Understanding How Unique Attributes Might Affect Poverty

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Abstract

The paper starts out noting that poverty has become a major problem for numerous nations. It is argued here that poverty is probably correlated with education, and that there are several factors which might have significant correlations with the poverty rate. These factors are coal production, government spending divided by Gross Domestic Product, and male smoking rate. The paper's literature review consists of two articles focused on coal, one on lung cancer, and another on government expenditures. The multiple regression, linear regression, and summary discuss things such as the history of the model, and key quirks presented in it. Finally, the robustness tests deal with the statistical significance. The end result of this analysis revealed that there is not a strong correlation between these variables.

Introduction

Western civilization has seen a massive development in technology since the Industrial Era. During this period, people have seen many luxuries introduced such as cars, the microwave, air conditioners, and various other handy home appliances. At the same time, though, there has been a steady increase in poverty in some areas (Lanter). There are many reasons why poverty is a constant issue. Education is a major factor in this. However, there also needs to be an in-depth look at how poverty is affected by government expenditures per capita divided by Gross Domestic Product (GDP), amount of coal produced in each nation, as well as the percentage of adult male population who regularly consume tobacco products. All of these traits are likely to have a correlation with poverty. There are important reasons for why poverty is linked to these

factors. Understanding why they have been chosen is critical to comprehending how some elements of poverty come about, and what can potentially be done about it.

Literature Review

"Cleaning Up Coal: From Climate Culprit to Solution"

The first article is "Cleaning Up Coal: From Climate Culprit to Solution" by Richard K. Morse (*Foreign Affairs, 2012).* This article explores several problems surrounding coal usage in developing countries and compares the coal policies to those of more developed countries. The paper observes that coal usage in more developed regions has leveled out in recent years, while coal usage in less developed countries has skyrocketed. This boom has kept coal at 30 % of the world's energy consumption, second only to oil's 34 %. The author notes that it will be difficult to reduce carbon emissions as long as coal is a prominent energy source. In observation of this, Morse explains that coal was not always considered problematic. In fact, back in the 1980s, it was deemed a solution to the oil shortage confronting countries during that decade. It was not until the development of natural gas that it became clear that coal was a problematic energy source, as the former is more efficient and less polluting than the latter. Most important, the article also notes that there are dangers to being overly dependent on coal, as evidenced by various cities in China having seen their air quality significantly contaminated by this resource. In observation of this, Morse has argued that the most practical solution to the problem of coal pollution would be to focus on developing carbon-neutral coal.

Elevated Risk in the Appalachian Region

This article discusses the elevated risk of lung cancer present in Kentucky (*Public Health Reports, 2011*). This is important, in part, because of the fact that lung diseases might be the

result of excessive smoking. If this is the case, it is possible that smoking might be a major feature of poverty. The authors, Huang and Christian, argue that tobacco is not the only cause of lung cancer, but it also has to do with the toxins resulting from coal mining. However, what is also noted is that Kentucky's problems might have something to do with the fact that the state has one of the highest rates of cigarette usage in the nation. Apparently, one-fourth of adults in the state smoke. What is also intriguing about the state is that there appears to be a regional divide, in terms of where cigarette usage is the most prominent. Western Kentucky, for example, is comparatively lower in cigarette usage than the eastern part of the state. The author notes that this may have something to do with the fact that the Appalachian part of the state is more affected by lung disease and smoking problems than other parts of Kentucky. The varying rates may also be the result of arsenic and other toxins having made their way into various private wells' underground sources.

Mining and Poverty Reduction

Coal production has become a major player in energy markets in South America. Several writers, Weber-Fahr, Strongman, Kunanayagam, McMahon, and Sheldon, address this. They begin by noting that policymakers have been attempting to craft solutions to the problems caused by coal that are related to macroeconomics, the environment, water quality, personal health, transportation, private-sector development, and energy. They note that the coal industry can be helpful to nations, as evidenced by leading to economic booms during thriving cycles with increased development, higher incomes, and more rapid GDP growth. In contrast, this can lead to major economic shocks to the system when things turn south, proven when countries have problems such as mine closures, contaminated water, and vast public corruption. The article notes how coal extraction is conducted through both small and large-scale operations, and the

impact that each of those business styles has on the local economy. Effectively, the authors note that large-scale actions have been undertaken, and it is necessary for policymakers to be capable of creating solutions to address the excess of coal excavation and how it has devastated the local economy.

Can Government Purchases Stimulate the Economy?

Valerie A. Ramey's article deals with the topic of government spending, and questions of whether increasing government expenditures significantly stimulates the economy (*Journal of Economic Literature*, 2011). Discussions of government spending are important because typically, economies have increased government spending during times of crisis as a way to limit devastating economic contractions. The author starts out by noting that there have been various theories by leading economists in regard to how much one dollar of expenditure increase results in how much economic growth. Two of these models brought up by the author are the government spending multiplier and the tax multiplier. The article notes that the multiplier for government spending is 1/1-mpc, while the tax multiplier is –mpc/1-mpc. In the last section, the article notes that economists have varying observations of how government spending stimulates the economy. Some economists apparently found a massive boost in stimulus, while others' findings were far less significant.

Literature Review Summary

In analyzing this information, I conclude that it is crucial to figure out the relationship between the coal industry and poverty. The industry seems likely to result in poverty, based on the evidence from the articles on Appalachia, and the potential problems involving coal. This project is unusual in the sense that it heavily focuses on the concept of coal relating to poverty.

The texts also raised intriguing questions about lung cancer and government spending related to poverty.

Data

Variables

The variables for this equation are povrat, coalprod, gdp, and *malsmok.* For this project, *povrat* represents the poverty rate for each nation as well as the dependent variable, while *coalprod, gdp,* and *malsmoke* represent amount of coal produced, per capita government spending/GDP, and smoking rate in the nations as well as the manipulated variables. These three concepts were chosen based on the fact that in the US, Appalachia is one of the poorest regions of the US (Lanter). The region itself has an economy which has two major products: tobacco and coal. Considering this, it seems probable that the excesses of coal production and tobacco consumption would also be positively correlated with the poverty rates of nations outside the US. There are other factors which seem just as likely, if not more likely, to have an impact on the poverty rate, such as income and education levels. The reason that those variables were eschewed was that I wanted to test factors which have not been tested as thoroughly. It is crucial to figure out how coal and smoking correlate with the poverty rate.

Reason for Variables Chosen

The independent variables chosen for this hypothesis may seem unusual to some experts since coal production and smoking are factors which many people would argue have little to do with world poverty. However, these analysts are missing the “big picture” in this research. These factors do seem likely to correlate with the poverty rate. The attributes chosen seem to be major problems in the Appalachian US, where the independent variables mentioned, each have some form of prominence (Christian, P.3). Given this situation, it seems likely that these issues would

be present in other regions that are heavily dependent on coal. There are numerous articles which look into how poverty is affected by these factors, especially coal.

Data Sources

In terms of the project's sources, it should be noted that the project used more than one information source for the same variable. This is due to the fact that some of the information used for this project has been relatively scarce. That originates from the limitations in the original model which demanded that the four variables in the multiple regression had to be from the year 2012. This left the project having very few countries with fully completed information. As a result, several sources of data were used for the assignment. The original outline had only four sources, each one specialized to a particular variable. The statistics on coal production originated from the British Petroleum (BP) website. The information on the poverty rate was found on the CIA Website. GDP originated from the World Bank, and the information on male smoking rates came from the World Health Organization Unfortunately, as mentioned earlier, these information sources did not contain enough data for the fiscal year 2012 to meet the minimum 30 countries needed for a valid model.

To fill in the gaps, information from the OECD was used to find data on the poverty rate for the 2012 fiscal. In terms of information on coal production, the source used in this project was the Energy Information Administration (EIA) which replaced the British oil company, BP's website. For the other two explanatory variables, *gdp* and *malsmok*, there was sufficient data in my original four sources.

Gauss-Markov Assumptions

It was somewhat difficult to analyze whether this project satisfied the five Multiple Linear Regression (MLR) assumptions, partly because the project relied on unique types of data. Some of the five parameters were satisfied by this project, while other parts of the model did not placate the requirements. Since the project was linear in parameters, MLR1 was satisfied. As for MLR2, the issue of random sampling was another area in this project which presented major issues because the model has only thirty-six countries, which is slightly fewer than the usual forty: otherwise, MLR2 is met. The variance of the project does appear to be positive, which satisfies MLR3. MLR4 requires that the error value of the model is equal to zero. The regression model probably does not meet the MLR4 assumption, as there are various other factors not included in the model which have a significant effect on the poverty rate, such as education levels. MLR5 discusses how much the independent variables are correlated with each other in terms of one independent variable's value significantly impacting another independent variable's value. Since the variables do not appear to have multicollinearity, the fifth assumption is satisfied.

Summary of Povrat, coalprod, gdp, malsmok Variables

Variable	Obs	Mean	Std Dev	Minimum	Maximum
Povrat	36	20.86869	15.86083	2.3	72.3
coalprod	36	94415.65	163474.4	0	658864
Gdp	36	15.84052	4.566045	5.04	23.84288
malsmok	36	37.46389	12.74085	17.2	71.8

Descriptive Results

Povrat

There were 33 variables used in the project, which were the number of countries which had the 2012, or a similar year, information on poverty rate, coal production, per capita

government spending/GDP, and male smoking rates. The mean describes the average values of each variable mentioned. The standard deviation indicates the extent of deviation for a group as a whole, while the minimum and maximum designate the minimum and maximum values of the variables, respectively. In terms of inferences/assumptions that can be made from each piece of data, it would seem that the average poverty rate of the nations selected was almost 21 percent with a standard deviation of 15.86 percent. The lowest poverty rate was two point three percent in Turkey, while the highest poverty rate was 72.3 percent in Zimbabwe (Population). There is one major inference that we can glean from this information; The average poverty rate seems to be skewed towards the lower end of the spectrum, with a few countries having noticeably higher poverty rates. This artificially inflates the mean in comparison to normal numbers.

Coalprod

We can make similar observations about coal production, although there are similarities between coal production and the other variables, it should be noted that a unique observation can be made about this variable. In terms of these values, what jumps out is that the mean is actually lower than the standard deviation. It is possible that the situation of *coalprod* having a higher standard deviation than mean might have had something to do with this variable not being calculated in percentages. The table shows that the average amount of coal produced was about 94415.65 thousand short tonnes with an estimated deviation of 163474.4 thousand short tonnes, a minimum production amount of zero thousand short tonnes, as well as a maximum production of 658864 thousand short tonnes (Primary Coal Production 2014). Circumstances such as this usually occur when the maximum value is noticeably higher than the mean. This situation is quite similar to what was observed in *povrat*. For both variables, the mean value is probably skewed by values which fall on the higher end of the range. This gives credence to the idea that

coal production and poverty rates tend to fall on the lower end of the distribution with a few anomalies.

Gdp* and *malsmok

It seems that there is a somewhat more common distribution for these values, partly because the range is much smaller than those of *Povrat* or *coalprod*. These two variables hae a definite upper limit of 100, because they are percentages of the population.

Results

Povrat **= 37.21 - (1.09*10^-5)***coalprod* **+ -.315***gdp* **+ -.276***malsmok* **+ u**

Povrat = 21.89 - 1.09*10^(-5)*coalprod* + u

Pwcorr Povrat, coalprod, gdp, malsmok

	Povrat	coalprod	gdp	malsmok
Povrat	1	0	0	0
Coalprod	-.119	1	0	0
Gdp	-.0002	-.0988	1	0
malsmok	-.1932	.0389	-.3586	1

Pwcorr Povrat, coalprod

	Povrat	coalprod
Povrat	1	0
Coalprod	-.119	1

Multiple Regression Results

Povrat = 37.21 - **(1.09*10^-5)***coalprod***+ -.315***gdp* **+ -.276***malsmok* **+ u**

It seems that coal has an insignificantly negative correlation with the poverty rate, rather than a positive one. The model also has a noticeably small R^2 value of .05. This indicates that the model does not use too many explanatory variables. In terms of the Root Mean Square Error (MSE), a 16.12 number indicates an unusually high variance. This might be the result of the

model having a relatively low number of observations. The intercept is 37.21. As for the residual sum of squares (SSR), this value's high level of 8317 indicates that the model is not valid. There are not enough observations in the model.

Linear Regression Results

Povrat **= -(1.09*10^-5)***coalprod + u*

Dropping *gdp* and *malsmok* did not change either the coefficient or the standard deviation. This gives the impression that *gdp* and *malsmok* were not statistically significant variables. The rest of the model is quite similar to the Multiple Regression. SSR is still quite high at 8694 and the Root MSE is still around 16, which indicates a high error level. The R-squared number becomes somewhat smaller at .0125. This noticeable change is probably the result of two variables having been dropped from the model. Interestingly, the intercept value also experienced a significant drop from 37.21 to 21.89. Similar to the Multiple Regression, the Linear Regression model is also probably not valid.

Statistical Significance: p-value, t-test, confidence interval

It seemed probable that coal production would have a strong positive correlation with the poverty rate. In an attempt to test this, the p-value, t-test and confidence interval were done at each interval (10%, 5%, 2.5%, 1%, and .5%). Surprisingly, each of these robustness tests showed that there is no statistical significance between any of the explanatory variables, as seen with the p-value of each variable. In the multiple regression, *coalprod*, *gdp*, and *malsmok* have p-values of .52, .627, and .238, respectively while in the linear regression, *coalprod* has a value of .516. If these values were to be converted to percentages divided in half, all of these values would be greater than 10 percent. Since the p-value is the lowest percentage in which you can reject the null hypothesis, and the null hypothesis has been failed to be rejected at each interval, this means

that none of the variables have statistical significance with the poverty rate, as the null hypothesis has been failed to be rejected at each interval. The same results are apparent with the confidence intervals and the t-tests. For the former, this is evident by the confidence intervals spanning from a negative non-zero number to a positive non-zero number, meaning that the zero is in the range for B_1. In terms of the t-test, each of the t-values' real value was less than the real value of all of the critical values for each confidence interval. Thus, the null hypothesis could not be rejected at any confidence interval.

Other Correlation Factors

There are two other factors which highlight that there is no correlation for the variables. The scatterplot shows practically no line of best fit for the *coalprod, gdp, or malsmok.* Additionally, the correlation chart depicts these variables as having no multicollinearity.

F-test statistic

The F statistic calculated from these two models is .725. Since it is lower than the critical values of all significance levels of 3.32 (there are 32 degrees of freedom with two numerator degrees of freedom), the null hypothesis is not rejected at any of the confidence intervals, meaning that all of these variables are jointly insignificant in this model. Thus, the variables chosen should be dropped from the model, as they have no serious impact on the poverty rate.

Conclusions

It seems clear that the hypothesis of poverty being significantly impacted by coal production, government spending/GDP and consumption of tobacco products has turned out to be a false assumption. This idea was based on the fact that Appalachia is one of the most impoverished regions in the US, and both coal production and smoking were abnormally higher in this region compared to other parts of the US (Christian, P.3).

As shown by the results of the robustness tests, those three explanatory variables do not have a major impact on the poverty rate. However, the literature review suggested some connections that may warrant further research in the relationship between poverty and coal industry. For example, a reason that Appalachia is extremely impoverished might have to do with the fact that the region has dealt with what is known as the "resource trap" where coal economies have limited the economic diversity of the region (McCarthy). In this situation, the local workforce limited itself to coal-based employment, driving other economic engines out of the area, leading to this resource being the sole source of jobs. As a result, when demand for coal falls, the economy falters.

On the other hand, this situation is apparently not present in coal-based areas of Latin America. This may have to do with this region just beginning experimentation with coal production. For example, Chile has seen a massive reduction in the poverty rate in conjunction with the increase in coal production, going from 785 thousand short tons to about 3338 thousand short tons, while the poverty rate fell a noticeable amount from 2011 to 2013, dropping from 22 percent to 14 percent (Population).

This greatly contrasts with the situation in Appalachia. It could be inferred that coal production can help a region become more economically productive, but this changes if the product has become the singular source of economic growth. In that situation, these places experience what occurred in Appalachia, where coal employment crowds out other forms of employment. The reasons it seemed like a possibility that coal production would correlate strongly with poverty could be constructed on both the Appalachian economy, as well as personal biases (i.e. the belief that solar energy would be necessary for economic growth).

Taking these into consideration, it seems necessary for future analysts to consider their own biases when working on data. Otherwise, failure to do so may render numerous models invalid.

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Appendix

Country	Povrat	coalprod	gdp	malsmok
Albania	14.3	5.5	10.84	52.1
Australia	12.9	492,786	18.03808	18.4
Bang	31.51	920	5.04	43.7
Brazil	8.963	7,293	18.57358	21
Bulgaria	21	36,847	15.30332	45.2
Chile	14.4	3338	12.15	41.7
Canada	16.6	73,299	21.10864	19.5
Croatia	19.5	785	12.15	39.4
Colombia	32.7	98,132	16.6768	17.2
Congo	63.6	146	12.69	32.1
Comoros	44.8	0	19.87	24.4
Czech	8.6	61,566	19.3652	38
Egypt	25.2	23	11.3	45.9
France	8.5	-	23.84288	31.1
Georgia	14.8	280.0	17.7	58.6
Germany	8.4	217,144	18.9741	33.6
Hungary	14.3	10,240	20.10607	34.5
India	21.9	658,864	10.66549	**22.8**
Indonesia	12	489,966	9.248	**71.8**
Japan	16.1	-	20.43737	**33.6**
Kazakhst	3.8	132,858	11.00773	46.3
Kyrgystan	38	1283.0	20.1	**50.2**
Mexico	18.9	15053.0	11.83258	**23.3**
Pakistan	22.3	3,504	10.48875	**40.6**
Poland	17.3	158,197	17.92593	34.9
Romania	22.4	37,418	14.97911	39.5
Russia	10.7	363,058	18.68218	60.3
S Africa	53.8	285,031	19.94972	32.1
Spain	14	6,813	19.67988	33.7
Thailand	12.6	19,918	16.40052	42.3
Turkey	2.3	78,772	14.84401	42.7
Ukraine	9.1	72,227	18.64973	51.4
U.K.	10.5	18,703	20.77512	21.8
Uzbekistan	16	4,247	15.8	25.9
Vietnam	17.2	46,389	5.927186	47.6
Zimbabwe	72.3	3,858	19.1367	31.5

Multiple Regression

Povrat **= 37.21 -(1.09*10^-5)***coalprod* **+ -.315***gdp* **+ -.276***malsmok* **+ u**

Source	SS	df	MS	**Number of Obs** = 36	
Model	487.269	3	162.42	**Prob>F** = .06042	
Residual	8317.54	32	259.92	R squared = .0553	
Total	8804.808	35	251.56	Root MSE = 16.12	
Povrat	Coef	Std dev	t	P > l t l	95% confidence interval
Coalprod	-1.09*10^(-5)	1.68*10^(-5)	-.65	.520	-4.5*10^(-5) <B_1 < 2.32*10^(-5)
Gdp	-.315	.642	-.49	.627	-1.622 <B_1<.99
malsmok	-.276	.229	-1.20	.238	-.7422502 < B_1< .1912072
_cons	37.21	15.87	2.34	.025	4.873187 <B_1< 69.53889

Linear Regression

Povrat = 21.89 - 1.09*10^(-5)*coalprod* + u

Source	SS	df	MS	Number of Obs = 36	Prob > F = 0.5157
Model	110.329945	1	110.329945	Adj R-squared = -0.0165	R-squared = 0.0125
Residual	8694.47884	34	255.719966		Root MSE = 15.991
Total	8804.80879	35	251.565965		
Povrat	coefficient	Standard dev	t	P-value	95% confidence interval
coalprod	-1.09*10^(-5)	1.65*10^(-5)	-.66	.516	-.0000445 <B_1< .0000227
_cons	21.89	3.09	7.09	0	15.61699 < B_1< 28.17126

T-tests:

Multiple Regression: *Coalprod* t value -.65 *gdp* -.49 *malsmok* -1.2

Linear Regression: *Coalprod* -.66

Since these t-values' net values are less than any of the critical values, we fail to reject the null hypothesis at all of the confidence intervals: critical values being -1.282, -1.645, -1.96, -2.326, -2.576.

P-Value:

Multiple Regression:

Coalprod: .52*100%/2 = 26% *gdp:* .627*100%/2 = 31.35%
malsmok: .238*100%/ 2= 11.9%

Linear Regression:

Coalprod : .516*100%/2 = 25.8%

Since the p-values are all greater than the confidence levels, we fail to reject the null hypothesis at each confidence interval.

Confidence Intervals:
At 90%:
Multiple Regression:
Gdp:

$((-.315)-(1.282*.642)) < B_1 < ((-.315)+(1.282*.642)) \rightarrow -1.14 < B_1 < .508$

Coalprod:

$((-1.09*10^{(-5)}) - (1.282*1.68*10^{(5)})) < B_1 < ((-1.09*10^{(-5)}) + (1.282*1.68*10^{(5)})) \rightarrow$
$-3.85*10^{(-5)} < B_1 < .106*10^{-5}$

Malsmok:

$((-.276) - (1.282*.229)) < B_1 < ((-.276)+(1.282*.229)) \rightarrow -.5695 < B_1 < .0176$

Linear Regression:
Coalprod:

$((-1.09*10^{(-5)}) - (1.282*1.65*10^{(5)})) < B_1 < ((-1.09*10^{(-5)}) + (1.282*1.65*10^{(5)})) \rightarrow$
$-3.85*10^{(-5)} < B_1 < .106*10^{-5}$

At 95%:
Multiple Regression:
Gdp:

$((-.315) - (1.645*.642)) < B_1 < ((-.315)+(1.645*.642)) \rightarrow -1.37 < B_1 < .508$

Coalprod:

$((-1.09*10^{(-5)}) -(1.645*1.68*10^{(5)})) < B_1 < ((-1.09*10^{(-5)}) +(1.645*1.68*10^{(5)})) \rightarrow$
$-3.80*10^{(-5)} < B_1 < 1.62*10^{-5}$

Malsmok:

$((-.276)-(1.645*.229)) < B_1 < ((-.276)+(1.645*.229)) \rightarrow -.653 < B_1 < .101$

Linear Regression:

Coalprod:

$((-1.09*10^{(-5)}) - (1.645*1.65*10^{(5)})) < B_1 < ((-1.09*10^{(-5)}) + (1.645*1.65*10^{(5)})) \rightarrow$
$-3.80*10^{(-5)} < B_1 < 1.62*10^{-5}$

At 97.5%:

Multiple Regression:

Gdp:

$((-.315) - (1.96*.642)) < B_1 < ((-.315) + (1.96*.642)) \rightarrow -1.57 < B_1 < .943$

Coalprod:

$((-1.09*10^{(-5)}) - (1.96*1.68*10^{(5)})) < B_1 < ((-1.09*10^{(-5)}) + (1.96*1.68*10^{(5)})) \rightarrow$
$-4.38*10^{(-5)} < B_1 < 2.2*10^{-5}$

Malsmok:

$((-.276) - (1.282*.229)) < B_1 < ((-.276) + (1.282*.229)) \rightarrow -.5695 < B_1 < .0176$

Linear Regression:

Coalprod:

$((-1.09*10^{(-5)}) - (1.96*1.65*10^{(5)})) < B_1 < ((-1.09*10^{(-5)}) + (1.96*1.65*10^{(5)})) \rightarrow$
$-4.38*10^{(-5)} < B_1 < 2.2*10^{-5}$

At 99%:

Multiple Regression:

Gdp:

$((-.315) - (2.326*.642) < B_1 < ((-.315) + (2.326*.642)) \rightarrow -1.81 < B_1 < .1.18$

Coalprod:

$((-1.09*10^{(-5)}) - (2.326*1.68*10^{(5)})) < B_1 < ((-1.09*10^{(-5)}) + (2.326*1.68*10^{(5)}))$
$\rightarrow -4.99*10^{(-5)} < B_1 < 2.82*10^{-5}$

Malsmok:

$((-.276)-(2.326*.229)) < B_1 < ((-.276) + (2.326*.229)) \rightarrow -.809 < B_1 < .257$

Linear Regression:

Coalprod:

$((-1.09*10^{(-5)}) - (2.326*1.65*10^{(5)})) < B_1 < ((-1.09*10^{(-5)}) + (2.326*1.65*10^{(5)}))$
$-4.99*10^{(-5)} < B_1 < 2.82*10^{-5}$

At 99.5%:

Multiple Regression:

Gdp:

((-.315) - (2.576*.642)) < B_1 < ((-.315) + (2.576*.642)) $\rightarrow$ -1.968 < B_1 < 1.338

Coalprod:

((-1.09*10^(-5)) - (2.576*1.68*10^(5))) < B_1 < ((-1.09*10^(-5)) + (2.576*1.68*10^(5))) $\rightarrow$
-5.417*10^(-5) < B_1 < .3.237*10^-5

Malsmok:

((-.276) - (2.576*.229)) < B_1 < ((-.276) + (2.576*.229)) $\rightarrow$ -.865904 < B_1 < .314

Linear Regression:

Coalprod:

((-1.09*10^(-5)) - (2.576*1.65*10^(5))) < B_1 < ((-1.09*10^(-5)) + (2.576*1.65*10^(5))) $\rightarrow$
-5.417*10^(-5) < B_1 < .3.237*10^-5

F statistic calculations

(8694.47884-8317.54)(98317.54/(36-3-1) *(1/2)= .725

$F_{2\ 32}$ =3.32