{it}$</td>
<td>+</td>
</tr>
<tr>
<td>precip$_{it}$</td>
<td>+</td>
</tr>
<tr>
<td>unemployment$_{it}$</td>
<td>-</td>
</tr>
<tr>
<td>population$_{it}$</td>
<td>+</td>
</tr>
<tr>
<td>populationdens$_{it}$</td>
<td>+</td>
</tr>
<tr>
<td>housingunits$_{it}$</td>
<td>-</td>
</tr>
<tr>
<td>personalincome$_{it}$</td>
<td>+</td>
</tr>
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</table>
Table 7– VIF

<table>
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<tr>
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<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
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<tr>
<td>nummount_{it}</td>
<td>-</td>
<td>1.21</td>
<td>-</td>
<td>1.18</td>
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<tr>
<td>mountainpres_{it}</td>
<td>1.10</td>
<td>-</td>
<td>1.09</td>
<td>-</td>
</tr>
<tr>
<td>precip_{it}</td>
<td>1.04</td>
<td>1.04</td>
<td>1.04</td>
<td>1.04</td>
</tr>
<tr>
<td>unemployment_{it}</td>
<td>1.28</td>
<td>1.38</td>
<td>1.32</td>
<td>1.41</td>
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<tr>
<td>population_{it}</td>
<td>2.04</td>
<td>2.03</td>
<td>2.02</td>
<td>2.01</td>
</tr>
<tr>
<td>populationdens_{it}</td>
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<td>1.82</td>
<td>1.83</td>
<td>1.82</td>
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<tr>
<td>housingunits_{it}</td>
<td>1.52</td>
<td>1.62</td>
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<td>1.65</td>
</tr>
<tr>
<td>personalincome_{it}</td>
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<td>1.54</td>
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<td>Mean VIF</td>
<td>1.48</td>
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h.  Table 9—Table of Results, Median Home Value

<table>
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<tr>
<th>Dependent</th>
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</thead>
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<tr>
<td>medhomevalue</td>
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<td></td>
</tr>
<tr>
<td>nummount_{it}</td>
<td>-</td>
<td>-.0178478</td>
</tr>
<tr>
<td></td>
<td>(.0226143)</td>
<td></td>
</tr>
<tr>
<td>mountainpres_{it}</td>
<td>-.0574089 (.0508652)</td>
<td>-</td>
</tr>
<tr>
<td>precip_{it}</td>
<td>-.0010317 (.0005532)</td>
<td>.001031 (.0226143)</td>
</tr>
<tr>
<td>unemployment_{it}</td>
<td>-.0158862*** (.0008226)</td>
<td>-.0158841*** (.0008229)</td>
</tr>
<tr>
<td>population_{it}</td>
<td>.0564471*** (.0081378)</td>
<td>.0563739*** (.0081321)</td>
</tr>
<tr>
<td>populationdens_{it}</td>
<td>6.91e-07 (4.70e-06)</td>
<td>9.50e-07 (4.68e-06)</td>
</tr>
<tr>
<td>housingunits_{it}</td>
<td>9.40e-06*** (2.37e-06)</td>
<td>9.40e-06*** (2.40e-06)</td>
</tr>
<tr>
<td>personalincome_{it}</td>
<td>.0000137*** (4.10e-07)</td>
<td>.0000137*** (4.10e-07)</td>
</tr>
<tr>
<td>_cons</td>
<td>10.85486*** (.1216831)</td>
<td>10.84497 *** (.1219344)</td>
</tr>
<tr>
<td>N</td>
<td>2,049</td>
<td>2,049</td>
</tr>
<tr>
<td>$\bar{R}^2$</td>
<td>.6515</td>
<td>.6506</td>
</tr>
</tbody>
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Standard errors are in parentheses,
*** significant at 1% level, ** significant at 5% level, * significant at 10% level
### Table 10—Table of Results, Average Home Value Per Square Foot

<table>
<thead>
<tr>
<th></th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent</strong></td>
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<td></td>
</tr>
<tr>
<td>avghomepricesqftit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>nummountit</td>
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<td>-.035605 (.0216702)</td>
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<tr>
<td>mountainpresit</td>
<td>-.1039183* (.0502002)</td>
<td>-</td>
</tr>
<tr>
<td>precipit</td>
<td>-.0009087 (.0006143)</td>
<td>-.0009075 (.0006145)</td>
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<tr>
<td>unemploymentit</td>
<td>-.0146899*** (.0008844)</td>
<td>-.0146901*** (.0008849)</td>
</tr>
<tr>
<td>populationit</td>
<td>.0527804*** (.0076037)</td>
<td>.0525262*** (0076047)</td>
</tr>
<tr>
<td>populationdensit</td>
<td>7.90e-06 (4.34e-06)</td>
<td>8.43e-06 (4.32e-06)</td>
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<tr>
<td>housingunitsit</td>
<td>9.88e-06*** (2.23e-06)</td>
<td>.00001*** (2.26e-06)</td>
</tr>
<tr>
<td>personalincomeit</td>
<td>.0000131*** (4.38e-07)</td>
<td>.0000131*** (4.38e-07)</td>
</tr>
<tr>
<td>_cons</td>
<td>3.563331*** (.1153409)</td>
<td>3.542644*** (.1154489)</td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>1.823</td>
<td>1.823</td>
</tr>
<tr>
<td>̂R²</td>
<td>.6983</td>
<td>.6959</td>
</tr>
</tbody>
</table>

Standard errors are in parentheses,  
*** significant at 1% level, ** significant at 5% level, * significant at 10% level
j. Table 11 – Percentage Results and Expected Values

<table>
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<th>Variable</th>
<th>Expected Values</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>nummount_{it}</td>
<td>+</td>
<td>-</td>
<td>-1.7847%</td>
<td>-</td>
<td>-3.5605%</td>
</tr>
<tr>
<td>mountainpres_{it}</td>
<td>+</td>
<td>-5.7408%</td>
<td>-</td>
<td>-10.3918%*</td>
<td>-</td>
</tr>
<tr>
<td>precip_{it}</td>
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<td>-0.1031%</td>
<td>-0.1031%</td>
<td>-0.0908%</td>
<td>-0.0907%</td>
</tr>
<tr>
<td>unemployment_{it}</td>
<td>-</td>
<td>-1.5886%***</td>
<td>-1.5884%***</td>
<td>-1.4689%***</td>
<td>-1.4690%***</td>
</tr>
<tr>
<td>population_{it}</td>
<td>+</td>
<td>5.6447%***</td>
<td>5.6373%***</td>
<td>5.2780%***</td>
<td>5.2526%***</td>
</tr>
<tr>
<td>populationdens_{it}</td>
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<td>0.0001%</td>
<td>0.0001%</td>
<td>0.0008%</td>
<td>0.0008%</td>
</tr>
<tr>
<td>housingunits_{it}</td>
<td>-</td>
<td>0.0019%***</td>
<td>0.0009%***</td>
<td>0.0010%***</td>
<td>0.0010%***</td>
</tr>
<tr>
<td>personalincome_{it}</td>
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<td>0.0014%***</td>
<td>0.0014%***</td>
<td>0.0013%***</td>
<td>0.0013%***</td>
</tr>
</tbody>
</table>

*** significant at 1% level, ** significant at 5% level, * significant at 10% level
### Table 12 – Cross-Study Comparison of the Impacts of Mountain Presence and Snowfall on Home Prices

<table>
<thead>
<tr>
<th></th>
<th>Time Period</th>
<th>Location</th>
<th>Mountain Presence</th>
<th>Precipitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheaton (2005)</td>
<td>1975-2000</td>
<td>Loon Mountain, NH</td>
<td>7.37%**</td>
<td>18% **</td>
</tr>
<tr>
<td>Nelson (2009)</td>
<td>2008</td>
<td>Deep Creek, Maryland</td>
<td>23.6%**</td>
<td>--</td>
</tr>
<tr>
<td>Benneyan (2019)</td>
<td>1996-2019</td>
<td>Northeast</td>
<td>-0.1032%</td>
<td>-5.7419%</td>
</tr>
</tbody>
</table>

*** significant at 1% level, ** significant at 5% level, * significant at 10% level
1. Graph 13—Median Home Price vs. Precipitation
Graph 14—Average Home Price Per Square Foot vs. Precipitation
n. Graph 15—Average Home Price Per Square Foot vs. Mountain Presence

Average Home Values Per Sq Ft vs. Mountain Presence

Mountain Presence

3.56
3.54
3.52
3.50
3.48
3.46

0
1
XII. References


Bureau Of Economic Analysis (n.d.). Personal Income by County, Metro, and Other Areas.

Retrieved from https://www.bea.gov/data/income-saving/personal-income-county-metro-and-other-areas


