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# An Analysis of Environmental Quality and Entrepreneurial Activity in Illinois

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# AN ANALYSIS OF ENVIRONMENTAL QUALITY AND ENTREPRENEURIAL ACTIVITY IN ILLINOIS

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RESEARCH PAPER APPROVAL

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Entrepreneurial activity and environmental quality are two of the biggest topics today when it comes to starting a business and meetings government regulations. Environmental quality is important for entrepreneurs to consider as they look for opportunities to make a profit. Entrepreneurship can have a negative impact on environmental quality if it is not taken into consideration and properly handled. However, there has been minimal research that describes the relationship between entrepreneurial activity and environmental quality. This study explores the relationship that entrepreneurial activity has on environmental quality. Personal income, total employment, population, number of establishments, number of employees, and annual payroll are used to reflect entrepreneurial activity in this study. We use an environmental quality index created by the Environmental Protection Agency as a measure of environmental quality. With the results from this study, farmers and entrepreneurs may make better management decisions on where to locate, how to operate, and how to reduce their environment footprint. Government agencies and the general public may also have more information available for future research to be conducted.

TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

LIST OF FIGURES

FIGURE PAGE

# CHAPTER 1

## INTRODUCTION

According to Firas Kittaneh, the CEO and co-founder of One Mall Group and guest writer on *Entrepreneur.com*, "the more entrepreneurs take responsibility for protecting the environment by giving consumers better choices about what they buy, the more likely future generations will enjoy a healthier world than we live in today" (Kittaneh, 2015). Working towards a cleaner environment starts with entrepreneurship and its entrepreneurs ability to not only produce more environmentally safe products, but also to operate more cleanly and efficient as a business.

The main objective of this study is to identify and determine if there is a relationship between entrepreneurial activity and environmental issues and degradation. From this analysis, the variables that have a significant impact on the environmental quality index are determined. This study uses cross sectional data and includes an ordinary least squares (OLS) model to determine the relationship between entrepreneurial activity and the amount of environmental issues and degradation. The information this study holds has the ability to create opportunities for further research in determining additional factors that affect environmental quality and entrepreneurial activity. This study uses Illinois county level data to determine if entrepreneurial activity has an impact of the level of environmental quality. The most recently available environmental quality index data was released in 2005. Therefore, all of the data for each variable has been collected for the year 2005 to gather a more accurate estimation.

An analysis of environmental quality and entrepreneurial activity provides information that may be useful to the general public, government regulators, future research, and future entrepreneurs. The general public will have access to the results of this study that will provide

informative results that can influence business strategies, environmental protection practices, and provide overall awareness of environmental degradation. This study will also be useful for future research in this area in hopes of establishing statistical evidence to aide in regulation and policy making for governments. Finally, possibly the most significant group that can benefit from this study are future entrepreneurs. When deciding how to operate, where to locate, and what opportunities to act on, the future entrepreneurs may choose to take advantage of available research conducted on the relationship between entrepreneurial activity and environmental issues and degradation.

Entrepreneurial activity and environmental quality should be linked because everything that happens in the world, whether it is business or recreation related, has a positive or negative effect on the environment. The reason they should be related is because businesses produce goods and services, which consumes natural resources and produces pollutants that affect the quality of the environment. However, that's not to say that more entrepreneurial activity causes more environmental degradation. Through educational, innovative, and technological advances, as well as with the addition of government regulations, more entrepreneurship has the potential to cause less environmental harm while continuing to profit. This may be through the development of cleaner more efficient machines and power supplies, or through the production of environmentally friendly goods and services.

# CHAPTER 2

## LITERATURE REVIEW

With regards to environmental quality and entrepreneurial activity, little research has been done in the past. This could be due to the fact that it is difficult to accurately determine an index for environmental quality and entrepreneurial activity especially at the county level. However, there has been research done for entrepreneurship and economic growth at the county level. Mojica, Gebremedhin, and Schaeffer (2009) looked at entrepreneurial factors affecting economic development in Appalachia. The authors used simultaneous equation models to analyze the relationship between entrepreneurship and economic growth using population growth, employment growth, and per capita income growth as factors determining economic growth. Other variables such as firm births, firm deaths, and number of proprietors per county were used as factors in estimating entrepreneurial activity. The authors' results from the models generally supported their hypothesis showing evidence of positive effects of entrepreneurial activity towards economic growth. Additionally, the study concluded that increases in entrepreneurial activity; particularly increases in self-employment and firm births significantly contribute to employment growth (Mojica et al., 2009). The analysis conducted by the authors of entrepreneurial activity determining changes in economic growth at the county level should nicely fit alongside entrepreneurial activity determining changes in environmental quality at the county level. Similar to the economic growth results from entrepreneurial activity, the environmental quality is also expected to increase and improve with more entrepreneurial activity. The reason is with increased entrepreneurial activity, there will be greater amounts of wealth and consumption leading to better environmental quality. When individuals make greater

amounts of wealth, they tend to buy more environmentally friendly goods, as well as, apply added pressure on government officials for stricter and additional environmental regulations.

Cohen and Winn (2007) examined four types of market imperfections including inefficient firms, externalities, flawed pricing mechanisms, and information asymmetries in their contribution to environmental degradation and creation of technology and business opportunities. The authors' literature-based research explores and defines several market imperfections, types of entrepreneurship, environmental degradation, and related variables. The study suggests that industries have the capability to reduce their negative impacts on environmental degradation as well as the ability to potentially reverse the negative trends by leading the world into the next industrial revolution. They say that public pressure is forcing industries and firms to improve their environmental performance through policy mandates. The four market imperfections listed earlier each are explained with their involvement to environmental degradation. Through this involvement, sustainable entrepreneurship opportunities arise, calling for innovative and technological advances to improve environmental quality by accessing new markets. The authors' intend to conduct future research that will explore deeper into market imperfections and sustainable entrepreneurship (Cohen and Winn, 2007). The evaluation of sustainable entrepreneurship opportunities derived from market imperfections that are causing environmental degradation to occur corresponds well with entrepreneurial activity impacting overall environmental quality. The research collected on entrepreneurial opportunities coming from poor environmental performance suggests a relationship at the county level.

Tyagi, Grag, and Paudel (2014) looked at the national and global causes and consequences of environmental degradation and social injustice in hope of providing literature to begin improving environmental quality and human health benefits. The authors focused on

available literature to determine what can be established as the factor most detrimental to environmental quality. The main factors examined were air pollution, water pollution, toxic pollutants, deforestation, solid waste pollution, global warming, and drought. They determined that activities conducted by the rich and powerful, and uneven distribution of wealth, were the main contributing factor to environmental degradation. The author's concluded that there is a need for better implementation of policy and regulations to begin reducing the amount of pollution and minimizing environmental damage caused by humans (Tyagi, Grag, and Paudel, 2014). The research conducted on identifying major causes of environmental degradation and how humans have contributed will be relatable in this study when considering the economic and entrepreneurial activity impact on environmental quality.

Lobdell et al. (2014) studied factors causing environmental degradation and developed the Environmental Quality Index (EQI) through years of research and work with the Environmental Protection Agency. The authors collected data at the county level for all of the United States in order to perform their analysis, which resulted in an index that can be used to estimate whether a regions environmental quality is in a healthy or poor condition. The study explains in detail how every aspect of the EQI was created. Although the EQI is not intended to be a policy-making determinant, the authors realized that the results of creating an EQI could have a wide variety of uses. This includes the results being utilized in public health research and providing information on environmental exposures faced in different counties and communities across the United States. Their study found that in the time frame from 2000-2005, "the bulk of the EQI scores across all RUCC strata were at the negative end of the distribution, indicating more counties could be characterized by healthier environments, compared with unhealthy (positive) environments" (Lobdell et al., 2014). The county level assessment of environmental

quality will be utilized in this study to see if entrepreneurial activity factors have a relationship with the EQI scores.

# CHAPTER 3

## ENVIRONMENTAL ISSUES AND CONCERNS

The environment is made up of living and non-living elements that are continuously influencing one another. While one entity in the environment may have a positive influence on another, it may unintentionally have a negative impact on a third party. For example, row crops such as corn, soybeans, and wheat benefit from the additional application of fertilizers. However, there are unintentional effects to the water supply. The excessive fertilizer that is not absorbed by the crops is leeched out of the soil into water sources like rivers and streams. This pollutes the water with an increased amount of nutrients that can be harmful to other components in the environment such as human health. This process is a continuous system where one component in the environment impacts another.

According to Swati Tyagi, a molecular biology, microbiology, biotechnology researcher pursuing a Ph. D at Chonbuk National University in Jeonju South Korea, "environmental degradation is the deterioration of the environment through depletion of natural resources such as air, water and soil; the destruction of ecosystems and the extinction of wildlife. Environmental degradation may be defined as any change or disturbance to the environment perceived to be deleterious or undesirable." Environmental degradation is caused by an enormous number of variables that can be broken down into two groups: natural occurrence and unnatural occurrence. Both of these groups are made up of everything on earth that affects one another and ultimately the environment.

Natural occurring degradation can come from a number of causes that are uncontrollable. Natural disasters affect everyone and everything on the globe by causing environmental disruptions. Several examples of natural disasters include hurricanes, wildfires, avalanches,

tornadoes, floods, and droughts. While this type of environmental degradation cannot be controlled, there are ways that humans can help to better prepare and manage it. Volunteerism and educational awareness of environmental degradation can help prepare and manage the aftermath from a natural disaster. Additionally, government and state funding is helpful in hiring cleanup crews and supporting interest groups that set out to help resolve the damages caused by these disasters.

Unnatural occurring degradation can come from a number of causes that are controllable. Through urbanization, poor waste management, deforestation, natural resource depletion, and ultimately pollution to water, air, and soil, humans are the primary cause of this type of degradation. Algae blooms have occurred naturally since the beginning of time and will continue to exist regardless of the actions of mankind. However, this has become a bigger issue as more fertilizers and chemicals are being applied to not only farmland, but also to urbanized areas such as household lawns, golf courses, and sports arenas. The nutrients are leeched out of the soil into the water supply, which can find its way to the Mississippi River, and dumps into the Gulf of Mexico. Once there, the algae blooms consume the excess nutrients causing an oxygen deficiency in the water, not allowing aquatic life to survive. These unnatural occurring environmental issues are linked to a wide variety of causes from mankind. However, beginning to reestablish a healthier more thriving environment starts at its source, that is the decisions made by mankind. In order to start fixing and cleaning up the damage there has to be entrepreneurial activity. Entrepreneurs are the leaders in the action plan to reduce environmental degradation whether it is through producing environmentally friendly products or by simply changing bad habits to good ones. Entrepreneurs want to address environmental issues because of the profit making opportunities. These opportunities arise by producing more environmentally friendly

products, thus allowing the entrepreneurs to grow their customer base by pulling in a new group of consumers concerned with environmental quality.

# CHAPTER 4

# ENVIRONMENTAL QUALITY INDEX

The environmental quality index (EQI) is an index created by the Environmental Protection Agency (EPA) to examine the relationship between environmental conditions and human health in the United States. According to Danelle T. Lobdell and other contributing authors of *Creating an Overall Environmental Quality Index* Technical Report, "the index was developed for all counties in the United States using indicators from the chemical, natural, built, and social environments. Included were five environmental domains: air, water, land, built and sociodemographic. The EQI was expected to be used in two primary ways: (1) as an indicator of ambient conditions/exposure in environmental health modeling and (2) as a covariate to adjust for ambient conditions in environmental models. However, it is expected that different end users as well as local, county, State, and Federal governments, nongovernmental organizations, and academic institutions will use the data. The underlying purpose of the EQI is to quantify overall environmental quality that encompasses where humans interact and may impact human health" (Lobdell 2014). The index was created by collecting a large amount of data from various sources under each of the five main domains. Once the data for all of the sub variables under each domain had been collected, it was compiled together and used in a PCA analysis. PCA stands for Principal Component Analysis, and was used in creating the EQI. PCA is used as a way of reducing the amount of data in order to create an index. "There are three main goals that PCA is trying to achieve: first it summarizes the patterns of correlations among observed or measured variables, second it provides an operational definition for underlying processes by using observed or measured variables, and third it reduces a large number of observed variables into a smaller number of factors or single component" (Lobdell et al., 2014). PCA was selected to

reduce the data because it puts all of the variables on the same scale after it standardizes the data. It first reduced the collected data and variables down into the five main domains and established an index for each domain. The PCA was then used again to reduce the data and variables down even further so that an overall EQI could be established encompassing all five domains.

According to Lobdell, and other contributing authors of *Data Sources for an Environmental Quality Index: Availability, Quality, and Utility, "*Data sources were found to represent each of the 5 a priori identified domains: air (12 data sources identified and 2 retained), water (80 sources identified and 9 retained), land (80 sources identified and 6 retained), built environment (12 sources identified and 4 retained), and sociodemographic (3 sources identified and retained)" (Lobdell et al., 2011). The two data sources that were selected to represent the air domain were The Air Quality System (AQS) and The National-Scale Air Toxics Assessment (NATA) databases. The nine data sources that were selected to represent the water domain were the National Water Information System, STORET, WATERS Program database, National Contaminant Occurrence Database, Safe Drinking Water Information System, Estimates of Water Use in US, Drought Monitor Data, National Atmospheric Deposition Program, and Nutrient Loss Database for Agricultural Fields in US databases. The main data sources that were considered to represent the land domain were County Pesticide Use Estimates, 2002 Census of Agriculture Full Report, Dun and Bradstreet Agriculture Data, Web Feature Service for National Priority List (NPL) Sites, Superfund NPL sites data, RCRA TSD and Corrective Action Facility data, RCRA LQG data, TRI sites data, ACRES Brownfields data, SSTS data, National Geochemical Survey data, and Map of Radon Zones databases. The four data sources that were selected for the built domain were Dun and Bradstreet North American Industry Classification System codes, Topologically Integrated Geographic Encoding and Referencing, Fatality Annual

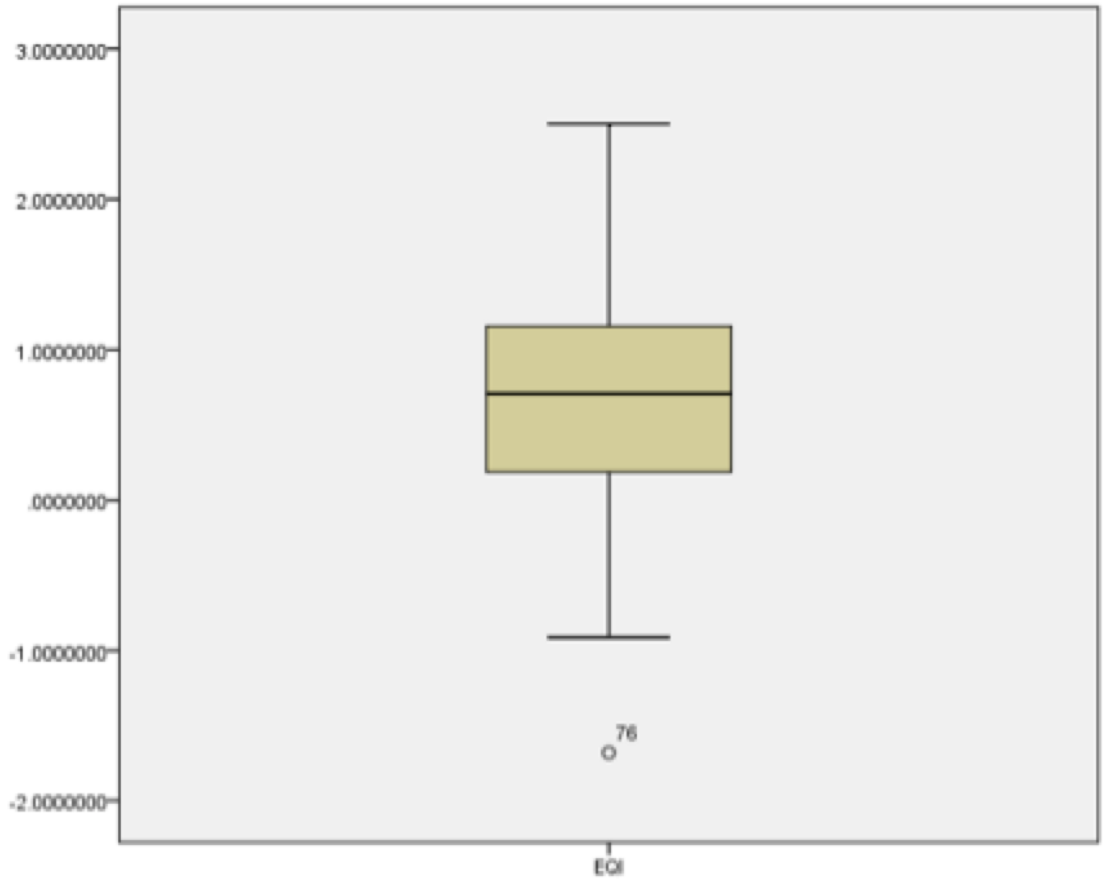
Reporting System, and Rural-Urban Continuum Codes. Lastly the three data sources that were selected to represent the sociodemographic domain were US Census data, Uniform Crime Report data, and Home Mortgage Disclosure Act Data.

The EQI also used a rural-urban continuum, which allowed for the creation of four main categories, which represents the differences in rural and urban environments. These categories are RUCC1 representing metropolitan-urbanized, RUCC2 nonmetropolitan-urbanized, RUCC3 less urbanized, and RUCC4 thinly populated (rural). To get more detailed regional numbers in the United States, these categories were used to weight the estimates by county. However for this study, only the data for overall EQI is used.

The index for the EQI does not have a set scale that it corresponds to because the PCA system was used. Instead, a county EQI of zero can be assumed to be neutral, in that the environmental quality is neither in a positive state nor negative state in regards to the other counties being observed. There will be no counties with an EQI of zero or neutral because environmental quality cannot be in a state of no condition, that is the environment is either in a good or bad standing. However, if a county has a negative EQI, then the environmental quality for that county is assumed to be in a healthier condition. The lower, or more negative, the EQI gets the environmental quality becomes better. In contrast, if a county has a positive EQI, the environmental quality for that county can be assumed to be in a worse condition. The higher, or more positive, the EQI gets the environmental quality becomes poorer.

The EQI was originally created to get an understanding of what the overall environmental quality was in the United States. In order to illustrate this, the scores were gathered for all counties and put into a boxplot type graph with a minimum and maximum value. The mean EQI scores were then put on the graph to get an understanding of where the United States as a whole

is trending. Figure 1 (located below) shows the distribution of overall EQI scores for Illinois in 2005, established by all 102 counties. Also included is the distribution of overall EQI scores for the United States in 2005, established by all 3,141 counties.




| Percentiles | 0% (Outlier) Minimum | 5% (Q1) | 25% (Q2) | 50% (MEAN) | 75% (Q3) | 100% (Q4) Maximum |
|---|---|---|---|---|---|---|
| EQI | -1.68264 | -.438550650 | .181163775 | 0.65694 | 1.158768000 | 2.50156 |

Figure 1: Environmental Quality Index (EQI) Data Box Plot

* 2005, Statistics from all 102 Illinois County EQI Scores and displayed in boxplot

# CHAPTER 5

## ENTREPRENURIAL ACITIVTY

Based on Israel Kirzner's theory of entrepreneurship, Gennady Stolyarov II, a philosophical essayist and chief editor of *The Rational Argumentator* (2015) said, "Entrepreneurship is the alertness to and foresight of market conditions; it must necessarily precede actions taken in accordance with that alertness" (Stolyarov, 2015). The term *entrepreneur* according to the Merriam-Webster online dictionary is defined as "one who organizes, manages, and assumes the risks of a business or enterprise" as well as "a person who starts a business and is willing to risk loss in order to make money" ("Entrepreneur"). While these definitions are true, they can be expanded so that one may better understand how one becomes an entrepreneur and what an entrepreneur does. The main condition that leads to entrepreneurship is whether or not there is an opportunity to make a profit, which is most commonly presented by taking advantage of new technology, goods, services, as well as, seeing where they're needed. Entrepreneurs use resources such as land, labor, and capital in order to carry out their plan to take advantage of changing market conditions, the lack of knowledge of others, and innovation/technological advances. Although these advantages are the objective for entrepreneurs, the ability to discover economic opportunities cannot simply be taught in a classroom. In order to skillfully act on these leads, the entrepreneur must learn by doing and from their setbacks.

According to Randall G. Holcombe, a research fellow and professor at *The Independent Institute*, "entrepreneurship creates an environment that makes more entrepreneurship possible", while also stating that most of the successful entrepreneurs did not invent "…the technology that made them wealthy, but they had the insight to take advantage of an entrepreneurial opportunity"

(Holcombe, 2014). In other words, entrepreneurship is not the random act of becoming an entrepreneur by waiting for that chance to happen or fall in one's lap, but rather taking advantage of one's personal experiences, skills, and knowledge. They can visualize an opportunity to take advantage of something new and making a profit. These opportunities that arise can come from other entrepreneurs' mistakes, misinformation, or innovation.

Israel Kirzner was an economist born in London who determined that the key distinctions of entrepreneurship are alertness and complete ignorance. According to Kirzner, "alertness is the entrepreneur's ability to perceive new economic opportunities that no prior economic actor has yet recognized" (Stolyarov, 2005). In other words, alertness is the entrepreneur's capability to find and take quick notice of an uncommon and potentially profitable opening before another entrepreneur takes advantage of it. This could be someone who sees an opportunity in making a profit by utilizing a different source of fuel for transportation. As natural resources are in a limited supply, not to mention the adverse effects from emissions on the environment, one entrepreneur may take advantage of the opportunity by starting a company that makes electric cars. The cars not only benefit the environment by eliminating emissions, but also make the entrepreneur a great deal of money. In other words, environmental entrepreneurship can be both helpful to the environment and profitable for the entrepreneur. Kirzner's core for uncertainty and complete ignorance is define as "not only not knowing a given piece of information but also of not knowing that one does not know it: no consideration of the information- positive or negative- even enters the economic actor's mind" (Stolyarov, 2005). This is stating that an entrepreneur, who is alert, acts on the missed opportunity or unawareness of another's abilities, knowledge, or mistakes by recognizing their failure to foresee future and changing events. While one entrepreneur's misfortune or mistakes lead to failure and disappointment, another entrepreneur's

success leads to reward and accomplishment. However, almost every successful entrepreneur has had his or her failures in the past. These failures allow the entrepreneur to learn and reestablish their goals by learning from their mistakes and continuing to move forward. An example of this would be a large electric power plant that is generated by coal, which pollutes the atmosphere by emitting large quantities of carbon dioxide into the atmosphere. While the company may not be suffering from low profitability, they are creating an opportunity for another entrepreneur to take advantage of through their ignorance of not taking the environmental effects into consideration. The innovative entrepreneur takes advantage and starts a business that creates carbon dioxide filters to reduce the large amounts of carbon dioxide emitted. This allows the filters to collect the pollution and for a much easier way to properly incinerate or dispose of it.

According to Nellie Akalp, a serial entrepreneur and CEO of CorpNet.com, "flip your mistakes around and turn them into a positive growth experience. The ability to do this will strengthen you as an entrepreneur and as a person" (Akalp, 2015). She wrote an article in the Huffington Post titled "Mistakes Can Be an Entrepreneur's Best Teacher (If You're Ready to Learn)", which is about her experience as an entrepreneur and on what makes a successful and strong entrepreneur. She explains that making mistakes will happen and what sets a person apart is how they react and recover from the their setbacks. She went on to explain that as a culture we are quick to blame others when it comes to failures, but by taking responsibility, one will be able to assess their mistakes, learn from them, and move forward. She states, "most importantly, when you share pitfalls, it helps everyone avoid making a similar mistake in the future" (Akalp, 2015). This article discusses the relationship of the sheer ignorance and mistakes made by entrepreneurs and how others capitalize to make a profit on errors. The article stresses the fact that entrepreneurs do not simply wake up one day, know exactly what is going to happen, and

become a successful entrepreneur. It points out that entrepreneurs become wiser when they do have failures. When they own up to their failures, it will result in them becoming a more effectively experienced businessperson and will reduce their chances of making a similar error in the future.

# CHAPTER 6

## METHODS AND DATA

The data that was selected for the analysis was taken from several sources, which include the Bureau of Economic Analysis, the Environmental Protection Agency (EPA), and the United States Census Bureau. The data collected was for all 102 Counties in State of Illinois for the year 2005. The reasoning for using data from 2005 is because it was the most current data for the Environmental Quality Index (EQI) that the EPA had available. The data being used is cross sectional, which is a type of data collected from a representative subset of the population at a specific point in time. In this study, the representative subsets of the population are the counties in Illinois for 2005. This study is focusing on Illinois' environmental quality and entrepreneurial activity.

The Environmental Quality Index (EQI) is the dependent variable, represented by Y. The data for the EQI has been found on the Environmental Protection Agency website. The data was downloaded into excel format, and Illinois data was selected. The data for the EQI was originally an index created by the EPA in an attempt to get an overall estimation of the level of environmental quality in all counties in the United States. The data was collected over a five-year period 2000-2005 and was only made available after 2005. This study was conducted based on the year 2005 when the EQI was first released. The index is specified so that the lower the index for a county indicates there is better overall environmental quality, where as higher index levels represent counties with worse environmental quality.

In order to improve environmental quality, there are several actions that can be taken. One action includes the development of laws and regulations. This can either be through the development of new regulations or by the tightening of existing ones. Another action that can be

taken to improve environmental quality is through the voluntary behavior of consumers and businesses. This can be influenced by the incentives to be gained through improved environmental quality such as gaining a more positive perception in the public eye.

The first independent variable in the study is Personal Income (P_INC), which is represented by $X_1$. The data for personal income was found on the Bureau of Economic Analysis website (https://www.bea.gov). The data was selected by completing a number of steps so that only the data was pulled for Illinois counties in the year 2005. It was downloaded into excel format where personal income was selected, which is measured in *thousands of dollars*. Personal income was defined according to (https://www.bea.gov), "as income received by persons from all sources." Personal Income for this study is expected to have a relationship with the amount of environmental issues and degradation. It is expected that in counties where personal income levels are higher, the environmental quality index (EQI) is lower indicating better environmental quality. The reason for using personal income as an independent variable is with the expectation that when citizens have a greater amount of income, they tend to give more back to their communities through monetary donations, volunteerism, and interest in living in a cleaner more environmentally friendly society. It is expected that in areas with increased wealth, the environmental quality is better. This is because families with high incomes tend to drive more environmentally friendly vehicles and buy healthier more expensive goods, as well as providing pressure on government officials for more environmental regulation. Families with higher income levels interest in living in a cleaner more environmentally friendly community will lead them to demand stricter regulations from the government.

The second independent variable in the study is Total Employment (T_EMPL), which is represented by $X_2$. The data for total employment was found on the Bureau of Economic

Analysis (https://www.bea.gov). The data was selected by completing a number of steps so that only the data was pulled for Illinois counties in the year 2005. It was downloaded into excel format where total employment was selected, which is measured in *number of jobs*. This measurement, according to (https://www.bea.gov), accounts for total employment, which includes both full and part time employment that receive pay. Unpaid and volunteerism numbers are not accounted for in these figures. Total employment for this study is expected to have an influence on the level of environmental quality. It is expected that in counties where total employment levels are higher, the environmental quality index is lower indicating better environmental quality. The reasoning for using total employment as an independent variable is with the expectation that in counties that there are more people employed, there is more entrepreneurship being conducted through business start-ups, which creates more employment. Also, the total number of jobs in a county is being used, as an independent variable because in areas where there are more jobs there is the expectation that those individuals who are making incomes and benefiting society are taking an interest in the quality of their local environment by demanding more regulation. This could be as simple as establishing a recycling program for the community, or as involved as pushing for increases in taxes on fertilizers and chemicals used in production to cover the cost of correcting the adverse environmental degradation they caused. Also, more jobs is an indicator of a growing business or industry which will be more carefully watched by lawmakers and environmentalist to insure it does not begin to pollute or pollute more as the firms continue to grow.

The third independent variable in the study is Population (POP), which is represented by $X_3$. The POP is an independent variable in the study, which is expected to be an influencing factor on the dependent variable EQI. The data for population was found on the Bureau of

Economic Analysis (https://www.bea.gov). The data was selected by completing a number of steps so that only the data was pulled for Illinois counties in the year 2005. It was downloaded into excel format where population was selected, which is measured in *number of persons*. Population was defined according to (https://www.bea.gov), as the number of individuals (both military and civilian) who reside in a given area. Population for this study is expected to have an influence on the level of environmental quality. It is expected that in counties in which the population is higher the environmental quality index is lower indicating better environmental quality. The reason for using population as an independent variable is with the expectation that in counties with high populations there is also improved technologies and energy efficiency that help to reduce environmental issues. Another expectation is that counties with higher populations are expected to be more urbanized which have stricter environmental regulations and standards than less populated rural regions due to the migration of people, particularly younger people, in search of education and jobs. According to Lori M Hunter, an associate professor of sociology and environmental research, "composition can also have an effect on the environment because different population subgroups behave differently. For example, the global population has both the largest cohort of young people (age 24 and under) and the largest proportion of elderly in history. Migration propensities vary by age. Young people are more likely than their older counterparts to migrate, primarily as they leave the parental home in search of new opportunities" (Hunter, 2000). These opportunities increase the population as people migrate to work, which leads to better environmental quality through more efficient uses of energy and technology while not overly using natural resources.

The fourth independent variable in the study is Number of Establishments (N_ESTAB), which is represented by $X_4$. The data for number of establishments was found using American

Fact Finder on the United States Census Bureau under 2014 County Business Patterns (https://factfinder.census.gov). Illinois counties were selected from 2005. It was downloaded into excel format where number of establishments was selected, which are measured in *number of establishments*. According to (https://factfinder.census.gov), an establishment is a single physical location at which business is conducted or services or industrial operations are performed. Number of establishments for this study is expected to have an influence on the level of environmental quality. It is expected that in counties that the number of establishment's levels are higher, the environmental quality index is lower indicating better environmental quality. The reason for using number of establishments as an independent variable is because of the expectation that counties with more businesses create more jobs. These jobs turn into an increase in the number of people in an area, which work to innovate and contribute to entrepreneurial activity. Also, it is expected that more establishments in an area work to be more competitive which in today's society, energy efficiency and environmental friendly entrepreneurism is highly sought after. Additionally, with the increase in the number of establishments, there will be more government regulations and rules in place to preserve the environment from pollution and excessive resource consumption.

The fifth independent variable in the study is Number of Employees (N_EMPL), which is represented by $X_5$. The data for number of employees was found using American Fact Finder on the United States Census Bureau under the 2014 County Business Patterns (https://factfinder.census.gov). Illinois counties were selected from 2005. It was downloaded into excel format and is measured in *number of employees*. According to (https://factfinder.census.gov), an employee includes all persons paid for personal services performed in the indicated pay period, including any persons in a paid leave status. It is expected

that in counties that the number of employees are higher, the environmental quality index is lower indicating better environmental quality. The reason for using number of employees as an independent variable is because of the expectation that counties with more employees indicate more contribution to entrepreneurial activity. It is expected that more employees in an area provide more input and involvement in contributing to planning and environmental friendly changes in business operations.

The sixth independent variable in the study is Annual Payroll (A_PROL), which is represented by $X_6$. The data for number of employees was found using American Fact Finder on the United States Census Bureau under the 2014 County Business Patterns (https://factfinder.census.gov). Illinois counties were selected from 2005. It was downloaded into excel format where the data was modified to include annual payroll, measured in *thousands of dollars*. According to (https://factfinder.census.gov), annual payroll includes all forms of compensation, such as salaries, wages, commissions, dismissal pay, bonuses, vacation allowances, sick-leave pay, and employee contributions, to qualified pension plans paid during the year to all employees. It is expected that in counties that annual payroll is higher, the environmental quality index is lower indicating better environmental quality. The reason for using annual payroll as an independent variable is because of the expectation that counties with higher annual payrolls indicate more environmentally conscious employees. This is due to the fact that with the higher pay, employees are more critically trained on health and environmental risks. This also helps when looking to employees for input on ways to help make the business run greener, or more environmentally friendly.

The model used to express the relationship between the one dependent and six independent variables is a multiple regression model. The Ordinary Least Squares (OLS)

estimator is used to establish coefficients for the explanatory variables. The OLS method is a way of estimating the unknown parameters in a linear regression model, while ultimately attempting to minimize the error sums of square. Additionally, elasticity will be calculated to determine which explanatory variable had the strongest impact on dependent variable (EQI). There are a number of assumptions that are required when determining OLS estimators. The first assumption is that the independent variables should be fixed or non-random. This means that only variation in the independent variables should impact the dependent variable, and variation in the dependent variable will have no effect on the independent variables. The second assumption is that the there is a linear relationship, which means the dependent variable is the function of the independent variables and the error term. The third assumption is that there is homoscedasticity, which means all random variables will have an equal error term variance. The forth assumption is that there is no autocorrelation between error terms, which means that error terms should be independent and identically distributed. The fifth assumption is that there is no multicollinearity and should have variability in the independent variables. The sixth assumption is there should be random sampling of observations. The seventh and final assumption is the conditional mean should be zero, which is saying that on average the expected value of error terms should be zero.

The hypothesis for this study is that there is a relationship between the amount of entrepreneurial activity and the level of environmental quality. That is, the environmental quality index is being used as the function of the six independent variables: personal income, total employment, population, number of establishments, number of employees, and annual payroll. Therefore the model for this study can be expressed as:

(1a)

$$EQI = B_0 + B_1(P_{INC}) + B_2(T_{EMPL}) + B_3(POP) + B_4(N_{ESTAB}) + B_5(N_{EMPL}) + B_6(A_{PROL}) + \mathcal{E}_i$$

The expected signs of all six coefficients for personal income, total employment, population, number of establishments, number of employees, and annual payroll is negative. This indicates that an increase in each of the independent variables will lead to a lower EQI score. To recap, a lower more negative EQI score indicates better environmental quality. The reasons the independent variables are expected to be negative are because the more negative the values the stronger the effect the variable has on environmental quality. This is due to the fact that the more negative the number, indicates improving/better environmental quality. Therefore, if a value is positive, it indicates that the variable is having an adverse effect on environmental quality. All six variables are expected to be negative because as described earlier, an increase in each of the variables are expected to improve environmental quality, thus create a lower more negative value.

Several hypothesis tests will be conducted in this study. A t-test will be conducted for each of the independent variables to obtain an estimated coefficient. If the null hypothesis is rejected, then the alternative hypothesis will be correct and the coefficient is not equal to zero. This indicates that there is a relationship between the entrepreneurial activity independent variable and the (EQI) dependent variable. If the null hypothesis fails to reject, then the null hypothesis will be correct and the coefficient is equal to zero. This indicates that there is not a relationship between the entrepreneurial activity independent variable and the (EQI) dependent variable. A test statistic is calculated for each hypothesis and then compared to the critical values. If the test critical value is greater than the test statistic, then the hypothesis test will fail to reject the null. Additionally, an f-test will be conducted in order to determine how much

variability among the means is due to chance. The f-test puts all independent variables equal to each other and to zero. If the f-value is greater than the f-critical value, the hypothesis test will reject the null.

Hypothesis tests for this study can be expressed as:

TABLE 1: Hypothesis Tests

1. $H_o: P\_INC = 0$
2. $H_o: T\_EMPL = 0$
3. $H_o: POP = 0$
4. $H_o: N\_ESTAB = 0$
5. $H_o: N\_EMPL = 0$
6. $H_o: A\_PROL = 0$
7. $H_o: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$

TABLE 2: Elasticity Tests

1. P_INC coefficient * $\frac{\overline{X1}}{\bar{Y}}$
2. T_EMPL coefficient * $\frac{\overline{X2}}{\bar{Y}}$
3. POP coefficient * $\frac{\overline{X3}}{\bar{Y}}$
4. N_ESTAB coefficient * $\frac{\overline{X4}}{\bar{Y}}$
5. N_EMPL coefficient * $\frac{\overline{X5}}{\bar{Y}}$
6. A_PROL coefficient * $\frac{\overline{X6}}{\bar{Y}}$

TABLE 3: Data Summary

Number of Observations: 102

| | Mean | Std Dev | Minimum | Maximum |
|---|---|---|---|---|
| EQI | 0.65694 | 0.71573 | -1.68264 | 2.50156 |
| P_INC | 4654229.54902 | 2.16653D+07 | 97918.00000 | 2.11833D+08 |
| T_EMPL | 72001.21569 | 328639.33459 | 1452.00000 | 3226056.00000 |
| POP | 123626.50000 | 527341.84824 | 4346.00000 | 5207615.00000 |
| N_ESTAB | 3123.97059 | 13422.08703 | 61.00000 | 130454.00000 |
| N_EMPL | 50711.84314 | 237993.77195 | 363.00000 | 2320005.00000 |
| A_PROL | 2114758.26471 | 1.11746D+07 | 6356.00000 | 1.09044D+08 |

TABLE 4: Explanation of Variables

| Variable | Explanation |
|---|---|
| EQI | Environmental Quality Index |
| P_INC | Personal Income ($1000) |
| T_EMPL | Total Employment by number of jobs |
| POP | Population by number of persons |
| N_ESTAB | Number of Establishments |
| N_EMPL | Number of Employees |
| A_PROL | Annual Payroll ($1000) |

# CHAPTER 7

## RESULTS

The following OLS estimation was used for this study:

(1b) $EQI = 0.385336 + 0.244913e^{-06}(P_{INC}) - 0.521945e^{-05}(T_{EMPL}) - 0.657710e^{-05}(POP) + 0.128531e^{-04}(N_{ESTAB}) + 0.518901e^{-04}(N_{EMPL}) - 0.111169e^{-05}(A_{PROL})$

The $R^2$ for this estimated model is 0.41, which means that 41 percent of the variation in EQI can be explained by the variation in personal income, total employment, population, number of establishments, number of employees, and annual payroll.

TABLE 5: Results

| Results | | | | | | |
|---|---|---|---|---|---|---|
| Model | Estimated Coefficient | Standard Error | t | Sig. | F | $R^2$ |
| (Constant) | .385336 | .074292 | 5.18677 | .000 | 11.0373 | .410758 |
| P_INC | .244913E-06 | .128680E-06 | 1.90327 | .060 * | | |
| T_EMPL | -.521945E-05 | .128502E-04 | -.406178 | .686 | | |
| POP | -.657710E-05 | .308617E-05 | -2.13115 | .036 ** | | |
| N_ESTAB | .128531E-04 | .296204E-03 | .043393 | .965 | | |
| N_EMPL | .518901E-04 | .313928E-04 | 1.65293 | .102 | | |
| A_PROL | -.111169E-05 | .302143E-06 | -3.67936 | .000 *** | | |
| Strong Significance……$\alpha = 0.010$ *** | | | | | | |
| Moderate Significance……$\alpha = 0.050$ ** | | | | | | |
| Weak Significances……$\alpha = 0.100$ * | | | | | | |

The critical value for the t-test conducted was +/- 1.984. Personal income had a test statistic of 1.903, so the statistical decision is that the null hypothesis fails to reject based on an alpha level of (0.05). This means that the coefficient for personal income is statistically no different from zero, which indicates it did not influence the EQI. However, if the alpha level was (0.100), personal income would have been rejected.

Total employment had a test statistic of -0.4062, so the statistical decision is that the null hypothesis fails to reject based on an alpha level of (0.05). This means that the coefficient for total employment is statistically no different from zero, which indicates it did not influence the EQI. Population had a test statistic of -2.1311, so the statistical decision is that the null hypothesis can be rejected based on an alpha level of (0.05).

Number of establishments had a test statistic of 0.0434, so we cannot reject the null hypothesis at the 0.05 level. This means that the coefficient for number of establishments is statistically no different from zero, which indicates it did not influence the EQI.

Number of employees had a test statistic of 1.6529, so the statistical decision is that the null hypothesis fails to reject based on an alpha level of (0.05). This means that the coefficient for number of employees is statistically no different from zero, which indicates it did not influence the EQI.

Finally, annual payroll had a test statistic of -3.6794, so the statistical decision is that the null hypothesis can be rejected based on an alpha level of (0.05).

P-values were also calculated for each variable and are an indicator of the likelihood the null hypothesis is correct, while also testing to see if each of the independent variables is statistically significant. Personal income (0.060), total employment (0.686), number of establishments (0.965), number of employees (0.102), all had P-values above the alpha level of

0.05, which fails to reject the null hypothesis. Population (0.036) and annual payroll (<0.000) each had P-values below the alpha level of 0.05, which allows us to reject the null hypothesis. The P-values gave the same statistical decision that the test statistics did when compared to the critical values. The F-statistic for the null hypothesis of $H_o$: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$ is 11.04, which is above the critical value of 2.309, so the null hypothesis can be rejected. This overall relationship test indicates that at least one variable is not equal to zero.

Elasticities were calculated to determine which explanatory variable had the strongest impact on dependent variable (EQI). The expected sign for EQI is to be negative, indicating better environmental quality. The result for personal income says that for a 1% increase in personal income, there is a 1.7351% increase in the EQI, indicating worsening environmental quality. The possible reason for this would be that government officials are not being pressured enough to increase environmental regulations, as well as, from lack of state and government funding. Another possibility for the decrease in environmental quality as personal income increases could be from the poor use of tax spending of local governments or that more income puts more pressure on environmental resources.

The result for total employment says that for a 1% increase in total employment, there is a -0.5721% decrease in the EQI, indicating better environmental quality as expected.

The result for population says that for a 1% increase in population, there is a -1.2377% decrease in the EQI, indicating better environmental quality as expected.

The results for number of establishments says that for a 1% increase in number of establishments, there is a 0.0611% increase in the EQI, indicating worsening environmental quality. The possible reason for this would be that the numbers of establishments in Illinois are old and not entirely efficient. Also, decreases in environmental quality as a result of increases in

the number of establishments may also be caused from lack of local and state government regulations. Another reason may simply be that more business produces more environmental pressure.

The result for number of employees says that for a 1% increase in number of employees, there is a 4.0056% increase in the EQI, indicating worsening environmental quality. The possible reason for this would be that in areas that the number of employees are greater or increasing, there is more deforestation, urbanization, and building being force on the area to accommodate housing and living space for more working people. Additionally, the decrease in environmental quality as a result of increase in the number of employees could be from the lack of regulation and change to accommodate for more people, as well as, from the lack of education and awareness provided by the firms to the increasing number of employees.

Finally, the result for annual payroll says that for a 1% increase in annual payroll, there is a -3.5786% decrease in the EQI, indicating better environmental quality as expected. The independent variable that had the strongest impact on dependent variable was the number of employees, as it caused the largest percentage change in the EQI. However, annual payroll had the strongest impact among the variables that supported better environmental quality.

# CHAPTER 8

# CONCLUSION

The results of this study show a distinct relationship between the environmental quality index and population and annual payroll. However, personal income, total employment, number of establishments, and number of employees had no significant impact on the environmental quality index. This may be due to a variety of reasons, one of which being that the EQI data was collected over a five year period and reported, while the independent variables were only collected for the year 2005. Another reasoning for personal income, total employment, number of establishments, and number of employees having no impact on the environmental quality index may have come from overestimated expectations and expected signs for each variable's impact. A key result of this study was that annual payroll was notable in explaining variation in the environmental quality index. This implies that counties with higher paid employees have significantly lower environmental quality index scores indicating better environmental quality. One major influence on annual payroll is education. As people become more sophisticated and achieve higher educational degrees, they also obtain a heightened sense of environmental awareness. When they move on in search of careers, that awareness stays with them and becomes part of their lifestyle. They may choose to simply recycle more, or to go beyond the norm and introduce more environmentally friendly business operations and products.

One possible limitation to this study was the data selection for the variables in relations to how the data was collected for the EQI. The reason is the EQI was a collection of data over a five-year period, which can be assumed to be an average of the five years, whereas the independent variables were only selected for the year 2005. Future studies may want to take the average of the five-year period (2000-2005) for each independent variable in order to more

accurately determine their relationship to the EQI. Another possible limitation to this study was that only six variables were used to signify the level of entrepreneurial activity, when determining if it has an impact on the environmental quality index scores. Additionally, using an index as a total representation of environmental quality has the possibility for error when estimating environmental quality in a county. Technological and human error may also be a factor in the variation of the EQI scores, specifically on of how and where the data samples were collected in each county.

When the EQI for 2006-2010 is released to the public, future studies may want to examine the changes in EQI scores from the 2000-2005 data sets. Additionally, future studies may want to provide a survey to try and get an understanding for how people in each county feel about their local environment quality status. Even though personal income, total employment, number of establishments, and number of employees were not significant in explaining variation in the EQI for this study, future studies may want to select a larger number of variables to represent the level of entrepreneurial activity in a given county. There is also opportunities for future studies in working to establish an entrepreneurial index at the state and county level in order to analyze what areas in a given region have higher amounts of entrepreneurial activity and which have lower.

Although this study determines that there is not a significant relationship between entrepreneurial activity and the EQI, it introduces the possibility for more research in this field. For example, there can be the alteration of the alpha level to allow for a broader perspective for the level of significant. This could be that an alpha level of (0.01) could be most significant, an alpha level of (0.05) could be moderately significant, and an alpha level of (0.10) could be weakly significant. This would allow for the personal income variable to be rejected with a p-

value of (0.06) as it was extremely close to being significant at an alpha level of (0.05). Another possibility for research would be for the addition of using the EQI as an independent variable while using POP or N_ESTAB as the dependent variables. This would see if or how the level of environmental quality effects the population and number of establishments in a county. If the environmental quality is better in a county, does that draw in people and establishments?

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# APPENDICES

# APPENDIX

Table 6: 2005 Univariate Summary Statistics

Univariate statistics

Number of Observations: 102

| | Mean | Std Dev | Minimum | Maximum |
|---|---|---|---|---|
| EQI | 0.65694 | 0.71573 | -1.68264 | 2.50156 |
| P_INC | 4654229.54902 | 2.16653D+07 | 97918.00000 | 2.11833D+08 |
| T_EMPL | 72001.21569 | 328639.33459 | 1452.00000 | 3226056.00000 |
| POP | 123626.50000 | 527341.84824 | 4346.00000 | 5207615.00000 |
| N_ESTAB | 3123.97059 | 13422.08703 | 61.00000 | 130454.00000 |
| N_EMPL | 50711.84314 | 237993.77195 | 363.00000 | 2320005.00000 |
| A_PROL | 2114758.26471 | 1.11746D+07 | 6356.00000 | 1.09044D+08 |

| | Sum | Variance | Skewness | Kurtosis |
|---|---|---|---|---|
| EQI | 67.00781 | 0.51227 | -0.15684 | 0.50593 |
| P_INC | 4.74731D+08 | 4.69386D+14 | 8.93122 | 84.95680 |
| T_EMPL | 7344124.00000 | 1.08004D+11 | 9.01965 | 86.23430 |
| POP | 1.26099D+07 | 2.78089D+11 | 9.10219 | 87.75437 |
| N_ESTAB | 318645.00000 | 1.80152D+08 | 8.76128 | 82.32120 |
| N_EMPL | 5172608.00000 | 5.66410D+10 | 8.88477 | 84.05558 |
| A_PROL | 2.15705D+08 | 1.24871D+14 | 8.97764 | 85.28988 |

Table 7: Cross Sectional Regression Output

```
Dependent variable: EQI
Current sample:  1 to 102
Number of observations:  102

       Mean of dep. var. = .656939
  Std. dev. of dep. var. = .715729
Sum of squared residuals = 30.4868
   Variance of residuals = .320914
Std. error of regression = .566493
               R-squared = .410758
      Adjusted R-squared = .373542
            LM het. test = 1.33596 [.248]
           Durbin-Watson = 2.12856 [<.904]
         Jarque-Bera test = 10.9104 [.004]
          Ramsey's RESET2 = 12.1140 [.001]
          F (zero slopes) = 11.0373 [.000]
           Schwarz B.I.C. = 99.3276
           Log likelihood = -83.1402
```

| Variable | Estimated Coefficient | Standard Error | t-statistic | | P-value |
|---|---|---|---|---|---|
| C | .385336 | .074292 | 5.18677 | | [.000] |
| P_INC | .244913E-06 | .128680E-06 | 1.90327 | * | [.060] |
| T_EMPL | -.521945E-05 | .128502E-04 | -.406178 | | [.686] |
| POP | -.657710E-05 | .308617E-05 | -2.13115 | ** | [.036] |
| N_ESTAB | .128531E-04 | .296204E-03 | .043393 | | [.965] |
| N_EMPL | .518901E-04 | .313928E-04 | 1.65293 | | [.102] |
| A_PROL | -.111169E-05 | .302143E-06 | -3.67936 | *** | [.000] |

| | | |
|---|---|---|
| Strong Significance…… | α=0.010 | *** |
| Moderate Significance…… | α=0.050 | ** |
| Weak Significances…… | α=0.100 | * |

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