

Impact of Energy Crisis on Economic Growth of Pakistan

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Abstract

Energy plays vital role in growth of any economy. The study relates energy consumption with economic growth for Pakistan based on the sample data taken for the period of 1982-2011. Energy consumption is taken as independent and GDP as dependent variable. Data is analyzed through descriptive statistics, correlation and regression tests. Descriptive statistics gives general summary and features of the data. Correlation results show the variables are strongly related to each other. While regression shows that if energy consumption increases by 1 kilo ton of oil equivalent, the GDP will increase by \$2.517 million. These results identify how important energy consumption is for the economic growth of Pakistan. Government of Pakistan should focus on utilization of energy resources which in turn will smooth the way for economic growth.

Introduction

Energy crisis is defined as price rise of the energy resources or a great shortfall in the supply of the resources of energy. Usually it is referred to shortage of electricity, oil, natural gas, and other natural resources. As the world is changed entirely by globalization, many issues have emerged among which the energy got significant attention of researchers. With respect to supply the demand for energy is continuously increasing in this globalized world; resultantly crisis for energy has emerged. Shortage of energy is faced by most of the countries and consequently it is severely affecting their economic growth and social transformation. There are numerous views and ideas that potentially make linkage between energy and economic growth. Energy is considered as a backbone of any economy and plays an important role in the socio-economic development of a country. If there is not sufficient energy, industrialization will not take place, it is crucial for running industries and output units, for residual and commercial use and for transportation, etc. As expansion in energy is expected to result higher growth similarly its shortage may hold back the growth process. In short, energy is vital for running all the resources and energy crisis directly influence all the sectors of economy such as agriculture sector, industrial sector, unemployment, poverty, lower GDP and higher inflation. Unfortunately, Pakistan is facing worst energy crisis in its history. Pakistan like other developing countries is one of the energy intensive growing economy, and its energy needs are met by large quantities of oil imports as in most other non-oil producing countries. Pakistan energy's infrastructure is not well developed and said to be managed poorly. Despite of population growth, economic growth and increased demand during the past decades, no serious efforts were made for the generation of energy. Moreover electricity theft and transmission losses due to outdated infrastructure have worsened the situation.

Hydro, oil, and natural gas are the three primary energy resources of Pakistan used to fulfill the energy needs of the economy. According to EAW 2013, the proportion of energy generation for Pakistan is 36% from hydro and nuclear source, about 35% generation from furnace oil-fired sources, 29% energy generation from gas-fired sources and 0.1% accounted from coal-fired plants (see Figure 1: Source: EAW 2013). Due to limited oil reserves and political system, Pakistan is importing large quantity of petroleum products from Middle East especially Saudi Arabia.

The production, economic, industrial and trade activities of Pakistan are badly affected due to the current industrial, financial and energy crisis. As industries continue shutting down the workers will get unemployed and will take on streets. In other countries of the world, government helps industries by providing numerous incentives along inputs at cheater rate which in turn increase productivity, exports, and competitiveness in the global market and thus ultimately boost their economy. But in Pakistan most industries are not self capable of generating power and also distressed with heavy taxes and costly energy supply with continuous disruption which results in loss of output production especially textile industry whose exports are restricted to a very low level and are shutting down or either shifting to the neighbor countries. For short-run Pakistan is implementing various strategies such as payment of circular debt, coal based 600MW electricity plant at Port Qasim with the help of China, 10,000 acre solar park in Punjab with Chinese support and importing electricity from Iran but for long-run government promptly needs to take some serious steps on priority basis to completely end energy crisis.

Objective

The main objective of the study is to find out the extent of energy crisis impact on economic growth of Pakistan.

Literature Review

Global Perspective

Article 1: For India and Indonesia, unidirectional Granger causality is found in the short run, while for Philippines and Thailand there is causality in bidirectional that runs between energy and income. Energy, income and prices were mutually casual for Thailand and Philippines. (Adjaye, 2000).

Article 2: For Asian developing countries there is positive impact on economic growth by electricity consumption and bidirectional causality is found between electricity consumption and economic growth. It shows that greater electricity consumption leads to higher economic growth and similarly higher economic growth raise electricity consumption (Bayar, 2014).

Article 3: Using error correction model and Granger non-causality tests, empirical results shows that in Pakistan case there runs unidirectional Grangers causality from coal to GDP, GDP to total energy consumption & GDP to electricity consumption. In case of Bangladesh and Sri lanka, unidirectional causality runs from GDP to electricity consumption, there is causal direction from petroleum to GDP in case of Nepal, while no causality was found in case of India (Asghar, 2008).

Article 4: Using integration tests on the panel data for ten Latin American countries, results show that for all the countries taken in sample, bidirectional causality exist between energy consumption and GDP. For further studies human capital, physical capital and labor can be included in variables as these are also important factors (Campo & Sarmiento, 2013).

Article 5: Applying various tests on panel data of Pakistan, India, Sri lanka, Bangladesh and Nepal, in short-run there is causality found which is unidirectional that runs from GDP per capita to energy consumption per capita, while in long-run, there is negative relationship between these two (Noor & Siddiqi, 2010).

Article 6: There is causality found from energy consumption to GDP and GDP to energy consumption but it is found more extensively in developed OECD countries in compare to the developing non-OECD countries. It shows that impact of electricity consumption on GDP for developed countries is greater than developing countries of the world (Chontanawat, Hunt, & Pierse, 2006).

Article 7: Analysis indicates that energy consumption and GDP co integrate with each other. Scarcity of energy is a big constraint for the growth of an economy but when there is plentiful energy then it effects on economy is lessen (Stern D. I., 2010).

Article 8: For South Asian countries in short-run, energy consumption and GDP, and energy consumption and exports are co-integrated with each other. It shows that any crisis in energy will result in trade reduction which in turn will affect the GDP growth (Shakeel, Iqbal, & Majeed, 2013).

Article 9: Applying test on over 90 countries divided into 4 income groups, Granger causality run from GDP to energy consumption in long run for high and low income groups, while bidirectional Grangers causality between GDP and energy consumption for lower middle and upper middle groups. While consistently there is a strong relationship for the sample countries between energy consumption and economic growth (Farhani & Rejeb, Link between economic growth and energy consumption in over 90 countries, 2012).

Article 10: Taking 23 countries into sample and applying dynamic panel data GMM-system, there is unidirectional causality that runs from GDP per capita to energy consumption (Nayan, Kadir, Ahmad, & Abdullah, 2013).

Article 11: Co-integration for the real output, energy, capital and labor is found using bound test. The results prove causality that runs from energy consumption to GDP for the South Asian countries in both short-term & long-run. This means economy of each country is dependent on energy and energy crisis will definitely result in reduction of economic growth (Khan & Qayyum, Dynamic modeling of energy and growth in South Asia, 2007).

Summary

From global perspective applying tests on panel data of various countries analysis shows relationship between energy consumption and economic growth do exists. For Asian developing countries there is positive relationship; some studies found it to be unidirectional while others found bidirectional relationship. Latin countries results showed bidirectional causality between energy consumption and economic growth. Comparison of OECD and non-OECD countries was made which revealed that effect of electricity consumption on GDP is strong for developed countries than developing countries. A study for South Asian countries shows co-integration between energy consumption and GDP, and between energy consumption and trade. Analyzing data for 90 countries divided in various income groups (Farhani & Rejeb, 2012), resulted strong relationship for all sample countries between energy consumption and economic growth. Dynamic panel data GMM-system also shows unidirectional causality from GDP per capita to energy consumption for a sample of 23 countries. Bound test also found co-integration between real output, energy, capital and labor for Bangladesh, India, Sri lanka and Pakistan.

From Developed Countries Perspective

Article 12: Granger causality test and co-integration analysis shows that energy consumption is strongly linked with economic activities as well as economic growth in USA. Energy required to produce a GNP unit can be reduced by shifting to high quality of energy (Stern D. I., 2004).

Article 13: Taking GDP and energy consumption as variables for France and applying VEC along geo-statistical methods, there is long-run unidirectional relationship that flow from energy consumption to economic growth (Amiri & Zibaei, 2012).

Article 14: Positive relationship between energy consumption and economic growth was found for Turkey from 1960-2008. This relationship over the past few years has strengthened which means economy dependency on energy (especially oil) has increased (Saatci & Dumrul, 2013).

Article 15: For Turkey, there is bidirectional causality between energy production and economic growth, which means increase in energy production will increase economic growth and same way around. Also bidirectional relationship between energy import and economic growth exists which means increase of energy amount to be imported will increase the economic activity and growth (Ozkan, Özkan, & Kuyuk, 2012).

Article 16: Johansen-Juselius co-integration methodology and Vector Error Correction Modeling results indicate a unidirectional causality that run from energy consumption to GDP. Thus any kind of possible short-fall in energy may affect the process of economic growth of Turkey (Soytas, Sari, & Ozdemir, 2001).

Summary

Analysis of Developed countries shows unidirectional relationship from energy consumption to economic growth except Turkey where bi-directional relationship is found between energy production and economic growth, and between economic growth and energy import. For Turkey this relationship is strengthen during the past few years. For USA energy consumption is strong liked with economic activities and energy required to produce a GNP unit can be reduced by shifting to high quality of energy which will reduce energy requirement and environmental impact. VEC alone and VEC along geo-statistical methods for France give a unidirectional relationship in a long run which flow from energy consumption to economic growth.

From Developing Countries Perspective

Article 17: For Malaysia, taking energy consumption as dependent variable and GDP, financial development, population as independent variables, results shows that economic growth and financial development influence energy consumption in short-run as well as long-run. Energy consumption is also influenced by population in long-run (Islam, Shahbaz, Ahmed, & Alam, 2013).

Article 18: Time series data from 1954 to 1997 for Taiwan, bidirectional causality is found between total energy consumption (coal, oil, natural gas and electricity) and economic growth (YangU, 2000).

Article 19: For China, no co-integration was found between GDP and energy consumption by Johansen co-integration test while using Hsiao's Granger causality there is bidirectional causality found between energy consumption and economic growth (Hou, 2009).

Article 20: Studying the relationship between electricity consumption and economic growth for Tunisia during the years 1971-2007, bivariate vector auto-regression structure show existence of unidirectional causality is found from electricity consumption to economic growth (Chouaibi & Abdasalem, 2009).

Article 21: When examined with VECM and Johansen co-integration estimation, results shows unidirectional causality that runs from energy consumption to GDP while in long-run, feedback relationship exists between them. So for Tunisia, energy limits the economic growth. So any shocks to energy supply will badly effect the economic growth (Belloumi, 2009).

Article 22: The analysis for Sri Lanka shows that real GDP is significantly impacted by the present as well as past changes in the supply of electricity. For every 1MWh increase in supply of electricity there is an extra output of Rs.88000-137000 (Morimoto & Hope, 2001).

Summary

Unidirectional relationship between energy consumption and economic growth is found for Tunisia and Sri lanka. In Malaysia, financial development influences energy consumption in both short-run and long-run while population also influences energy consumption in long-run. For China there is no co-integration between GDP and energy consumption through Johansen co-integration test while through Hsiao's Granger causality there is bidirectional relationship. Through another study for Tunisia there is bidirectional relationship between energy consumption and economic growth, in long-run. There is also bidirectional relationship between energy consumption and economic growth.

From Under-developed Countries Perspective:

Article 23: In the economy of Nigeria, there is a positive and strong relationship between national income and

energy use. Granger causality results bidirectional relationship between manufacturing capacity utilization and energy consumption (Kabir, Zaku, A.A.Tukur, & J.G, 2013).

Article 24: For the period under study, results support that the Vietnam's economic growth is not limited by the energy consumption. With increase in economic growth demand for energy use increases but not vice versa (Binh, 2011).

Summary

For Nigeria there is relationship between energy use and national income while for Vietnam economic growth is not effected by energy consumption but with increase in economic growth demand increases for energy use.

From Pakistan Perspective

Article 25: In Pakistan, increase in energy supply will increase the economic growth while any crisis in energy supply will lead to barrier in economic growth. The impact of petroleum products and electricity is significantly high (Siddiqui, 2004).

Article 26: Applying co-integration and Hsiao's version of Granger causality on time series data from 1956 to 1996, results shows higher electricity consumption leads to economic growth while there is no feedback relationship. Increase and decrease in petroleum consumption does not affect economic growth but economic growth causes petroleum use. And there is no co-integration between gas consumption and economic growth (Aqeel & butt, 2001).

Article 27: In industries, cost of production may increase due to any shocks in the energy supply but investment in capital stock is not affected by these energy shocks (Mahmud, 2000).

Article 28: With model of non-linear relationship, real output is negative affected by the change in prices of crude oil no matter these changes or less or more than the critical price of crude oil. Subsidies on electricity should be provided by the government (Kiani, 2011).

Article 29: Consumption of electricity and economic growth are in a long-run equilibrium relationship, electricity consumption do not leads to economic growth but economic growth leads to electricity consumption, as analyzed by Granger causality test with ARDL bounds testing approach (Shahbaz & Feridun, 2011).

Article 30: For GDP and oil consumption, and electricity and GDP there is a unidirectional relationship while in case of gas and GDP neutrality relationship is proved. Demand for oil consumption will increase by any future growth in agriculture sector (Mushtaq, Abbas, Abedullah, & Ghafoor, 2007).

Article 31: From 2007 to 2009 (post energy crisis period) performance is declined by the industries of textile, cement and engineering while during the same period the industries of sugar and chemical remain consistent. To save the industries, government of Pakistan should focus on energy sector (Khurshid & Anwar, 2013).

Article 32: A long-run relationship exists between electricity consumption and GDP. There is a unidirectional causality that runs from electricity use to economic growth; this means that any possible energy crisis may retard the process of economic growth in Pakistan. Government needs to invest in energy infrastructure in order to support economic growth (Yasmin, Javid, & Ashraf, 2013).

Article 33: Horizontal analysis of the major ratios of textile industry results that as compared to pre energy crisis period, the performance of textile industry is badly affected in post energy crisis period (Shah, Essrani, Shah, & Rahat, 2013).

Article 34: Analysis through multiple linear regression analysis of independent variables; electricity use and interest rate, shows that there is negative relationship between output of textile industry and energy use, and also out of textile industry and interest rate. Government should take serious actions for the survival of industries (Afzal, 2012).

Article 35: From GDP to energy consumption there is one way causality resulted from Granger causality test while positive relationship also exists between them while tested by ordinary least squares method. GDP increases by 1.23% for 1% increase in energy consumption (Ahmad, Hayat, Hamad, & Luqman, Energy consumption and economic growth: Evidence from Pakistan, 2012).

Article 36: Johansen co-integration test and VECM confirms that there is positive relationship between energy consumption and industrial output, bidirectional causality for oil consumption, unidirectional causality from electricity use to industrial output and from industrial output to coal consumption, while for gas consumption no causality exist (Qazi, Ahmed, & Mudassar, 2012).

Article 37: Using tools as Granger causality tests, statistical analysis, correlation analysis, shows that GDP of Pakistan depend on energy consumption which include all forms i.e. electricity, oil, gas, coal. For trade there is unidirectional causality found from GDP to trade openness which means growth in GDP promotes trade openness (Chaudhry, Safdar, & Farooq, 2012).

Article 38: Any rise in prices of energy will affect the economic growth. As prices rises, manufacturers will either improve the quality standards or cut off the labor in order to survive in the market (Rashid, Azeem, & Ramzan, 2012).

Article 39: Bound testing approach to co-integration and Granger causality test results bidirectional causality in short-run between economic growth and energy consumption, while in long-run unidirectional causality exists that flow from economic growth to energy consumption. Frequent changes in energy price also impact economic growth (Adnan & Riaz, 2008).

Article 40: By applying Structural Vector Auto-regression, results reveal that economic growth increases the demand for labor force, capital stock and energy consumption. Pakistan government needs to supply energy at affordable prices to facilitate growth in economic activities (Zeshan & Vaqar, 2013).

Summary

For Pakistan several studies carried out with several models such as Granger causality, bound test, multiple regression analysis, Johansen co-integration test, VECM and correlation analysis, and all of them confirm relationship between energy consumption and economic growth. The impact of petroleum products and electricity is significantly high. Due to energy shocks cost of production may decrease which in turn effect economic growth. Future growth in agriculture sector will increase demand for oil consumption. Performance of textile, cement, and engineering industries has also declined during 2007-2009 crises which prove that industries are badly affected by energy and government should focus on energy sector. Output of textile industry is also affected by interest rate along with energy use. GDP of Pakistan depends on all forms of energy consumption i.e. oil, electricity, coal and gas. With one percent increase in energy consumption GDP increases by 1.23 percent. Economic growth increases the demand for labor force, capital stock and energy consumption. Government of Pakistan needs to provide energy required and at affordable prices for economic growth.

Hypothesis

H_0 : There is no relationship between energy consumption and economic growth for Pakistan.

H_1 : There is a relationship between energy consumption and economic growth for Pakistan.

Methodology

To study the impact of energy crisis on the economic growth of Pakistan, we take two variables; GDP (as economic growth) and EC (as energy consumption). Source used for the data is WDI (World Development Indicator). A sample of time series data is taken from 1982 to 2011.

The impact of energy usage on economic growth is discussed in various studies most of them used Granger causality test, Johansen co-integration approach, Vector Error Correction Mechanism and ordinary least square method [see for example, (Asafu-Adjaye, 2000), (Stern D. I., 2003), (Aqeel & butt, 2001), (Islam, Shahbaz, Ahmed, & Alam, 2013), (YangU, 2000), (Yasmin, Javid, & Ashraf, 2013), (Chaudhry, Safdar, & Farooq, 2012), (Stern D. I., 2010), (Hou, 2009), (Ozkan, Ömer, & Kuyuk, Energy production and economic growth: Empirical evidence from Turkey, 2012), (Binh, 2011) and (Belloumi, 2009)]. To study the relationship between the two variables study implies descriptive statistics, correlation and regression analysis. Descriptive statistics tells the basic features of data. They give general summary about the sample under study and the measures. Correlation shows whether pair of variables are related or not and if they are related then how strongly they are related. While regression analysis is used to describe the dependence of GDP on energy consumption regarding the possible causation of changes in GDP by changes in energy consumption.

$$GDP = \alpha + \beta EC + \mu \text{ ----- (1)}$$

Gross Domestic Product (GDP) is taken in \$ millions, while Energy Consumption (EC) is taken in kilo tons of oil equivalent, α is the total productivity factor, β denotes coefficient of energy consumption and μ denotes error term.

Correlation Analysis

As the correlation test from SPSS is analyzed it can be seen from (Table 3) that Pearson's r for the correlation between the energy consumption and economic growth is 0.906. Thus there is strong relationship between energy consumption and economic growth and changes in one variable is strongly correlated with changes in other variable, as the number is very close to 1. The Pearson's r value is positive so there is positive correlation between them; increase in one variable's value will increase the other variable's value. The Sig. (2-tailed) value is less than 0.01 i.e. 0.00; it does not mean that it is equal to zero but a very smaller value. So there is statistically significant correlation between energy consumption and economic growth.

The scatter plot graph (

Figure 2) shows that dots seem to go together. They are densely positioned in a way that it is easy to imagine a line connecting them and going upward. Thus it is concluded by graph that strong and positive correlation exists between the variables.

Regression Analysis

Results (Table 4) give coefficient of determination or “goodness of fit” as 0.821; therefore about 82.1% of the variation in GDP is explained by energy consumption. Standard error of the estimate is a measure of the accuracy of predictions; thus smaller the standard error of estimate is, the more accurate the predictions are.

From Table 5, $F = 128.297$ and $p - \text{value} = 0.000$. The significance is very small, less than 0.001, thus null hypothesis is rejected that R-square in the population is equal to zero and EC cannot be used to predict GDP. Hence it is concluded that energy consumption is useful as a predictor of GDP.

The coefficients table (Table 6) results regression equation as;

$$GDP = -64982.782 + 2.517EC \text{ ----- (2)}$$

Here intercept in -64982.782, this means that the least square line will touch the ordinate axis at value $Y = -64982.782$. For slope parameter (coefficient of EC), equation (2) tells that if energy consumption increases by 1 kilo ton of oil equivalent, the GDP will increase by \$2.517 million.

From the analysis study comes to an end that alternate hypothesis H_1 is accepted and there is relationship between energy consumption and economic growth for Pakistan.

Conclusion

The study uses correlation and regression tests and summarizes how tightly economic growth is coupled with energy use. Pakistan is facing worst energy crisis and gap between energy demand and supply is constantly widening over time. This energy shortage is intensely affecting the production of various sectors and thus impeding the growth of economy. As correlation and regression shows how strongly energy consumption and economic growth are correlated and increase in energy consumption will smooth the way for economic growth of Pakistan. Some remedies include; shift from oil usage to hydro energy which has higher resources available and it is estimated that Pakistan can generate about 40000MW electricity by implementing different hydro projects, government should also give attention towards the use of wind and solar energy which can help to fulfill some energy deficit, and energy through nuclear resources and coal reserves can also be increased.

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Appendices

Figures

Figure 1: EAW 2013

Proportion of Energy Generation for Pakistan

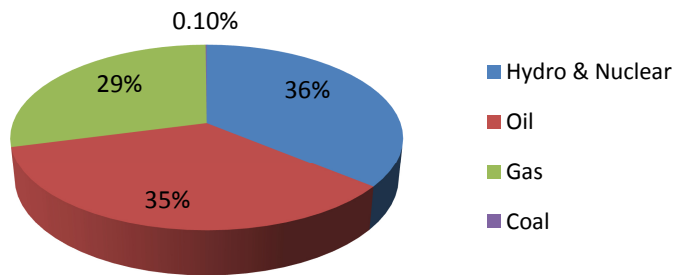
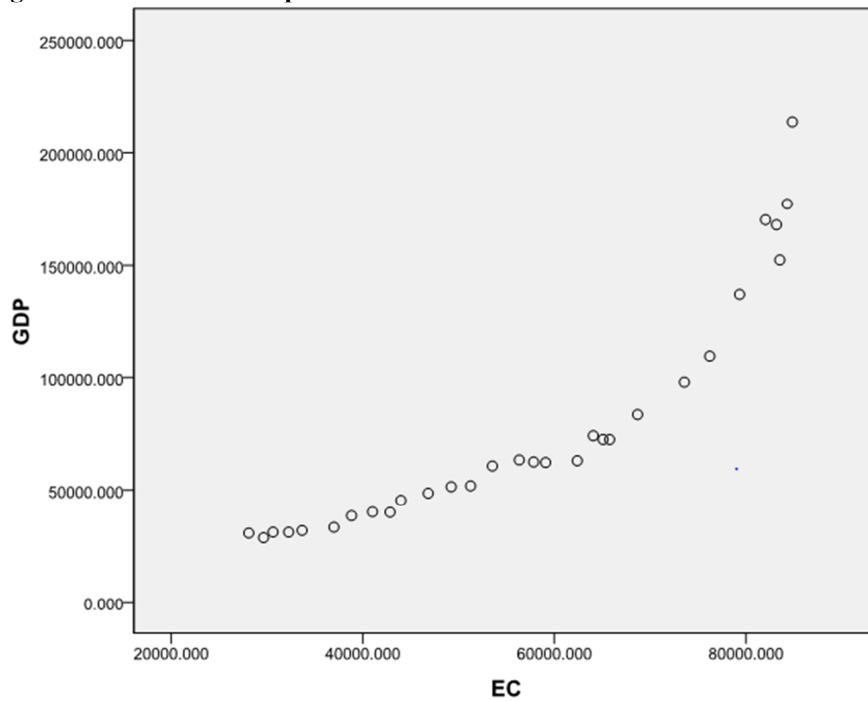


Figure 2: Scatter Plot Graph



Tables

Table 1: Source: World Development Indicator

Years	Energy Consumption (kilo tons of oil equivalent)	GDP (\$ millions)
1982	28108.635	30725.9722278188
1983	29645.523	28691.8908649248
1984	30637.067	31151.8250481397
1985	32266.921	31144.9208665131
1986	33672.938	31899.0727153606
1987	36995.259	33351.5263362521
1988	38835.035	38472.7410713218
1989	41021.708	40171.0211197757
1990	42857.23	40010.4255871428
1991	43989.811	45451.9612339905
1992	46838.218	48635.2422741567
1993	49236.676	51478.3545583299
1994	51259.623	51894.7956577709
1995	53537.984	60636.0716841918
1996	56342.95	63320.1700844076
1997	57842.077	62433.3404680228
1998	59094.028	62191.9558143478
1999	62394.512	62973.8557188874
2000	64066.691	73952.3749697995
2001	65090.754	72309.7389213329
2002	65775.33	72306.8203962325
2003	68694.679	83244.8010927096
2004	73579.859	97977.7661976724
2005	76227.354	109502.102510883
2006	79345.372	137264.061106043
2007	83538.149	152385.716311916
2008	82045.781	170077.814106305
2009	83196.879	167874.973609977
2010	84311.28	177165.635077065
2011	84844.564	213685.91859893

Table 2: Statistics

	EC	GDP
N		
Valid	30	30
Missing	0	0
Mean	56843.09623	78079.42887
Std. Error of Mean	3397.615134	9438.185000
Median	57092.51350	62312.64814
Std. Deviation	1.860950E4	5.169507E4
Variance	3.463E8	2.672E9
Skewness	.055	1.261
Std. Error of Skewness	.427	.427
Kurtosis	-1.270	.548
Std. Error of Kurtosis	.833	.833
Range	56735.929	184994.028
Minimum	28108.635	28691.891
Maximum	84844.564	213685.919

Table 3: Correlations

		EC	GDP
EC	Pearson Correlation	1	.906**
	Sig. (2-tailed)		.000
	N	30	30
GDP	Pearson Correlation	.906**	1
	Sig. (2-tailed)	.000	
	N	30	30

** . Correlation is significant at the 0.01 level (2-tailed).

Table 4: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.906 ^a	.821	.814	2.226757E4

a. Predictors: (Constant), EC

Table 5: ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.362E10	1	6.362E10	128.297	.000 ^a
	Residual	1.388E10	28	4.958E8		
	Total	7.750E10	29			

a. Predictors: (Constant), EC

b. Dependent Variable: GDP

Table 6: Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	-64982.782	13268.571		-4.897	.000
EC	2.517	.222	.906	11.327	.000

a. Dependent Variable: GDP

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