Bryant University

HONORS THESIS

An Examination of Sectoral Growth's Impact on Income Inequality in the United States

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Senior Capstone Project for Josh Paton

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ABSTRACT

This paper is threefold in purpose; it aims to explore the relationship between the growth of manufacturing and service sectors and income inequality, determine if GDP growth helps reduce income inequality, and establish the existence of the Kuznets Curve from 1967-2017. The data supports an inverse relationship between growth in the manufacturing sector and income inequality however is not sufficient enough to conclude growth in the manufacturing sector impacts income inequality. Growth of GDP is shown to decrease income inequality which supports the notion that "a rising tide lifts all boats" and makes everyone better off than before. The positive impacts of GDP growth are equal in magnitude to the negative impacts of the service sector so if the economy grows but the service sector grows faster inequality will increase. Finally, the data confirms the existence of a Kuznets Curve in the United States over this time period.
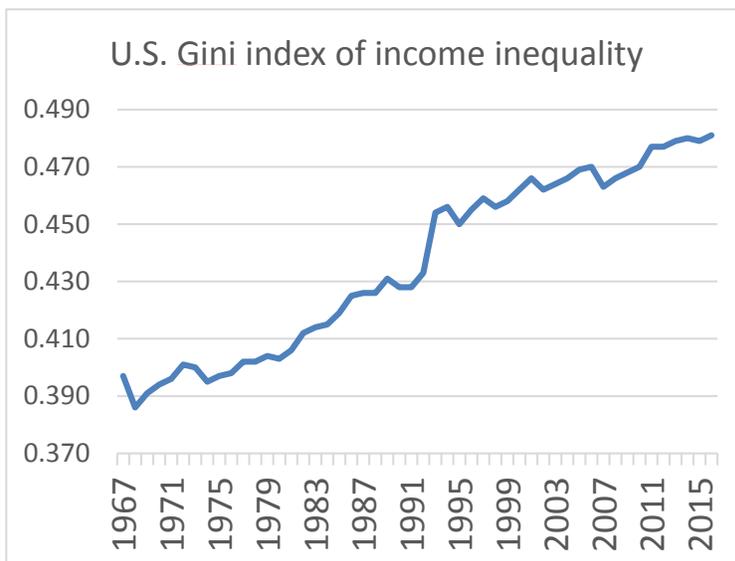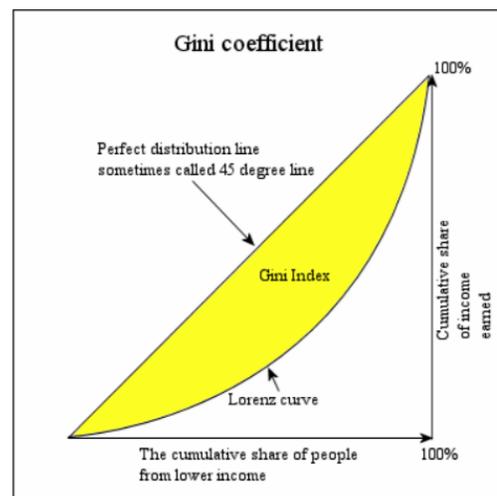
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Introduction

This Senior Capstone Research Project explores the relationship between income inequality and the allocation of labor to the agriculture, manufacturing and service sectors in the United States from 1967 to 2017.

Today the most common measurement of inequality stems from a study published by sociologist Corrado Gini in 1912. A Gini coefficient measures inequality of some distribution, using a Lorenz curve (Pictured right). The 45 degree line represents perfect distribution where by 20% of the population has 20% of the income and the line below shows the actual distribution. The shaded area between the two lines is the Gini coefficient. A

score of 1 represents complete inequality where 1 person holds all the wealth and a score close to zero represents perfect distribution.


In 2010 the United Nations published the *Human Development Report,* which classified the global Gini coefficient between .61 and .68. As comparison, the U.S. coefficient was .396 suggesting that the U.S. has a more favorable

distribution than the rest of the world; however it needs to be noted the U.S. coefficient is not close to other developed countries. As you can see from the above chart the Gini coefficient has been steadily increasing for years and is at its highest levels ever, which is cause for concern.

From 1993 to 2012 the bottom 99% of income earners saw a real increase in their incomes by a mere 6.6%. Over that same time horizon, the top 1% of earners witnessed their incomes grow by an astounding 86.1% (Saez, 2013). Clearly, there is a discrepancy in the growth of wages during this time across income quintiles. According to a 2013 study published by the Organization for Economic Co-operation and Development (OECD), a group of 34 developed countries, the U.S. ranks second to last (only after Chile) in before taxes and transfer income inequality. After accounting for taxes and transfers, the U.S. ranks 10th in this list of countries for income inequality after countries like France, the U.K, and Ireland who all have more equal distributions.
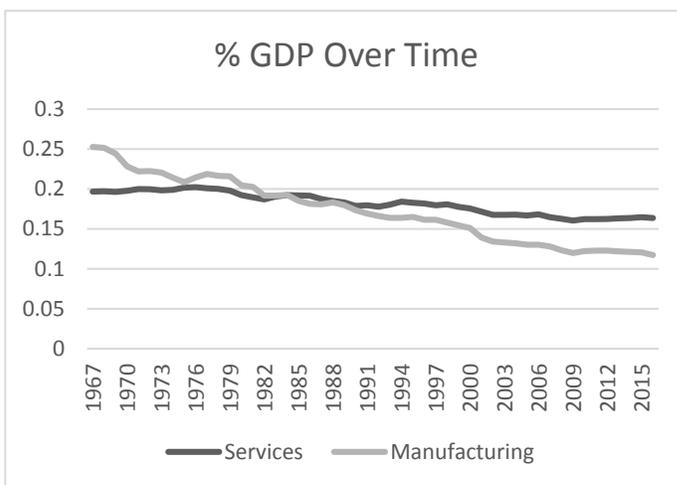
During this same time period the U.S. economy experienced two major "Ages" of production. The first being a manufacturing-based economy and the later a service-based economy. One can see the clear cross-over occurs around 1982, when the percentage of GDP produced by the service sector surpassed the percentage of GDP generated

by the manufacturing sector. I am interested in examining how the sectoral shift from manufacturing to services impacted income inequality in the U.S. from 1967 to 2015.

There are two approaches to defining the income inequality variable. Pikkety and Saez (2003) use income groupings of the top 10%, 5%, 1%, .5%, .1% and .01% of income earners' shares of all U.S. income, and how they have changed over time. The advantage to this approach is it can provide insight into how income changed for the "wealthy" and "ultra-wealthy" over a given time period.

The alternative measure of income inequality is the afore mentioned Gini coefficient, published by the World Bank. I chose to use the Gini coefficient because it is a more current measure of inequality (available up to 2017) and it considers the population as a whole and not just the rich.

The second set of data comes from the Bureau of Economic Analysis (BEA) and shows the sectoral shifts in the economy that have occurred over time. The BEA publishes a sectors percentage contribution to GDP over time. Included in this is total U.S. GDP which is used to calculate growth in GDP.

This research is relevant now more than ever because income inequality increasing and our economy is shifting to the service sector. To date, very little information regarding this topic exists so these findings will help focus the research efforts of other economists. Understanding the historical effects of a sectoral shift on income inequality will leave policy and decision makers better prepared to minimize the negative effects of income inequality.

Literature Review

Our world is currently experiencing a perplexing paradox. Inequality between countries has decreased significantly, due major economic progress in poorer countries. At the same time, inequality within countries has significantly increased (Verbeek, 2015). The International Monetary Fund (IMF) conducted a study that found from 1990-2010 inequality increased 11% within emerging economies. This indicates that while poorer countries are catching up in income inequality, within developed nations it is getting worse. In that same study they also discussed the consensus in the literature is that income inequality hinders economic growth . (Ostry et al. 2014). At the same time, in the last 20 years, the share of service based jobs in the U.S. has skyrocketed from 60% to 80% of the economy while manufacturing jobs have plummeted from 35% to 20% (Bureau of Labor Statistics, 2012). Since income inequality can retard economic growth, it is imperative to determine the causes of such inequality. This research seeks to determine the relationship between these shifts in the economy and income inequality.

To execute this research, conduct an empirical quantitative analysis will be conducted. My perspective on this topic has been shaped through my past courses in finance and economics as well as a personal interest in income inequality. Taking Public Finance with Professor Bates offered insight into the huge discrepancies of income in the U.S. At the same time, in the Archway Investment Fund I more clearly understood the historical weightings of company's market caps in benchmarks and how technology and service companies surged recently. Thus, I questioned if the changes in the economy impacted income inequality at all.

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Background/History

Research into income inequality begins with the pioneer study published by Simon Kuznets in 1955. Kuznets proposed the idea of an inverted U relationship between economic growth and income inequality, called a Kuznets Curve. He argued that in the early stages of an economy's development, increasing levels of income inequality occur, while as development continues the level of income inequality decreases. Historically, as economies develop they transition from agricultural production to manufacturing; this implies that as an economy develops and transitions from an agrarian to a manufacturing, income inequality initially rises and then falls afterwards. The Kuznets Curve exists because the new sector will initially be more profitable than the previous and the labor moving into the more profitable sector will cause inequality to rise until the majority of the population shifts over and inequality starts to fall again. In effect, the newer sector is more profitable because workers in it have a higher productivity of labor. This means that their wages should also be higher, since wages are a function of some productivity.

One major limitation Kuznets had with his proposal was the lack of data that existed. His publication was more of a call to arms for economists to address issues like these and start collecting data and performing analysis to empirically prove the inverted relationship between GDP growth and inequality.

Literature Review

Since Kuznets published his original study there have been countless attempts to prove or disprove the existence of a Kuznets curve as an economy develops. Ravallion and Chen (1997) and Deininger and Squire (1996) published dissenting views with Kuznets. They

suggested more robust estimators than growth to income inequality and in the process added a larger sample size to the research.. Huang (2012) recently disagreed with any affirmation of the existence of a Kuznets curve due to a statistical bias. He pointed out that the test researchers were performing to test for the Kuznets Curve inherently pointed towards the existence of the relationship since the Kuznets curve is supposed to be "U" shaped. Therefore when you run a quadratic test on it you are more likely to get "erroneously yield a U (or inverted)" shaped result. For this reason he suggested testing it differently to ensure that at low values the relationship is decreasing and at higher values the relationship is increasing. Finally, most recently Beddoes (2012) proposed an augmented Kuznets Curve that increases at the end due to high income sectors benefitting from an economic boom.

One thing researchers do agree on is that some type of income inequality exists in all modern nations. However, there is little consensus on it's effects on growth or the best way to address it. Barro (2000, 2008) found no statistically significant relation in income inequality and growth of a nation. Barro's study included 84 "sovereign nations." Some setbacks Barro faced was that some of his data was tampered with by the governments and therefore not clean which could skew the results. Ultimately, Barro concluded that income inequality slightly benefitted growth in richer countries and retarded growth in poorer countries. This point is important because it sets a base line for how income inequality should affect a developed country like the U.S by retarding growth. On the other hand, Perotti (1996) found that income inequality and investment have an inverse relationship that can prove fatal to development of a country, developed or developing. Similar to Barro he used a panel of 70 countries in his study. He calls investment "the primary engine for growth". Income

inequality impedes investment because only a few rich people determine where capital is allocated. Therefore money is not efficiently allocated to where it should be and growth is hindered as a result.

In Capital in the 21st Century Thomas Piketty, one of the most profound income inequality experts of this generation, argues that income inequality is inherent in a capitalistic society since the return of capital is greater than the growth rate of the economy ($r_{capital} > g_{economy}$). Lopez-Bernardo (2016) criticizes some of Piketty's points by coming up with four arguments against what he says. The most important of these is that post-Keynesian economists can learn from Piketty's insights about personal income distribution and incorporate them into their models. This nullifys Piketty's point of it being inherent because they argue that if you know what causes it you can get rid of it.

In these different perspectives to decreasing income inequality, one side of researchers offer a classical approach by leaving the market alone since it will eventually reach an equilibrium. The opposite perspective on how to deal with inequality is strict government regulation in order to redistribute incomes with less inequality (Spithoven, 2013). Spithoven concludes that income distribution cannot be left to the market alone but society rather needs the government to ensure market reform conducive to a "more favorable" distribution of income. Peterson (2001) would argue that government intervention has further increased income inequality. He agrees that some policies are needed to improve income inequality however he notes that it is not only the policies that the government is creating that are contributing to the problem, but also "what they have not done is also contributing to the increase in income inequality in the past two decades". Special interest groups can cause policy makers to shift

focus and thus pass watered downed versions of what really needs to be passed to lessen inequality.

I agree more with Peterson's perspective. He understands that today there is too much focus on the policies that are being proposed and how they "could" help income inequality. Instead society should focus on where we still need reform and regulation because the regulation that does come through is often too diluted from the political environment, resulting in little to no effect. My research topic is intended to provide insight into whether or not certain industries help or hinder the income inequality in the U.S. and thus the government could create policies to help.

EMPIRICAL MODEL AND DATA SOURCES:

The model I chose to empirically study this relationship is based off of Gonzalez and Resosudarmo (2016), where they explored sectoral shifts impact on income inequality in Indonesia. The model is best described by Eq. 1.

$$GINI = \delta + \boldsymbol{\beta_1} gGDP + \boldsymbol{\beta_2} gMGDP + \boldsymbol{\beta_3} gSGDP + \boldsymbol{\beta_4} GDP + \boldsymbol{\beta_5} GDP^2 + \boldsymbol{\varphi X} + \varepsilon \quad \text{(Eq. 1)}$$

Where:

$GINI$ is the U.S. yearly Gini coefficient

$\boldsymbol{\beta_n} gX$ is the per capita growth of GDP value added by the manufacturing (M) and service (S) sector

$\boldsymbol{\beta_n} GDP$ is GDP and GDP squared to test for the existence of the Kuznets Curve

$\boldsymbol{\varphi X}$ are the additional covariates of unemployment and education

ε is some error term

These data come from the Bureau of Economic Analysis. They published yearly industry value added to total GDP. I divided this by the population of the United States to get per capita industry value added. I then used the NAICS classification codes for each sector to aggregate and get total GDP for each sector. See **Appendix A** for a list of industries in each sector. From here I calculated the 5 year average growth rate of each. Using growth rates for sectors eliminates any statistical unit roots issues and is better because absolute levels are linearly biased whereas growth rates vary. φX includes data on education and employment to population as well as growth of GDP. The data for education are obtained from the United States Census Bureau. It is a measure of the percent of the population that is older than 25 years and have completed at least 4 years of college. The employment data are gathered from the United States Bureau of Labor Statistics. The employment to population ratio is used to control for population. Both of these controls are on a per capita level. This ensures that demographics of the population are not driving the output but rather the meaning behind the economic variable. The growth of GDP variable is used to control for the growth of all other sectors not accounted for in this model.

For a complete descriptive summary and correlation table reference **Appendix B**.

Statistical Corrections

In order to ensure robust results various statistical tests were conducted for multicolinearity, homoscedasticity, and serial correlation. I calculated the variance inflation factors (VIF) for this model and got a mean VIF of 99.35. This is substantially higher than 10 which would suggest multicolinearity exists. One reason for this multicolinearity could be my small sample size of 45 observations. While small, these observations should still have good

predicting power because they exceed the recommended 35 observations. To look more into this high VIF I looked at the correlation matrix. The highest correlation is between GDP and GDP^2. This makes sense because GDP^2 is a derivation of GDP. Also when I look at the breakdown of VIF the two highest factors involved those two variables. Because they are not correlated by chance and have a dependent effect I will not worry about correcting for this multicolinearity.

Second, with multicolinearity taken care of I decided to test for any heteroskedasticity in my data to ensure that the OLS estimator assumptions were met. At first I created residual plots for all of my variables but did not see any heteroskedasticity in the data. To be sure I calculated a White's test (**Appendix D**). The White's test failed to reject the null hypothesis of homoskedasticity. To ensure the reliability of this test, I also performed a Breusch-Pagan test for heteroskedasticity (**Appendix E**). This test also confirmed that the dataset was homoskedastic in nature. Because it is homoskedastic in nature it satisfies the assumption for an OLS regression and no transformations needs to be carried out.

Last, I checked for serial correlation amongst the dataset. I performed a Breusch-Godfrey test (**Appendix F**). The test confirmed the presence of serial correlation by rejecting the null hypothesis. To verify the accuracy of this test I also performed the Durbin's alternative test for serial correlation (**Appendix G**). This yielded the same result so I can confidently conclude that some form of serial correlation exists. . Now that I diagnosed serial correlation I determined the extent by calculating a Durbin-Watson d-statistic. The d-statistic was 1.0504. This statistic ranges from 0 to 4 with 0 representing perfect positive serial

correlation, 2 meaning no serial correlation and 4 representing negative serial correlation. A value of 1.0504 is less than 2 which confirms the presence of positive serial correlation.

RESULTS AND DISCUSSION

Existence of Kuznets Curve

Table 1. (CO) Regression

Prais-Winsten AR(1) regression -- iterated estimates

Source	SS	df	MS			
				Number of obs	=	45
				F(7, 37)	=	254.66
Model	.024135963	7	.003447995	Prob > F	=	0.0000
Residual	.000500963	37	.00001354	R-squared	=	0.9797
				Adj R-squared	=	0.9758
Total	.024636926	44	.00055993	Root MSE	=	.00368

GINI	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
gMANU	-.1347816	.0863892	-1.56	0.127	-.3098228	.0402595
gSERV	.3004189	.1390454	2.16	0.037	.0186862	.5821516
gGDP	-.2722465	.1289369	-2.11	0.042	-.5334974	-.0109956
EDU	.0400723	.1407723	0.28	0.777	-.2451595	.3253041
EMPLOYPOP	.0004265	.0006109	0.70	0.489	-.0008113	.0016644
GDP	8.70e-09	2.90e-09	3.01	0.005	2.83e-09	1.46e-08
GDP2	-2.45e-16	9.28e-17	-2.64	0.012	-4.33e-16	-5.73e-17
_cons	.3576494	.0395654	9.04	0.000	.2774823	.4378166
rho	.4988075					

Durbin-Watson statistic (original)   1.050415
Durbin-Watson statistic (transformed) 1.800222

To correct for the serial correlation I used the Cochrane-Orcutt(CO) method. After completing this method the transformed Durbin-Watson statistic was 1.8002 which is much closer to two and therefore corrected for the serial correlation.

As you can see from Table 1 there is a significant coefficient on the growth of service sector but insignificant coefficient on the growth of manufacturing sector vector. The growth of service coefficient of .3004 means that a 1 point increase in the growth of GDP will increase the Gini coefficient and thus inequality by .3. Because the growth is measured as a percentage in decimal format this suggests a 1% increase in the service sector raises the Gini coefficient by .0034 points. This is to say that as people enter the service sector income inequality increases. However, people leaving the manufacturing sector doesn't affect income inequality. Thus the growth of the manufacturing sector has no predictive power.

One of the interesting results is the significance and sign on GDP and GDP^2. GDP is positive and significant at the .01 level and GDP^2 is negative and significant at the .05 level. This means that GDP is a significant predictor of income in equality in the U.S. Because GDP^2 is negative that means that GDP is related to Gini coefficient in a negative quadratic. This agrees with the Kuznets curve that Kuznets proposed in 1955.

The growth of GDP is also significant at the .05 level and negative. This means that as the economy grows, that is that the GDP gets bigger, inequality decreases. Theoretically as the economy grows there will be more jobs and people will fill those jobs. People who were not previously working will now be making money and this will decrease inequality in the U.S. A coefficient of -.2722 means that for every 1% increase in GDP the Gini coefficient decreases by .0027 points.

It is important to note that the service sector might be underrepresented due to inefficiencies in measuring productivity. This is because two people in the service sector can work the same

amount of time however their productivity will be drastically different. A doctor or a consultant that works an hour will have a different amount of output than a worker at a cashier at some fast food restaurant. However, all of these occupations get put into the service sector. In addition to this it is difficult to measure what the true ouput of these workers are so sometimes the data is unrepresentative of their true contribution to GDP.

CONCLUSION

This paper investigated the effects of growth in the manufacturing and service sector on income inequality in the United States from 1967 to 2017. In essence, the past literature explores in detail the factors and consequences of income inequality in the United States. The literature fails to connect how economic growth, measured by the allocation of labor to different sectors over time, impacts income inequality. The results indicate that that general growth of the economy, in terms of GDP, benefits all members of the economy. Also growth in the service sector increases income inequality while growth of the manufacturing has no predicting power in determining income inequality. Finally, it also confirms the existence of a Kuznets Curve.

Growth of GDP decreasing income inequality is a significant finding since it indicates that not only the rich benefit from the economy growing. This means that "a rising tide lifts all boats and not just the yachts." Therefore, as the economy grows everybody is better off because economic growth creates more jobs that people fill and get paid for. In turn, income inequality decreases because less people are unemployed and working less skilled jobs.

It is important to note that this economic growth is almost equal in magnitude to the service sector results. Market forces continue to move us to the service sector. If this growth is greater than the growth of the economy, inequality will worsen since the negative effects of the service sector will outweigh the positive effects of overall growth. However, if the growth of the economy can sustain at a rate larger than the growth of the service sector, then income inequality as a whole will decrease. Therefore policy makers should be focusing on growing the economy as a whole and not just on sector to impact inequality.

Finally, the data also confirm the existence of the Kuznets curve for the U.S. over this same time period. Therefore as the U.S. economy develops income inequality should initially rise and then fall.

The Gini coefficient will never be 0 and some levels of inequality are good. With this said policy makers can target to decrease inequality and make more people better off. These results suggest that policy makers should not be focusing their efforts on the manufacturing and service sectors, but rather the economy as a whole. If they can help grow it at a rate faster than the growth of the service sector then everyone will be better off because the rising tide lifting all boats will serve the U.S. better than focusing on lifting just one industry.

Future Research

One thing that researchers could look into in the future is the same study with a panel data set of states in the United States. This would multiply the number of observations by 50 and make the results more robust because of the larger sample size. This would also control for any regional effects such as the Midwest being more agricultural based or the Northeast being

more service oriented. Any econometric model is only as good as the data that is behind it and unfortunately it would be very difficult to locate state level data for all of these variables .

Another thing researchers can look into in the future is the idea of the *augmented age*. As technology advances more and more we are entering an age in which human production is augmented by a machine of some point. In theory the augmented age would make manufacturing a more attractive sector than services because humans would be able to lift more, perform tasks faster, etc. with the help of robots. Therefore someone could look into the effects of the augmented age on income inequality. Since the manufacturing sector was not seen as a significant predictor of income inequality there is another sector that is contributing to the huge increase in U.S. income inequality.

Finally, researchers could segment the sectors into industries. Right now things like "Legal Services" fall into the same service sector as "Museums". These are clearly totally different services being offered. I did not take a look at the significance of each of these industries that make up the sector. Lawyers are going to make more than museum workers so growing one of these industries more would definitely contribute to inequality more and therefore investigating which had a larger impact would prove useful.

APPENDICES

Appendix A- Manufacturing and Service Industries according to NAICS

Manufacturing:

Code	Industry Title	Number of Business Establishments
20	Food and Kindred Products	42,516
21	Tobacco Products	562
22	Textile Mill Products	10,462
23	Apparel, Finished Prdcts from Fabrics & Similar Materials	23,395
24	Lumber and Wood Products, Except Furniture	45,331
25	Furniture and Fixtures	12,993
26	Paper and Allied Products	9,534
27	Printing, Publishing and Allied Industries	88,936
28	Chemicals and Allied Products	37,783
29	Petroleum Refining and Related Industries	4,301
30	Rubber and Miscellaneous Plastic Products	17,074
31	Leather and Leather Products	4,835
32	Stone, Clay, Glass, and Concrete Products	21,709
33	Primary Metal Industries	11,484
34	Fabricated Metal Prdcts, Except Machinery & Transport Eqpmnt	50,689
35	Industrial and Commercial Machinery and Computer Equipment	78,074
36	Electronic, Elctrcl Eqpmnt & Cmpnts, Excpt Computer Eqpmnt	37,473
37	Transportation Equipment	22,011
38	Mesr/Anlyz/Cntrl Instrmnts; Photo/Med/Opt Gds; Watchs/Clocks	29,967
39	Miscellaneous Manufacturing Industries	64,703
	Total Business Establishments	613,832

Services

Code	Industry Title	Number of Business Establishments
70	Hotels, Rooming Houses, Camps, and Other Lodging Places	121,820
72	Personal Services	670,701
73	Business Services	2,063,429
75	Automotive Repair, Services and Parking	341,735
76	Miscellaneous Repair Services	268,579
78	Motion Pictures	73,535
79	Amusement and Recreation Services	309,283
80	Health Services	1,101,923
81	Legal Services	295,022
82	Educational Services	324,598
83	Social Services	335,583
84	Museums, Art Galleries and Botanical and Zoological Gardens	25,320
86	Membership Organizations	632,460
87	Engineering, Accounting, Research, Management & Related Svcs	1,075,075
89	Services, Not Elsewhere Classified	109,819
	Total Business Establishments	7,748,882

Appendix B- Descriptive Statistics and Correlation Table

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
GINI	50	.43632	.0312576	.386	.481
gMANU	45	.0564402	.0343451	.0114276	.1422673
gSERV	45	.0707767	.0340275	.0159999	.1383383
gGDP	45	.0763432	.0332187	.0231753	.1420301
EDU	50	.2166656	.067658	.1006065	.3343953
EMPLOYPOP	51	76.16275	3.897741	69	81.5
GDP	50	7630452	5534200	861731	1.86e+07
GDP2	50	8.82e+13	1.02e+14	7.43e+11	3.47e+14

Correlation Matrix

	GINI	gMANU	gSERV	gGDP	EDU	EMPLOY~P	GDP	GDP2
GINI	1.0000							
gMANU	-0.8317	1.0000						
gSERV	-0.9187	0.9389	1.0000					
gGDP	-0.9277	0.9329	0.9687	1.0000				
EDU	0.9681	-0.7631	-0.8895	-0.8841	1.0000			
EMPLOYPOP	0.6567	-0.4791	-0.5906	-0.5320	0.5914	1.0000		
GDP	0.9512	-0.7555	-0.8653	-0.8805	0.9853	0.4831	1.0000	
GDP2	0.8665	-0.6654	-0.7673	-0.8063	0.9283	0.2965	0.9730	1.0000

Appendix C- Variance Inflation Factor (VIF)

Variable	VIF	1/VIF
GDP	354.64	0.002820
GDP2	140.42	0.007121
EDU	117.26	0.008528
gSERV	37.15	0.026915
gGDP	25.19	0.039697
gMANU	13.80	0.072441
EMPLOYPOP	7.00	0.142833
Mean VIF	99.35	

Appendix D- Whites Test for Heteroskedasticity

```
White's test for Ho: homoskedasticity
        against Ha: unrestricted heteroskedasticity

        chi2(26)       =      27.46
        Prob > chi2    =      0.3857

Cameron & Trivedi's decomposition of IM-test
```

Source	chi2	df	p
Heteroskedasticity	27.46	26	0.3857
Skewness	12.73	6	0.0476
Kurtosis	0.50	1	0.4812
Total	40.68	33	0.1683

Appendix E- Breusch Pagan Test for Heteroskedasticity

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
        Ho: Constant variance
        Variables: fitted values of GINI

        chi2(1)        =       1.27
        Prob > chi2    =      0.2595
```

Appendix F- Breusch Godfrey Test for Autocorrelation

```
Breusch-Godfrey LM test for autocorrelation
```

lags(p)	chi2	df	Prob > chi2
1	17.207	1	0.0000

```
                    H0: no serial correlation
```

Appendix G- Durbin's Alternative Test for Serial Correlation

Durbin's alternative test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	22.906	1	0.0000

H0: no serial correlation

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