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Research Article

The Effect of Foreign Direct Investment and Economic Development on Renewable Energy in Indonesia

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Abstract.

The study aims to explore the indicators of foreign direct investment (FDI) and their impact on economic development, with a specific focus on renewable energy in Indonesia. It is well-known that FDI plays a significant role in the development of developing countries, and Indonesia, being one of them, still faces challenges in meeting the energy needs of its citizens. The empirical analysis utilizes the Multiple Regression approach with data spanning from 1981 to 2021. The results indicate a cointegration relationship between model parameters and cross-sectional dependence. Additionally, the study finds that FDI and inflation have a negative impact on renewable energy, while population and GDP have a positive and significant effect. Furthermore, economic growth and fossil fuel consumption also positively influence renewable energy consumption. In the long term, the estimation results suggest that FDI and financial development have a simultaneous effect on energy consumption, which aligns with economic growth but not necessarily with renewable energy consumption. This implies that while FDI and financial development contribute to overall energy consumption as the economy grows, they may not directly impact the adoption of renewable energy sources. Based on the research findings, policymakers in Indonesia are encouraged to focus on sustainable development and consider policy transformations that facilitate the transition from fossil fuels to renewable energy sources.

Keywords: FDI, GDP, inflation, population, renewable energy, multiple regression

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1. Introduction

Foreign Direct Investment (FDI) has traditionally been a flow associated with the transfer of knowledge, technology, management practices, and systems from the home country of the multinational corporation (MNE) to the host country. Many researchers argue that only better practices and superior knowledge can give multinational companies a competitive advantage overseas, and this means increased productivity and direct investment in the environment. This explains the impact. Will such technology-based

improvements extend to energy use? Can foreign companies introduce energy-saving technologies, reduce energy intensity, and create an ”FDI halo effect” for the host country? And vice versa, do multinational companies lead to an increase in industrial consumption per capita? These groups can be explained by very different energy infrastructures, and thus the energy use of developing and developed countries has a dramatic effect on the energy sources used in the country, resulting in an increase and decrease in the use of ”green” energy. Which of the ”green” energy sources leads to Are these traditional consumption sources such as gas, oil, and coal? What kind of FDI could have such an impact?

The potential impact of foreign direct investment on energy consumption arises through competition or direct knowledge transfer. Meanwhile, according to the new trade theory, it shows that exposure to foreign competition has led to a higher level of efficiency so that it has an impact on all company operations [1]Therefore, the presence of foreign companies in any industry can be a catalyst in improving the energy efficiency of domestic companies. In addition, there is also evidence that foreign companies are more compliant with

high environmental standards in the industry and in certain countries [2]. Such foreign companies will be more likely to use clean energy from environmentally friendly renewable sources. In addition, the potential impact of energy-saving practices that may be carried out by foreign companies from their home countries will have an impact on energy conservation and reduce costs and have international competitiveness.

At the same time, macroeconomic policies minimize the trade-off effects of economic growth and inflation on poverty. Economic growth is still believed to be a powerful remedy for reducing poverty [3]Using annual data for the period 1990 to 2020, this study shows that poverty reduction is correlated with monetary and fiscal policy adjustments. Poverty is simultaneously affected by economic growth, money supply and inflation, but foreign investment does not have a statistically significant impact on poverty [4].

To date, several empirical studies investigating the relationship between FDI and energy use and investigating possible side effects of energy efficiency have yielded mixed results based on total energy use. The spillover effect of energy-efficient technologies is estimated to differ between renewable and non-renewable energy types. Moreover, unlike previous studies, we only examined the impact of FDI on industrial energy use. In other words, segregate household energy use where FDI is not involved.

The researcher assumes that knowledge related to FDI is highly dependent on the industry. FDI in manufacturing and mining is related to the transfer of industrial processes and equipment, whereas FDI in services is dependent on technical, managerial and

marketing knowledge, expertise, organizational skills and related general information. Although sectoral FDI is under-discussed in the energy use literature, previous studies examining the productivity and environmental impact of FDI found sectoral FDI to be important for spillovers [5]. So from a sectoral perspective, we asked which sectors of FDI are related to technology. energy saving and which sectors are associated with energy efficient technologies. This is consistent with the assumptions [6] "In general, there is no reason to believe that energy technologies will spread differently from other technologies. energy usually spreads along with other technologies, as the former are more likely to spread than other technological advances in PR the same product. Method This study uses data from various institutions in Indonesia as well as world institutions, such as BPS, World Development Indicators (WDI) collected by the World Bank during the period from 1981 to 2021 to see the effect of FDI, economic development on renewable energy. For this purpose, this empirical research is based on the multiple regression method as the main estimator, which is first tested for classical assumptions to prove the data is valid for analysis.

2. Analysis technique

The main purpose of applying this multiple regression approach is an approach taken to test each effect of the dependent variable on the independent variable, either partially or simultaneously. The equation model is an equation that refers to [7] as follows:

$$Y= \alpha + ß1\ X1 + ß2\ X2 + ß3\ X3 + \mu$$

Table 1

With the following description:	Y = Rewenable energy
	α = Konstanta
	ß1, ß2 = Koefisien Regresi
	X1 = Foreign Direct Investment
	X2 = Inflation
	X3 = Gross domestic Product
	X4 = Populasi
	μ = Term Error

The data will be analyzed quantitatively with this multiple regression using eviews 9, the results will show how much:

(a) Coefficient of Determination (R2) to measure how much influence the dependent variable has on the independent variable which states the percentage change in the dependent variable is caused by the independent variable.

(b) T test statistic, to show the effect of independent variable on dependent variable individually.

(c) The F statistic test was carried out to test the independent variable affecting the dependent variable together.

3. Methods

For robustness, we apply a nonparametric approach 1, namely quantile regression. Quantitative regression is a type of regression analysis used in statistics and econometrics. Unlike OLS, which estimates the conditional mean of the response variables over the values of the predictor variables, quantile regression estimates the conditional median (or other quantile) of the response variables. [8]. Quantitative regression has several advantages. First, they are more or less sensitive to outliers than OLS estimates. Second, there are no assumptions about the distribution of parameters. OLS estimates make strict assumptions about the normality of the data. If this is not met, the result is inefficient. However, QR is stronger against non-normal data and outliers. Third, we can consider the effect of covariates on the dependent variable. This study tries to estimate the following models:

In particular some variables as controls, such as: Economic growth, as measured by annual GDP growth, and the definitions of variables and their sources are shown in This shows that Indonesia achieved high economic growth during this period (1981-2021). Economic growth peaked at around 8% and reached a new minimum of 4%. This shows the high consumption of energy and capital (physical and human resources) for the Indonesian economy to reach this high level. Even though Indonesia is a developing country group, from an industrial perspective, Indonesia is a new industrial country. This change has an impact on GDP output due to sustainable economic growth which has an impact on improving the people's economy.

This study uses the independent variable (y) is renewable energy and the dependent variable is FDI, inflation, population and GDP in Indonesia. While the method used to collect data is to collect information, theories related to research variables. While the research data is secondary data available from BPS, World Bank.

4. Analysis

The Foreign Direct Investment (FDI) variable shows a probability value of 0.1446 and the result is greater than (0.05) which means that the Foreign Direct Investment (FDI) variable does not have a significant individual effect on the level of environmental damage which is proxied using the Renewable Energy variable. The correlation between Foreign Direct Investment (FDI) and Renewable Energy shows a negative relationship, meaning that if Foreign Direct Investment (FDI) changes by 1% of GDP, it will increase the level of Renewable Energy by -5.4500, but not significantly. These results are in accordance with the Pollution Heaven Hypothesis, namely the higher the investment will increase the environmental damage, but the results of this study show results that are not significant because each country has implemented regulations for environmental protection. These results are also in accordance with research conducted by [9] and [10] which states that with FDI, the economy of developing countries can be stimulated and lead to increased economic performance. better in the short term, but in the long term, the consequences of the flow of FDI can lead to losses in the carrying capacity of nature, worsening environmental quality and declining levels of human health.

The inflation variable shows a probability value of 0.7077 and the result is greater than (0.05) which means that the inflation variable has a negative but not significant individual effect on the level of environmental damage or environmental quality decline as proxied using the inflation variable. The correlation between inflation and Renewable

Energy shows a positive correlation, meaning that inflation increases the level of environmental damage through Renewable Energy by -0.0445.

The GDP per capita variable shows a probability value of 0.0000 and the result is smaller than (0.05), which means that the GDP per capita variable has a significant negative effect individually on the environment which is proxied using the Renewable Energy variable. The correlation between GDP per capita and Renewable Energy shows a negative relationship, meaning that if GDP per capita changes by 1 billion US$, it will reduce the environment through Renewable Energy by -9,900 Renewable Energy.

The population variable shows a probability value of 0.0032 and the result is smaller than (0.05), which means that the population variable has a significant individual effect on Renewable Energy. The correlation between population and Renewable Energy shows a positive relationship, meaning that if the population changes by 1 million people, it will increase Renewable Energy by 1.83. [11] An increase in population will increase the level of CO2 emissions, the higher the population of a country will increase energy consumption per capita which tends to cause excessive air pollution, where if the

air pollution is not absorbed by the soil, it will be harmful to health and well- being. environment of living things. These results are in accordance with the theory that states the relationship between population and environmental degradation which was first described [12] and research conducted by [13]. With the increase in the population, the land is unable to provide agricultural products to meet the food needs of the increasing population. The carrying capacity of the soil as a component of the environment will decrease and subsequently result in high environmental damage.

Based on the results of multiple regression analysis using e-views 9, the variable Foreign Investment (PMA) has a positive and significant effect on economic growth. This is in accordance with Adam Smith's classical theory that there are three determinants of economic growth: natural resources, human resources, and economic growth.

capital goods.

5. Discusion

FDI includes investment in capital goods because it is an actual investment in the form of business establishment, factory establishment, purchase of capital goods, land management, raw materials and investment. Allows FDI to support stronger economic growth. Without foreign direct investment in Indonesia, inadequate capital and infrastructure can slow economic activity and reduce productivity. The results of this study are also in accordance with the classical theory of economic and non-economic factors proposed by Thomas Robert. Economic factors such as land, labor, capital, and organization. On the other hand, non-economic factors such as asset security, special laws, work ethic and high work discipline. Among these economic factors, the factor of capital accumulation (investment) is the most influential in this theory. No additional capital.

The results of the certainty test showed that the r-squared value for this study was 0.8548. It can be concluded that the independent variables are GDP per capita, GDP per capita squared, foreign direct investment (FDI), population, energy consumption, and the dummy of the economic crisis that affects the dependent variable increases. The remaining 14.52% is explained by variables other than the model used. If the probability value of F-statistic is less than 0.0000 or (0.05), then the independent variables are GDP per capita, GDP per capita squared, foreign direct investment (FDI), population, and energy consumption. . and the dummy is the economic crisis, which affects the dependent variable, namely the level of carbon emissions. The t-test results show that the variables GRDP per capita, GRDP per capita squared, total population, and energy consumption have a significance value less than or equal to 0.05.

6. Conclusion

Based on the results of the research that has been done, several conclusions can be drawn. The results of the simultaneous test (Test F) show that the Foreign Direct Investment (FDI, inflation, GDP, population) variables simultaneously have a significant effect on Renewable Energy. The results of the partial test (T test) show that the variable GDP, population has a significant effect on the level of Renewable Energy, while the variables of Foreign Direct Investment (FDI) and inflation have a negative but not significant effect on the level of Renewable Energy. The GDP per capita variable shows a positive effect and GDP shows a negative and significant effect on Renewable Energy. This result is in accordance with the Environmental Kuznets Curve (EKC) theory which states that the rate of economic growth at the beginning of the economy will show positive and significant results for Renewable Energy, but in the long term when it reaches a certain point it will reduce Renewable Energy. The population population variable shows positive and significant results on the level of Renewable Energy which indicates that the higher the population, which is in line with the higher energy consumption, the greater the need for land in a country to absorb gas produced by residents' activities and industrial waste in the country. the country. This result is in accordance with Malthus' theory. The Foreign Direct Investment (FDI) variable shows a negative result on the level of Renewable Energy and meets the Pollution Haven Hypothesis but is not significant. These results indicate that the higher the level of incoming investment, the higher the burden on the environment and in the long term will reduce Renewable Energy. Inflation variable shows negative results on Renewable Energy but not significantly. This is because the economic crisis does not directly affect Renewable Energy, but through the economic channel where the economic crisis causes a weakening of economic activity but still shows a positive level of Renewable Energy because there is still economic activity even though it is weak and the remaining waste must be absorbed or controlled. so as not to damage the environment and the health of the population. The impact of the crisis on the environment sector is caused more by the accumulation of climate change, including the impact of looting forests and resources by the population to survive.

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Lampiran Data Analisis

Table 2

Dependent Variable: REW				
Method: Least Squares				
Date: 10/04/22 Time: 21:08				
Sample: 1981 2021				
Included observations: 41				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	14.50020	10.84981	1.336448	0.1898
FDI	-5.45E-10	3.65E-10	-1.491443	0.1446
INF	-0.044585	0.117968	-0.377938	0.7077
POPULASI	1.83E-07	5.80E-08	3.155701	0.0032
GDP	-9.99E-07	1.83E-07	-5.461450	0.0000
R-squared	0.761872	Mean dependent var		39.90220
Adjusted R-squared	0.735413	S.D. dependent var		11.70140
S.E. of regression	6.018970	Akaike info criterion		6.541559
Sum squared resid	1304.208	Schwarz criterion		6.750531
Log likelihood	-129.1020	Hannan-Quinn criter.		6.617655
F-statistic	28.79474	Durbin-Watson stat		0.292056
Prob(F-statistic)	0.000000			

Estimation Command:

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LS REW C FDI INF POPULASI GDP

Estimation Equation:

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REW = C(1) + C(2)*FDI + C(3)*INF + C(4)*POPULASI + C(5)*GDP

Substituted Coefficients:

==========

REW = 14.5002036409 - 5.45047872314e-10*FDI - 0.0445847310753*INF + 1.83179097801e-07*POPULASI - 9.99139191547e-07*GDP

10

8

6

4

2

0

-10 -5 0

5 10

TABLE 3

Gradients of the Objective Function			
Gradients evaluated at estimated parameters			
Equation: UNTITLED			
Method: Least Squares			
Specification: REW C FDI INF POPULASI GDP			
Variable	Sum	Mean	Weighted Grad.
C	6.22E-13	1.52E-14	3.70E-16
FDI	-0.004486	-0.000109	-3.14E-30
INF	5.57E-12	1.36E-13	-9.35E-21
POPULASI	-5.34E-05	-1.30E-06	-5.21E-40
GDP	-2.38E-07	-5.82E-09	5.20E-39

C(1)

0

Derivatives of the Equation Specification

2.5E+10

C(2)

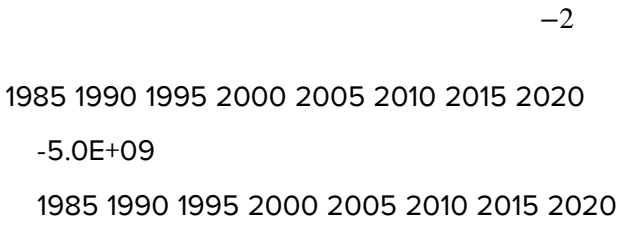
2.0E+10

1.5E+10

-1 1.0E+10

5.0E+09

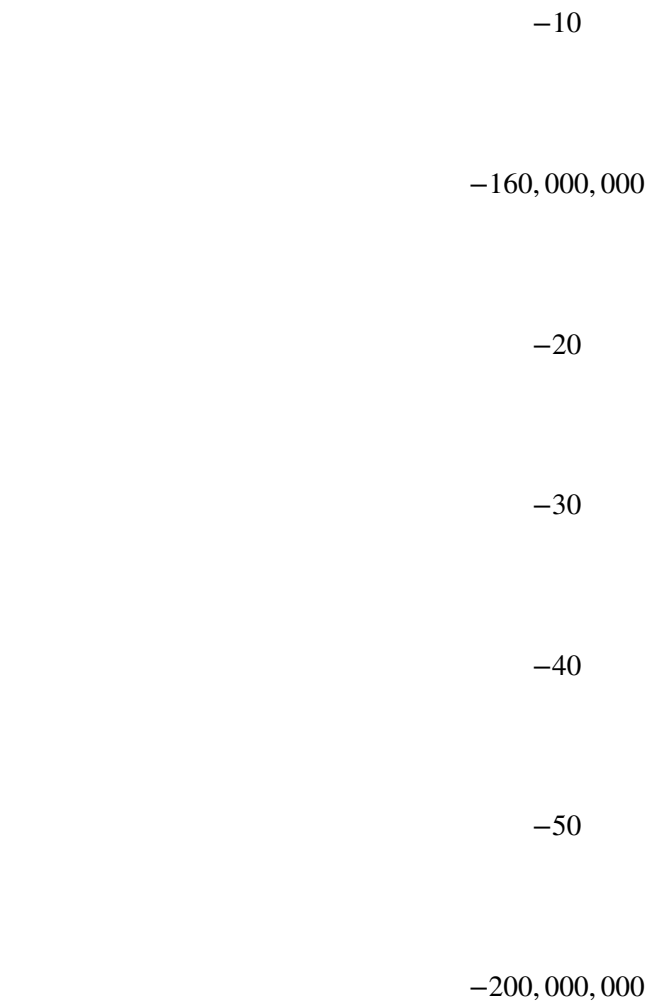
0.0E+00


−2
1985 1990 1995 2000 2005 2010 2015 2020
-5.0E+09
1985 1990 1995 2000 2005 2010 2015 2020

C(3)


0
−120, 000, 000

C(4)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−160, 000, 000
−20
−30
−40
−50
−200, 000, 000

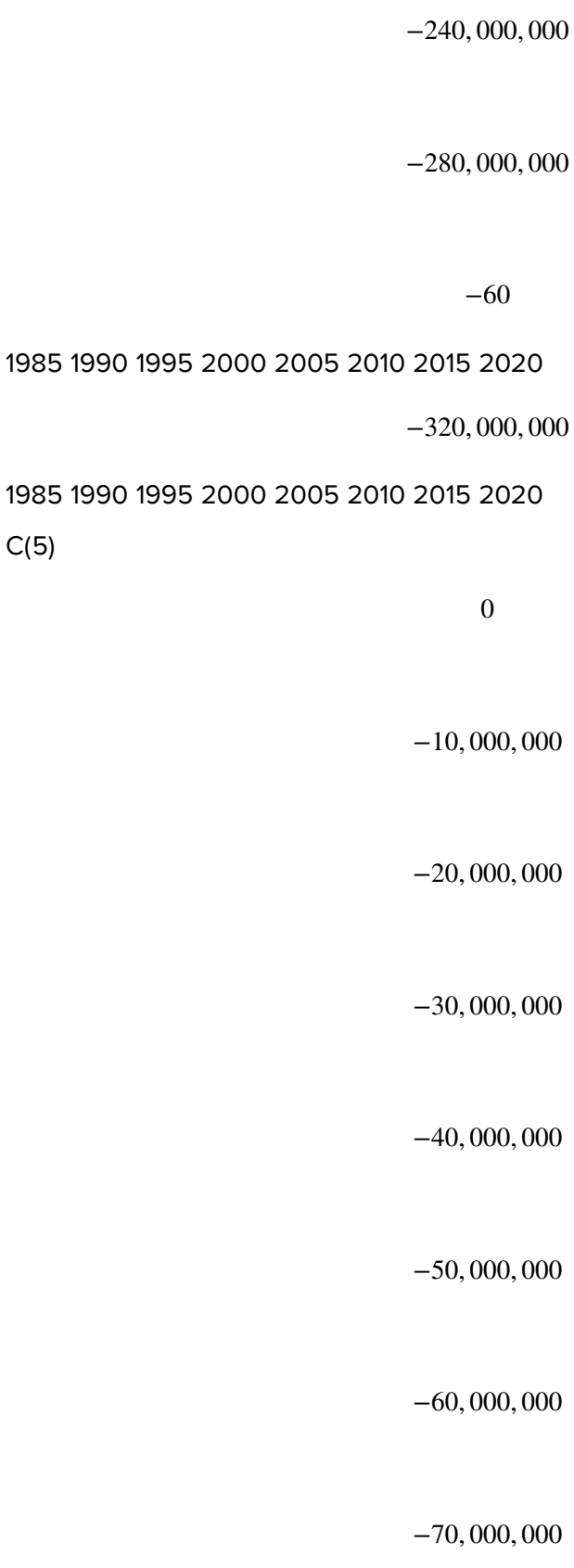
−240, 000, 000
−280, 000, 000
−60
1985 1990 1995 2000 2005 2010 2015 2020
−320, 000, 000
1985 1990 1995 2000 2005 2010 2015 2020
C(5)
0
−10, 000, 000
−20, 000, 000
−30, 000, 000
−40, 000, 000
−50, 000, 000
−60, 000, 000
−70, 000, 000
1985 1990 1995 2000 2005 2010 2015 2020

Table 4

	C	FDI	INF	POPULASI	GDP
1981	22.37347	-2.98E+09	274.5225	3.38E+09	8008385.
1982	23.70778	-5.33E+09	224.0385	3.66E+09	9152408.
1983	14.72941	-4.30E+09	173.8071	2.33E+09	6869992.
1984	12.32635	-2.74E+09	128.9337	1.99E+09	6643425.
1985	5.882576	-1.82E+09	27.76576	9.70E+08	3377343.
1986	4.636779	-1.20E+09	26.98606	7.81E+08	2823963.
1987	-18.15017	6.99E+09	-168.4336	-3.12E+09	-13194011
1988	-21.92381	1.26E+10	-176.4867	-3.84E+09	-17805183
1989	-21.93596	1.50E+10	-140.8289	-3.92E+09	-20578951
1990	-23.05389	2.52E+10	-180.2814	-4.20E+09	-24856360
1991	-20.26151	3.00E+10	-190.8634	-3.77E+09	-24965796
1992	-16.77572	2.98E+10	-126.1534	-3.18E+09	-23222293
1993	-13.73601	2.26E+10	-132.8272	-2.65E+09	-23734741
1994	-7.762784	1.16E+10	-66.21655	-1.52E+09	-15300783
1995	0.628442	-2.35E+09	5.919925	1.26E+08	1450412.
1996	6.042436	-3.38E+10	48.15821	1.23E+09	16097990
1997	8.742234	-3.93E+10	54.46412	1.81E+09	27054971
1998	-5.321724	-1.28E+09	-311.0548	-1.12E+09	-24723617
1999	2.761062	5.15E+09	56.54654	5.90E+08	14555158
2000	-1.065445	-4.85E+09	-3.931492	-2.31E+08	-7000598.
2001	1.599117	4.76E+09	18.38984	3.53E+08	12277631
2002	4.179258	-6.06E+08	49.73317	9.37E+08	35029396
2003	6.911800	4.13E+09	46.72377	1.57E+09	63175295
2004	8.053877	1.22E+10	48.80650	1.86E+09	82810073
2005	12.16314	-6.41E+10	127.1048	2.85E+09	1.49E+08
2006	8.244854	-1.80E+10	108.0900	1.96E+09	1.20E+08
2007	5.434370	-1.22E+10	34.83431	1.31E+09	92396705
2008	-2.598129	8.88E+09	-26.57886	-6.37E+08	-54602898
2009	-0.732036	1.92E+09	-3.213638	-1.82E+08	-17198613
2010	6.692231	-7.43E+10	34.33114	1.69E+09	1.90E+08
2011	9.061738	-1.04E+11	48.57092	2.32E+09	2.90E+08
2012	11.65345	-1.60E+11	49.87679	3.02E+09	4.04E+08
2013	2.755966	-3.35E+10	17.66574	7.24E+08	1.04E+08
2014	2.560122	-3.77E+10	16.35918	6.81E+08	1.06E+08
2015	-3.645536	3.90E+10	-23.18561	-9.83E+08	-1.63E+08
2016	-4.900202	7.91E+10	-17.29771	-1.34E+09	-2.32E+08
2017	-4.750102	8.79E+10	-18.09789	-1.31E+09	-2.44E+08
2018	-7.914464	9.90E+10	-25.32629	-2.22E+09	-4.39E+08
2019	-0.086787	1.78E+09	-0.262965	-24610465	-5077384.
2020	-1.131483	1.60E+10	-2.172446	-3.25E+08	-63862298
2021	-5.394711	9.12E+10	-8.415749	-1.57E+09	-3.31E+08