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Statistical Analysis of Climate Change, Renewable Energies, and Sustainability

An Independent Investigation for Introduction to Statistics

College of Menominee Nation &
University of Wisconsin Milwaukee

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Contents

Research Ideas

- Within the Menominee Indian Reservation, how has the annual temperature changed over the past 100 years?
- What is the statistical relationship between measured emissions of carbon dioxide and temperature on the Menominee Indian Reservation?
- Which type of alternative energy would be the most efficient or reliable option for the Menominee Indian Reservation?
- What is the statistical relationship between emissions and transportation?
- What is the statistical relationship between climate change, water availability, and energy production?
- Is the manufacturing of hybrid vehicles in the U.S. related to the purchasing of hybrid vehicles in the U.S.?
- From a global perspective, are countries renewable energy production equivalent to renewable energy consumption? What about the individual states in the U.S.?
- Is politics related to renewable energy government funding? Is governor type (Republican or Democrat) related to renewable energy production?
- Are government renewable energy manufacturing incentives related to renewable energy production?
- Has recycling increased over time? Do we recycle more paper, plastic, glass, or aluminum cans? Is recycling higher on specific days of the week? Does recycling have a seasonally attribute? Are some states or countries better recyclers than others?
- Is forest health and vitality related to forest management practices? Which is the highest determinant of forest loss: humans, insects and wildlife, fire, or other?
- With respect to sustainability, is the production of organic food products related to the consumption of organic food products (state level and country level)?
- Have vehicle emissions gone down over time? What is the impact of energy efficient vehicles on vehicle emissions? Do cities with a higher percentage of energy efficiency vehicles have a lower pollution rate?
- Is hunting and conservation negatively or positively influence the wildlife population? Prior to conservation initiatives, what did the wildlife population look like?
- Does the quantity of fishery production relate to fishery consumption? Is fishery production related Which countries
- Is the quantity of municipal waste related to the quantity of people per square area? Is the quantity of recycling related to the quantity of people per square area?
- Is the quantity of renewable energy college degrees related to the quantity of renewable energy manufacturing employers?
- Is gas mileage related to vehicle weight and volume? Which vehicles are the most gas efficient?

Project Description

The semester long project has five major modules:

1. Introduction and Background
2. Regression Analysis, Results, and Conclusions
3. Hypothesis Testing, Results, and Conclusions
4. Inferences about Differences, Results, and Conclusions
5. Final Report and Presentation, Reflection

The project is a scaffold assignment, in that each module builds on the previous, with deadlines about three weeks apart. This scaffold assignment allows the student ample opportunity to gain feedback, both peer and instructor, to ensure the student is on track and headed in the right direction. The first four modules use a checklist to ensure basic requirements are met, in addition to peer critiques. The last module, Final Report and Presentation, applies a rubric to assess the quality of the completed project. The last module also includes a reflection to assess what the student has learned with respect to Climate Change, Renewable Energies, and Sustainability. The checklists and rubrics, with deadlines, are shown below.

Module 1: Introduction and Background

Directions: You will receive points based on the criteria met in the check list below. As long as you meet the criteria below, based on a pass/fail rating, you will receive 5 points. The ultimate goal of the research is to meet the Final Report Rubric expectations, which will determine your overall grade for the final report. Due Week 3.

Introduction

- € Clearly state research question(s).
- € Provide motivation for the research to explain why this research is important. Find a minimum of two academic sources (books, journals, magazines, and websites) that provide practical support for the importance of this research question.

Background

- € Clearly state 3 hypotheses.
- € Provide logic and reasoning for the hypotheses. Find a minimum of two academic sources (books, journals, magazines, and websites) that provide practical support for the logic and reasoning behind the hypothesis development.
- € Find a data source (and cite it) that will potentially be used to answer the research question.

Peer Critiques

1. One thing my group mate did well is…
2. One thing my group mate could improve upon is…

Module 2: Regression Analysis, Results, and Conclusions

Directions: You will receive points based on the criteria met in the check list below. As long as you meet the criteria below, based on a pass/fail rating, you will receive 5 points. The ultimate goal of the research is to meet the Final Report Rubric expectations, which will determine your overall grade for the final report. Due Week 6.

Introduction

- € Updated per feedback.

Background

- € Updated per feedback.

Method

- € Insert the data table.
- € Describe the variables.
- € Provide descriptive statistics (mean, standard deviation, variance, and range) of each variable.
- € Create a frequency histogram of data.
- € Explain the usefulness and purpose of Regression Analysis

Analysis

- € Insert the scatter plot including the equation of the line.
- € Insert a copy of the regression results.

Results

- € State the equation of the line and its implications.
- € State the coefficient of determination and its implications.
- € State the slope and its implications.
- € State the r-square value and its implications.

Peer Critiques

1. One thing my group mate did well is…
2. One thing my group mate could improve upon is…

Module 3: Hypothesis Testing, Results, and Conclusions

Directions: You will receive points based on the criteria met in the check list below. As long as you meet the criteria below, based on a pass/fail rating, you will receive 5 points. The ultimate goal of the research is to meet the Final Report Rubric expectations, which will determine your overall grade for the final report. Due Week 9.

Introduction

- € Updated per feedback.

Background

- € Updated per feedback.

Method

- € Updated per feedback.
- € Insert the data table.
- € Describe the variables.
- € Provide descriptive statistics (mean, standard deviation, variance, and range) of each variable.
- € Create a frequency histogram of data.
- € Explain the usefulness and purpose of Hypothesis Testing.

Analysis

- € Updated per feedback.
- € Clearly state which type of hypothesis test will be used.
- € Clearly identify the 7 steps of the hypothesis test.

Results

- € Updated per feedback.
- € Explain if reject or cannot reject and its implications.

Conclusions

- € Updated per feedback.

Peer Critiques

1. One thing my group mate did well is…
2. One thing my group mate could improve upon is…

Module 4: Inferences about Differences, Results, and Conclusions

Directions: You will receive points based on the criteria met in the check list below. As long as you meet the criteria below, based on a pass/fail rating, you will receive 5 points. The ultimate goal of the research is to meet the Final Report Rubric expectations, which will determine your overall grade for the final report. Due Week 12.

Introduction

- € Updated per feedback.

Background

- € Updated per feedback.

Method

- € Updated per feedback.
- € Insert the data table.
- € Describe the variables.
- € Provide descriptive statistics (mean, standard deviation, variance, and range) of each variable.
- € Create a frequency histogram of data.
- € Explain the usefulness and purpose of Hypothesis Testing.

Analysis

- € Updated per feedback.
- € Clearly state which type of hypothesis test will be used.
- € Clearly identify the 7 steps of the hypothesis test.

Results

- € Updated per feedback.
- € Explain if reject or cannot reject and its implications.

Conclusions

- € Updated per feedback.

Peer Critiques

a) One thing my group mate did well is…
b) One thing my group mate could improve upon is…

Module 5: Final Report, Presentation, and Reflection

Directions: The final report and presentation are due Week 15. After each student presents his or her project, you need to provide immediate verbal peer feedback for each presenter. The reflection is due at the end of the week. See rubrics for grade assessment of final report, final presentation, and reflection.

Peer Feedback on Presentation

1. One thing the presenter(s) did well is…
2. One thing the presenter(s) could improve upon is…

Reflection Assignment

Each student will include a written summary of:

- the beliefs, ideas and strategies about Climate Change, Renewable Energies, and Sustainability that have *changed* and made the strongest impression on them this semester, and
- an assessment of your individual responsibility for Climate Change, Renewable Energies, and Sustainability at this point and what you want to strengthen.

Final Report Rubric

Topic	Novice (0-2 pts)	Effective (3-6 pts)	Expert (7-10 pts)
Introduction	Little or no grasp of research agenda. Data set is not aligned with research objectives. Major deficiencies that will impact the quality of the analysis and results.	Overall sound understanding of the research objectives. Does not show evidence of practical link between research outcomes and intended data set. In addition, data set is cited and there are a minimum of two sources to support the research.	Clear and complete understanding of research problem and constraints, research goal, potential practical outcomes, and intended data set. In addition, data set is cited and there are a minimum of two sources to support the research.
Background	Hypothesis development is not relevant or only relevant for some aspects; theory is not clearly articulated and/or has incorrect or incomplete components or lack of cited support.	Hypothesis development is relevant and accurately described; some components may not be present or are unclear. Connection to supported sources is mostly clear and complete, or has some minor errors.	Hypothesis development is relevant, accurately described and all relevant components are included. In addition, there are a minimum of two sources to support the hypothesis development.
Method	Missing components or lack of connection to research question.	Data set, including variables, is not entirely identified or relevance to research question is only somewhat supported.	Data set, including variables, is clearly identified and relevant to research question. Descriptive statistics provide clear and concise introduction to data set.
Analysis	Analysis selected is vague, incomplete, or not relevant to the research question.	Analysis is relevant to the research question and is mostly accurate and complete.	Analysis selected is highly relevant to the research question, is presented accurately and completely.
Results	Results are inaccurate or incomplete.	There are some unclear components or some minor errors in the results.	Results are presented clearly, accurately, and completely.
Conclusion	Conclusion may not be clear and the connections to the research are incorrect or unclear or just a repetition of the findings without explanation.	Conclusion is clearly stated and connections to research and position are mostly clear, some aspects may not be connected or minor errors in logic are present.	Conclusion is clearly stated and connections to the research and position are clear and relevant. The underlying logic is explicit.
Overall Flow	Paper is poorly organized and difficult to read – does not flow logically from one part to another. There are several spelling and/or grammatical errors. Writing lacks clarity and conciseness.	Paper is generally well organized and most of the argument is easy to follow. There is only a few minor spelling or grammatical errors, or terms are not clearly defined. Writing is mostly clear but may lack conciseness.	Paper is coherently organized and the logic is easy to follow. There is no spelling or grammatical errors and terminology is clearly defined. Writing is clear and concise and persuasive.

Final Presentation Rubric

Topic	Novice (0-2 pts)	Effective (3-6 pts)	Expert (7-10 pts)
Organization	Audience has difficulty following presentation because student jumps aground.	Student presents information in logical sequence which audience can follow.	Student presents information in logical, interesting sequence which audience can follow.
Subject Knowledge	Student is uncomfortable with information and is able to answer only rudimentary questions.	Student is at ease with expected answers to all questions, but fails to elaborate.	Student demonstrates full knowledge (more than required) by answering all class questions with explanations and elaboration.
Graphics	Student uses superfluous graphics or no graphics.	Student's graphics relate to text and presentation.	Student's graphics explain and reinforce screen text and presentation.
Mechanics	Student's presentation has three or more spelling and/or grammatical errors.	Presentation has not more than two misspellings and/or grammatical errors.	Presentation has not misspellings or grammatical errors.
Eye Contact	Student occasionally uses eye contact, but still reads most of presentation.	Student maintains eye contact most of the time but frequently returns to notes.	Student maintains eye contact with audience, seldom returning to notes.
Elocution	Student's voice is low. Audience members have difficulty hearing presentation.	Student's voice is clear. Most audience members can hear presentation.	Student uses a clear voice and correct pronunciation of terms so that all audience members can hear presentation.

Reflection Rubric

	Expert (10-7 pts)	Effective (6-4 pts)	Novice (3-0 pts)
Specificity	Student identifies specific beliefs about Climate Change, Renewable Energies, and Sustainability that have changed; student points out specific concepts and ideas that are new; student elaborates on specific strategies (based on beliefs and concepts) beginning to use or intends to use; explains critically why all changes matter to them and their impact in their individual responsibility.	Student identifies specific beliefs about Climate Change, Renewable Energies, and Sustainability that have changed; student points out specific concepts and ideas that are new; student elaborates on specific strategies (based on beliefs and concepts) beginning to use or intends to use; thoughtfully explains why most changes matter to them.	Student identifies a few specific beliefs about Climate Change, Renewable Energies, and Sustainability that have changed; student vaguely points out some specific concepts and ideas that are new; student minimally describes few strategies (unclear if related to beliefs and concepts) beginning to use or intends to use; vaguely explains why these changes matter to them.
Thorough	Student provides numerous examples of Climate Change, Renewable Energies, and Sustainability strengths and weakness; assessment well linked to project objectives and outcomes.	Student provides some examples of Climate Change, Renewable Energies, and Sustainability strengths AND weakness; assessment at times clearly linked to project objectives and outcomes.	Student provides few examples of Climate Change, Renewable Energies, and Sustainability strengths OR weakness; assessment not easily linked to project objectives and outcomes.

Actual Student Peer Feedback and Lessons Learned

Examples of Peer Feedback: One thing the presenter did well…

- "Good eye contact and nice flow."
- "Knew the information well."
- "Spoke clearly."
- "I liked how you engaged your audience."
- "Loved the video."
- "Went above and beyond the professor's expectations."
- "Had lots of data. Can see you put a lot of work into project."

Examples of Peer Feedback: One thing the presenter could improve…

- "Try not to hide behind the computer."
- "Put less information on the slides."
- "Have more eye contact and speak a little louder."
- "Reduce using words 'like' and 'um' and 'uh'."
- "Facial expressions – don't act like your presentation is horrible."
- "You should have practiced the presentation ahead of time."
- "More eye contact."

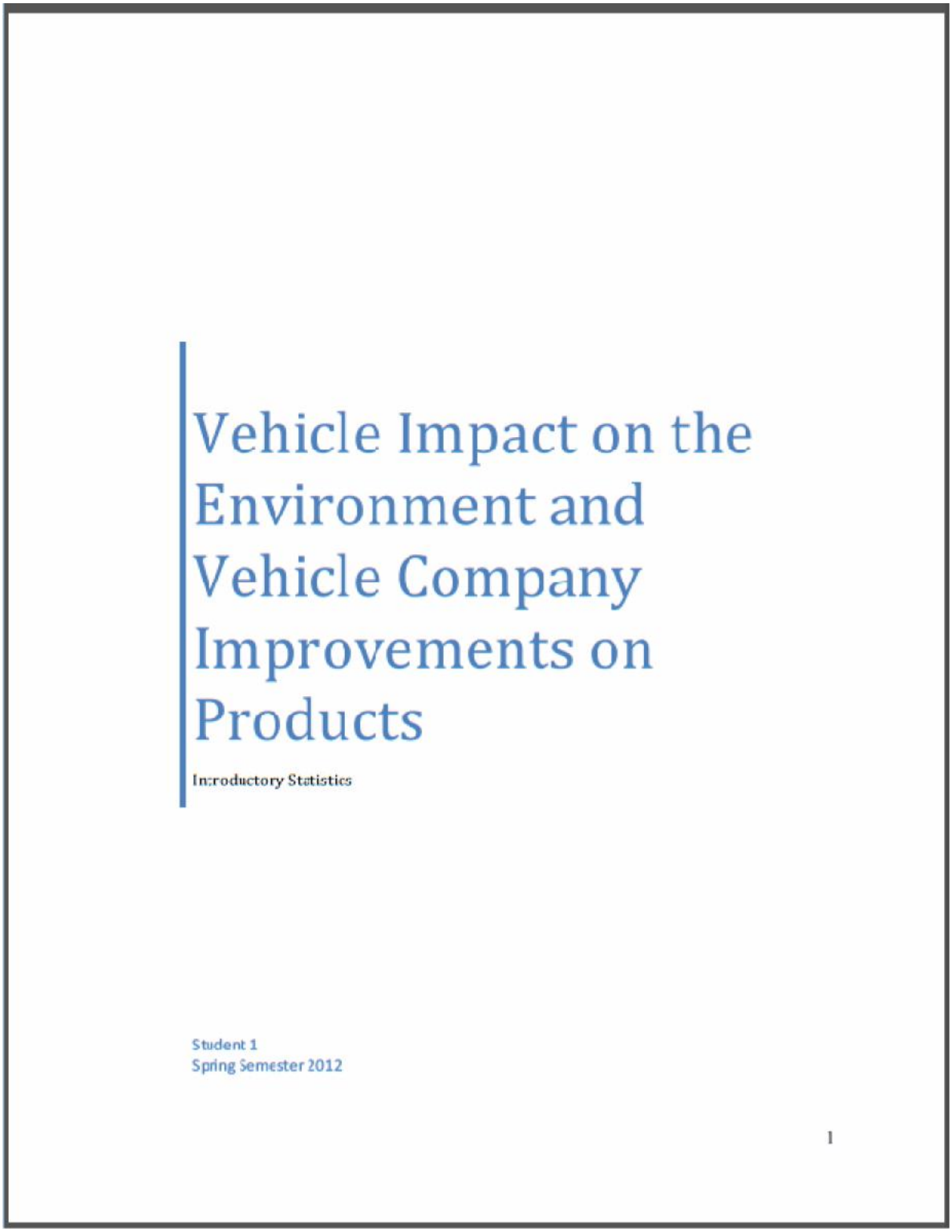
Examples of Lessons Learned:

- "What I learned from the presentations given yesterday as a whole is there are many different issues which need our attention. [Student] opened my eyes to something I had always wondered about because of my recent trip to Arizona. From my reservation you can see this giant cloud of smog over the populated areas as the sun is setting. [Student] made me aware of what this smog was created from and I can now tell people about the toxins given off."
- "[Student] told us about the ambient noise from the [wind] turbines and how they cause sleep disturbances. They are very controversial yet are in our backyard! Never knew they were so many so close."
- "The story of stud told us each person produces 4.5 lbs of waste a day and yes we can recycle the foil from the Hershey kiss."
- "[Student] made me think twice about how much of an impact our actions have on our surroundings."
- "I realized how important recycling is and how it can improve the world so that we are able to have a place to live."
- "Thanks for making stats fun and I really learned a lot. I was very worried about taking this class as I took college math many many years ago but I did survive!"
- "I learned to be attentive to the information that one presents to tan audience. Ensure the data is correct and supports my conclusion. Do not manipulate the data to achieve a hypothesis that favors the wrong conclusion."
- "I especially like how [the student] presented the information and made us aware of the debates other energy sources bring to the table."

Benefits for Learners

- Semester long project promotes student engagement in climate change, renewable energies, and sustainability issues throughout the semester, instead of the common last minute cram sessions to get a paper done (not done correctly).
- Rubrics and due dates provide clear guidelines as to what is expected and when.
- Potential list of ideas give students an idea about where to get started and what data is associated with sustainability and renewable energies.
- Scaffold assignment provides students with 4 opportunities for peer critiques and instructor feedback to ensure they are heading in the right direction.
- Project applies higher levels of Bloom's taxonomy.
- Students are given the opportunity to present their information, which builds their confidence in public speaking. Furthermore, students obtain immediate feedback from their peers as to what went right and how to improve the presentation.
- The combination of project, presentation, and reflection applies all components of Kolb's learning cycling (Concrete, Reflection, Abstract Conceptualization, and Active Experimentation).
- Option to work individually or in groups aims to promote awareness of student's needs related to the demands of school, work, and home.
- The independent nature of the project considers different aspects of student learning styles (visual, audio, reading, kinesthetic) as students can choose their own type of data format and references (e.g. videos, podcasts, etc…).
- The requirement for peer critiques gives students the ability to learn about topics outside his or her specific project area.
- The final reflection allows the student to reflect on what was learned over the semester. Furthermore, they will assess what the projects mean to their personal life and their individual responsibility to Climate Change, Renewable Energies, and Sustainability.
- Quantitative topic focuses on students technical writing skills.

Sample Final Report



Vehicle Impact on the Environment and Vehicle Company Improvements on Products

Introductory Statistics

Student 1
Spring Semester 2012

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INTRODUCTION

In my study, I would like to distinguish whether or not vehicle companies are trying to make a difference in their vehicles in order to make them more environmentally friendly. My research question is: Since studies have found that vehicles indeed do put CO2 into the atmosphere, have vehicle producers been improving their products? The population for my study comes from every vehicle make and model there is. However, the sample of which I will be using only comes from seven different makes and models from the years 2001 and 2012. In ANOVA testing, my sample comes from three different makes and models in order to infer about predicting future scores.

I hope to infer that the amount that we drive does cause an increase in the CO2 in the air and that we should look into alternative options such as hybrid vehicles, riding bicycles, and other ways that minimize putting CO2 in the air through the use of transportation. I also hope to infer that the increase in CO2 in the atmosphere from vehicles causes a bit of global warming and that vehicle companies are overall trying to improve their products to make them more environmental friendly.

The answer to this question is important in order to reduce the amount of CO2 that we put in the air and in order to reduce global warming by such ways as "leav[ing the] car at home two days a week [to] reduce your carbon dioxide emissions by1,590 pounds per year."[1] Also, the people of the United States should be able to know whether or not vehicle companies are working hard to improve their products in order to make those products less harmful to the environment. In the book Pollution, some writers agree that vehicles give off CO2 emissions into the environment and others disagree.[2] In a book by Chris Goodall, he tells readers that they

[1] http://youthcedare.int/Main.aspx?code=1109
[2] Hay, Jeff. Pollution. Farmington Hills, MI: Greenhaven, 2009. Print.

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can reduce their carbon footprint by such things as walking, carpooling, or investing in more fuel efficient vehicles.[3]

BACKGROUND

My hypotheses are as follows: Vehicle companies are working to improve the air pollution and greenhouse gas scores. an increase in the greenhouse gas score for a vehicle should cause an increase in the air pollution score for the same vehicle, and that vehicle models are good indicators of predicting air pollution and greenhouse gas scores.

It is logical to say that transportation by vehicles causes higher CO2 in the atmosphere because of graphs and data collected, as well as the knowledge that the standard vehicle that a person drives puts out CO2, and that it is let out into the environment. As higher levels of CO2 are in the atmosphere, the outer layer thins out causing global warming.[4] Consequently, because of a thinning in the ozone layer, the Earth cannot as easily protect itself from the sun's harmful rays. [5] By checking out websites and comparing data, it is logical to say that there is an increase in improvement of vehicle efficiency towards the environment by seeing an increase in their greenhouse gas scores and air pollution scores (ten being friendliest towards the environment and one being the least). Another possible hypothesis is that the better the greenhouse gas score, the better the air pollution score will be for a particular vehicle. The data source where I found particular scores on air pollution and greenhouse gases comes from the U.S. Environmental Protection Agency.[6]

METHOD

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[3] Goodall, Chris. "Chapter 7: Car Travel." *How to Live a Low-carbon Life: The Individual's Guide to Tackling Climate Change*. 2nd ed. London: Earthscan, 2010. 131-63. Print.
[4] Browner, Carol M., and Daniel S. Menzel. "Part 2: The Environment and Technology." *Clashing Views on Controversial Environmental Issues*. Ed. Theodore Goldfarb. London: McGraw-Hill, 1999. 160-81. Print.
[5] Dunn, Terry Lawson. *Guide to Global Environmental Issues*. Golden, Colo: Fulcrum Publ., 1997. Print.
[6] http://ofmpub.epa.gov/greenvehicles/Index.do;jsessionid=xyS1PDpGFZ/jp7hzvOv2C9SKTxRjnY0svtPFrY3Onv3N411vaMdIZ!788633877

The variables we will be using are air pollution score ratings and greenhouse gas score ratings on seven different vehicles with the same make and model in two different years. The ratings from each score categories range from 1-10. One is defined as "least friendly" towards the environment, and ten is defined as "most friendly." The following data below are the descriptive statistics from data collected:

Air Pollution Score							
2	2	0	0	6	6	1	
1	5	6	5	2	3	7	
Count	14	Std.Dev.	2.452912	Maximum	7	Range	7-0 = 7
Average	3.285714	Variance	6.065934	Minimum	0		
Greenhouse Gas Score							
6	5	6	7	2	2	4	
5	4	3	7	6	8	9	
Count	14	Std.Dev.	2.127786	Maximum	9	Range	9-2 = 7
Average	5.285714	Variance	4.527473	Minimum	2		

The following are the frequency histograms from each data collection. The first one does not have a normal distribution, but it will be used anyways. However, the second one has a normal bell curve distribution. The analysis that will be done on the data is hypothesis testing, correlation and regression analysis, and ANOVA. I am going to do hypothesis testing on the whether or not vehicle companies are making differences in order to change their air pollution scores and their greenhouse gas scores. It is important to conduct each type of analysis in order to gain a well-rounded and solid conclusion.

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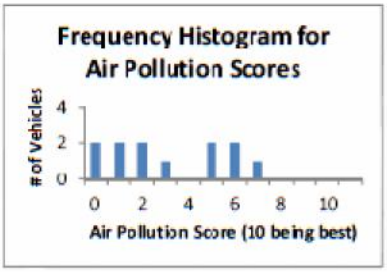

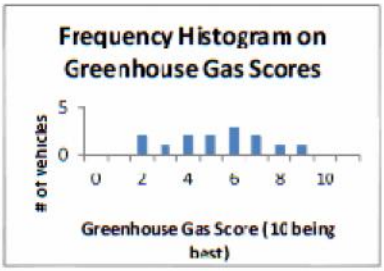

ANALYSIS

Hypothesis 1A (dependent samples): To see if vehicle companies have made changes in their products to try to change their air pollution scores.

To see if vehicle companies have made changes to try to change their air pollution scores.

	Air Pollution Score - Gasoline						
Year	Impala	Buick	Dodge	Ford	Jeep	Nissan	Toyota
2001	2	2	0	1	1	2	3
2012	6	6	0	5	6	5	7
	-4	-4	0	-4	-5	-3	-4

Step 1 - Ho: Md=0, Ha: Md does not = 0

Step 2: t = the avg. of differences x square root of n all divided by the std. dev.

Step 3: alpha = 0.05

Step 4: two tail test, draw graph... df = 7-1=6... look up 0.025 (because 0.05/2=0.025) on t tables by df =6 and get a t value of 2.447. T tables are symmetrical... so the other value is -2.447. Reject Ho if tvalue < -2.447 or if tvalue > 2.447.

Step 5: n=7, the avg. of differences = -3.23, std. dev. = 2.46

Step 6: fill in formula... (-3.23)(square root of 7)/2.46 = -3.47 (tvalue)...

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Step 7: Reject Ho and infer Ha, that the mean difference doesn't equal zero. Therefore, vehicle companies seem to have made changes in order to change their air pollution scores.

Hypothesis 1B (dependent samples): To see if vehicle companies have made changes to their products try to change their greenhouse gas scores.

	Greenhouse Gas Score - Gasoline						
Year	Impala	Buick	Dodge	Ford	Jeep	Nissan	Toyota
2001	6	6	2	4	4	7	8
2012	5	7	2	5	3	6	9
	1	-1	0	-1	1	1	-1

Step 1 - Ho: Md=0, Ha: Md does not = 0

Step 2: t= the avg. of differences x the square root of seven all divided by the std. dev.

Step 3: alpha = 0.05

Step 4: two tail test. draw graph.... df = 7-1=6... look up 0.025 (because 0.05/2=0.025) on t tables by df = 6 and get a t value of 2.447. T tables are symmetrical, therefore the other value is -2.447. Reject Ho if tvalue < -2.447 or if tvalue > 2.447.

Step 5: the avg. of differences = 0, n = 7, std. dev = 2.13

Step 6: fill in formula... (0)(square root of 7)/2.13 = 0 (tvalue = 0).

Step 7: Fail to reject Ho, thus we infer Ho that Md = 0. Therefore, vehicle companies appear to have made no changes in order to change their air pollution scores.

RESULTS OF HYPOTHESIS TESTING

1. Hypothesis 1A stated that companies have either changed their air pollution scores or have kept them the same.

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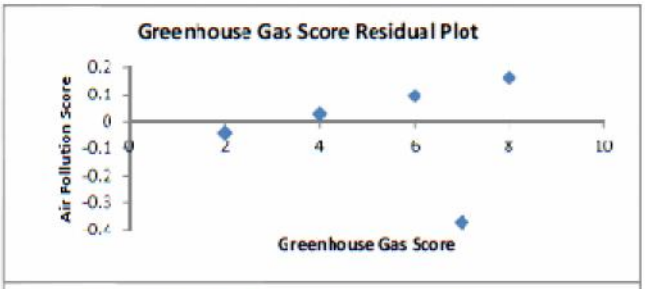
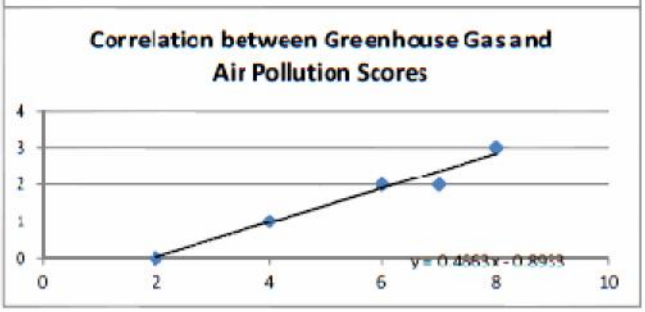
2. The results of the hypothesis testing states that there is a mean difference in the air pollution scores, meaning that vehicle companies have made changes in order to change their air pollution score ratings.
3. Hypothesis 1B stated that companies have either changed their greenhouse gas scores or have kept them the same.
4. The results of the hypothesis testing states that there is a mean difference of zero between the greenhouse gas scores thus inferring that vehicle companies have not tried to make differences in their greenhouse gas score ratings.

CORRELATION AND REGRESSION ANALYSIS

Hypothesis 2A: An increase in the greenhouse gas score for a vehicle should cause an increase in the air pollution score for that particular vehicle.

SUMMARY OUTPUT								
Regression Statistics								
Multiple F	0.983644336							
R Square	0.967555618							
Adjusted R Square	0.963067416							
Standard Error	0.193558177							
Observations	7							
	Coefficients	*Standard Error*	*t Stat*	*F-value*	*lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.893258427	0.214559675	-4.163216726	0.008796614	-1.444801613	-0.341715224	-1.444801613	-0.341715224
Greenhouse Gas Score	0.466292135	0.038185672	12.21116514	6.51341E-05	0.368132616	0.564451653	0.368132616	0.564451653





What is the R Squared value? What does it mean? The R Squared value is 0.967556 18. It means that the greenhouse gas scores and air pollution scores are highly correlated by about 97%.

What is the Intercept Coefficient? What does it mean? The Intercept Coefficien: is -0.893258427. It is the same as the variable "b," meaning the starting point on the y-intercept.

What is the Greenhouse Gas Score Coefficient? What does it mean? The Greenhouse Gas Score Coefficient is 0.466292135. It is the slope, and means that if there is a one unit increase in the greenhouse gas score, that there should be a 0.466 increase on the y-intercept (air pollution score).

What is the regression equation? Does the regression line fit the data? The regression equation is y = 0.466x – 0.893. Yes, the regression line does fit most of the data.

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ANOVA ANALYSIS

ANOVA RAW DATA												
	Air Pollution Score - Gasoline											
Car Year>	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Chev. Impala	2	2	3	6	6	6	6	6	7	7	6	6
Jeep Wrangler	1	1	2	2	6	6	6	6	5	6	5	6
Nissan Altima	2	3	3	6	6	6	6	6	5	6	5	5
	Greenhouse Gas Score - Gasoline											
Car	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Chev. Impala	6	6	6	6	6	6	6	6	5	6	5	5
Jeep Wrangler	3	4	4	4	4	4	5	5	3	3	2	3
Nissan Altima	7	7	7	7	7	7	8	8	7	7	6	6

Air Pollution Score - Gasoline ANOVA Analysis

Anova: Single Factor							
SUMMARY							
Groups	*Count*	*Sum*	*Average*	*Variance*			
Chev. Impala	12	53	5.25	3.295454545			
Jeep Wrangler	12	53	4.416666667	4.810606061			
Nissan Altima	12	50	5	2.181818182			
ANOVA							

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Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Between Groups	4.38888 88889	2	2.19444 4444	0.63591 1635	0.53375 6938	3.28491 7651	
Within Groups	113.16 66667	33	3.42929 2929				
Total	117.55 55556	35					
ANOVA single factor for air pollution score - Gas							
FAIL TO REJECT Ho because the F value is less than the F crit value							
H_o: $\mu_1 = \mu_2 = \mu_3$							
H_a: At least one of the means is different from the other							
Results show that each air pollution score mean is statistically the same, therefore using vehicle types are not good indicators of predicting air pollution scores.							

Greenhouse Gas Score - Gasoline ANOVA analysis

Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Chev. Impala	12	70	5.83333333 3	0.15151515 2		
Jeep Wrangler	12	44	3.66666666 7	0.78787878 8		
Nissan Altima	12	84	7	0.36363636 4		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	68.6666666 7	2	34.3333333 3	79.0465116 3	2.5998E-13	3.28491765 1
Within Groups	14.3333333 3	33	0.43434343 4			
Total	83	35				

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ANOVA Greenhouse Gas Score - Gasoline										
REJECT H_o & Infer H_a that at least one of the means is different										
H_o: $\mu_1 = \mu_2 = \mu_3$										
H_a: At least one of the means is different from the other										
larger values = a better greenhouse gas score										
smaller values = a worse greenhouse gas score										

Thus, we go into Multiple Comparison Testing for the ANOVA analysis of Greenhouse Gas Scores (Gasoline) on vehicles.

Multiple Comparison Test for Greenhouse Gas Score Results												
Comparison 1												
H_o: $\mu_1 = \mu_2$	The mean of the Chev. Impala and the Jeep Wrangler are the same											
H_A $\mu_1 \neq \mu_2$	The mean of the Chev. Impala and the Jeep Wrangler are different											
	Greenhouse Gas Score - Gasoline											
Car	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Chev. Impala	6	6	6	6	6	6	6	6	6	6	5	5
Jeep Wrangler	3	4	4	4	4	4	5	5	3	3	2	3
Nissan Altima	7	7	7	7	7	7	8	8	7	7	6	6
t-Test: Two-Sample Assuming Equal Variances												
	Chev. Impala	*Jeep Wrangler*										
Mean	5.833333333	3.666666667										
Variance	0.151515152	0.787878788										
Observations	12	12										
Pooled Variance	0.469697											

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Hypothesized Mean Difference	0											
df	22											
t Stat	7.74388 4163											
P(T<=t) one-tail	5.04409 E-08											
t Critical one-tail	1.71714 4335											
P(T<=t) two-tail	1.00882 E-07											
t Critical two-tail	2.07387 3058											
Pval on a two tail test is approximately 0.000000302, which is less than the apha value of 0.05												
Reject H_o, meaning that the means are statistically different.												
Comparison 2												
H_o: $\mu_2 = \mu_3$	The mean of the Jeep Wrangler and the Nissan Atima are the same											
H_A: $\mu_2 \neq \mu_3$	The mean of the Jeep Wrangler and the Nissan Atima are different											
t-Test: Two-Sample Assuming Equal Variances												
	Jeep Wrangler	*Nisson Altima*										
Mean	3.66666 6667	7										
Variance	0.78787 8788	0.36363 6364										
Observations	12	12										
Pooled Variance	0.57575 7576											
Hypothesized Mean Difference	0											
df	22											

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t Stat	-10.76055174											
P(T<=t) one-tail	1.56471E-10											
t Critical one-tail	1.717144335											
P(T<=t) two-tail	3.12942E-10											
t Critical two-tail	2.073873058											
Pval on a two tail test is approximately 0.000000000313129, which is less than alpha value of 0.05												
Reject H_o, meaning that the two sample means are statistically different.												
Comparison 3												
$H_o: \mu_1 = \mu_3$												
$H_a: \mu_1 \neq \mu_3$												
t-Test: Two-Sample Assuming Equal Variances												
	Chev. Impala	*Nissan Altima*										
Mean	5.833333333	7										
Variance	0.151515152	0.363636364										
Observations	12	12										
Pooled Variance	0.257575758											
Hypothesized Mean Difference	0											
df	22											
t Stat	-5.630797656											
P(T<=t) one-tail	5.80494E-06											
t Critical one-	1.71714											

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tail	4335											
P(T<=t) two-tail	1.16059 E-05											
t Critical two-tail	2.07387 3058											
Pval on a two tail test is approximately 0.000011609, which is less than alpha value of 0.05												
Reject H_0, meaning that the two means are statistically different.												
What is the overall conclusion from the initial hypothesis and the multiple comparison test?												
In the initial hypothesis test, we rejected H_0 and inferred H_a that at least one of the means was different.												
The results of the multiple comparison testing suggest that the mean scores for each vehicle are statistically different,												
meaning that vehicle types are good indicators for predicitons.												

CONCLUSIONS

Overall, all of this hypothesis testing has been done in order to infer as to whether vehicle companies have been trying to improve their air pollution and greenhouse gas scores to make their products more environmental friendly. The testing was also done to see if there is a correlation between an increase in greenhouse gas scores and an increase in air pollution scores, as well as whether or not vehicles are good predictors for distinguishing future vehicular scores.

Thus, in our hypothesis testing, we inferred that yes, companies have tried to change their air pollution scores, yet they have not tried improving their greenhouse gas scores. Following that, in our correlation and regression analysis testing, we inferred that there is in fact a correlation between greenhouse gas scores and air pollution scores. Thus, if a greenhouse gas score rises, we can assume that the air pollution score shall increase as well. Lastly, in our ANOVA analysis testing, we found out that vehicle types are not good indicators for predicting air pollution scores. However, we found that vehicle types are good indicators for predicting

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future greenhouse gas scores because the multiple comparison testing showed that each Pvalue was less than alpha of 0.05, meaning that we rejected Ho and inferred that all of the means were statistically differen:.

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Sample Final Presentation

Vehicle Impact on the Environment and Vehicle Company Improvements on Products

Student 1
Introductory Statistics
Spring Semester 2012
May 7th, 2012

Introduction

In my study, I would like to distinguish whether or not vehicle companies are trying to make a difference in their vehicles in order to make them more environmental friendly. Since there is proof that vehicles do in fact put CO_2 in the atmosphere, I think it is important to know where vehicle companies stand in regards to this issue. By knowing what our vehicle companies are doing with their products, society can decide whether or not they should keep buying or look into other options.

Background

It is logical to say that vehicle transportation causes higher CO_2 in the atmosphere because of data and graphs. As higher levels of CO_2 are in the atmosphere, the outer layer thins out causing global warming. It is also logical to say that there's an increase in the improvement of vehicle efficiency towards the environment by seeing an overall increase in air pollution and greenhouse gas scores (10 being most optimal, and 1 being the least). I found my data scores from the U.S. Environmental Protection Agency's website.

Hypotheses

- ***H1a:*** Vehicle companies have made changes in their products to change their air pollution scores.
- ***H1b:*** Vehicle companies have made changes in their products to change their greenhouse gas scores.
- ***H2:*** An increase in the greenhouse gas score for a vehicle should cause an increase in the air pollution score for that particular vehicle.
- ***H3a:*** The means of the air pollution scores of three different vehicle types over a 12 year span (2001-2012) are different, causing vehicle types to be good indicators of predicting future air pollution scores.
- ***H3b:*** The means of the greenhouse gas scores of three different vehicle types over a 12 year span (2001-2012) are different, causing vehicle types to be good indicators of predicting future greenhouse gas scores.

H1: Data

- H1a Raw Data

	Air Pollution Scores - Gasoline						
Year	Impala	Buick	Dodge	Ford	Jeep	Nissan	Toyota
2001	2	2	0	1	1	2	3
2012	6	6	0	5	6	5	7
	-4	-4	0	-4	-5	-3	-4

- H1b Raw Data

	Greenhouse Gas Scores - Gasoline						
Year	Impala	Buick	Dodge	Ford	Jeep	Nissan	Toyota
2001	6	6	2	4	4	7	8
2012	5	7	2	5	3	6	9
	1	-1	0	-1	1	1	-1

H1: Analysis & Results

H1a Analysis & Results

1) Vehicle companies have made changes in their products to change their air pollution scores.

- Step 1 – Ho: Md = 0, Ha: Md ≠ 0
- Step 2 – t = the avg. of differences times the square root of 7 (n) divided by the standard deviation.
- Step 3 – Alpha = 0.05
- Step 4 – 2 tail test, draw graph. DF = 6. Look up 0.025 on t tables. Get a value of 2.447. Other value is -2.447 (symmetrical). Reject Ho if t value < -2.447 or >2.447.
- Step 5 – n = 7, the avg. of differences = -3.23, standard deviation = 2.46
- Step 6 – fill in formula. (-3.23)(square root of 7) all divided by 2.46 = -3.47 (t value)
- Step 7 – Reject Ho & infer Ha, that the mean difference doesn't equal zero.

H1b Analysis & Results

1) Vehicle companies have made changes in their products to change their greenhouse gas scores.

- Step 1 – Ho: Md = 0, Ha: Md ≠ 0
- Step 2 – t = the avg. of differences times the square root of 7 (n) divided by the standard deviation.
- Step 3 – Alpha = 0.05
- Step 4 – 2 tail test, draw graph. DF = 6. Look up 0.025 on t tables. Get a value of 2.447. Other value is -2.447 (symmetrical). Reject Ho is t value < -2.447 or > 2.447.
- Step 5 – n = 7, the avg. of differences = 0, standard deviation = 2.13
- Step 6 – fill in formula. (0) square root of 7) all divided by 2.13 = 0 (t value)
- Step 7 – Fail to reject Ho, thus we infer Ho that Md = 0.

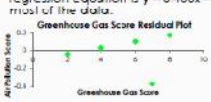
H2: Data

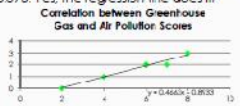
Greenhouse Gas & Air Pollution Scores 1-10 (10=best)							
2001	Buick	Dodge	Ford	Jeep	Nissan	Toyota	Impala
Greenhouse Gas Score	6	2	2	4	2	3	6
Air Pollution Score	2	0	1	1	7	8	2
2012	Buick	Dodge	Ford	Jeep	Nissan	Toyota	Impala
Greenhouse Gas Score	7	2	5	3	6	9	6
Air Pollution Score	6	0	5	6	5	7	6

H2: Analysis & Results

An increase in the greenhouse gas score for a vehicle should cause an increase in the air pollution score for that particular vehicle.

- What is the R Squared value? What does it mean? The R Squared value is 0.967556618. It means that the greenhouse gas scores and air pollution scores are highly correlated by about 97%.
- What is the Intercept Coefficient? What does it mean? The Intercept Coefficient is -0.893258427. It is the same as the variable "b," meaning the starting point on the y-intercept.
- What is the Greenhouse Gas Score Coefficient? What does it mean? The Greenhouse Gas Score Coefficient is 0.466292135. It is the slope, and means that if there is a one unit increase in the greenhouse gas score, that there should be a 0.466 increase on the y intercept (air pollution score).
- What is the regression equation? Does the regression line fit the data? The regression equation is y = 0.466x – 0.893. Yes, the regression line does fit most of the data.





H3: Anova Raw Data

H3a: Air Pollution Scores - Gasoline												
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Impala	2	2	3	6	6	6	5	6	7	7	6	6
Wrangler	1	1	2	2	6	6	5	6	6	6	5	6
Altima	2	3	3	6	6	6	5	6	6	6	5	5

H3b: Greenhouse Gas Scores – Gasoline												
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Impala	6	6	6	6	6	6	5	6	6	6	5	5
Wrangler	3	4	4	4	4	4	5	5	3	3	2	3
Altima	7	7	7	7	7	7	8	8	7	7	6	6

H3a: Analysis & Results

- Hypothesis: The means of the air pollution scores of three different vehicle types over a 12 year span (2001-2012) are different, causing vehicle types to be good indicators of predicting future air pollution scores.
- Ho: $\mu 1 = \mu 2 = \mu 3$
- Ha: At least one of the means is different from the others.
- From our ANOVA single factor table, the F value is 0.63991 and the F critical value is 3.28491. Therefore, we must fail to reject Ho because the F value < F critical.
- Thus, we believe Ho to be true, that the air pollution score means are statistically the same.

H3b: Analysis & Results

- Hypothesis: The means of the greenhouse gas scores of three different vehicle types over a 12 year span (2001-2012) are different, causing vehicle types to be good indicators of predicting future greenhouse gas scores.
- Ho: $\mu 1 = \mu 2 = \mu 3$
- Ha: At least one of the means is different from the others.
- Since the F value > F critical value, we reject Ho & infer Ha, that at least one of the means is different and we go into multiple comparison testing.

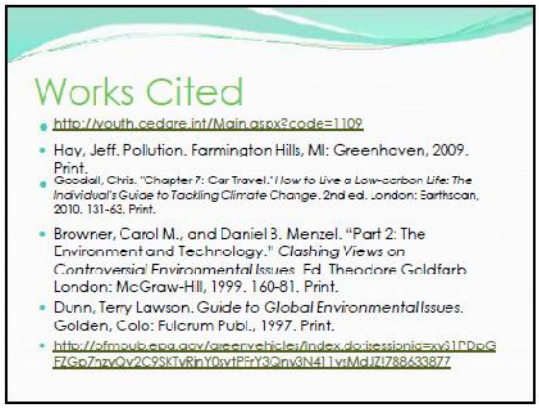
Comparison 1 – Ho: $\mu 1 = \mu 2$, Ha: $\mu 1 \neq \mu 2$ ($\mu 1$ = Chev. Impala, $\mu 2$ = Jeep Wrangler). From the chart on Excel, the p val. is ~ 1.00882E-7, which is < alpha of 0.05. Therefore, we must reject Ho, meaning that the two means are statistically different.

Comparison 2 – Ho: $\mu 2 = \mu 3$, Ha: $\mu 2 \neq \mu 3$ ($\mu 2$ = Jeep Wrangler, $\mu 3$ = Nissan Altima). From the chart on Excel, the p val. is ≈ 3.12F-10, which is < alpha of 0.05. Therefore, we again reject Ho, meaning that the two means are statistically different.

Comparison 3 - Ho: $\mu 1 = \mu 3$, Ha: $\mu 1 \neq \mu 3$ ($\mu 1$ = Chev. Impala, $\mu 3$ = Nissan Altima). From the chart on Excel, the p val. is ≈ 5.80494E-6, which is < alpha of 0.05. Therefore, we reject Ho, meaning that the two means are statistically different.

Conclusions

- From H1a, we can conclude that vehicle companies seem to have made changes to their products in order to change their air pollution scores because we found out that the mean difference does not equal zero.
- From H1b, we can conclude that vehicle companies appear to have made no changes to their products in order to change their greenhouse gas scores due to a mean difference of zero.
- From H2, we can conclude that greenhouse gas scores and air pollution scores are correlated about 97% meaning that there is a 97% chance that an increase in a vehicles greenhouse gas score indeed should cause an increase in the same vehicles air pollution score.
- From H3a, we can conclude that vehicle types are not good indicators for predicting future air pollution scores because the air pollution score means are statistically the same for each vehicle.
- From H3b, we can conclude that vehicle types are good indicators for predicting future greenhouse gas scores because the results of our multiple comparison testing suggests that the mean greenhouse gas scores for each vehicle are statistically different.
- Overall, from the findings above, we see that vehicle companies have made changes in order to change their air pollution scores, but not their greenhouse gas scores. so it is up to you to decide which vehicle products you invest in. Do your research on vehicle efficiency, pollution, and friendliness to the environment, and you should be fine.



Works Cited

- http://youth.cedare.int/Main.aspx?code=1109
- Hay, Jeff. Pollution. Farmington Hills, MI: Greenhaven, 2009. Print.
- Goodall, Chris. "Chapter 7: Car Travel." *How to Live a Low-carbon Life: The Individual's Guide to Tackling Climate Change*. 2nd ed. London: Earthscan, 2010. 131-63. Print.
- Browner, Carol M., and Daniel 3. Menzel. "Part 2: The Environment and Technology." *Clashing Views on Controversial Environmental Issues*. Ed. Theodore Goldfarb. London: McGraw-Hill, 1999. 160-81. Print.
- Dunn, Terry Lawson. *Guide to Global Environmental Issues*. Golden, Colo: Fulcrum Publ., 1997. Print.
- http://ofmpub.epa.gov/greenvehicles/Index.do;jsessionid=xy61PDpGFZGp7nzyQv2C9SkTyRnY0svtPFrY3Qnv3N41VrMdJZI788633877