ECONOMIC SHOCK, VULNERABILITY AND RESILIENCE: SOME EVIDENCE FROM PERFORMANCE OF THE WESTERN UNITED STATES

By

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ABSTRACT

Starting with the events surrounding September 11, 2001 and since the real estate market-led recession starting in 2008, interest in how countries, regions, and metropolitan cities respond to economic shocks has assumed prominence among researchers and policy makers. However, there is little work on how rural regions respond to, or manage such shocks. In this thesis, I argue and show that the effects of economic shock on different rural counties in the Western United States is different because of their differences in degrees of economic vulnerability and resilience. In order to show this, I estimate the degrees of economic vulnerability and resilience of 225 rural counties in the Western United States, and estimate empirical relationships between them and both the level and change in their unemployment rates in the period 2007-2010. The results strongly support my hypothesis, which is that rural counties can overcome unexpected economic shocks by investing in resilience enhancing programs and policies.

CHAPTER 1

INTRODUCTION

Societies and economies from the local to the national and even at global scales have been in a period of great uncertainty during the last couple of decades. Those uncertainties, brought about by events such as natural disasters, financial crises, and shortage of resources, challenge people to face conditions that will change their daily life tremendously. We often define those events as shocks to economies.

Off the Pacific coast of Tohoku, Japan an earthquake happened on March 11, 2011. Later, the earthquake triggered powerful tsunami waves that reached heights of up to 40.5 meters and affected not only Japan but nearby Pacific Ocean countries. Based on a Japanese National Police Agency report there were 15,883 confirmed deaths, 6,150 injured, and 2,643 people missing. Also 129,225 buildings totally collapsed, with a further 254,204 buildings 'half collapsed,' and another 691,766 buildings partially damaged [23]. The earthquake and tsunami also caused extensive and severe structural damage to infrastructure in north-eastern Japan, including heavy damage to roads and railways as well as fires in many areas. Around 4.4 million households in northeastern Japan were left without electricity and 1.5 million without water. The World Bank estimated a US$235 billion economic loss in Japan caused by this natural disaster. This record breaking magnitude 9 earthquake plunged the country into a state of crisis.

The Great Recession during 2007 to 2009 is also a good example of an economic shock. The Great Recession, is has been described as occurring between the period from December 2007 to June 2009 [24]. The beginning of the Great Recession is often attributed to the bursting of an 8 trillion dollar housing bubble. The tremendous wealth

loss led to sharp cutbacks in consumer spending. The market chaos triggered by the bursting of the housing bubble combined with shrinking of consumer spending led to a collapse in business investment. When big companies stopped putting money into business investment, mass layoffs and a huge unemployed rate increase followed. In 2008 to 2009, the U.S. labor market lost 8.4 million jobs. In December 2007, the national unemployment rate was 5.0 percent. However, at the end of the Great Recession, the unemployment rate had already rise to 9.5 percent with much higher rates in some regions (Figure1.1). Even after the period of the Great Recession, economic recovery has not been nearly strong enough to create jobs opportunities for all those who were unemployed during the collapse. In October 2010, after 16 months of official recording since the recession began, the economy still had 5.4% fewer jobs than it did before the recession started. The Great Recession has brought the whole economy a great shock in the form of severe job losses and slow recovery. The Great Recession caused a decline in family income, a rise in the those falling below the poverty line, loss of health insurance and other important aspects that influence people's daily lives. The whole nation is still trying to get rid of the negative effects resulting from the Great Recession.

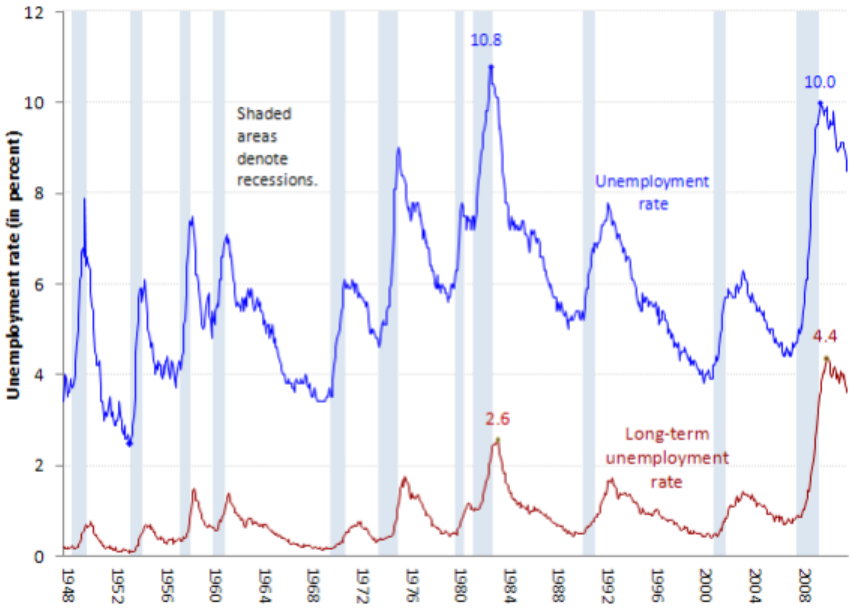

Figure1.1: Unemployment rate and long-term unempolyment rate, January 1948-December 2011, seasonally adjusted

Source: U.S. Bureau of Labor Statistics,2012
Note: People are classified as unempolyed if they do not have a job, have actively looked for work in the prior 4 weeks, and are currently available for work. The long term unempolyment rate is the number of people unemployed for 27 weeks or longer as a percentage of the labor force.

Economic shocks occur very often in economies, though the effect that the shocks have differ from region to region. The reason for this phenomenon of unequal effect are mainly because different regions have distinct ways to cope with shocks and different abilities to recover from negative effects caused by economic shocks. Economists are interested in why some regions are resistant to shocks but others are not, and why some regions are what is known as having resilience, the ability to recover from a shock in a relatively short period of time while others are not able to do so.

The remainder of this chapter contains three sections. The next section talks about rural economic development in the United States. Section1.2 will narrow to discuss the rural economic development in the western part of the United States, the main object of this thesis study. Section 1.3 will discuss the idea of economic resilience and define it

more closely. The last section outlines the structure of this study.

1.1 Rural Economic Development in the United States

America's rural counties exhibit great diversity [9]. Generally speaking, rural businesses and industries often specialize in resource based activities such as traditional agriculture, forestry, mining, or natural amenity-based recreation. Some the rural areas also have industries for manufacturing involving the processing of food, wood, and mining products. The important parts of rural economic activities are mostly related to local natural resources. Compared to metropolitan areas, rural areas tend to have significantly fewer financial, professional, scientific, and information service activities that tend to concentrate in urban economies. Most of the critical services such as education, health care, and communication concentrate in urban areas. Not only are better services provided for those who live in cities, but also these services offer the availability of good-paying jobs. The same conditions do not hold in rural areas. Small-scale and low-density settlement patterns make it more costly for communities and businesses to provide critical services. Declining job numbers and income in the natural resource-based industries lead many rural workers to live in property. Other factors are the lack of education or training for workers and that low-skill and low-wage rural manufacturing industries must find new ways to challenge the increasing number of foreign competitors. Distance and remoteness are also problems that prevent rural areas from being connected to the urban centers of economic activity. Finally, relying on only one or more local natural resources lets the rural area become vulnerable. When the resource has been exhausted or the price of the product or commodity declines, that brings a huge shock to a rural area and affects all the workers who work in that industry.

Different rural areas use different ways to deal with economic challenges. Some rural areas have met these challenges successfully, achieved some level of prosperity, and are ready for facing future challenges. Other rural areas have met these challenges, but have little capacity to adapt further. Still other rural areas have neither met the current challenges nor positioned themselves for the future. Different rural areas have tried different methods to find ways out of being harmed by economic shocks. Nonetheless, when talking about economic development, the first thing that comes to mind is not rural development. Rural America is still an important producer of critical goods and services, and also the home of a large amount of nature resources and also of people. That is why it is important for researchers to care about the issue of rural economic development. However, translating concern into effective policy for the betterment of rural America is not an easy task. The challenge lies, at least partly, in the complex nature of the subject. Rural America, like the rest of America, is changing and is very diverse as I mentioned before. Those two characteristics make studying of rural economic development difficult and complicated. While we want to simplify things in the course of carrying out policy debate and building models, we will, by doing that, lose a grasp on the nature of rural economic development. However, if we want to capture all the factors in rural economic development, that will make the model be too complicated and unpredictable. That is the dilemma and challenge for researchers studying rural economic development.

1.2 Rural Economic Development in the Western United States

The Western United States often refers to the region of the United States lying to the west of the Mississippi River. The Western United States can be divided into the Pacific States: Alaska, California, Hawaii, Oregon, and Washington, and the Mountain States: Arizona,

Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming. However, Alaska and Hawaii, being detached from the other western states, have few similarities with others states west of the Mississippi. Some of the literature excludes Alaska and Hawaii from the Western United States for this reason. During the whole thesis study, I use the definition of the West United States with only 11 states:

Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico,

Oregon, Utah, Washington, and Wyoming (Figure.2). The conditions of rural counties in each state and even inside these states are quite different. I will start by giving a general introduction for the whole western rural United States and then introduce rural western states one by one in order to provide an overview for the western part of rural United States.

Figure 1.2: The West United States
Source: Wikipedia

Most part of the Western United States is located in the temperate zone, which has the climate, temperature, and other physical features generally favorable to human

habitation. But the great variations in altitude, rainfall, soil, and topography cause corresponding variations in the ability of areas to support human life [18]. The historical rural development of the West United States is was largely predetermined by its geography. Good farming land is suitable for agriculture; a stand of timber attracts lumbering; minerals induce mining. Tourism is attracted by a magnificent natural landscape. The mountain barriers and the river valleys together determine the routes for trails and roads. All of those things above together determined the life style and the economic development in the western rural United States.

Arizona became part of the United State in 1912 and is the sixth largest state in the country. The geographic landscape in Arizona is quite contradictory. Although widely known for its hot, low-elevation desert covered with cereus and bushes, more than half of the state lies at an elevation of at least 4000 feet above sea level, and it holds a great amount of forests and evergreen pine trees. Their specific natural resources make the Arizona rural areas rely on primary production such as mineral extraction, lumbering, cattle raising, and crop growing. Good soil, well-established irrigation systems, and a long growing season enable Arizona to produce cotton, alfalfa, and a variety of grains, vegetables, fruits, and nuts. Arizona continues to be one of the country's leading cotton producers. Livestock products including beef, dairy goods, and eggs are also important and an expanding part of the state's economy. Recently, wine producers have been successful in growing a number of varietal grapes. Metallic ores such as copper and zinc have brought revenue to the state, too. Coal from the Black Mesa area in northeastern Arizona is important as an important energy resource. Benefits the from natural geographic corridor created by the Colorado Plateau together with its Mogollon Rim escarpment have made possible Arizona's irrigation projects and most of the state's hydroelectric power. The Roosevelt, Hoover, and Glen Canyon dam not only help in

reserving the water, but also provide energy to the whole of Arizona. Recently, tourism and retirement have become one of the important industries for rural Arizona. The warm climate, unique and magnificent scenery, and casual lifestyle attract millions of visitors and retired people every year, and also bring revenue to the state. In conclusion, agriculture, mining, manufacturing, and tourism compose the rural economy in Arizona.

California is the largest and southern of the West's coastal states. As a state that is on the Pacific Ocean, the geography, landscape, climate, and life style is diverse in California. More than three-fourths of the state's people live in the coast area in metropolitan California. California leads the country in agricultural production due to the suitable climate, good soil, and long growing season in its inland areas, particularly the extensive Central Valley. The state produces more than half of the country's vegetables and fruits. Its major cash products are cattle, milk, cotton, and grapes. Most rural California areas specialize in one or two agriculture products: almonds are grown north of Sacramento; cotton and forge are cultivated near Fresno; the Napa and Sonoma valleys are famous for grapes and wine. Services are a dominant economic sector in rural California. Tourism is a consistent source of income. More than one-fourth of the state's land area is preserved as recreational areas, national parks, or wildlife refuges. Rich natural resources and pleasant weather attract millions of visitors every year, also bringing revenue to the state.

Colorado is classified as one of the Mountain states in the Western United States, although only about half of its area lies in the Rocky Mountains. Colorado's natural landscape ranges from the grass-covered eastern plains to the high and numerous mountains in the western portion of the state. Location, soil, minerals, water, and physical beauty are principle resources that have contributed to rural Colorado's growth. Agriculture has been a crucial part of rural Colorado's economy. Maize, wheat, and hay

are the major crops. In the western part of Colorado are the sites of large fruit orchards and vegetable fields. Colorado is also a major cattle, hog, and sheep producer. It ranks among the top cattle-producing states in the country. Colorado also has a mineral industry, producing coal, petroleum, molybdenum, and gold. Northwestern Colorado has some of the largest and most valuable coal deposits in the country. Natural gas accounts for more than four-fifths of the state's mineral output. Colorado is a state that is rich in natural energy resources and those energy resources contribute in large measure to its economy. Colorado also provides outstanding opportunities for outdoor recreation and is especially famous for winter ski events. Millions of tourists visit Colorado each year, a large part of them on vacation to outdoor destinations. In conclusion, agriculture, cattle raising, energy resources, and tourism are compose the rural economy in rural Colorado.

Idaho is classified as one of the Mountain states in the Western United States. It owns some of the largest unspoiled natural areas in the country, including about 3900 square miles of wilderness and primitive land. Its abundant natural resources make Idaho's economy rely heavily on agriculture, lumbering, mining, and tourism. Idaho has the richest agricultural land in the United States, producing one-third of the country’s total potato crop. Wheat, barley, oats, sugar peas, and alfalfa are also important sources of farm income. Nearly two-fifths of the state's total area is in forest, thus, a huge amount of lumber is also an important product of Idaho. Idaho also has a mining industry, producing molybdenum, silver, lead, and phosphate. Especially, phosphate mining and processing is important in the Western United States. Hydroelectric power, provided by a power station on the Snake River, is the main source of energy in Idaho. Tourism has recently become increasingly important to the state's economy. More than one -fourth of the state's workforce is employed in the service sector. Idaho has also emerged as one of the top states in tourist income, telling us the importance of the tourism industry in this

state.

Montana is the fourth largest state in the United States. However, it is also the third lowest population density state. The western two fifths of Montana falls within the Rocky Mountains, and the eastern three-fifths lies upon the Great Plains. Thus, Montana is composed by two different geographic landscapes. Rocky Mountain Montana is a land of high mountains, deep valleys, and green forests, whereas Great Plains Montana is a vast horizontal sweep of rangeland, grain fields, and fallow strips. The contrast between mountain and plain is the most powerful geographic feature of Montana, and also affects the economic activity in the state. Montana's economy is dominated by the primary sector such as agriculture, forest products, mining, and energy production. Cattle, sheep, potato, and fruit are produced on irrigated farms in the valleys of the Rocky Mountain and in the Great Plains of Montana. The two main crops, wheat and barley, are grown in the northeastern Montana. Most of the rest of the state is rangeland and is used in the livestock-ranching industry for the production of beef cattle and sheep. Lumbering and the manufacturing of forest products are vital to western Montana. Forest products constitute Montana 's third-largest industry. Coal is one of the major energy resources of Montana, mostly extracted from Great Plains Montana. Montana also produces gold, copper, platinum, phosphate, and other minerals from the hard rocks of the Rocky Mountains of Montana. Tremendous water resources provide for hydroelectric power production in Montana. The rich nature resources and the lifestyle in nature attract people who love nature. Tourism has become a significant component of Montana's economy and is heavily promoted.

New Mexico is the fifth largest state in the United States. It is comparatively poor state, ranking among the lowest in per capital income in the country. About half of its economy is based on the service sector, while the remainder is centered on extraction

industries (mining and oil production). Agriculture is not as important in New Mexico compared to other western states in the country because of the scarcity of water. Some rural area crops are sorghum, wheat, hay, and onions. The extraction industries are more important in the New Mexico, producing gold, silver, copper, iron ore, lead, zinc, and molybdenum. It is worth mentioning that New Mexico produces more than four-fifths of U.S. potash and is the country's leading producer of perlite. Oil and natural gas account for half of the state's income from natural resources. Natural gas is mainly produced in the southeastern corner and the northwest of New Mexico. Tourism is now rural New Mexico's leading industry. Known as "The Land of Enchantment," the state attracts millions of visitors and part-time residents to visit annually, bringing revenue to the state.

Nevada is located in a mountainous regions that includes vast semiarid grasslands and sandy deserts. The majority of people live in urban areas, with about half of the population residing in the famous gambling city, Las Vegas. However, the way of life in most of Nevada still follows traditional way, and agriculture and mining are still important in rural Nevada. The major crops are feed crops such as alfalfa and hay, and barley and wheat are also important crops. Livestock ranching is the primary source of agricultural income. The large cattle and sheep ranches are mainly in Elko, Humboldt, and Lander counties. Dairy and poultry farms have become important in western and southeastern Nevada. Nevada also produces mineral goods such as gold, silver, and copper, and copper has historically been the largest component of the state's mineral production. Nowadays, Nevada is also a major producer of barite, tungsten, and mercury. Other important minerals include gypsum, sand, and magnesium. Most of the electricity is generated by coal and natural gas power plants located in southern Nevada. In conclusion, most of the rural Nevada economy depends on the mineral and energy industries.

Oregon is bounded to the north by Washington state, from which it receives the water of the Columbia River; to the east by Idaho, through which winds the major tributary of the Columbia, the Snake River, which forms part of the boundary between Oregon and Idaho and which includes the scenic Hells Canyon; to the south by Nevada and California, with which Oregon shares its mountains and desert systems; and to the west is the Pacific Ocean, which produces the moderate climate of the wester part of Oregon. This diverse geography of Oregon make its economy resource-oriented, strongly dependent upon its forests and farms. The important agriculture products are livestock products (cattle and calves), wheat, potato, barley, apples, and grapes for wine. Oregon is also one of the leading states in the country in the production of hazelnuts, peppermint, raspberries, and blackberries. It produces large export crops of cauliflower, cranberries, hops, plums, and strawberries. Nearly three-fifths of the state's land produces commercial timber. Oregon is one of the top softwood lumber producers in the country. Bless with all the rich natural resources that the Oregon owns, the state attracts millions of tourists to visit this beautiful state. Visitors to the state enjoy its scenery and myriad opportunities for recreation, including hiking, skiing, fishing, beachcombing, and windsurfing. Recently, tourism has become one of the major industries in rural Oregon.

Utah is consists of mountains, plateaus, and deserts. The economy of rural Utah is based on agriculture, mining, and tourism. Almost three-fourths of Utah's farm income comes from livestock products, and the remainder from field crops, fruit, and canning crops. Forests cover nearly one-third of Utah, but only one-fifth of the forestland is used commercially. Utah ranks high among the states in nonfuel mineral production, especially for beryllium: in fact, Utah is the only beryllium producer in the United States. Utah also produces copper, gold, silver, uranium, sand, crushed stone, lime, gemstones, and molybdenum. Tourism continues to increase at a faster rate than any other sectors of

the rural Utah economy. The tourism sector relies upon the attraction of the region's fiery, intricately sculptured natural bridges, arches, and other masterpieces of erosion. Another draw for tourists is skiing. Utah has more than a dozen ski resorts offering tourists from all around the world opportunities to enjoy skiing vacations.

Washington lies at the northwestern corner of the United States. The terrain and the climate of Washington divide the state into a rainy western part and a drier eastern part. Western Washington depends on agriculture, forests, and fisheries, whereas eastern Washington is mainly agricultural, producing wheat, irrigated crops, and livestock. Winter wheat is the state's leading crop, while Washington also grows barley, dry pea, lentils, and hay in dry land farms. Irrigated crops include potatoes, vegetables, and fruits that are also important products of Washington. Poultry is a leading rural industry of the northern Washington. Beef cattle and sheep graze on the eastern grasslands and the open forestlands of the mountain regions. About three-fourths of Washington's forest land is used for commercial timber production. Forests support both wood-products industries and wildlife and recreation. Commercial fisheries are another significant sector in the state's economy. Salmon, cod, and herring are the principal species landed at ports in western Washington. Water is Washington's most valuable natural resource. The most important freshwater source is series of dams on the Columbia River drainage system that impound water for irrigation, hydroelectric power, and flood control while also providing for fisheries, recreation, and industrial uses. The Columbia and the rivers of western Washington account for one-third of all hydroelectric production in the United States. Washington produces sand, clay, magnetite, lead, coal, and zinc. A limited amount of precious-metal mining, including gold and silver, occurs in the eastern Cascade Range in Washington. Recently, tourism has become a major source of income for Washington. The variety of scenic areas, including three national parks, draws increasing numbers of

visitors to the state, and also brings revenue to the state.

Wyoming is one of the mountain states in the Western United States; it is also the state with least population density in the whole country. Wyoming's economy is highly tied to mining and agriculture. The state also has an important and growing tourist industry, serving millions of visitors to the state's parks and historic sites. The most important agricultural activity is livestock production (cattle, hogs, and sheep). The cattle industry is dominant: it accounts for more than two-thirds of Wyoming's agricultural economy. Wyoming's most valuable export grain crop is wheat; other important crops include oats, barley, maize, and potatoes. Wyoming has been one of the top coal-producing states in the country; however, today it not only produces coal now, but also petroleum and natural gas. Wyoming also contains vast quantities of clay, gypsum, limestone, and iron ore. Tourism and recreation are major growth industries in Wyoming. The world-famous national park, Yellowstone, is the first established national park in the United States, and attracts millions of travelers to pay a visit to Wyoming.

1.3 Defining Economic Resilience

Resilience is a word that first came from studies in ecology. But it also has been widely used across several other fields: sociology, engineering, disaster studies, and economics. Within the ecological, social science, and engineering literatures, resilience has been defined as the ability to bounce back. In 1998, Berkes and Folke indicated resilience as the stability at a presumed steady-state and stress resistance to a disturbance and the speed of return to the equilibrium point [3]. In this kind of study, the interest and focus are on systems that only have a single equilibrium such as measuring the change of body temperature after being affect by some stimulus or the stable state for an ecological

system after being affect by a specific event. This sense of resilience tends to dominate in the field of disaster studies, which seeks to understand how and why people and regions recover from disturbances or the shocks. Such studies focus on the vulnerability of neighborhoods, cities, regions, and nations to disaster, more specifically focusing on the probability that a catastrophic event (e.g. hurricane, flood, tornado, or tsunami) will cause systematic breakdowns and consequent loss of life, property, and social support networks [30]. Later, the idea of resilience was also been brought into the field of economics, which wants to understand how people, regions, or even nations recover after being affected by economic shocks. Although resilience has different aspects, in this thesis study, I only put emphasis on examining economic resilience.

Economic resilience is a concept that is frequently used but rarely well defined. Based on the previous studies of Pendall, Foster, and Cowell [22], they introduced two common frameworks underlying resilience analysis: "equilibrium analysis" and "complex adaptive system analysis." The first refers to resilience as the ability to return to normalcy or pre-existing state in a single equilibrium system. The majority of the literature uses this approach. The second framework for resilience begins from the assumption that a system might have multiple equilibriums. This sense of resilience indicates that disturbances can flip a system from one equilibrium to another in a complex adaptive system. This definition puts emphasis on robustness and buffering capacity of the system to changing conditions.

Other researchers, Maguire and Cartwright, provide an overview of the origins and different perspectives on resilience [19]. They not only consider the external factors that may affect a region's ability to recover from shocks but also consider the inherent factors that make a region resilient: "*the resilience approach indentifies the resources and adaptive capacity that a community can utilize to overcome the problems that may result*

from change. The approach builds upon the inherent capacities of a community, rather than only relying an external interventions to overcome vulnerabilities ." Based on Maguire and Cartwright's paper about economic resilience, we can make clear definitions of two terms. The first is economic resilience, which indicates the resources and ability of a community to cope with change. The second is economic vulnerability, which indicates the components that may weaken a community's ability to respond adaptively to a change. Maguire and Cartwright 's idea is similar to that in Briguglio's work in 2004 [5]. Briguglio defined the factors that affect the total risk of being affected by external shocks as having two components. The first part is vulnerability, which is an inherent feature and is not adjusted for by policies and government. The second is resilience, which measures coping ability after encountering external shocks. The combination of the two indicators can give us the overall risk of being harmed by external shocks due to inherent vulnerability features counterbalanced by different degrees of policy-induced resilience..

Other researchers have a different definition of resilience [12, 20]. They define resilience into three different categories: resilience as stability, resilience as recovery, and resilience as transformation. Resilience as stability can be viewed as buffering capacity. Resilience as stability measures the ability of the system to tolerant or absorb disturbance before it shifts to another state. Resilience as recovery can be seen as the ability to bounce back. Resilience as recovery is measured by the time it takes a system to return to its previous state after a shock. Resilience as transformation is the newest idea in regard to resilience. Compared to resilience as stability and resilience as recovery, resilience as transformation focuses on the ability of the system to maintain its state or recover back to a previous state. Resilience as transformation indicates the ability of a community to respond to a change adaptively, rather than just simply returning to a pre-existing state. Is

can also mean changing to a new state that is more sustainable in the current environment. For example, an agricultural-based rural community is affected by an economic depression that causes a rise in its unemployment rate. It may start to develop different kinds of economic activities such as tourism that may better suit the current environment. Resilience as transformation is more about innovation and adapting to a shock. As Folke argues, the resilient community knows how to use the experience of change to continually develop and to reach a better state after a shock [12]. This kind of thinking gives resilience a broader meaning in that resilience is not only to maintain or return to previous state, but also to transform in an adaptive way to external change.

1.4 Outline of the Study

As I mentioned above, the importance of rural economic development and the relationship with resilience is the main study area that I focus on here. There are still other researchers doing the research on economic resilience. However, to the best of my knowledge, most previous resilience studies focus on examining resilience in metropolitan economies. They wish to know why some metropolitan areas are resilient to shocks but other are not. Little of the literature examines resilience in the rural county context. That brings us to the objective of my thesis study. The main objective of this thesis is to determine what kind of factors will make some rural counties more resilient to shocks while others are not able to do so. Briefly speaking, my research question is to determine the economic factors that promote resilience in western rural, non-metropolitan counties in the United States.

The thesis is structured as follows. The next chapter, Chapter 2, will start by looking at the work of other people on resilience and about how they measure resilience

and how to built a resilience index. Chapter 3 will talk lay out an econometric model and the variables that I use to measure western rural counties level resilience. Chapter 4 will discuss the results from Chapter 3. Finally, Chapter 5 concludes the study with a word of caution relating to the interpretation of results and also the potential uses of this resilience model.

CHAPTER 2

LITERATURE REVIEW

As I mentioned in the first chapter of this thesis, the main goal for my research is to determine the economic factors that promote resilience in western rural, non-metropolitan counties. In this chapter I will start by discussing the "Singapore Paradox" which is a phenomenon defined by Brigugilo [4, 5]. The Singapore Paradox uses Singapore as a model to explain how a country that is highly exposed to external shocks can maintain a high growth rate and high GNP per capita. The ability of Singapore to deal with external shocks can be explained by the combination of its inherent vulnerability and economic resilience. Section 2.2 will discuss the previous studies about economic resilience and economic vulnerability in metropolitan areas to see what factors may contribute to the economic resilience of a metropolitan area after being affected by external shocks. Section 2.3 will discuss the previous studies about economic resilience and vulnerability in rural areas. These studies help to clarify the research question of how to measure western US rural counties' resilience.

2.1 The "Singapore Paradox": Economic Vulnerability and Resilience at the Country Level

Brigugilo indicated four possible scenarios to explain how countries may be classified according to their inherent vulnerability and their external or policy induced resilience [5]. These four scenarios are called "best-case," "prodigal son," "self-made," and "worst-case" (Figure 2.1). Vulnerability is defined as the characteristic that is inherent or

permanent (or quasi permanent) such as a country's proneness to external shocks. Resilience, on the other hand, is defined as the ability to recover from or adjust to the negative impacts of external economic shocks.

Countries classified as "best-case" are those not inherently highly vulnerable and also who adopt good policies that build strong resilience. On the other hand, the "worst-case" refers to countries that are inherently highly vulnerable and adopt poor policies that exacerbate the negative effects of their vulnerability.

Countries classified as "prodigal son" indicate those with a relatively low degree of inherent economic vulnerability but adopt poor policies that cannot deal with the negative effects caused by external shocks. On the other hand, countries defined as "self-made" are those with a high degree of inherent economic vulnerability but adopt appropriate policies to enable them to cope with or withdraw from negative effects.

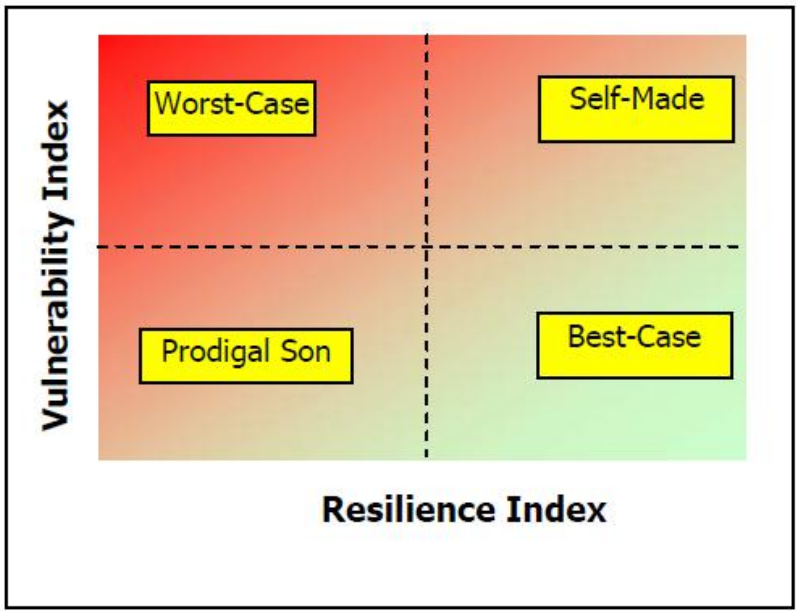

Figure 2.1: Four Possible Scenarios
Source: Briguglio, L(2004)

Based on the method of Briguglio, we can think about assessing the risk of being

affected by external shocks in terms of two components (Figure2.2). The first part is vulnerability, which is an inherent feature and is not adjusted for by policies and government. The second is resilience, which measures coping ability after encountering external shocks. The combination of the two indicators can give us the overall risk of being harmed by external shocks due to inherent vulnerability features counterbalanced to different extents by policy measures.

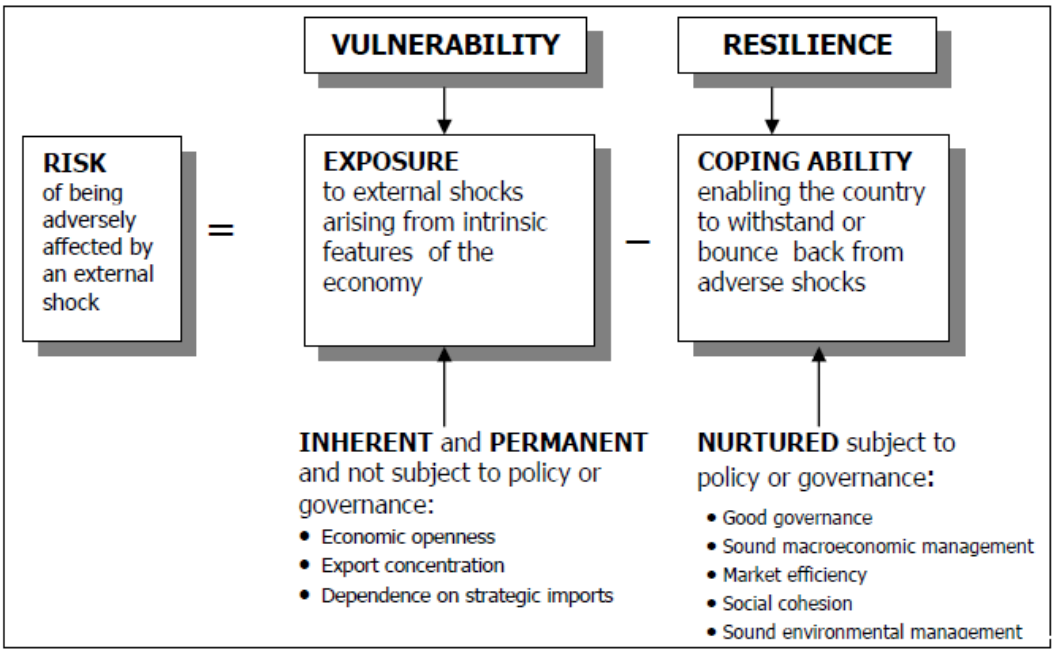

Figure2.2: Risk Associated with being Adversely Affected by External Shocks
Source: Briguglio, L(2004)

2.1.1. Economic Vulnerability

Briguglio discusses details for constructing vulnerability using country level data [4]. Empirical work on the construction of economic vulnerability is often based on the premise that a country's proneness to exogenous shocks stems from a number of inherent economic features, including high degrees of economic openness, export concentration,

and dependence on strategic imports.

Economic openness can be measured as the ratio of international trade to GDP. A high degree of economic openness renders a country susceptible to external economic conditions over which it has no direct control. On the other hand, economic openness can be seen as an extension of inherent features of the country's economy. It shows the country's ability to produce the range of goods and services to satisfy its own needs

Export concentration is another feature relating to economic vulnerability. A country that only depends on a narrow range of exports gives rise to risks associated with lack of diversification. Export concentration is also, to a large extent, the result of inherent features in the production bases of an economy and reflects the fact that small size restricts a country's ability to diversify its exports. Export concentration can be measured by the UNCTAD index of merchandise trade [25].

The last aspect of measuring economic vulnerability is dependence on strategic imports. Strategic imports include such goods as food, energy, and industrial supplies. If a country relies on other countries to offer large amounts of those goods, that would expose an economy to shocks with regard to the availability and cost of such imports. This variable can be measured as the ratio of the imports of strategic goods to GDP.

All vulnerability indices utilizing these variables come to the conclusion that there is a tendency for small countries to be more vulnerable economically than other sizes of countries.

2.1.2. Economic Resilience

Briguglio defined economic resilience as the ability to recover from or adjust to the negative impacts of external shocks [5]. The paper also defines resilience in two aspects. The first is the ability of an economy to recovery quickly. This recovery is associated with the flexibility of an economy, enabling it to bounce back after being adversely affected by a shock. This type of resilience also called "shock-counteraction." Second is the ability to withstand shocks wherein the adverse effect of a shock are absorbed or neutered, so that the end effect is negligible. This type of resilience is also called "shock-absorption."

It is hypothesized that elements of "shock-counteraction" and "shock-absorption" resilience can be found in the following areas: macroeconomic stability, microeconomic market efficiency, good governance, and social development.

Macroeconomic stability relates to the interaction between an economy's aggregate demand and aggregate supply and includes three variables in the resilience index: the fiscal deficit to GDP ratio, the sum of the unemployment and inflation rate, and the external debt to GDP ratio.

Microeconomic market efficiency relates to efficient operation through the price mechanism or how well resources are allocated in the economy. They include two areas in the resilience index: the size of government and freedom to trade internationally.

The size of government includes four indicators: (a) government consumption as a percentage of total consumption, (b) subsidies and transfers as a percentage of GDP, (c) the share of investment accounted for by public entities, and (d) the top marginal income tax rate together with the income threshold at which it applies.

The freedom to trade internationally considers the effects of revenues from tariffs,

regulatory trade barriers, size of the trade sector, exchange rates, and international capital market controls.

Good governance is related to the rule of law and property rights. Briguglio uses the "Economic Freedom of the World Index" to represent good governance. The index covers the following indicators: judicial independence, impartiality of courts, the protection of intellectual property rights, military interference in the rule of law, and the political system and the integrity of the legal system.

Social development indicates the extent to which social relations in a society are properly developed. The paper used the "Human Development Index" (HDI) to represent social development. The index covers the following indicators: education (measured by the adult literacy and school enrollment ratios), and health (measured by life expectancy at birth).

2.1.3. Assessing the Risk of Being Affected by External Shocks by Using Economic Vulnerability and Resilience

Briguglio's hypothesis is that it is possible to assess the risk of being affected by external shocks through two components, economic resilience and economic vulnerability (Figure2.2). The first part is vulnerability which comes from inherent features and is not adjusted to policies and government. The second is resilience which measures the coping ability after encounters with external shocks. The combination of the two indicators can give us the overall risk of being harmed by external shocks due to inherent vulnerability features and resilience which can be effected by policy. This hypothesis is the basic foundation of my index model (see chapter 3).

2.2 Economic Vulnerability and Resilience in Metropolitan Areas

Hill et *al.* and Augustine et *al.* focus on measuring regional economic resilience and building a resilience index for metropolitan areas [2, 16] . They also include similar variables in their models to try to explain the phenomenon of economic resilience in metropolitan areas.

Hill et *al.* (hereafter cited as Hill) want to understand the regional resilience in metropolitan areas: why are some metropolitan areas resilient to shock or after a shock why can some recover in a relatively short period of time while others do not? Hill starts by defining important key concepts: economic shock, economic downturns, shock-resistance, and economic resilience. The economic shocks are defined as in any year (the base year) the growth rate declining by more than two percentage points from its annual growth rate over the previous eight years.

The definition of economic downturn is a two percentage point drop in the rate of employment growth in a single year relative to the average employment growth rate for the preceding eight years. Hill defines those regions as “shock-resistant” that do not experiencing an economic downturn once a shock has happened. If a region does indeed experience an economic downturn but then recovers soon (back to the prior growth path within four years), it is considered "resilient." If it does not, it is "non-resilient."

Hill then builds empirical models to capture different aspects of economic resilience. These three models try to answer three different kind of questions. The first question is what are the characteristics associated with areas that experience downturns of their regional economies compared to those that do not. The second question is why are some regions shock-resistant, while others are not. The last question is, when experiencing an economic downturn, why are some areas resilient while others are not.

In order to answer those questions, Hill's dataset consists of the total employment from 1997 to 2007 for 361 metropolitan areas in United States. Also used is a set of independent variables in the regression in order to capture different aspects of economic resilience. Hill assumes that regional economic resilience is related to characteristics of a region's economy, and thus includes variables on the sector composition of a region's economy, including the percentages of employment in durable manufacturing, non-durable manufacturing, health care and social assistance, and tourism-related industries, based on Kolko and Neumark's study of regional resilience that shows that the more diverse its economy, the more resilient a region will [17]. Hill then includes a Herfindahl index (which measures the extent to which a regional economy is concentrated in a few sectors or diversified among many) as one of the independent variables. Another variable such as the number of export-based sectors in the region also is added to the model as an independent variable. All of these variables above are built on the assumption that the more diverse and less concentrated regional economies are more resilient.

Hill also includes variables that are related to the labor force and the labor market. The percentage of the population aged 25 and older who possess no more than a high school education is the variable that captures the labor education level. As many previous studies have shown, human capital is a major driving force of growth [13, 14, 15], so Hill assumes that the areas with a higher proportion of low-skilled labor are likely to be more susceptible to economic downturns and less resilient in terms of recovery. As one indicator of labor market flexibility, the paper includes a variable for whether the region is wholly or predominantly in a state that has a right-to-work law. A "right-to-work" law is a statute in the United States that prohibits union security agreements, or agreements between labor unions and employers, that governs the extent to which an

established union can require employees' membership, payment of union dues, or fees as a condition of employment, either before or after hiring [32]. The previous study of Duval, Elmeskov, and Vogel finds that the public policies that restrict firms' ability to lay off or the places with right-to-work laws may make labor markets more flexible in a way that makes regions more resilient [11].

Hill also includes background characteristics of metropolitan areas that might affect shock-resistance and resilience. The size and the age of the metropolitan area and the percentage of the region's population who reside in the central city also are added as independent variables. Age of the metropolitan area is frequently used as a proxy for the match between an area's urban form and modern transportation needs as well as for the structure and condition of the urban infrastructure (with the implication that older areas are likely to have less effective and efficient infrastructure, more prone to breakdown and need for repair). Some literatures also talk about how income inequality makes flexible regional responses more difficult while facing external shocks [21]. In this regard, Hill uses a variable that is the ratio of the income of high-income households to that of low-income households in the region.

The first model intends to explain the occurrence of regional economic downturns. It examines the regional characteristics that influence whether or not a region will suffer a downturn. In the model the dependent variable measures the duration of time that an entity spends in a steady state before experiencing a particular event.

There are four keys features of the first model. A region's industrial structure affects the probability that the region will experience a downturn. Durable goods manufacturing makes a region more susceptible to economic downturns, while health care and a social assistance industry makes it less so. The reason for this phenomenon may be because durable goods manufacturers will hire more workers when demand for

those goods rises and lay them off when demand falls, and thus the more people who are working in durable goods manufacture will make the region more susceptible to economic downturns. On the other hand, the health care and social assistance industries more or less remain as a constant, and are always in demand. People always need health care and the need for social assistance remains because poverty and unemployment cannot go to zero. That is the possibly why more health care and social assistance industry in the area, the less susceptible it is to economic downturns.

Having a large number of major export industries makes a region less likely to experience a downturn, suggesting that the larger the number of industries that are major exporters, the more protected the region is from economic shocks. The reason for this phenomenon may be because different export industries are more unlikely to provide similar goods to diverse markets. Thus, the more major export industries a region has, the less likely that all of them will suffer industry shocks at the same time, because even in a large multiregional shock event not all markets will be affected and reduce their demand. That will make the region become less susceptible to economic downturns.

Regions where a large share of the population have low levels of formal schooling (no more than a high school diploma) are more susceptible to downturns. Such a region might be agricultural or heavy in manufacturing but with little in research and development so that it would be immediately affected by a drop in demand for its output, rather than having the cushion of long term contracts that research and development industries may have. Regions with large income gaps between high- and low-income households are more susceptible to downturns than those with lower levels of income inequality. This result fits in with Pastor's hypothesis that inequality has an impact on other socioeconomic features such as crime rates or social stability [21]. The more income inequality in the system, the less stable the system, thus reducing the economic

capacity to face external shocks. These two factors show that the regions with more income inequality and more low-educated workers are more likely to experience economic downturns.

The second model explains shock resistance. It uses a logistic regression that examines what makes regions "shock-resistant" once they have experienced a shock. There are two key findings from the second model. Some of the regional characteristics that make a region more or less likely to experience a downturn also affect the region's chances of being shock-resistant once a shock has occurred. Regions that are more shock susceptible are also less shock resistant. Durable goods manufacturing indicates less shock resistance while health care and social assistance, and a large number of major export industries, promote shock resistance. A less well educated population also led to less shock resistance. The reasons for this phenomenon are more or less similar to those I just mentioned for the first model.

Regions whose overall economic structure is more diverse (as measured by the Herfindahl index) are likely to be more shock-resistant. Higher values on the Herfindahl index represent less diversification of the market. Thus, the region would be less shock-resistant, and vice verse. That is also consistent with the hypothesis of Kolko and Neumark [17].

The last model explains regional responses to economic shocks. It is a logistic regression that examines the regional characteristics that influence whether a metropolitan area economy that experienced an economic downturn was resilient.

The results of the last model are broadly similar to those of the first model, except for one thing: Right-to-work laws in a region appear to have a positive effect on resilience. Regions with more flexible labor markets may be more likely to recover employment after it has been temporarily lost. The odds of a region being resilient are

nearly 2.2 times greater if it is located in a state which has right to work laws compared to the state without such laws. That result is consistent with the hypothesis of Duval, Elmeskov, and Vogel that places with right-to-work laws may make labor markets more flexible in a way that makes those regions both more resilient and less shock-resistant [11].

The main results of Hill's work can be summarized as follow (Table 2.1). The regions that have a higher proportion of their employment in durable goods manufacturing were likely to experience more downturns and to be less shock-resistant. However, they were also more likely to be resilient after experiencing a downturn. As Briguglio et.*al* hypothesized, industrial concentration also mattered: The greater the number of major export industries in a region, the less susceptible the region is to a downturn and the more shock-resistant it is. Similarly, the greater the industrial diversity of a region, the more likely it is to be resilient to a downturn [7].

Human capital plays a role in the regional resilience as well. Regions that have a higher proportion of workers that have at least high school degree are likely to experience fewer downturns and also be more shock-resistant while facing external shocks, and they are more likely to recover in a relatively short period of time.

Labor market flexibility is also related to resilience. Regions that have right-to-work laws are likely to be more resilient when experiencing a downturn than other regions. The greater the income disparities in a region, the more likely it is to experience a downturn and also be less resilient after experiencing the downturn.

Table 2.1: Summary for Hill (2010) paper

	Occurrence Downturn	**Shock-resistant**	**Resilience**
Durable Manufacturing	more downturns	less shock-resistant	more resilience
Health Care and Social Assistance	less downturns	more shock-resistant	none
Export- based sectors	less downturns	more shock-resistant	more resilience
Industry Diversity	less downturns	more shock-resistant	more resilience
Low-Educated Population	more downturns	less shock-resistant	less resilience
Right to Work Law	none	none	more resilience
Income Inequality	more downturns	less shock-resistant	less resilience

Augustine et *al.* brings out another way to measure economic resilience [2]. The paper introduces the idea of economic capacity. The objective of their paper is to find out whether metropolitan regions can develop resilience capacity that makes them more resistant to economic shocks or if they experience shocks, can they still recover in a relatively short period of time.

The paper starts by defining three important terms: economic downturn, resilience, and region capacity. The definitions of economic downturn and resilience are the same as Hill's. The only difference is that Augustine uses the idea of a regional economic capacity index (RECI) to measure economic capacity. The RECI consists of five components: income equality, economic diversification, business environment, specific export industries, and other factors that affect regional economic capacity.

Income equity measures how evenly income is distributed across a population, and is base on the previous study of Cutter *et* al., which makes the claim that the more equal a region's distribution of economic resources, the more cohesive the response to disturbance [10]. The 80/20 ratio indicates income equity, which is a ratio of the income

of upper middle class to poor. The lower this ratio, the smaller the gap in income between the poor and upper middle class, representing more income equity.

Economic diversification measures the degree to which economic activity is spread across sectors of an economy. When economic activity is concentrated in relatively few sectors, the overall regional economy is more vulnerable when facing external shocks. The use of the Herfindahl index (HHI) to measure market concentration represents the degree of economic diversification. Lower on the HHI indicates being higher in economic diversity, and thus more regional resilience.

Business environment characterizes the various conditions that render an area more favorable to business. A more favorable business environment renders a regional economy more resilient. The right-to-work measure indicates whether the area has laws that prohibit employment agreements that require participation in a union. The more right-to-work an area is, the better the economic resilience. The research and education sector also plays a role in building economic resilience. The paper also includes research institutions and workers with at least a high school education to indicate a favorable business environment. A higher number of research institutions and a more educated labor force denotes a potentially higher level of economic resilience.

Augustine includes four additional variables to capture the share of employment in four specific export industries: durable and nondurable manufacturing, healthcare, social assistance, and tourism. Finally, Augustine also includes other variables to help measure economic capacity; the eight-year growth rate prior to the downturn, employment in the previous year, wages per employee, percentage of metro population living in the central city, and age of metropolitan areas.

The author used multivariate analysis to see which variables can most successfully explain economic resilience. The multivariate test resulted in four conclusions: First, the

region with more educated workers has higher resilience. Second, the right-to-work states are more likely to be resilient. Third, more wage per worker will decrease the odds of being resilient. Last, for each additional percentage point share of workers in health industries, there will be less resilience.

Comparing Hill's and Augustine's work on regional resilience, I find that their methodologies are pretty quite similar. They both include the economic diversification (Herfindahl Index), specific export industries (durable and nondurable manufacturing, healthcare, social assistance, and tourism), income inequality, education, and right-to-work laws. Some of their conclusions are similar. Hill and Augustine both agree that the places with right-to-work laws and more well-educated labors are more likely to be resilience. However, the results of Augustine show that the more people who work in the health care industry will make the region become less resilient. This result is in conflict with Hill that the more people work in health care industry will make the region become more resilient. Furthermore, both authors used similar but not exactly the same variables and also somewhat different methods to capture the idea of regional resilience. This difference implies we need to do more studies and have further discussion on this topic.

2.3 Economic Resilience and Economic Vulnerability in Rural Areas

To the best of my knowledge, little research has been conducted on the economic resilience of rural areas. However, we can still learn from the case of measuring economic resilience and vulnerability in metropolitan areas. Some of the variables that can explain the phenomenon of economic resilience and vulnerability can also be used in the rural areas case. Thus, in this section, I will combine the literatures talking about

rural economic resilience with the case in metropolitan areas to find out the potential factors that may explain the phenomenon of economic resilience and vulnerability in rural areas.

2.3.1. Economic Resilience and Vulnerability in Rural Communities Using a Multifunctionality Model

Wilson gave the definition of rural community resilience [31]. Rural community resilience can be seen as the balance between the economic (material property), social (networks of social connections and mutual obligation), and environmental capital (a stock of natural assets such as land, water, and minerals used for production) needs of a rural community. In other words, resilience is about communities being able to successfully weather the vicissitudes of endogenous and exogenous changes. He also pointed out that resilience is the ability of a system to absorb impacts or disturbances and to reorganise into a fully functioning system, as well as undergoing a post-event adaptive process. Community vulnerability, on the other hand, can be defined as a function of exposure and sensitively of a system that is usually not able to cope with risks or changes, leading eventually to the disappearance of the system.

Wilson builds a conceptual model to show how the intertwining of economic, social, and environmental capital creates different spaces of multifunctionality (Figure 2.3). The space defined as having strong multifunctionality is where the three capitals are equally well developed. The spaces defined as having moderate multifunctionality are where only two capitals are well developed. The rural areas with no well developed capital type or only one capital as well developed are characterized as having weakly multifunctionality. The model also pointed out the two extreme cases:

super-productivism (extreme economic capital intensive) and non-productivism (extreme environmental capital intensive).

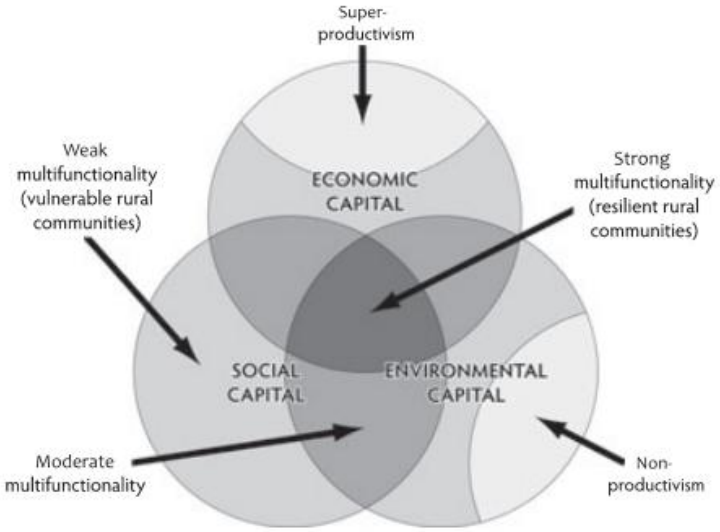

Figure2.3: Multifunctional equality and the intersection between economic, social and environmental capital
Source: Wilson (2010)

The question then is as to what characteristics make regions identifiable as strong multifunctional rural communities in economic, social, and environment capital, respectively. The variables in economic capital fall into three categories: economic well-being, diversified income streams, and low dependency on external funds. Economic well-being means the community has sufficient income for survival or can escape from the poverty trap. A diversified income stream means the community does not rely on only one or a few products for income and they have multifunctional businesses in the community. Low dependency on external funds (ex. agricultural subsidies) indicates the community does not rely on government subsidies while facing external shocks, which means the community can overcome external shocks using their

own abilities.

The variables in social capital are more complex, but can generally be listed as these: availability of skills training and education, good health and sanitation, an open-minded community, and multifunctional services. The availability of skills training and education means the community has more skilled and educated workers. Good health and sanitation services indicate the community has provided residents with good health care. An open-minded community has the ability to accept changes. The last one, multifunctional services, indicates that the community has different kinds of services including a health industry, education industry, research industry, and so on. Wilson also points out multifunctional services in a rural area is an indicator of more resilience because the job opportunities available in that sector.

Debates about the characteristics of environmental capital of rural areas are less contentious compared to those over social capital. Most of the previous studies agree that the stronger the environment capital a rural community has, the more resilient the community is [10, 31]. The variables in environmental capital are high levels of biodiversity, good water quality and availability, good soil quality, sustainable management of environmental resource, and multifunctional environmental resources. While facing external shocks, the more available environmental capital the rural community has, the better the community can overcome challenges using their own resources, and thus, the more resilience they have.

Wilson concluded the communities with highly multifunctionality are more likely to be economically resilient. In other words, the places with strongly developed economic, social, and environmental capital are likely to be more resilient than places where only one or none of these factors is present. Conversely, the communities with weak multifunctionality or the communities with poorly developed economic, social, and

environmental capital are more vulnerable to external shocks. Using a multifunctionality model framework can help us understand more deeply the issue of rural community resilience and the model can be applied to any rural area because of the relatively scale-independence of this approach.

CHAPTER 3

EMPIRICAL MODEL

3.1 Four Quadrant Model

I cited Brigugilo's work in Chapter 2 [4, 5]. His hypothesis at the country level is that in assessing the risk of being affected by external shocks, two components are the most important: economic vulnerability and economic resilience. I define economic vulnerability in terms of inherent features that are not adjusted to policies and government. Economic resilience, on the other hand, is the feature that can be induced by policies and government and which can help rural areas to develop coping ability after encounters with external shocks. Following Brigugilo, I develop a "Four Quadrant Model" to categorize western US rural counties based on their inherent vulnerability and resilience (Figure 3.1). The counties located in the first quadrant (named "self-made") are counties with high vulnerability but have adopted appropriate policies enabling them to build strong resilience. The counties located in the second quadrant (named "worst case") are counties with high vulnerability and also with poor policies that exacerbate the negative effects of their vulnerability. The counties located in the third quadrant (named "prodigal son") indicate counties with low vulnerability but which have adopted poor policies that waste their inherent advantage. The counties located in the fourth quadrant (named "best-case") indicate counties with low vulnerability and also that have adopted appropriate policies to enable them to built strong resilience.

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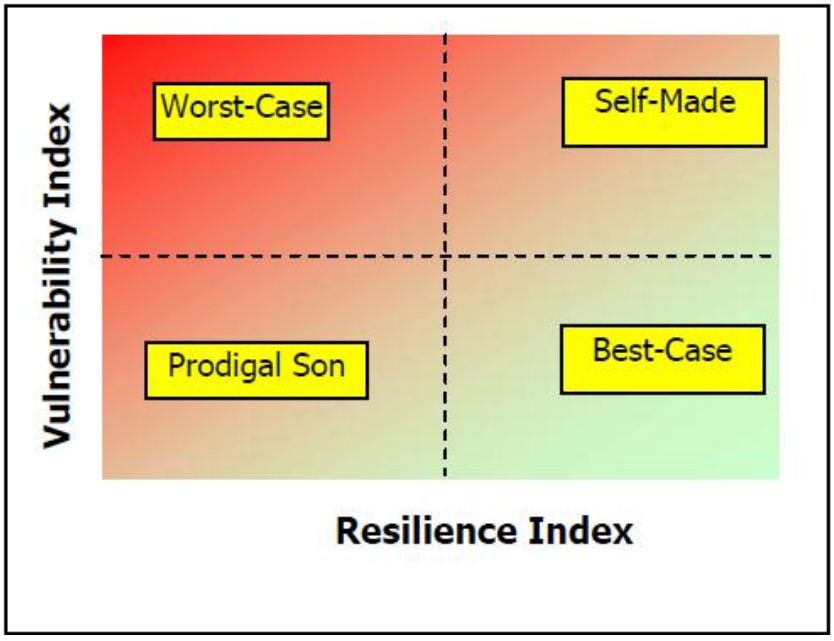

Figure3.1: Four Quadrant Model

The objective of this thesis is to develop two indexes, a resilience index (RI) and vulnerability index (VI), and then I will combine these two indexes to give the overall risk of being harmed by external shocks to the western rural counties. This is the basic framework of my thesis model (Figure 3.2).

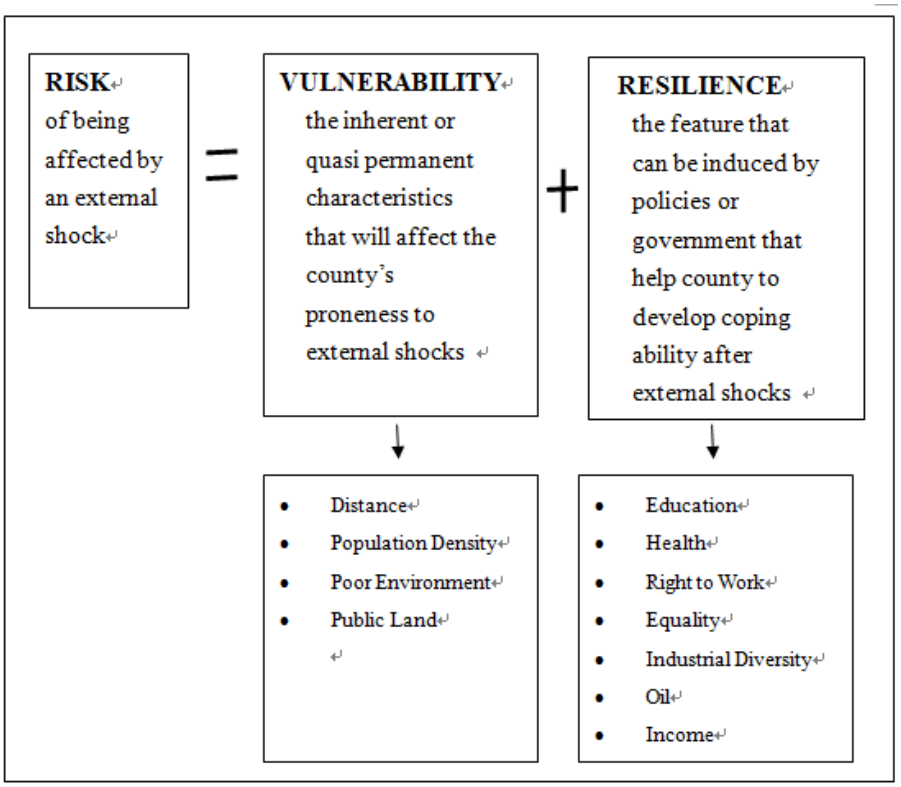

Figure 3.2: Basic Framework

3.2 Study Area

The unit of analysis is county. I consider 11 states in the western part of the United States (Figure 3.3). According to the U.S. Census Bureau, the western part of United States refers to the region lying to the west of the Mississippi River [27]. It can be divided into the Pacific States: Alaska, California, Hawaii, Oregon, and Washington, and the Mountain States: Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming. However, Alaska and Hawaii, being detached from the other western states, have few similarities with them. Thus, I do not include Alaska and Hawaii in my analysis.

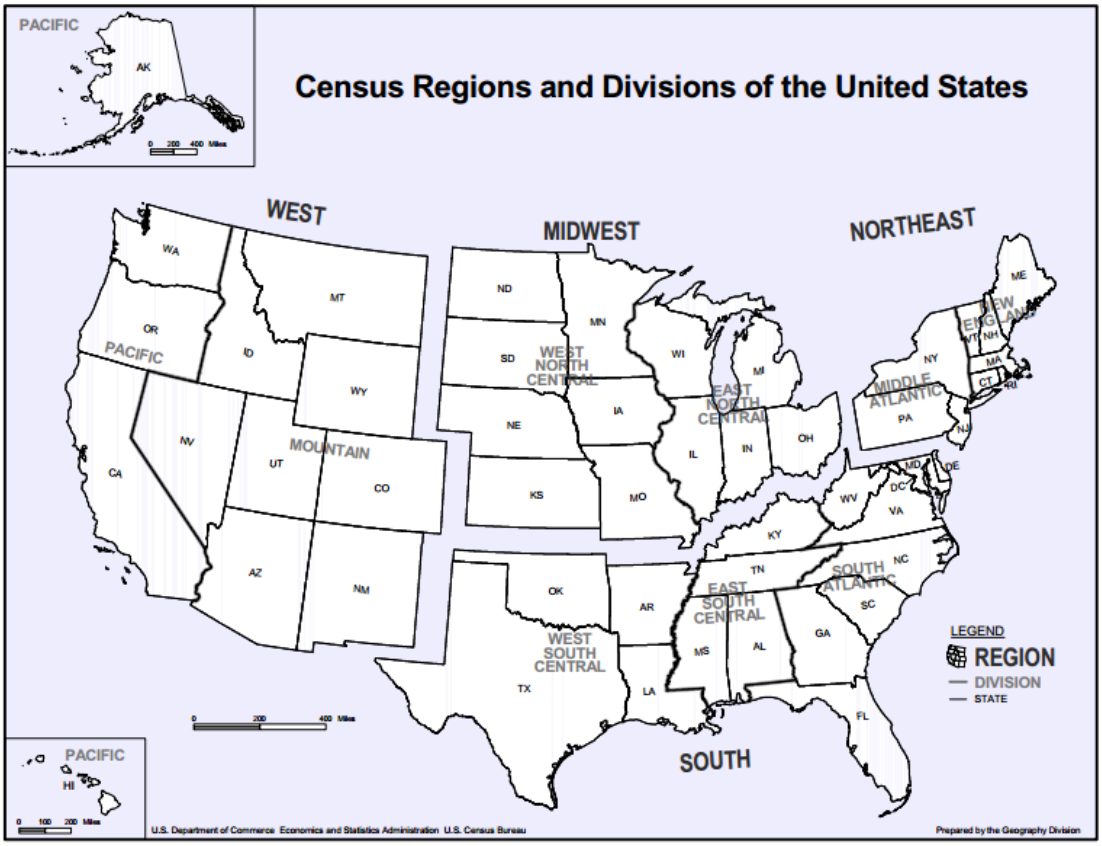

Figure 3.3: Divisions of the United States
Source: U.S. Census Bureau (2014)

The 11 states (Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming) contain a total of 414 counties. However, as I mention in previous chapters, the main focus here is on rural counties. Therefore, I used the Rural-Urban Continuum Codes developed by the USDA as a classification scheme that distinguishes metropolitan counties by the population size of their metro area, and nonmetropolitan counties by their degree of urbanization and adjacency to a metro area (see Table 3.1 for definitions) [28]. The counties with a code from 1 to 3 can be considered to be metro counties based on their population. The counties with code from 4 to 9 can be considered as the non-metro counties based on their population and adjacency to a metro area. In order to meet my objective of studying western rural counties, I only choose the counties with a code 6 to 9 as my study subjects.

Thus, the final dataset for my thesis study contains 11 states with 225 rural counties.

Table 3.1: 2013 Rural-Urban Continuum Codes

2013 Rural-Urban Continuum Codes	
Code	Description
Metro counties:	
1	Counties in metro areas of 1 million population or more
2	Counties in metro areas of 250,000 to 1 million population
3	Counties in metro areas of fewer than 250,000 population
Nonmetro counties:	
4	Urban population of 20,000 or more, adjacent to a metro area
5	Urban population of 20,000 or more, not adjacent to a metro area
6	Urban population of 2,500 to 19,999, adjacent to a metro area
7	Urban population of 2,500 to 19,999, not adjacent to a metro area
8	Completely rural or less than 2,500 urban population, adjacent to a metro area
9	Completely rural or less than 2,500 urban population, not adjacent to a metro area

Source: USDA (2013)

3.3 Dependent Variable

The unemployment rate is defined as the percentage of unemployed workers in the total labor force. It is widely recognized as a key indicator of labor market performance. Based on U.S. Bureau of Labor Statistics (BLS) notes, when workers are unemployed, their families lose wages, while the nation as a whole loses their contribution to the economy in terms of the goods or services that could have been produced [26]. Unemployed workers also lose their purchasing power, which can lead to unemployment for other workers, creating a cascading effect that ripples through the economy. Thus, using the unemployment rate as a economic indicator is very useful and common in economic studies.

The U.S. government conducts a monthly sample survey – known as the Current

Population Survey (CPS) – to capture the unemployment rate in the nation. The CPS has been conducted monthly in the U.S. since 1940. About 60,000 households, or approximately 110,000 individuals, are in the CPS sample survey, selected to be representative of the entire U.S. population. The basic definitions used by the BLS in compiling labor statistics are quite straightforward. People with jobs are employed; people who are jobless, looking for jobs and available for work are unemployed; and people who are neither employed nor unemployed are not in the labor force. The total sum of employed and unemployed people makes up the labor force. The unemployment rate is simply defined as the percentage of unemployed workers in the total labor force. All researchers can obtain the unemployment rate data from the website of U.S. Bureau of Labor Statistics.

As I mentioned in the first chapter, the Great Recession that ran from December 2007 to June 2009 brought strong economic shocks to the whole United States. The beginning of the Great Recession was triggered by the bursting of an 8 trillion dollar housing bubble accompanied with tremendous wealth loss that led to sharp cutbacks in consumer spending. The market chaos triggered by the bursting of the housing bubble combined with shrinking of consumer spending led to a collapse in business investment. When the big companies stopped making business investments, mass layoffs and a huge unemployed rate followed. During the year between 2008 and 2009, the U.S. labor market lost 8.4 million jobs. Before the Great Recession, the national unemployment rate was 5.0 percent. However, during the Great Recession, the nation unemployment rate rose to 9.5 percent.

Since my work is to study the western rural counties' ability to recover from the negative effects resulting from economic shock, I chose 2007 as the base year and 2010 as the end year for this study. I use two independent variables: y1 and y2; y1 represents

the change in the unemployment rate between 2007 to 2010, and y2 represents the percentage change of the unemployment rate during this period. The formula is:

(1) *y1= (Unemployment rate in 2010- unemployment rate in 2007)=△ unemployment rate*

(2) *y2= (Unemployment rate in 2010- unemployment rate in 2007)/ (Unemployment rate in 2007)= percent △employment rate*

3.4 Indicators of Vulnerability

I use the definition of economic vulnerability from Brigugilo [4]. Economic vulnerability is affected by the inherent or permanent (or quasi permanent) characteristics that will affect the county's proneness to external shocks.

Recall that I cite Hill's work in chapter two about how the size and the population that live in a metropolitan area both influence the bounce-back ability of the region [16]. The hypothesis is that the bigger the size and the more people inside the region, the better is the chance that there are enough resources and human capital to help the region to overcome the negative effects caused by external shocks. Thus, I include a variable that can simultaneously capture both population size and geographic size in each county. The variable population density (2010 data) is defined as the number of people per square mile. The hypothesis is that the more dense the population density, the less vulnerable a county is. The second vulnerability variable is the percentage of public land for each county (2010 data). In the rural Western U.S., the ownership of land is diverse. Some of land is in private ownership but much land is publically owned. The usage of

these two land types are quite different. As I defined in the beginning of this chapter, vulnerability is an inherent feature of a county. Thus, analyze if the percentage of public land in a county may be a candidate variable that will influence economic vulnerability in the rural Western United States.

Wilson's work points to the importance of environmental capital (a stock of natural resources such as land, water, and minerals used for production). Thus, an index that can capture environmental capital is crucial. The United State Department of Agriculture (USDA) developed an index called the Natural Amenities Scale [29]. It is a measure of the physical characteristics of a county area that enhance the location as a place to live. The scale was constructed by combining six measures of climate, topography, and water area that reflect environmental qualities most people prefer. These measures are warm winter, winter sun, temperate summer, low summer humidity, topographic variation, and water area. Based on those six aspects the USDA gives every county a standardized scores ranging from -2 to 3. A higher standardized scores indicates the better the area is suitable for people to live in, and vice verse.

The last variable in the vulnerability index is the distance between a rural county's county seat to the nearest metropolitan area (metropolitan area defined as the area with more than 10000 residents based on the USDA definition). Based on a previous study by Andrew, a rural area is a place of both residence and economic activity [1]. Andrew pointed out that rural areas near metropolitan areas may become residence areas for metropolitan workers. Thus, the shorter the distance between metropolitan areas and rural counties, the more job opportunities are available. Therefore, I developed a new dataset that calculates the distance between the county seat to its nearest metropolitan area as one variable for vulnerability (2014 data).

3.5 Indicators of Resilience

Economic resilience is defined as the features that can be induced by policies or government that help a county to develop the ability to recover from or adjust to the negative impacts of external economic shocks.

I cited both Hill's and Augustine's work in Chapter 2. Both of their papers mention that the labor force and labor market institutions can affect regional resilience. Thus I include two variables to capture the labor force. One is education, another is health. The education level within each county represents education (2006-2010 data). The number of people enrolled in health insurance represent labor force health (2007 data). The measurement of education and health are defined as follows:

(3) *Education= (Number of people having at least high school degree)/ (Total population in each county)*

(4) *Health= (Number of people enrolled in health insurance)/ (Total population in each county)*

In order to capture labor market flexibility. I include a dummy variable for whether the county is in a state that has a right-to-work law.

(5) *Right-to-work= 0 if the state with right-to-work law*

Right-to-work= 1 if the state without right-to-work law

Since it is sometimes argued that the degree of income inequality makes flexible regional responses more difficult when facing economic shocks, I include an index called

the Gini index to represent the degree of income inequality.

The Gini coefficient is a measurement of income inequality that was first developed by Corrado Gini in 1912. The Gini index is the Gini coefficient expressed in terms of a percentage with values between 0% to 100%; these two things actually give the same meaning but are just different expression [32]. To know more about the Gini coefficient, it usually mathematically defined based on the Lorenz curve, which plots the proportion of the total income of the population (y axis) that is cumulatively earned by the bottom x% of the population (Figure 3.4). A line at 45 degrees thus represents perfect equality of incomes, meaning the percentage of total income equals the percentage of total population. We define the Gini coefficient as the area that lies between the line of equality and the Lorenz curve over the total area under the line of equality or we can simplify as the ratio A/A+B. As we can see from the Figure 3.4, the lower the Gini coefficient, the more equal the income distribution, and vice verse. A Gini coefficient equal to 0 means everyone has the same income (complete equality) and a Gini coefficient equal to 1 means there is one person who has the total income and the rest of the people have none of the income (complete inequality).

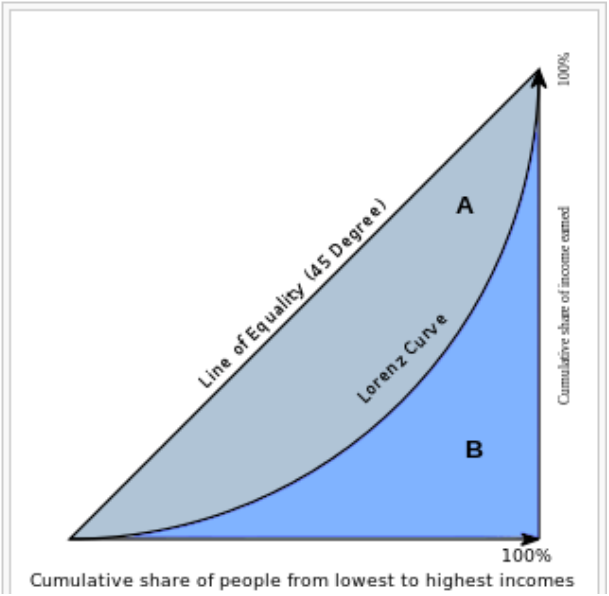

Figure 3.4: Lorenz Curve and Gini coefficient

Source: Wikipedia

Note: The graph shows that the Gini coefficient is equal to the area of A/A+B

The U.S. Census Bureau developed a specific survey, the American Community Survey (ACS), to collect annual data. The ACS gives communities the current information they need to plan investments and services. Information from the survey generates data that helps determine how more than $400 billion in federal and state funds are distributed each year. Therefore, I use the Gini index from ACS 5-year estimates (2008-2012) to represent household income inequality in each county as one of the resilience variables.

It is argued that an area with natural energy sources can bring more job opportunities to that local area. Thus, I include one variable "oil" to capture annual gross withdrawals of crude oil in each county as one of the resilience variables (2007 data).

The last variable in resilience is about economic diversification. Recall that both Hill's and Augustine's work mention the importance of economic diversification on a region’s resilience. Thus I use the Herfindahl index as a indicator for the level of

economic diversification. The Herfindahl index is also known as Herfindahl–Hirschman Index, or HHI [33]. This index was originally developed by two economists—Orris C. Herfindahl and Albert O. Hirschman, and measures the size of firms in relation to their industry and also is an indicator of the amount of competition among firms. The definition of HHI is the sum of the squares of the market shares of the 50 largest firms (or summed over all the firms if there are fewer than 50) within the industry, where the market shares are expressed as fractions.

$$H = \sum_{i=1}^{N} s_i^2 \tag{6}$$

where s_i is the market share of firm i in the market, and N is the number of firms. The result is proportional to the average market share, weighted by market share. As such, it can range from 0 to 1.0. Increases in the HHI generally indicate a decrease in competition and an increase of market power, whereas decreases indicate the opposite. If the HHI is close to 1.0 that indicates there is only one firm, a monopoly, in this industry, and vice verse. General speaking, an HHI below 0.01 indicates a highly competitive situation. An HHI between 0.15 to 0.25 indicates moderate concentration. An HHI above 0.25 indicates high concentration.

The major benefit of the HHI is that it can represent the degree of concentration of the firms. Thus, I use the HHI to measure the degree of diversity in different sectors in each western rural county. I chose four sectors—agriculture, government, manufacturing, and services—as the four main industries in western rural counties.

$$HHI = A^2 + G^2 + M^2 + S^2 \tag{7}$$

A indicates the percentage of people working in the agricultural sector within each county. G indicates the percentage of people working in the government sector within each county. M indicates the percentage of people working in the manufacturing sector within each county. S indicates the percentage of people working in the service sector within each county (all 2007 data).

3.6 Index Model

(a) Standardizing and Transforming the variables

The standardization procedure is required to render the index insensitive to the scale of measurement used, since the variables composing the index are measured in different units. The transformation procedure can make the variables inside the vulnerability index and resilience index move in the same direction and make sure that they won't cancel the effects of each other out. All observations (except for the natural amenity scale) were standardized using the well know transformation:

$$(8) \qquad XSij = Xij / Maxj$$

where

XSij is the value of the standardized observation i of variable j;

Xij is the actual value of the same observation;

Maxj are the maximum values of variable j.

Because the range of natural amenity scale lies between -2 to 3, I cannot use formula (8) to standardize it. Instead of using formula (8), I use another formula to do the natural amenity scale standardization:

$$(9) \qquad XSij = (Xij - Minj) / (Maxj - Minj)$$

where

XSij is the value of the standardized observation i of variable j;

Xij is the actual value of the same observation;

Minj and Maxj are the minimum and maximum values of variable j.

All standardized values of observations in a particular variable array take a range of values from 0 to 1.

The second step is to transform the standardized variables in order to construct the vulnerability index and the resilience index. The transformation procedure is summarized in Table 3.2 and Table 3.3.

Table 3.2: Summary for Vulnerability Index

Name	**Description**	**Transformation**	**Interpretation**
Distance	Measure the distance from the center of each county to its nearest metropolitan area Standardized at range 0 to 1	None	Longer distance increases vulnerability
Low density	Measure the number of people in each square mile. Standardized at range 0 to 1	1-standardized population density	Bigger number in "low density" increases vulnerability
Public land	Measure the percentage of the public land in each county. Standardized at range 0 to 1	None	Bigger number in "public land" increases vulnerability
Poor environment	Measure the physical characteristics of a county area that enhance the location as a place to live. Standardized at range 0 to 1	1- standardized natural amenity scale	Bigger number in "poor environment " increases vulnerability

Table 3.3: Summary for Resilience Index

Name	**Description**	**Transformation**	**Interpretation**
Education	Measure the percentage of people have at least high school degree. Standardized at range 0 to 1	None	Bigger number in "education " increases resilience
Health	Measure the percentage of people enroll in health insurance. Standardized at range 0 to 1	None	Bigger number in "health" increases resilience
Right to work	Measure the state with right-to-work law or not. (dummy variable)	None	Bigger number in "right to work" increases resilience
Equity	Measure the degree of income distribution equity in each county. Standardized at range 0 to 1	1- standardized Gini index	Bigger number in "equity" increases resilience
Oil	Measure the annual gross withdrawals of crude oil in each county. Standardized at range 0 to 1	None	Bigger number in "oil " increases resilience
Diversity	Measure the degree of industrial diversity in each county. Standardized at range 0 to 1	1- standardized Herfindahl index (HHI)	Bigger number in diversity" increases resilience

(b) Building Vulnerability Index and Resilience Index

The vulnerability index was computed by taking a simple average of the four components as I described in the last paragraph:

1. Distance (2014),

2. Low density (2007),

3. Public land (2007),

4. Poor environment(1941-1970).

The resilience index was computed by taking a simple average of the six components as I described in last paragraph:

1. Education (2006-2010),

2. Health (2007),

3. Right to work (2014),

4. Equity (2008-2012),

5. Oil (2007),

6. Diversity (2007),

Thus I get two index numbers for each county, one is the county vulnerability index, another is county resilience index.

$$(10) \qquad County = (VI, RI)$$

(c) The relation between change of the unemployment rate, vulnerability index, and resilience index

In order to examine the change in the unemployment rate and the percent change of the unemployment rate in different western rural counties, and how those can be explained by vulnerability and resilience, I use the ordinal least square method of

regression, change of unemployment rate (y1) and the percent change of unemployment rate (y2), which were regressed on the vulnerability index and on the resilience index produced for this study. In order to simplify expressions, I will define the change of unemployment rate (y1) regressed on the vulnerability index and on the resilience index as regression one, and the percent change of unemployment rate (y2) regressed on the vulnerability index and on the resilience index as regression two.

(11) Regression one: y1(change of unemployment rate) = f(VI, RI)

(12) Regression two: y2 (percent change of unemployment rate) = f(VI, RI)

3.7 Multivariate Model

The main purpose of my thesis is to construct and index model as I describe in section 3.6. However, in order to know the actual contribution to change of the unemployment rate in 2007 to 2010 of each of the vulnerability and resilience variables, I also construct a multivariate model. The multivariate model uses the same data as the index model. The only difference is that the index model uses the vulnerability index and resilience index as explanatory variables, and the multivariate model uses the vulnerability variables and resilience variables separately. First, I standardized and transformed all variables to eliminate the effect of different measurement scales. Second, I regressed the change of unemployment rate (y1) and the percent change of unemployment rate (y2) on the vulnerability variables and on the resilience variables (Table 3.4). In order to simplify expression, I define the change of unemployment rate (y1) regressed on the vulnerability variables and on the resilience variables as regression three, and the percent change of

unemployment rate (y2) regressed on the vulnerability variables and on the resilience variables as regression four.

Table 3.4: Vulnerability Variables and Resilience Variables in OLS model

Vulnerability Variables	**Resilience Variables**
Distance	Education
Low density	Health
Public land	Right to work
Poor environment	Equity
	Oil
	Diversity

(13) Regression three: y1(change of unemployment rate) = f(Distance, Low density, Public land, Poor environment, Education, Health, Right to work, Equity, Oil, Diversity)

(14) Regression four: y2 (percent change of unemployment rate) = f(Distance, Low density, Public land, Poor environment, Education, Health, Right to work, Equity, Oil, Diversity)

Chapter 4 will compare and contrast the results from both the index model and OLS model.

Table 3.5: Original Data for Vulnerability Variables

Variable	**Unit**	**Description**	**Source**
Distance to big city	Miles	Measure the distance from the center of each county to its nearest metropolitan area. (2014 data)	U.S. Census Bureau http://www2.census.gov/geo/maps/metroarea/us_wall/Feb2013/cbsa_us_0213_large.gif Google Map https://www.google.com/maps/previw
Size of county	Square miles	Measure the total size in each county. (2007 data)	U.S. Census Bureau http://censtats.census.gov/usa/usa.shtml
Population size	Absolute number	Measure the total number of people in each county. (2007 data)	U.S. Census Bureau http://censtats.census.gov/usa/usa.shtml
Population density	People /square mile	Measure the number of people in each square mile. (2007 data)	U.S. Census Bureau http://censtats.census.gov/usa/usa.shtml
Percent of public land	Percentage	Acre of public land in each county/ Total acre of each county. (2007 data)	U.S. Department of the Interior http://www.doi.gov/pilt/county-payments.cfm
Natural amenity scale	Standardized scores from -2(worst) to 3 (best)	A measure of the physical characteristics of a county area that enhance the location as a place to live. (1941-1970 data)	United State Department of Agriculture http://www.ers.usda.gov/data-products/county-level-oil-and-gas-production-in-the-us.aspx#.U4PT8vldXD0

Table 3.6: Original Data for Resilience Variables

Variable	**Measure**	**Description**	**Source**
Education	Percentage	Percentage of people with at least high school degree. (2006-2010 data)	U.S. Census Bureau http://censtats.census.gov/usa/usa.shtml
Health	Percentage	People enrolled in health insurance/ total population in each county. (2007 data)	U.S. Census Bureau http://censtats.census.gov/usa/usa.shtml
Right to work	1=none 0=yes	Measure the state with right-to-work law or not. (2014 data)	U.S. Census Bureau http://censtats.census.gov/usa/usa.shtml
Income inequality	Gini Index ranging from 0 to 1	The Gini index indicates the degree of income inequality ranging from 0 to 1. The larger number in the Gini index represents more inequality. (2008-2012 data)	U.S. Census Bureau American Community Survey(ACS) http://www.census.gov/acs/www/
Employees percentage in different sectors	Percentage	Percent employed in agriculture, Percent employed in manufacturing, Percent employed in services, Percent employed in government. (2007 data)	U.S. Census Bureau http://censtats.census.gov/usa/usa.shtml
Oil	Barrels	Annual gross withdrawals of crude oil in each county. (2007 data)	United State Department of Agriculture http://www.ers.usda.gov/ data-products/county-level-oil-and-gas-production-in-the-us.aspx# .U4PT8vldXD0
Industrial concentration	Herfindahl index (HHI)	Herfindahl index can represent the degree of industrial diversity in different sectors in each western rural county. (2007 data)	U.S. Census Bureau http://censtats.census.gov/usa/usa.shtml

CHAPTER 4

RESULTS

4.1 Multivariate Model

The main purpose of the multivariate model is to examine the factors influencing change in the unemployment rate during 2007 to 2010. I begin with presenting the correlation matrix of indicators of vulnerability and resilience. Then I present the results for the multivariate regression model. Finally, I do the robustness test to confirm the results of the multivariate model.

The hypotheses of the multivariate model is straightforward. Vulnerability is the inherent feature that will weaken a county's ability while facing economic shocks. Resilience, on the other hand, is the coping ability that can be induced by policies to help a county get rid of the negative effects of economic shocks. I expect the vulnerability variables will increase the change (also percent change) of the unemployment rate in the county and the resilience variables will decrease the change (also percent change) of the unemployment rate in the county.

(13) Regression three: y1= f(Distance, Low density, Public land, Poor environment, Education, Health, Right to work, Equity, Oil, Diversity)

(14) Regression four: y2= f(Distance, Low density, Public land, Poor environment, Education, Health, Right to work, Equity, Oil, Diversity)

4.1.1. Correlation among the Indicators of Vulnerability and Resilience

Table 4.1 shows the correlation matrix for vulnerability variables. The correlation between vulnerability variables is somewhat weak, with the exception of public land and poor environment. The question arises, therefore, as to whether or not one of these two variables is redundant. To answer this question, I will show the result in section 4.1.3, a robustness test.

Table 4.1: Correlation Matrix for Vulnerability Variables

	Distance	Public land	Poor Environment	Low Density
Distance	1.000			
Public Land	0.050	1.000		
Poor Environment	-0.315	0.458	1.000	
Low Density	0.258	0.007	-0.170	1.000

Table 4.2 shows the correlation matrix for resilience variables. The correlation between resilience variables is somewhat weak.

Table 4.2: Correlation Matrix for Resilience Variables

	Education	Health	Right-to- work	Equity	Oil	Diversity
Education	1.000					
Health	0.077	1.000				
Right- to- work	-0.209	0.040	1.000			
Equity	0.206	0.009	-0.312	1.000		
Oil	-0.076	0.035	0.049	-0.110	1.000	
Diversity	0.072	-0.290	0.218	-0.205	0.029	1.000

4.1.2. The Multivariate Model Results

Table 4.3 presents the results of the multivariate model.

Table 4.3: Multivariate Model Regression Results

Variable	**Δ** unemployment rate		Percent **Δ** unemployment rate	
	Estimator	**Pr > |t|**	estimator	**Pr > |t|**
Intercept	6.5330	0.0123	0.1781	0.8064
Vulnerability Variables (VV)				
Distance	-0.8097	0.2940	0.1939	0.3702
Public Land	1.5792	0.0028	0.1448	0.3248
Poor Environment	6.6577	<.0001	1.2394	<.0001
Low Density	-0.8253	0.5898	-0.1057	0.8055
Resilience Variables (RV)				
Health	0.9164	0.2568	-0.8703	0.0002
Education	-7.1065	0.0014	-0.7242	0.2399
Equity	2.8787	0.1723	1.3534	0.0227
Righttowork	-1.0006	0.0011	-0.5560	<.0001
Oil	-2.5266	0.0687	-0.3537	0.3623
Diversity	1.5376	0.3128	0.4279	0.3166
Adjusted R^2	**0.4120**		**0.4563**	
N: 225				

*<Note>*** indicate 1% significant ** indicate 5% significant * indicate 10% significant*

The results for regression three and four are somehow similar, except for "Distance" and "Health." I get a negative sign on "Distance" in regression three, but a positive sign on "Distance" in regression four. However, "Distance" is not statistically significant in either model.

For other vulnerability variables, public land and poor environment both have the expected positive sign. The most powerful explanatory variable in the vulnerability variables is "Poor Environment." It reaches 1% significance in both models three and four. The sign of "Low Density" in both regressions are negative and against my hypothesis. However, "Low Density " is not statistically significant in either model. This suggests that "Distance" and

"Low Density" are not as important as "Poor Environment" and "Public Land." The signs of all statistically significant variables are as expected.

For resilience variables, the results for the models on three and four are somehow similar, except for "Health." I get a positive sign on "Health " in model three, but a negative sign on "Health" in model four. However, the positive sign on " Health " in model three is not statistically significant. "Health" in model four is statistically significant.

For other resilience variables, "Education," "Right-to work," and "Oil" all have the expected negative signs. The most powerful explanatory variable among the resilience variables is "Right-to work." It is significant at the 1% level in both models three and four. That shows the county in a none right-to-work state will have a relatively lower increase in the unemployment rate after a shock. The sign of "Equity" and "Diversity" in both models are positive and against my hypothesis. However, "Diversity" is not statistically significant in either model.

The results of the multivariate model shows a county with a large percentage of public land and the nature environment that is not suitable for people to live has a higher unemployment rate after being affected by an economic shock. A county with a higher percentage of people having health insurance, higher education level, more oil, and no right-to-work law has a relatively lower increase in the unemployment rate after being affected by an economic shock.

4.1.3. The Robustness Check

The last part of the multivariate model is to conduct the robust test to confirm the results from the multivariate model. I created five models to test the robustness of the multivariate model:

Model (1): With only vulnerability variables

Model (2): With only resilience variables

Model (3): Vulnerability variables (without public land) + resilience variables

Model (4): Vulnerability variables (without poor environment) + resilience variables

Full Model: Original multivariate model with all vulnerability and resilience variables

Table 4.4 contains the results when the dependent variable is changed for unemployment rate (y1) and Table 4.5 is the results when the dependent variable is percent change for unemployment rate (y2).

Table 4.4: Robustness Test for change of unemployment rate (y1)

	Model (1)	Model (2)	Model (3)	Model (4)	Full Model
Intercept	1.5726	9.3550 ***	5.2704 **	11.3977 ***	6.5330 **
Vulnerability Variables (VV)					
Distance	-1.4295*		-0.4811	-2.6315***	-0.8097
Public Land	2.1744***			3.3658***	1.57912***
Poor Environment	5.3035***		8.1140***		6.6577***
Low Density	0.1548		-0.0947	-1.8913	-0.8253
Resilience Variables (RV)					
Health		-1.0168	0.6895	0.3276	0.9164
Education		-3.6192	-6.0115***	-6.6851***	-7.1065***
Equity		0.7376	3.1310	0.2838	2.8787
Right-to-work		-1.3694***	-1.3673***	-0.7295**	-1.0006***
Oil		-4.6203***	-2.9051***	-2.3376	-2.5266*
Diversity		-0.2921	1.2042	0.9549	1.5376
Adjusted R^2	**0.3248**	**0.1003**	**0.3898**	**0.2857**	**0.4120**
N: 225					

*<Note>*** indicate 1% significant ** indicate 5% significant * indicate 10% significant*

Table 4.5: Robustness Test for percent change of unemployment rate (y2)

	Model (1)	Model (2)	Model (3)	Model (4)	Full Model
Intercept	0.8015*	0.8607	0.0624	1.0837	0.1781
Vulnerability Variables (VV)					
Distance	0.1177		0.2240	-0.1453	0.1938
Public land	0.7549***			0.4774***	0.1448
Poor Environment	0.7239***		1.3729***		1.2394***
Low density	-0.3131		-0.0387	-0.3042	-0.1057
Resilience Variables (RV)					
Health		-1.1467***	-0.8911***	-0.9799***	-0.8703***
Education		1.2560*	0.8246	0.8026	-0.7242
Equity		0.8422	1.3765**	0.8703	1.3534**
Right-to-work		-0.6143***	-0.5896***	-0.5055***	-0.5560***
Oil		-0.5391	-0.3884	-0.3185	-0.3537
Diversity		0.1096	0.3973	0.3194	0.4279
Adjusted R^2	**0.1884**	**0.3478**	**0.4310**	**0.3786**	**0.4563**
N: 225					

*<Note>*** indicate 1% significant ** indicate 5% significant * indicate 10% significant*

The results from the robustness test support the multivariate model. No matter for which of the dependent variables, the results in Table 4.4 and Table 4.5 are consistent. The full model has the highest explanatory power of any of the models. That shows the robustness of my original multivariate model.

4.2 Index Model

The main purpose of the index model is to examine the relationship between in the unemployment rate, vulnerability, and resilience across western U.S. counties. I construct indices of vulnerability and resilience. My hypothesis is simple. Vulnerability is the inherent feature that weakens a county's ability to face economic shocks. It is the simple average of all standardized indicators of vulnerability. Resilience, on the other hand, is a county's coping ability that can be induced by policies to improve the county

ability to face the negative effects of economic shocks. It is also the simple average of all standardized indicators of resilience. I expect that the increase of unemployment rate after the economic shock will be greater in a more vulnerable county than in a less vulnerable county. Conversely, the increase of the unemployment rate will be relatively lower in a more resilient county than a less resilient county. The hypotheses are as follows:

- Hypothesis 1: After an economic shock the increase in the unemployment rate will be greater in a more vulnerable county that a less vulnerable county.

- Hypothesis 2: After an economic shock the increase in the unemployment rate will be lower in a more resilient county that a less resilient county.

4.2.1. Correlation Between Indices of Vulnerability and Resilience, and Dependent Variable

I start with checking the correlations between change in unemployment and indicators of vulnerability and resilience. The reason to do this step is to have a basic idea of the relationship between the variables. Figures 4.1 and 4.2 show the scatter plots . They show a positive linear correlation between change of unemployment rate and vulnerability index, and a negative linear correlation between change in the unemployment rate and resilience index.

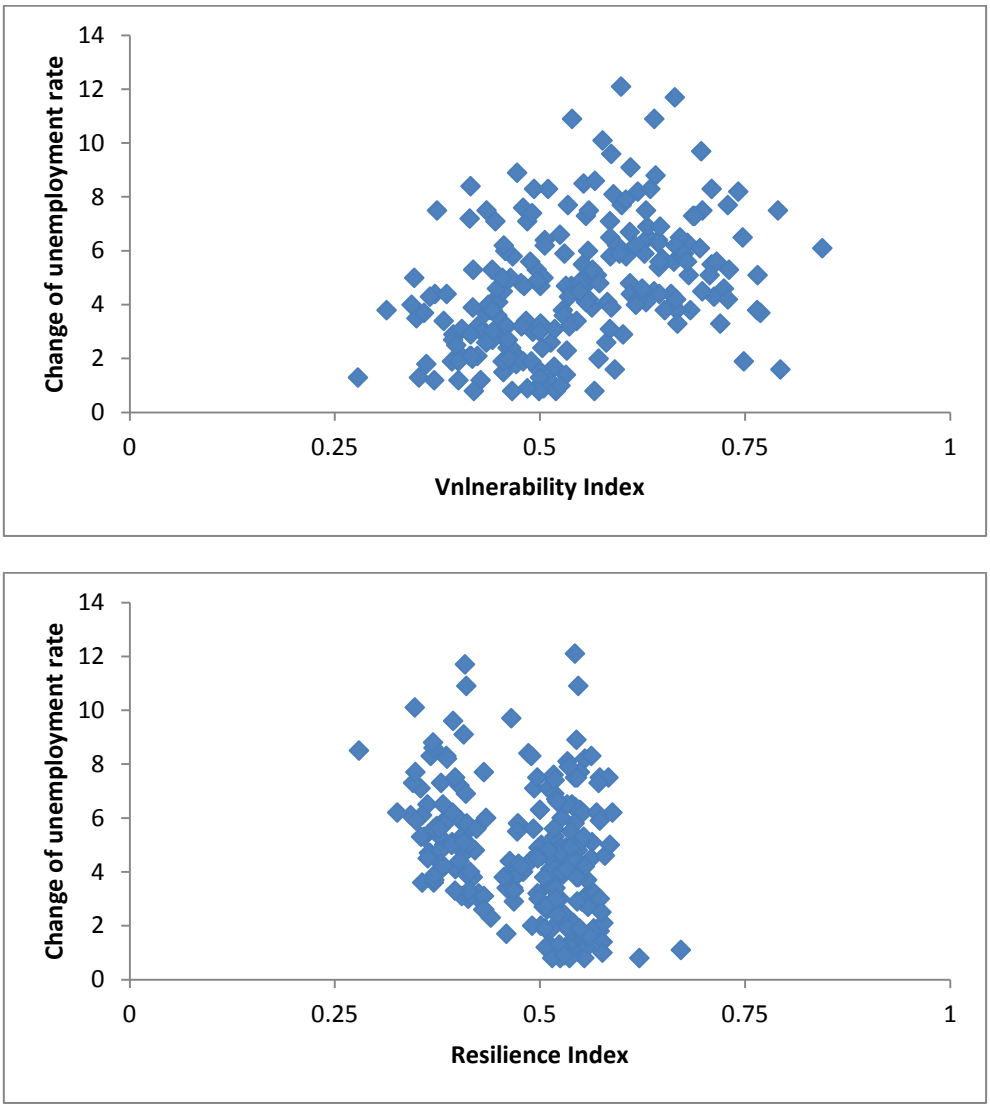

Figure 4.1: Correlation between the Vulnerability Index and Resilience Index with Change of Unemployment (2007-2010)

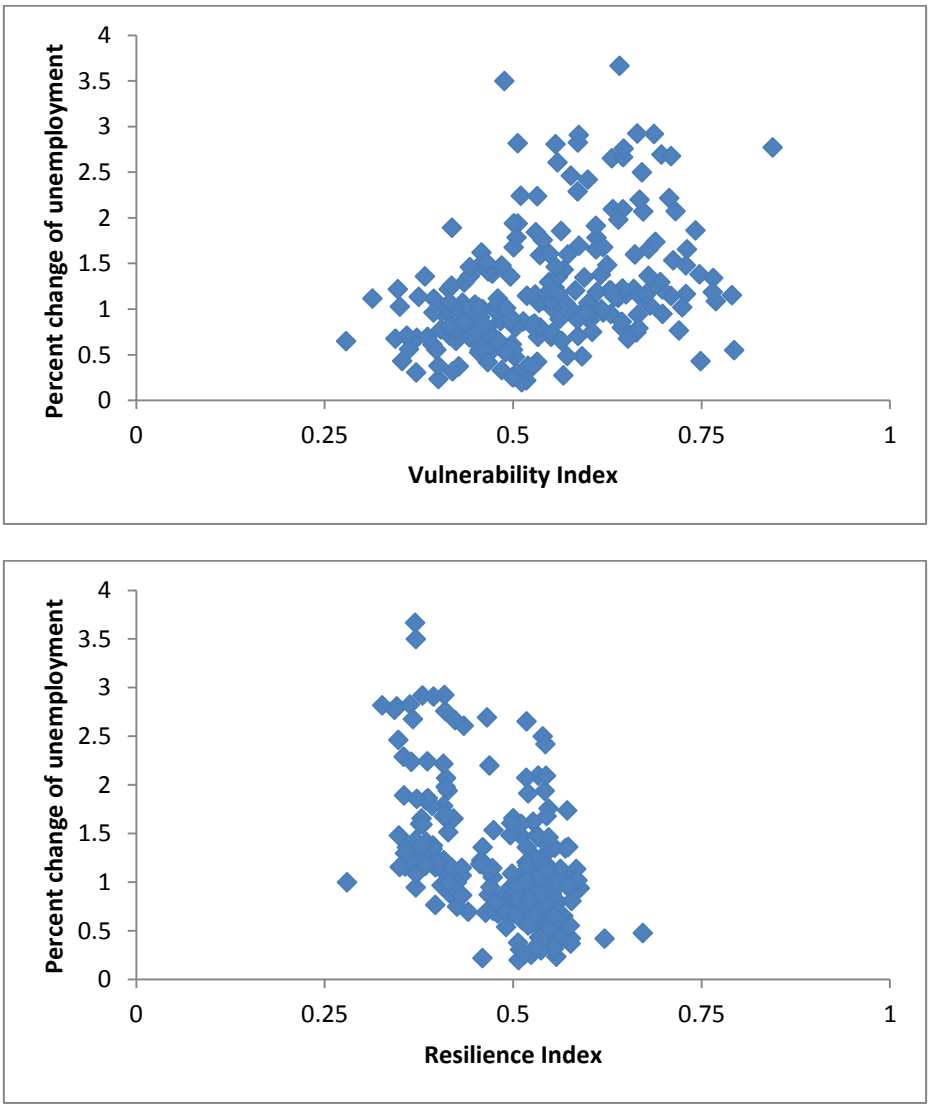

Figure 4.2: Correlation between the Vulnerability Index and Resilience Index with Percent Change of Unemployment (2007-2010)

4.2.2. Results of Index Model

From the scatter plots, we observe that that there is a positive linear correlation between change in the unemployment rate and vulnerability index, and a negative linear correlation between change in the unemployment rate and resilience index. However, the results of the scatter plots do not determine how the vulnerability index and resilience index affect the change in the unemployment rate. Therefore, I regress the change in the unemployment rate (y1) and the percent change of the unemployment rate (y2) on the

indices of vulnerability and resilience:

$$(15) \qquad y1_i = a + \beta 1 * VI_i + \beta 2 * RI_i + \varepsilon_i$$

$$(16) \qquad y2_i = a + \beta 3 * VI_i + \beta 4 * RI_i + \varepsilon_i$$

where i=1 to 225

Table 4.6 shows the estimated results. The results in both models are similar. Vulnerability index (VI) increases the change (also percent change) in the unemployment rate, and resilience index (RI) decreases the change (also percent change) in the unemployment rate. The results are all statistically significant and the signs are as expected. The different between regression one and two lies in regression two having a much higher R square value than regression one.

Table 4.6: Index Model Regression Result

Variable	Δ unemployment rate		Percent Δ unemployment rate	
	estimator	**Pr > |t|**	estimator	**Pr > |t|**
Intercept	3.7935***	0.0050	2.2613***	<.0001
VI	6.7352***	<.0001	1.3841***	<.0001
RI	-5.5246***	0.0019	-3.5953***	<.0001
Adjusted R^2		**0.1808**		**0.3344**
N: 225				

*<Note>*** indicate 1% significant ** indicate 5% significant * indicate 10% significant*

Next, in order to confirm the results of index model, I create three models to test the robustness of my index model:

Model (1): With only vulnerability index

Model (2): Original index model with vulnerability index and resilience index

Model (3): Vulnerability index and resilience index and state controls (10 state dummies)

Table 4.7 is the results for the dependent variable as change of the unemployment rate

(y1) and Table 4.8 is the results for the dependent variable as percent change of the unemployment rate (y2).

Table 4.7: Robustness Test for change of unemployment rate (y1)

	Model (1)	Model(2)	Model(3)
Intercept	0.21200	3.79354***	1.72268
VI	8.20595***	6.73517***	6.27966***
RI		-5.52463***	-3.07611*
Arizona			3.60772***
California			3.28755***
Colorado			0.96202
Idaho			2.39123***
Montana			-0.54392
Nevada			0.27726
New Mexico			0.97951
Oregon			2.26401***
Utah			1.03675*
Washington			2.19429**
Adjusted R^2	**0.1482**	**0.1808**	**0.4273**
N: 225			

*<Note>*** indicate 1% significant ** indicate 5% significant * indicate 10% significant*

Table 4.8:Robustness Test for percent change of unemployment rate (y2)

	Model (1)	Model(2)	Model(3)
Intercept	-0.06945	2.26134***	1.19904
VI	2.34124***	1.38409***	1.69625***
RI		-3.59532***	-1.81426*
Arizona			0.21321
California			-0.26134
Colorado			0.15538
Idaho			0.47739***
Montana			-0.33842*
Nevada			-0.47979*
New Mexico			0.01866
Oregon			-0.11529
Utah			0.27390
Washington			-0.05309
Adjusted R^2	**0.1485**	**0.3344**	**0.4444**
N: 225			

*<Note>*** indicate 1% significant ** indicate 5% significant * indicate 10% significant*

The results from the robustness test show interesting results. First, the robustness

test supports the index model. No matters for what dependent variable, the results in Table 4.7 and Table 4.8 are consistent. The sign of VI remains positive and the sign of RI remains negative after the adding the state dummies into the model (3). The only different is that after adding the state dummies, the significance of VI more or less remains the same (compare VI in model (2) and model (3) in both Table 4.7 and Table 4.8). However, the significance of RI goes down tremendously (from 1% significance to 10% significance in both Table 4.7 and Table 4.8). This result strongly supports my definition of resilience, the coping ability that can be induced by policy. That is why adding state dummies into the model reduces the significance of the resilience index.

4.2.3 Results of Four the Quadrants

I constructed two index values for each county (RI, VI).

To sketch the graph (Figure 4.3), I set RI to be x-axis, and VI to be y-axis.

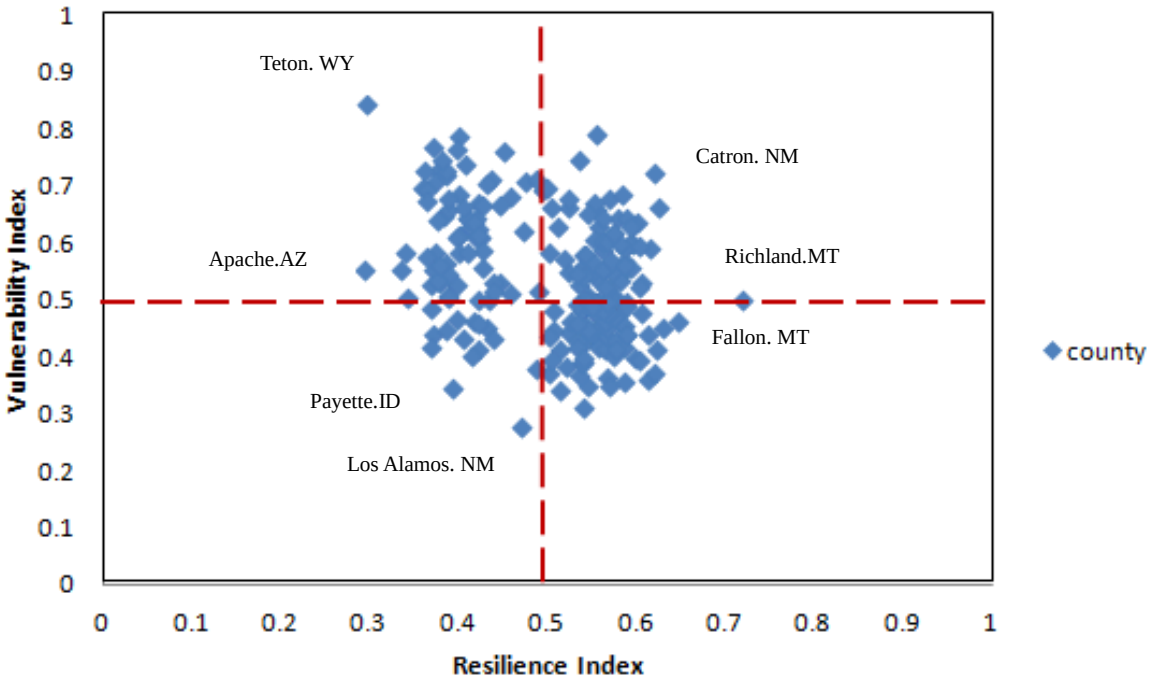

Figure 4.3: The Four Quadrant

The counties located in the first quadrant are counties with high vulnerability but have adopted appropriate policies enabling them to build strong resilience (ex. Catron County, New Mexico). The counties located in the second quadrant are counties with highly vulnerability and also with poor policies that exacerbate the negative effects of their vulnerability (ex. Apache County, Arizona). The counties located in the third quadrant indicate counties with low vulnerability but which have adopted poor policies and that waste their inherent advantage (ex. Payette County, Idaho). The counties located in the fourth quadrant indicate counties with low vulnerability and that also have adopted appropriate policies enabling them to build strong resilience (ex. Fallon County, Montana).

Figure 4.4 is the illustration diagram of the four quadrant model. The overall tendencies are that:

(a) The point "worst" indicates the county with highest vulnerability and no resilience. The point "best" indicates the county with zero vulnerability and the highest resilience. Moving from the "Worst" point to the "Best" point represents "improving action" to a county. That means the counties try their best to reduce natural vulnerability and build resilience.

(b) The point "Quiet" indicates the county with no vulnerability and no resilience. The point "Risky" indicates the county with highest vulnerability and highest resilience. Moving from the "Quiet" point to the "Risky" point represents "taking risk action" to a county. That means the counties built their resilience, and at the same time, put themselves into a vulnerable situation.

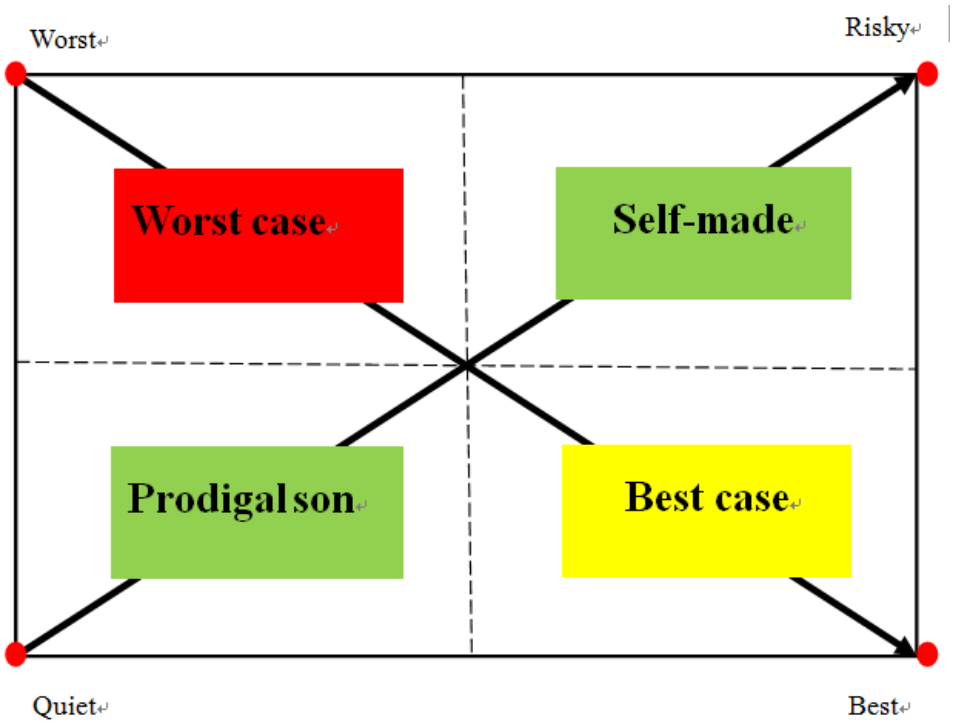

Figure 4.4: The Four Scenarios

4.2.4 Ranking Vulnerability Index and Resilience Index

It is interesting to look again at the characteristics of the best and worst performing counties. Table 4.9 presents the 5 most vulnerable counties. Table 4.10 presents the 5 least vulnerable counties. Table 4.11 presents the 5 most resilient counties and Table 4.12 presents the 5 least resilient counties. To see the characteristics of those most/ least vulnerable and most /least resilient gives a vivid insight into how economic vulnerability and resilience work.

Table 4.9: 5 Most Vulnerable Counties

Rank	VI	Distance	Public Land	Poor Environment	2007 unemployment rate	2010 unemployment rate
Teton County. WY	0.8443	278	0.9900	0.6321	2.2	8.3
Hinsdale County.CO	0.7932	174	0.9461	0.7358	2.9	4.5
Mineral County. NV	0.7902	250	0.8079	0.6541	6.5	14
Lander County. NV	0.7688	218	0.9487	0.5141	3.4	7.1
White Pine County. NV	0.7654	241	0.9149	0.4708	3.8	8.9

<Note> All of numbers in this table are rounded to the fourth decimal places

Table 4.10: 5 Least Vulnerable Counties

Rank	VI	Distance	Public Land	Poor Environment	2007 unemployment rate	2010 unemployment rate
Los Alamos County. NM	0.2783	41	0.5228	0.4708	2	3.3
San Juan County. WA	0.3132	74.6	0.0216	0.5607	3.4	7.2
Adams County. WA	0.3437	87.1	0.0170	0.1702	5.9	9.9
Payette County. ID	0.3470	35	0.2457	0.3850	4.1	9.1
Morgan County. CO	0.3497	59.4	0.0039	0.3603	3.4	6.9

<Note> All of numbers in this table are rounded to the fourth decimal places

Table 4.11: 5 Most Resilient Counties

Rank	RI	Health	Education	Right-to-work	Oil	2007 unemployment rate	2010 unemployment rate
Richland County.MT	0.7202	0.1839	0.8513	none	16474656	2.3	3.4
Fallon County. MT	0.6478	0.1998	0.8812	none	6318646	1.9	2.7
Sherman County. OR	0.6288	0.2645	0.9000	none	0	4.9	9.9
Curry County. OR	0.6238	0.3149	0.9161	none	0	6.6	12.8
Harding County. NM	0.6220	0.2845	0.8977	none	0	2.6	4.7

<Note> All of numbers in this table are rounded to the fourth decimal places

Table 4.12: 5 Least Resilient Counties

Rank	RI	Health	Education	Right-to-work	Oil	2007 unemployment rate	2010 unemployment rate
Apache County. AZ	0.2951	0.1214	0.7209	Yes	45149.25	8.5	17
Teton County. WY	0.2969	0.0895	0.9507	Yes	0	2.2	8.3
Wasatch County. UT	0.3338	0.0921	0.9097	Yes	0	2.6	9.9
Blaine County. ID	0.3393	0.1012	0.9199	Yes	0	2.3	8.8
Clark County. ID	0.3422	0.1134	0.6889	Yes	0	2.2	8.4

<Note> All of numbers in this table are rounded to the fourth decimal places

I compared the characteristics of the 5 most vulnerable and 5 least vulnerable counties (Table 4.13). The counties with the higher scores in the vulnerability index tend to have longer distances from their county seat to the nearest metropolitan area, a much bigger percentage of public land in their counties, and environments that are less suitable for people to live in. The most interesting part is the average unemployment rate in 2007, in the absence of economic shock, are the same in the 5 most vulnerable counties and 5 least vulnerable counties. However, after the great recession, the average unemployment

rate in the less vulnerable counties was 7.28 percent, but in the most vulnerable counties it reached8.56 percent.

Table 4.13: Comparison of Most to Least Vulnerable Counties

	Average of Top 5 Most Vulnerable Counties	Average of Top 5 Less Vulnerable Counties
Distance	232.2	59.42
Public Land	0.9215	0.1622
Poor Environment	0.60138	0.3894
2007 unemployment rate	3.76	3.76
2010 unemployment rate	**8.56**	**7.28**

Next I compared the characteristics of the 5 most resilient and 5 least resilient counties (Table 4.14). The counties with higher scores in the resilience index tend to have more people with health insurance and greater percentage of people who have at least a high school degree. All the top 5 counties that are highly resilient are without a right-to-work law and have average higher annual gross withdrawals of oil. The most interesting part is the average unemployment rate in 2007 are the similarities in the top 5 most resilient counties and top 5 less resilient counties. However, after the great recession, the average unemployment rate in the more resilient counties was 6.7 percent, but in the less resilience counties reached to 10.48. .

Table 4.14: Comparison of Most and Least Resilient Counties

	Average of Top 5 Most Resilience Counties	Average of Top 5 Less Resilience Counties
Health	0.2495	0.10352
Education	0.88926	0.83802
Right-to-work	None	Yes
Oil	4558660.4	9029.85
2007 unemployment rate	3.66	3.56
2010 unemployment rate	**6.7**	**10.48**

These results strongly support the results in section 4.1.2. (see Table 4.3). The counties with less vulnerability and more resilience will have a loser unemployment rate,

and vice versa.

4.3 Summary

I employed two models in my analysis, multivariate model, and an Index model. The only difference is that one uses Index as explanatory variables, and the other uses the variables separately.

The multivariate model results shows that a county with more percentage of public land and a natural environment that is not suitable for people to live in has a higher unemployment rate after being affected by economic shock. The county with a higher percentage of people have health insurance, higher education level, more oil, and has no right-to-work laws has a relatively lower increase in the unemployment rate after being affected by economic shock.

The index model results show the vulnerability index increased the county's unemployment rate after the Great Recession, and the resilience index decreased the county's unemployment rate after the Great Recession . In other words, a more vulnerable county will have a relatively high unemployment rate after an economic shock, and a more resilient county will have a relatively low unemployment rate after an economic shock, and vice versa.

CHAPTER 5

CONCLUDING REMARK

5.1 Conclusions

To best of my knowledge, this is the first economic study trying to examine the effects of economic shock on different rural counties of Western United States. The effects are different in different counties because of differences in degrees of economic vulnerability and resilience. In order to show this, I estimated the degrees of economic vulnerability and resilience of 225 rural counties in the Western United States. I use two approaches to fulfill this goal, one an OLS model, the other an Index model. The empirical model examined the relationships between economic vulnerability and resilience and both the level and change in unemployment rate during 2007-2010.

The results strongly support my hypotheses that a more vulnerable and less resilient county will have a relatively higher increase in change of the unemployment rate after an economic shock, and a less vulnerable and more resilient county will also have a relatively lower increase in change of the unemployment rate after an economic shock. The results show that the percent change of the unemployment rate during 2007 to 2010 can be highly explained by economic vulnerability and economic resilience. This is strong evidence that the economic vulnerability index and economic resilience index are useful and powerful in simplifying questions and helping researchers in the field of rural development. Also, the results exhibit that rural counties can overcome unexpected economic shocks by investing in resilience enhancing programs and policies.

5.2 Future Work

It is important to know, that the index developed by this study is still preliminary. Due to data constraints, this study do not include time series data for each county. That means that this study only examines the economy of counties as affected by a single shock. However, it is possible that these economies would be affected differently by multiple shocks over a period of time. Including time series data for each county can examine the relationship between economic vulnerability and resilience and multiple economic shocks. Furthermore, I only included 11 western states and 225 rural counties in my study. It will be interesting for future studies to include other parts of the rural United States in the analysis to find out whether the vulnerability index and resilience index can be used in other part of the United States.

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APPENDIX

(A) Summary Statistics

Table A.1: Summary Statistics

Name	N	Std Dev	Mean	Min	Max
Distance	225	0.1806180	0.3233271	0.0664804	1.0000000
Public land	225	0.3001493	0.4224255	0	1.0000000
Poor environment	225	0.1570982	0.4676092	0	1.0000000
Low density	225	0.0893230	0.9530863	2.416066E-10	0.9989444
VI	225	0.1098136	0.5416121	0.2783540	0.8443370
Health	225	0.1596475	0.5688239	0.1524541	1.0000000
Education	225	0.0588229	0.8713070	0.6802159	1.0000000
Equity	225	0.0638187	0.2942921	0	0.4765886
Right-to-work	225	0.4740069	0.6622222	0	1.0000000
Oil	225	0.0893499	0.0216274	0	1.0000000
Diversity	225	0.0945606	0.6063012	4.7277208E-8	0.8146253
RI	225	0.0846762	0.5040956	0.2951351	0.7202774
y1	225	2.3109533	4.6564444	0.8000000	12.1000000
y2	225	0.6588222	1.1985940	0.2000000	3.6666667

(B) Dependent Variable Distribution

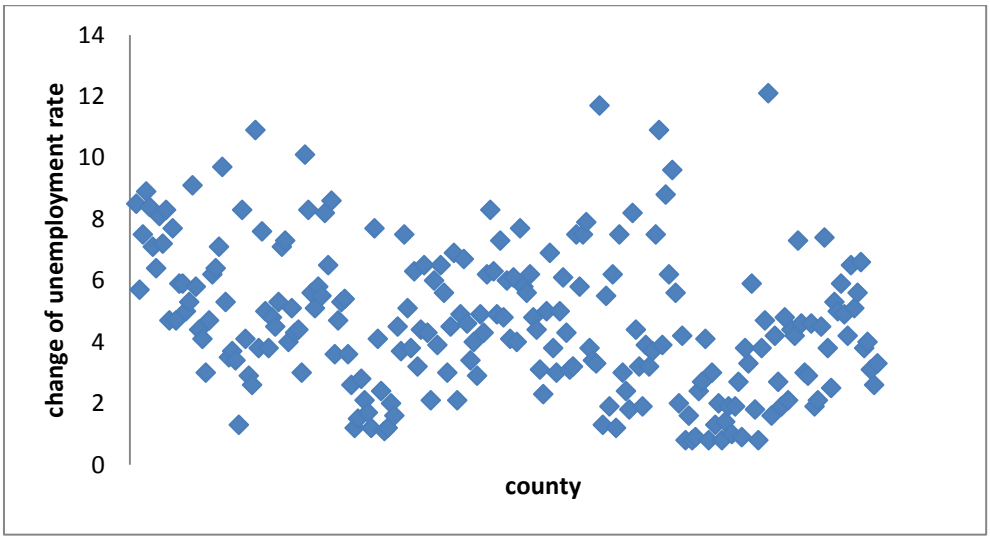


Figure A.1: Dependent Variable Distribution for Change of Unemployment Rate (2007-2010)

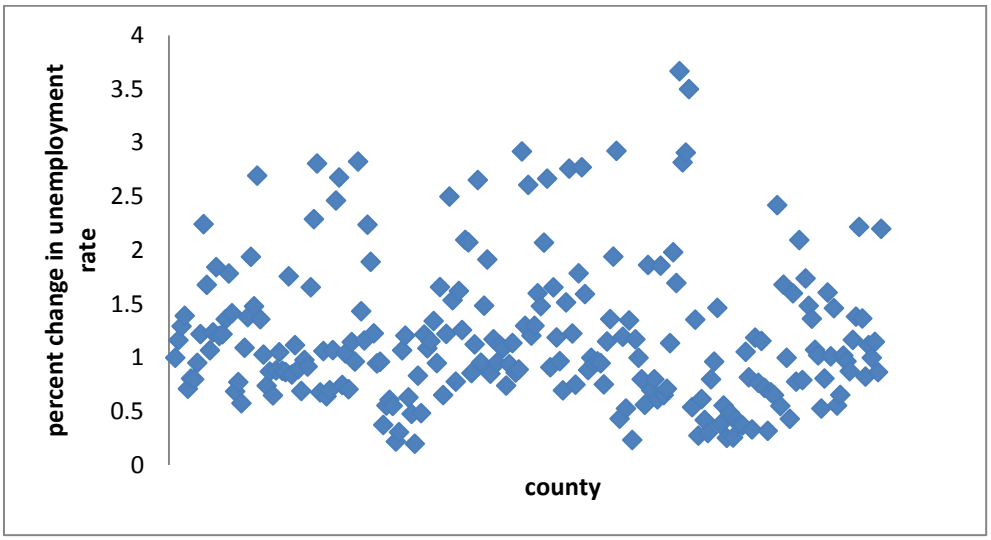


Figure A.2: Dependent Variable Distribution for Percent Change of Unemployment Rate (2007-2010)

(C) Unemployment Trend During 2004 to 2012

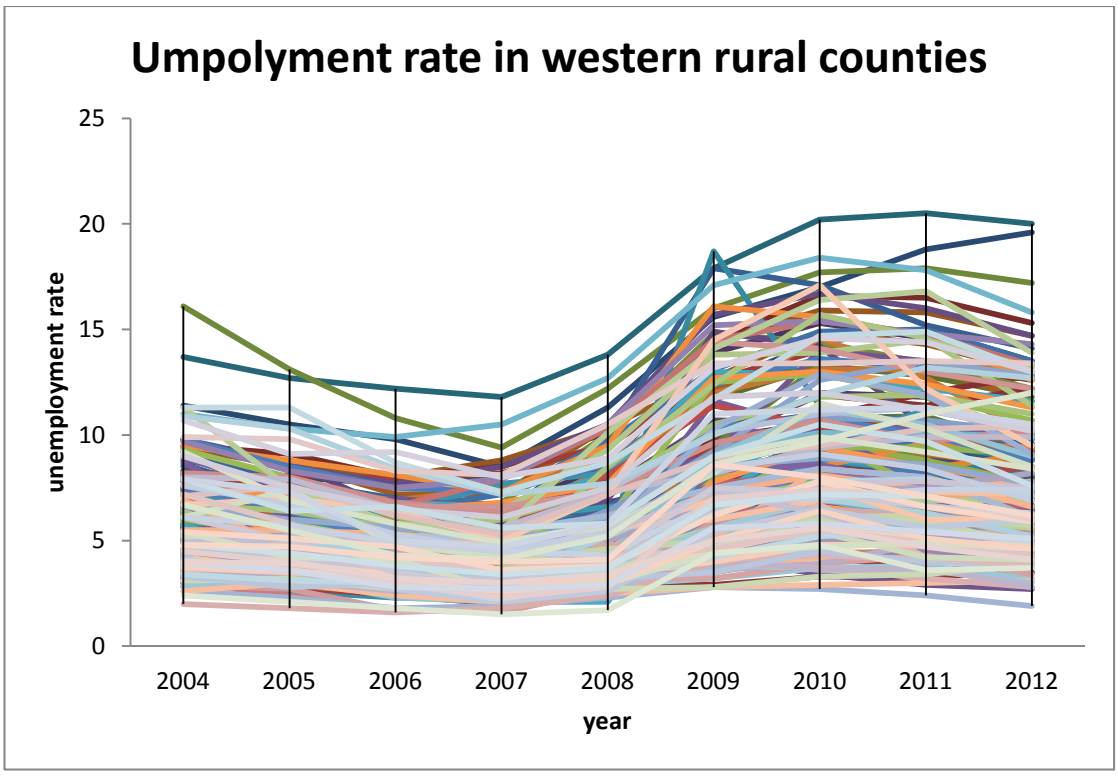
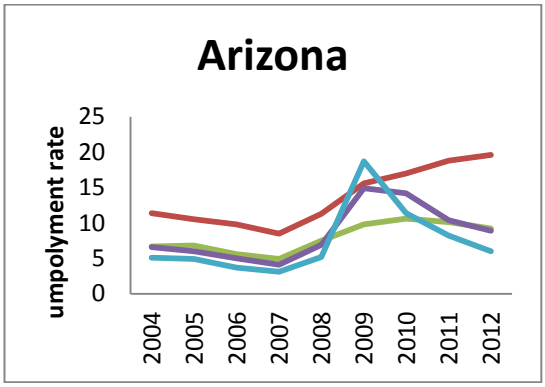


Figure A.3: Unemployment Trend in 225 Rural Counties of the Western United States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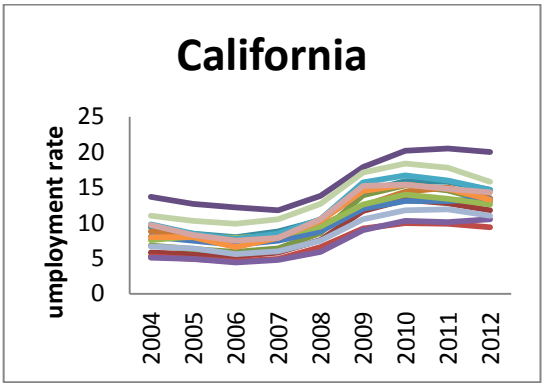
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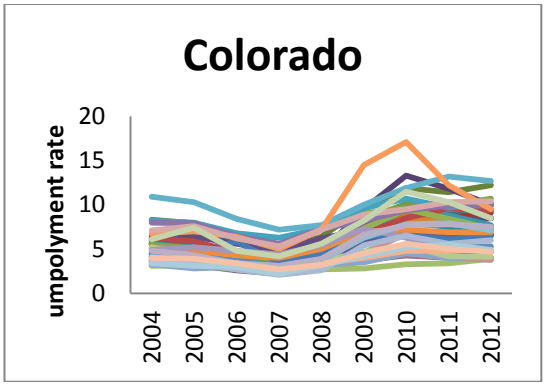
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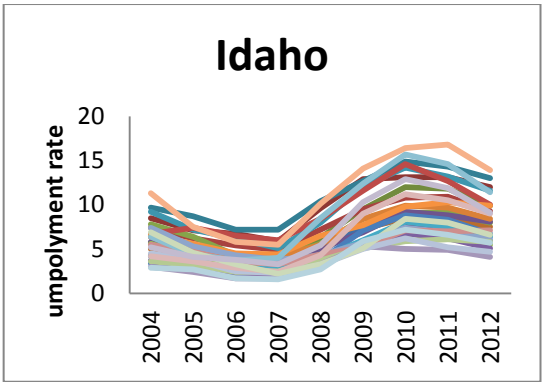
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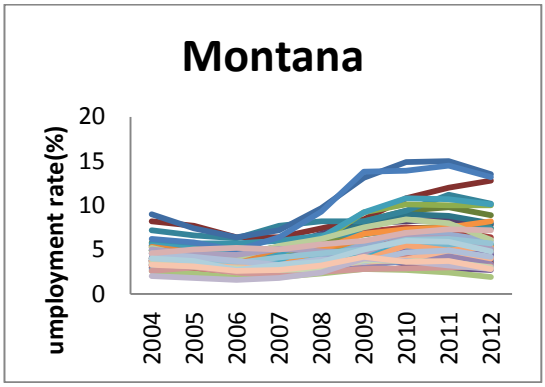
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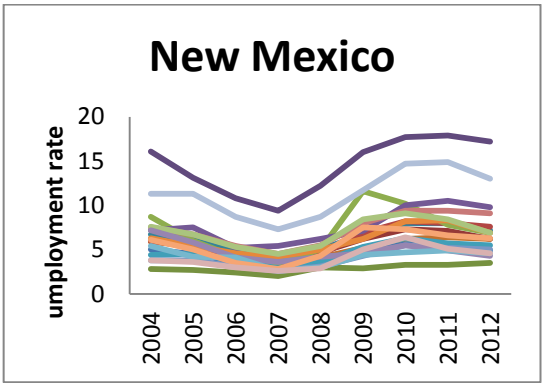
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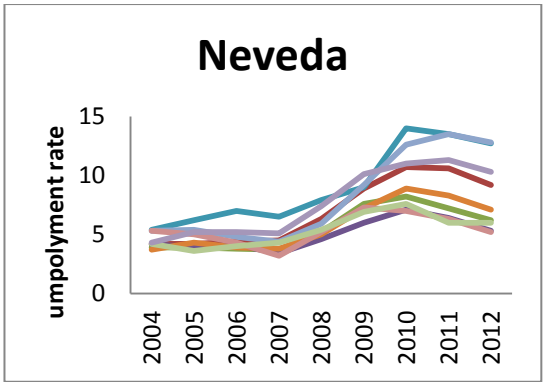
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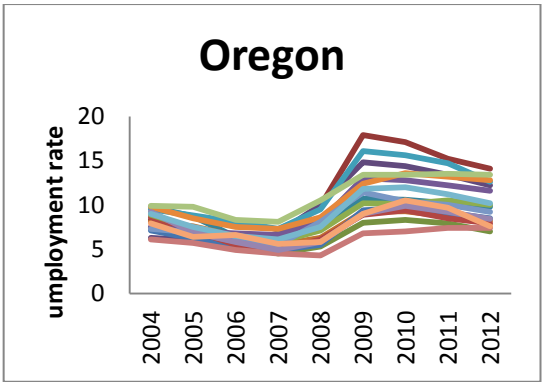
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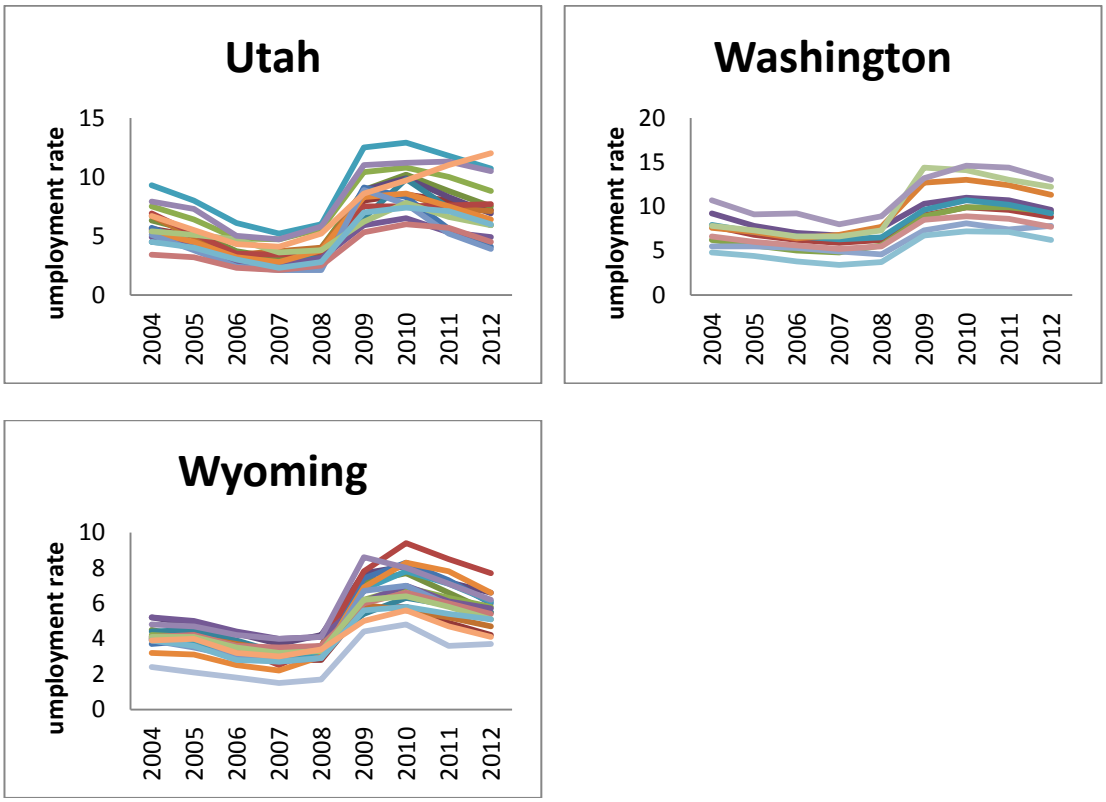

Figure A.4: Unemployment Trend in 11 states of the Western Rural United States