European Journal of Economics, Finance and Business Development
ISSN (E): 2938-3633
Volume 1, Issue 4, July 2023

The Relationship Between Economic Development and Selected Economic Indicators of the United States of America

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Abstract

Purpose: The United States is a highly developed mixed economy. It is the world's largest economy by nominal GDP. Indeed, in some research it is been shown that there are a lot of factors that effect on the development of the US economy and one the most important of them is GDP (Gross Domestic Product) per capita. The major goal of this study is to identify the challenges that the US will encounter and how they will affect the growth of the US economy over the next five years. Secondary data from secondary sources were retrieved for the current investigation such as an independent variable and a dependent variable used in this study, the data were prepared from the Federal Reserve Economic data (FRED), from 1980 to 2021. In our research used annual time-series data and the OLS model on GDP per capita was the dependent variable, while Inflation, Unemployment, Exchange rate, FDI, Interest rate and Export were the independent variables. Using multi-factor time-series models, particularly VAR model analysis, we analyzed that GDP per capita has been found to have positive and negative relationships with, FDI, Interest rate, Export, Import, Industry, Unemployment rate. Moreover, after using forecast test, we predicted that in the next 5 years the Economy of USA will face some fluctuations and increase, so that reason government should consider all the factors that affect the development of the state economy.

Keywords: Economic development; USA; GDP per capita; Unemployment; VAR model; OLS model.

INTRODUCTION

The United States of America (USA) has the largest economy globally, with a Gross Domestic Product (GDP) of $21.4 trillion as of 2021. This review examines the historical development, present state, and future predictions of the US economy. The review also includes data analysis of key indicators, such as GDP, GDP growth, employment rates, inflation, and trade.

Historical Development

The US economy has undergone significant transformations throughout history, with notable changes occurring in the 20th century. During the early 1900s, the US underwent a period of

industrialization, which led to significant economic growth. The country's GDP increased dramatically, and it became a world leader in manufacturing and production.

The Great Depression of the 1930s had a significant impact on the US economy. The country experienced a sharp decline in GDP, high unemployment rates, and inflation. It was not until the Second World War that the economy began to recover. The war stimulated economic growth, and the US emerged as a superpower. In the 1970s, the US experienced high inflation rates and a stagnation of economic growth, which led to the adoption of new economic policies in the 1980s. The Reagan administration implemented supply-side economics, which led to a period of sustained economic growth and low inflation.

Present Development

The US economy is currently the largest in the world, with a GDP of $21.4 trillion in 2021. The country has a highly diversified economy, with the service sector being the largest contributor to GDP, followed by the manufacturing and agriculture sectors. GDP growth has been steady in recent years, with an average growth rate of 2.3% between 2010 and 2019. The COVID-19 pandemic had a significant impact on the economy, with a contraction of 3.5% in 2020. However, the economy has shown signs of recovery, with a growth rate of 6.4% in the first quarter of 2021.

Employment rates have been steadily increasing since the 2008 financial crisis, with the unemployment rate decreasing from a high of 10% in 2009 to 4.8% in November 2021. However, the pandemic led to significant job losses, and as of November 2021, there were still 3.9 million fewer jobs than in February 2020. Inflation has been a concern in recent years, with the Consumer Price Index (CPI) increasing by 6.8% in November 2021, the highest rate in over 30 years. The high inflation rate is attributed to supply chain disruptions, labor shortages, and increased demand due to the reopening of the economy after the pandemic. Trade is an essential part of the US economy, with the country being a significant player in international trade. The US is the world's second-largest exporter, with a total of $1.9 trillion worth of goods and services exported in 2020. The US also imports a significant amount of goods, with a total of $3.3 trillion worth of goods and services imported in 2020.

The future of the US economy is subject to various factors, including government policies, technological advancements, and global events. The following are some predictions for the future of the US economy:

GDP growth is expected to remain steady, with an average growth rate of 2% to 3% per year. As a result of this research, the development of US mostly consists of sectors such as GDP per capita, Inflation, Unemployment rate and other factors mentioned above. So, our study showed that used these sectors like methodology, approaches and variables. Therefore, the aim of our study is learning the economy of US by using there is a relationship or not between these sectors in order to find how they are affecting on the growth of the economy of US.

This essay is broken up into five sections, each of which addresses a different subject. The abstract in the first section describes our primary objective and research strategy. The following one is the introduction, which gives a backdrop and justification for the study. The details of the data and research methods are covered in more detail in the third section. The fourth and fifth sections, respectively, provide the results and discussion. The sixth section contains a summary of the conclusion.

Methodology

In order to identify the relationship among GDP per capita, inflation rate, unemployment rate, export-import, FDI and industry, we have opted for a quantitative approach using multi-factor

time series model. GDP per capita was selected as a dependent variable, because we learned how GDP per capita will change under other independent variables. Inflation, FDI and other variables were selected as an independent variable.

Actually, we took the data of USA form 1980, till 2021, in order to develop an econometric model and equations using multi-factor time series to construct econometric equations. A number of methods and techniques were used to analyze these data and obtain results from STATA. The used methods will be mentioned below:

- Dickey-Fuller test; In this test method, p-values were checked according to the criteria, and if it did not meet the specified criteria, it was passed to the second test.
- Differentiate; The values that did not pass the first test were differentiated and adjusted in the second test method.
- Logarithmic model; In this method, all dependent and independent variables were transferred to the same unit through the ln function.

Dependent variable = $\beta 0 + \beta 1$*independent variable + ε(standart error)
lnGDPpercapita = $\beta 0 + \beta 1$*lnInflation + ε(standart error)
lnGDPpercapita = $\beta 0 + \beta 1$*lnUneployment + ε(standart error)

- All conditions of Gauss-Markov method:

1.The number of observations should be six times the number of variables.
2.The sum of empirical data should be equal to the sum of theoretical data.
3.Residues should not be associated with factor signs.
4.Residues should not be interconnected.
5.The residuals should be normally distributed.
6.Factor signs should not be connected to each other.

- VAR model; The Vector Autoregression (VAR) model is a widely utilized statistical framework for analyzing the interrelationships among multiple time series variables. This test was obtained for GDP per capita to fully represent this dependent variable.

The general expression for a VAR model with p lags is represented by the equation:

$$\mathbf{Y_t = c + A_1Y_{t-1} + A_2Y_{t-2} + ... + A_pY_{t-p} + \varepsilon_t}$$

Here, Y_t signifies a k-dimensional vector of variables at time t, c denotes a k-dimensional vector of constants, A_1, A_2, ..., A_p are k x k matrices of coefficients for each lag, ε_t represents a k-dimensional vector of error terms at time t, and p signifies the number of lags incorporated in the model.

- OLS model; OLS (Ordinary Least Squares) is a statistical method used to estimate the relationship between a dependent variable (Y) and one or more independent variables (X). It is a linear regression technique that aims to minimize the sum of squared errors between the observed values of Y and the predicted values of Y.

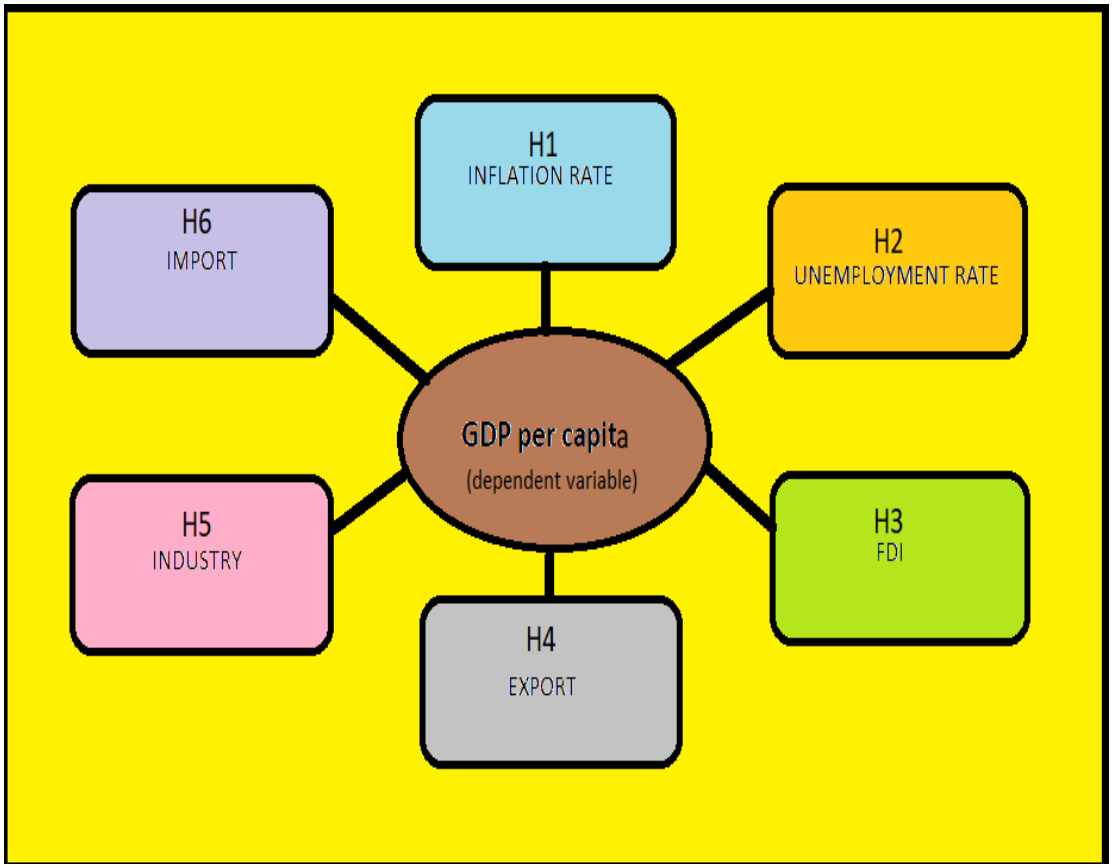
The formula for OLS model is:

$$\mathbf{Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + ... + \beta_kX_k + \varepsilon}$$

where:
- Y is the dependent variable
- X_1, X_2, ..., X_k are the independent variables
- β_0 is the intercept (the value of Y when all Xs are zero)

- β_1, β_2, ..., β_k are the regression coefficients (the change in Y for a unit change in X)
- ε is the error term (the difference between the observed value of Y and the predicted value of Y)

Graph 1. Classification of Hypothesis.



Our Hypothesis is as follows:

- **$H1_0$**: There is no link between GDP per capita and Inflation.
- **$H1_a$**: There is a link between GDP per capita and Inflation.
- **$H2_0$**: There is no link between GDP per capita and Unemployment.
- **$H2_a$**: There is a link between GDP per capita and Unemployment.
- **$H3_0$**: There is no link between GDP per capita and FDI.
- **$H3_a$**: There is a link between GDP per capita and FDI.
- **$H4_0$**: There is no link between GDP per capita and Export.
- **$H4_a$**: There is a link between GDP per capita and Export.
- **$H5_0$**: There is no link between GDP per capita and Industry.
- **$H5_a$**: There is a link between GDP per capita and Industry.
- **$H6_0$**: There is no link between GDP per capita and Import.
- **$H6_a$**: There is a link between GDP per capita and Import.

H_0 – our null hypothesis. **H_a** – is the alternative hypothesis.

There is our hypothesis and we should reject $H1_0$, $H2_0$, $H3_0$, …, and accept $H1_a$, $H2_a$, $H3_a$, … hypothesis.

And after checking all the test methods, the forecast for the next five years was made, the forecast was made mainly for GDP per capita, inflation and unemployment rates and explained in the discussion part of the article.
In conclusion, it can be said that all the tests used in the results part of the article were briefly described in the methodology part. You can see its full operation in the next part.

Literature Review

As one of the biggest and most developed economies in the world, the United States is frequently used as a benchmark for other nations' economic success. The Gross Domestic Product (GDP), unemployment rate, inflation rate are some of the economic indicators that are used to gauge the economic development of a nation. This literature review's goal is to investigate the connection between the United States' chosen economic metrics and economic development. In the last few decades many popular scientists have made research about this topic. In the United States, studies have revealed a positive association between GDP and economic progress. Mankiw et al. (1992), for example, discovered that GDP per capita is positively connected with indicators of human development such as life expectancy and literacy rates. Similarly, Barro (1991) discovered a positive association between GDP per capita and the number of patents per capita in the United States in his study. According to research, there is a negative association between the US inflation rate and economic progress. For instance, a research by Romer and Romer (2000) discovered a negative link between the inflation rate and GDP growth. Similarly, Taylor (1993) discovered a negative link between the inflation rate and GDP growth in the United States. Trends in import and export are significant economic indicators that reflect the volume of global commerce. According to studies, the United States' economic growth and export patterns are positively correlated. As an illustration, a 1999 research by Frankel and Romer established a link between export patterns and GDP growth in the United States. Similar to this, a 1989 study by Froot and Klemperer discovered a link between export patterns and GDP growth in the United States. The link between import trends and economic growth is more complicated, though. While some studies have discovered a favorable association, some have discovered a negative relationship between import trends and economic progress. Another crucial economic metric that is directly linked to economic growth is unemployment. According to studies, the unemployment rate and economic growth in the United States are inversely related. For instance, a research by Blanchard and Diamond (1994) discovered that the unemployment rate and GDP growth in the United States are negatively correlated. Similar to this, a research conducted in 2002 by Ball and Mankiw discovered a negative correlation between the unemployment rate and GDP growth in the United States.

European Journal of Economics, Finance and Business Development
ISSN (E): 2938-3633
Volume 1, Issue 4, July 2023

Results and discussion

Table 1. Economic indicators of the USA from 1980 to 2021.

Years	GDP per capita	Inflation	Unemployment	FDI	Export	Industry	Import
1980	12547	13.54920197	7.175	127105	82.3	50.3066	76.2
1981	13943	10.33471534	7.616666667	164623	83.7	50.9677	77.4
1982	14399	6.131427	9.708333333	184842	84.2	48.3259	78.3
1983	15508	3.212435233	9.6	193708	85.3	49.6478	77.8
1984	17080	4.300535475	7.508333333	223538	85.6	54.0736	78.1
1985	18192	3.545644152	7.191666667	247223	84.0	54.7358	76.3
1986	19028	1.898047722	7	284701	83.2	55.2904	76.2
1987	19993	3.664563218	6.175	334552	86.3	58.1726	83.6
1988	21368	4.077741107	5.491666667	401766	92.5	61.1827	88.1
1989	22805	4.82700303	5.258333333	467886	94.7	61.7368	91.1
1990	23835	5.39795644	5.616666667	505346	95.5	62.3310	94.0
1991	24290	4.234963965	6.85	533404	96.3	61.4119	94.2
1992	25379	3.028819678	7.491666667	540270	96.3	63.2086	94.9
1993	26350	2.951656966	6.908333333	593313	96.9	65.2849	94.6
1994	27660	2.607441592	6.1	617982	98.9	68.7223	96.2
1995	28658	2.805419689	5.591666667	680066	103.9	71.9066	100.6
1996	29932	2.9312042	5.408333333	745619	104.5	75.1711	101.6
1997	31424	2.337689937	4.941666667	824136	103.1	80.5740	99.1
1998	32818	1.552279099	4.5	920044	99.7	85.3080	93.1
1999	34480	2.188027197	4.216666667	1121328	98.4	89.0460	93.9
2000	36300	3.376857271	3.966666667	1459092	100.0	92.4951	100.0
2001	37100	2.826171119	4.741666667	1571593	99.2	89.6767	96.5
2002	37954	1.586031627	5.783333333	1577945	98.2	89.9785	94.1
2003	39420	2.270094973	5.991666667	1658275	99.7	91.1422	96.9
2004	41660	2.677236693	5.541666667	1830644	103.6	93.5781	102.3
2005	44052	3.392746845	5.083333333	2007151	106.9	96.7144	110.0
2006	46234	3.225944101	4.608333333	2255955	110.7	98.9224	115.4
2007	47976	2.852672482	4.616666667	2463600	116.1	101.4562	120.2
2008	48498	3.839100297	5.8	2598789	123.1	97.9417	134.1
2009	47123	0.355546266	9.283333333	2560407	117.4	86.8092	118.6
2010	48570	1.640043442	9.608333333	2791358	123.1	91.6213	126.8
2011	49952	3.156841569	8.933333333	2990410	133.0	94.5035	140.6
2012	51645	2.069337265	8.075	3158652	133.5	97.3878	141.0
2013	53117	1.464832656	7.358333333	3320861	133.0	99.3462	139.5
2014	54914	1.622222977	6.158333333	3552897	132.3	102.3290	138.0
2015	56521	0.118627136	5.275	3936864	123.9	100.8807	123.9
2016	57593	1.261583206	4.875	4142972	119.9	98.6972	119.8
2017	59589	2.130110004	4.358333333	4603263	122.8	100.0000	123.3
2018	62450	2.442583297	3.891666667	4909240	126.9	103.1501	127.1
2019	64690	1.812210075	3.683333333	5182666	125.9	102.4293	125.5
2020	63476	1.233584396	8.091666667	5272454	122.4	95.0682	122.4
2021	70152	4.697858864	5.366666667	5837482	139.4	99.2450	133.2

In the first table, information about the main economic indicators of the United States from 1980 to 2021 is given. If we pay attention, these seven important indicators have grown significantly for 30 years. In the beginning of the 1980 the GDP of United States was 2.857 trillion USD, and in the end of 2021 this numbers consisted of 23.32 trillion of USD.
As earlier mentioned above, we will see how the variables listed in the first table are related to each other. As we know the main regression function, here too GDP per capita indicators are used as dependent variable and the remaining 6 variables - Inflation, Unemployment, Export and others - are used as independent variables.
Since our study is conducted in multi-factor time series, the first step in the criterion of multi-factor time series is to examine the variables which are non-stationary or stationary in the Dickey-Fuller test and find if they are cointegrated or not. After that, we can select a particular appropriate model.
Firstly, we can see p-value is 0.998 and greater than 0.005, it should be less than 0.005. And also all critical values (1%, 5%, 10%) should be greater than test statistic value and it is non-stationary indicators, we should differentiate these indicators.

Table 2.GDP per capita of USA after differentiate

	Test statistic	1% Critical Value	5% Critical Value	10% Critical Value	p-value
Z(t)	-5.797	-3.648	-2.958	-2.612	0.000

As you can see in this table, p-value is less than 0.05 and all critical values (1%, 5%, 10%) greater than test statistic value after we differentiated the data and it changed to stationary indicators.

Table 3. Inflation rate of USA in the Dickey-Fuller test

	Test statistic	1% Critical Value	5% Critical Value	10% Critical Value	p-value
Z(t)	-5.819	-3.641	-2.955	-2.611	0.000

According the table 3, p-value is 0.000 less than 0.05 and test statistic value is -5.797, it is also less than 1%, 5% and 10% critical values. It means all data is stationary and we don`t need differentiate the data.
All the information which given by Unemployment rate is not stationary. P-value is 0.117, test statistic value is -2.495 and greater than all critical values. We should differentiate the data of unemployment rate.

Table 4. Unemployment rate of USA after differentiate.

	Test statistic	1% Critical Value	5% Critical Value	10% Critical Value	p-value
Z(t)	-5.575	-3.648	-2.958	-2.612	0.000

This is the information after we differentiated and changed from non-stationary to stationary, p-value is less than 0.05 and 1% critical value, 5% critical value and 10% critical values are greater than -5.575(Z test statistic value).
All FDI data is not stationary, that is why we need differentiate.

Table 5. FDI of USA after differentiate.

	Test statistic	1% Critical Value	5% Critical Value	10% Critical Value	p-value
Z(t)	-2.67	-3.648	-2.958	-2.612	0.079

As you see, there is not stationary indicators, yet. P-value is greater than normal which is equal 0.079 and test statistic value is also less than critical values, we should differentiate one more time.

Table 6. FDI indicators of USA after two times differentiate.

	Test statistic	1% Critical Value	5% Critical Value	10% Critical Value	p-value
Z(t)	-8.211	-3.655	-2.961	-2.613	0.000

Now our data transferred to stationary after we differentiated two times. P-value, test statistic value and all critical values are perfectly combined.
Indicators of Export is non-stationary, where P-value equals to 0.935 and it should be less than 0.05, test statistic value is -0.228, it is more than other critical values. We need to change it to stationary.

Table 7. Export indicators of USA after differentiate.

	Test statistic	1% Critical Value	5% Critical Value	10% Critical Value	p-value
Z(t)	-4.427	-3.648	-2.958	-2.612	0.0003

0.0003 is less than 0.05 and -4.427 is also less than -3.648, -2.958 and -2.612. It shows all the indicators turned into stationary from non-stationary.

Table 8. Industry level of USA before and after differentiate.

	Test statistic	1% Critical Value	5% Critical Value	10% Critical Value	p-value
Z(t)	-1.324	-3.641	-2.955	-2.611	0.6183
Z(t)after dif.	-5.252	-3.648	-2.958	-2.612	0.000

Table 8 says that, second row is non-stationary (p-value, test statistic values) and we differentiated it in order to change to stationary and you can see it on second row.

Table 9. Import indicators of USA before and after differentiate.

	Test statistic	1% Critical Value	5% Critical Value	10% Critical Value	p-value
Z(t)	-0.939	-3.641	-2.955	-2.611	0.7749
Z(t)after dif.	-5.901	-3.648	-2.958	-2.612	0.000

In the second row, p-value is 0.7749 greater than 0.05 and on the third row its value is 0.000 and it is completely appropriate. Test statistic value is also non-stationary on the second row after differentiated it turned into the stationary, as shown on the last row.

Now we will consider the relationship of all economic indicators with the help of the correlation function using STATA. Here, the main indicator is GDP per capita and it is a non-independent value, and we take other indicators as independent variables. And also, we used the ln function to be in the same unit. Being in the same unit shows that the indicators are more clearly connected to each other.

Table 10. Correlation of economic indicators(ln) of USA.

	lnGDPpercapita	lnInflation	lnUnemloyment	lnFDI	lnExport	lnIndustry	lnImport
lnGDPpercapita	1.000						
lnInflation	-0.5824	1.000					
lnUnemloyment	-0.424	0.1887	1.000				
lnFDI	0.9976	-0.5751	-0.4062	1.000			
lnExport	0.9366	-0.4914	-0.2295	0.9366	1.000		
lnIndustry	0.9676	-0.5571	-0.5101	0.9642	0.874	1.000	
lnImport	0.9275	-0.4665	-0.2201	0.9287	0.9904	0.8783	1.000

The correlation between these model indicators indicates that there is a long-term correlation between the model indicators. If we analyze according to the above table 10, all indicators are interrelated. And there are two kinds of relationship, which are negative and positive relationship. Positive relationship means that if one indicator increases, the value of the second indicator also increases as directly proportional, and if the first value decreases, the second one also decreases. The negative relationship is that if the amount of the first value increases, the value of the second indicator decreases depending on it as inversely proportional, and vice versa, if the first value decreases, the second value increases.

Firstly, there is negative 58.24% correlation between GDP per capita and inflation, it means if inflation increases 1 unit, GDP per capita decreases 0.58 unit. Because, GDP per capita is a dependent variable, here. There is also negative 42.4% correlation between GDP per capita and an unemployment rate, if an unemployment rate decreases for 1 unit, GDP per capita increases for 0.42 unit. And there are positive 99.7%, 93.6%, 96.7%, 92.7% correlation between GDP per capita and FDI, export, industry and import directly. If FDI, export, industry or import increase 1 unit, GDP per capita will also increase for 0.99, 0.93, 0.96 or 0.92, according to the which is independent variable in the correlation function and vice versa. These indicators consist of GDP, that's why they influence more.

Secondly, there is also connection between independent indicators. There are positive 18.8% correlation between inflation and unemployment, negative 57.5% correlation between inflation and FDI, also negative 49.1%, 55.7%, 46.6% correlations between inflation and export, industry and import.

Thirdly, all correlations are negative with unemployment rate, FDI(-0.406), export(-0.229), industry(-0.557) and import(-0.2201).

Fourthly, export connected with positive 93.6% correlation to the FDI, industry and import connected with also positive 96.4% and 92.8%% correlation to the FDI. It means if there is an increase in export, import or industry, FDI will increase also.

Lastly, we can see the positive 0.874 and 0.9904 unit correlation of industry and import, in terms of the export rate. And import indicators connected to the industry with the positive 87.8% correlation.

Source	SS	df	MS	Number of obs	=	41
				F(6, 34)	=	1612.45
Model	9.36925185	6	1.56154197	Prob > F	=	0.0000
Residual	.032926611	34	.00096843	R-squared	=	0.9965
				Adj R-squared	=	0.9959
Total	9.40217846	40	.235054461	Root MSE	=	.03112

lnGDPpercapita	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnInflation	-.0118029	.0089303	-1.32	0.195	-.0299514	.0063456
lnUnemployment	-.0466927	.0275587	-1.69	0.099	-.1026987	.0093133
lnFDI	.3573292	.0254523	14.04	0.000	.305604	.4090544
lnExport	.439976	.2649099	1.66	0.106	-.0983856	.9783376
lnIndustry	.1508827	.0913882	1.65	0.108	-.0348405	.336606
lnImport	-.1752433	.2037837	-0.86	0.396	-.5893816	.238895
_cons	3.647607	.4280077	8.52	0.000	2.777791	4.517423

Scheme 1. Regression scheme with the same unit(ln).

In order to make it easier to understand, there are examples of regression functions below, with the indicators presented in the table above.
As you see on Scheme 1, there are all the values of each indicator and how they related to dependent variable and also how they interrelated to independent variables. Probability amount is perfectly satisfactory, because it less than 0.05. R-squared (R^2) is a statistical measure that represents the proportion of the variance in a dependent variable that can be explained by an independent variable or variables in a regression model. It ranges from 0 to 1, with 1 indicating a perfect fit where all the variation in the dependent variable is explained by the independent variables and 0 indicating no relationship between the variables. R-squared is 0.9965, it is less and not equal to 1 and it will appropriate to the criteria.

Dependent variable = β0 + β1*independent variable + ε(standart error)

lnGDPpercapita= 3.647+(-0.0118)*lnInflation+0 .0089303

lnGDPpercapita= 3.647+(0 .35732)*lnFDI+0 .0254523

We used the information from the regression table and build these equations, which is given above.
Now, relying on our methodology, we will consider the Gauss-Markov conditions one by one. The first condition is that the number of observations should be six times more than the number of variables. Since we took from 1980 to 2021, we have 42 observations. And we have seven variables. If we multiply seven by six, it will be 42, and we had also 42 observations. Right here, we can accept it and say that it totally satisfies the first condition of Gauss-Markov.
If we check according to the second condition of Gauss-Markov, the second condition is that the sum of empirical data should be equal to the sum of theoretical data.

Table 11. Checking second condition of Gauss-Markov methodology.

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
lnGDPpercapita	42	10.42988	0.4817186	9.437237	11.15842
Model	41	10.42181	0.4839745	9.496683	11.12686

If we look the table above, the indicators are almost equal, for example standard deviation based on lnGDPpercapita is 0.4817186 and for model is 0.4839745. And we can accept these indicators as equal, it also perfectly satisfies the second condition of Gauss-Markov.

The third condition of Gauss-Markov is that the residuals should not be connected with the factor signs, if they are connected, it is called heteroscadastic condition, if not, it is called homoscadastic condition. We need a second case to satisfy the third condition of Gauss-Markov method. To check this, we use graph, White-test and Breusch-Pagan test.

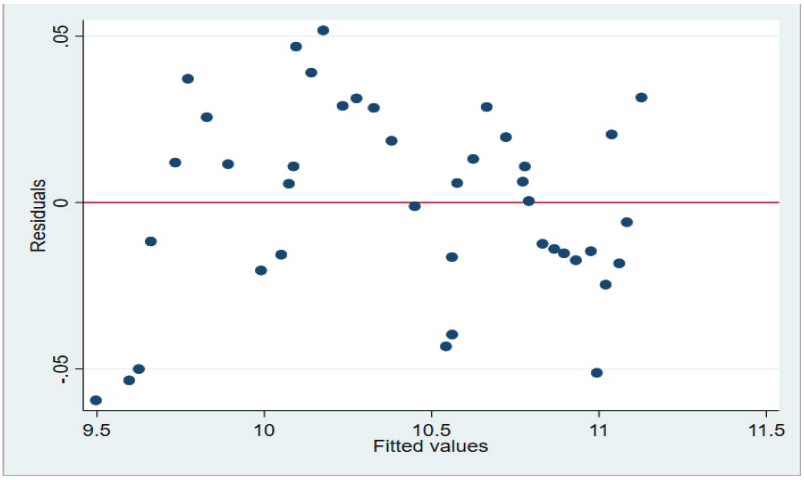


Figure 1. Graphical checking of 3-condition of Gauss-Markov method.

As you see, all observations situated between -0.05 and 0.05 and also, observations around the average 0, there is not outliners in this figure. It is good and it satisfied the first checking method, graphical method.

Subtable 1. Breusch-Pagan test of Gauss-Markov method.

chi2(1)	4.31
Prob>chi2	0.0378

In this subtable, probability is less than 0.05, it should be greater, this is because it doesn't satisfy the test. However, chi-test enough greater and it is good.

Table 12. Cameron & Trivedi's decomposition of IM-test of Gauss-Markov.

Source	chi2	df	P
Heteroskedasticity	36.76	27	0.0996
Skewness	7.47	6	0.2798
Kurtosis	1.78	1	0.182
Total	46.01	34	0.082

In this type of Gauss-Markov test, all p-values and their total must be greater than 0.05. As you can see, the indicators in the above table are consistent and satisfy the third condition of Gauss-Markov.

The fourth condition of Gauss-Markov is as follows: Residuals must be normally distributed. There are several test and graphical methods to check this condition.

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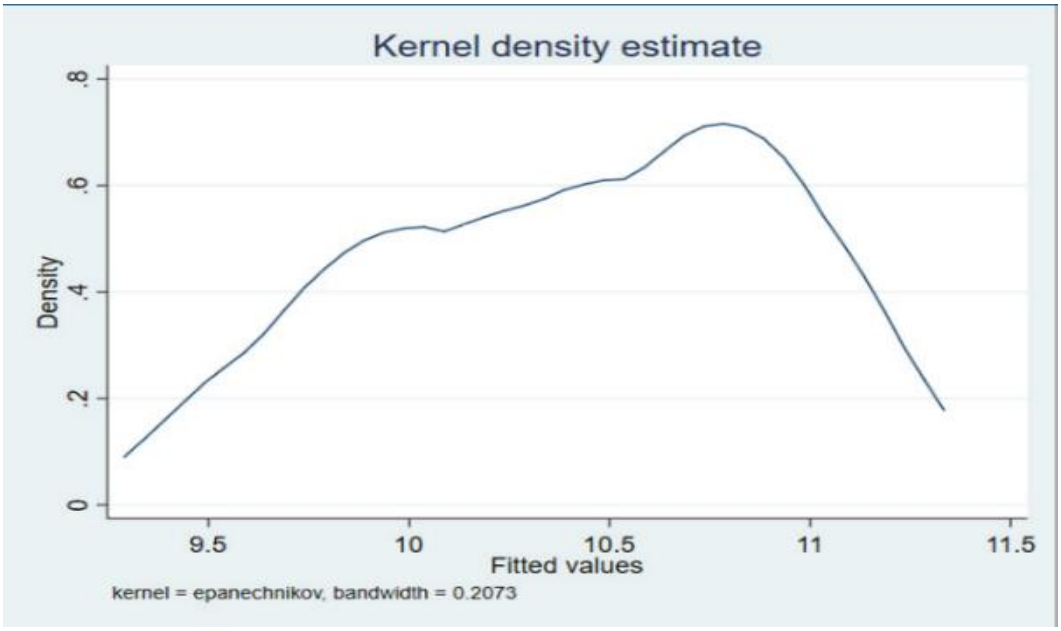

Figure 2. Karnel density estimate graph.

The Karnel density estimate graph is one of the Gauss-Markov conditions, and here, the density reached the highest point at 0.7 and there was a recession, which is not satisfactory. This should be greater than 10%.

Table 13. Skewness/Kurtosis tests for Normality.

Variable	Obsevations	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
R	41	0.4109	0.0081	6.91	0.0316
Qoldiq	41	0.3673	0.39	1.64	0.4396

In the Table 13, you can see the Skewness and Kurtosis tests for checking normality, the probability should be greater than 0.05 in this case. For r, this indicator is less than 0.05 which is equal to 0.0316 and we cannot say it is stationary. But 'qoldiq' residual is perfectly stationary for fifth condition of Gauss-Markov methodology.

Subtable 4. Shapiro-Wilk W test for normal data.

Variable	Observations	W	V	Z	Prob>z
Qoldiq	41	0.96747	1.311	0.57	0.28432

We used the Shapiro-Wilk W test for 'qoldiq', because in the subtable 4, only the 'qoldiq' residual was accepted. And there is probability is equal to 0.28432, greater than 0.05, we will accept it.

European Journal of Economics, Finance and Business Development
ISSN (E): 2938-3633
Volume 1, Issue 4, July 2023

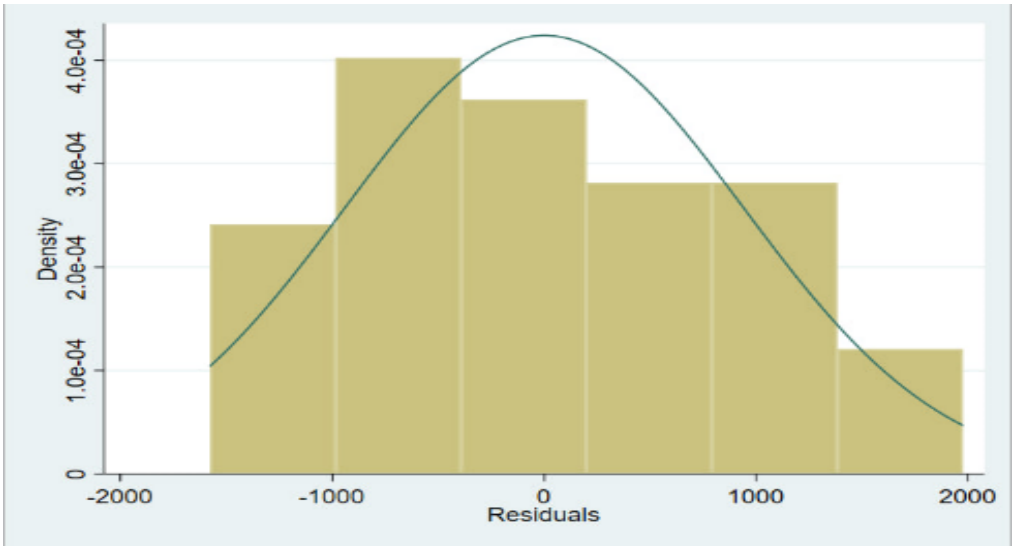

Figure 3. Histogram test. (graphical)

This graph also has several shortcomings, for example, the last column of the bar chart is reduced, but the rest of the columns are satisfactory, so we can say that it supports the fifth condition.
The fifth and the last condition of Gauss-Markov is that the signs of the factor should not be interconnected. And we do this using STATA through the VIF test.

Table 14. VIF test with the non-stationary indicators.

Variable	VIF	1/VIF
lnExport	72.25	0.01384
lnImport	65.87	0.015182
LnFDI	34.1	0.029326
lnIndustry	22.81	0.043834
lnUnemployment	2.06	0.485732
lnInflation	1.67	0.599657
Mean VIF	33.13	

According to the fifth condition of Gauss-Markov, VIF of the independent variables should be less than 10, and also their mean should be less than 10. If there are variables which are greater than 10, we should remove them and build all regression functions again. In Table 17, the inflation and unemployment rates stay only, because their VIF is less than 10. Other independent variables will have been remove.

Subtable 5. VIF test with the stationary indicators.

Variable	VIF	1/VIF
lnUnemployment	1.04	0.964398
lnInflation	1.04	0.964398
Mean VIF	1.04	

European Journal of Economics, Finance and Business Development
ISSN (E): 2938-3633
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As you see, this is the stationary indicators after removing all non-stationary indicators. With this indicator and values regression function worked perfectly and there is not any intercorrelation, we can accept for sixth condition of Gauss-Markov method.
As for the sixth condition, the fourth condition is that the residuals must be uncorrelated and the autocorrelation between the residuals is checked. For verification, we use Durbin-Watson and Breusch-Godfrey tests.

Subtable 2. Durbin-Watson test analysis of Gauss-Markov method.

Number of gaps in sample	1
Durbin-Watson d-statistic (7 ; 41)	0.4334629

In this test analysis, d-statistic value should be between 1.5 and 2.5, otherwise we will not accept it. In this case, it is 0.4334629, it doesn't satisfy.

Subtable 3. Breusch-Godfrey LM test for autocorrelation.

lags(p)	chi2	Df	Prob > chi2
1	25.467	1	0.0000

Probability of this test should be greater than 0.05, however there is 0.0000 and it does not support the fourth condition of Gauss-Markov.

Scheme 2. Vector autoregression model

The p-values are less than 0.05, R-sq. is also perfectly combined for each variable, AIC, HQIC

```
Sample:  1982 - 2021, but with a gap          Number of obs     =        37
Log likelihood =   116.0608                   AIC               =  -5.138423
FPE            =   1.19e-06                   HQIC              =  -4.816088
Det(Sigma_ml)  =   3.78e-07                   SBIC              =  -4.224118

Equation           Parms      RMSE     R-sq      chi2     P>chi2
------------------------------------------------------------------
lnGDPpercapita         7     .017316   0.9988   30129.41   0.0000
lnInflation            7     .534779   0.4422     29.334   0.0001
lnUnemployment         7     .158435   0.6396   65.66007   0.0000
```

and SBIC models aren't perfect, because they should be positive and greater, but it`s good and we can accept. Log likelihood and sigma are also satisfactory.

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Scheme 3. GDP per capita based on VAR model.

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnGDPpercapita						
lnGDPpercapita						
L1.	1.299684	.2383621	5.45	0.000	.8325029	1.766865
L2.	-.3184823	.233712	-1.36	0.173	-.7765494	.1395849
lnInflation						
L1.	-.0023588	.0051613	-0.46	0.648	-.0124748	.0077573
L2.	-.0138607	.0052178	-2.66	0.008	-.0240874	-.003634
lnUnemployment						
L1.	.0938343	.0248903	3.77	0.000	.0450502	.1426183
L2.	-.0639451	.0230802	-2.77	0.006	-.1091815	-.0187086
_cons	.1887393	.1229703	1.53	0.125	-.052278	.4297567

The scheme shows the all connections and effect between GDP per capita and inflation rate and unemployment rate for the two years. If p-value is less than 10%, it will be affected. GDP per capita affected a little itself positively in the first year, in the second year didn't affect. In the first-year inflation didn't affect, but second year it affected negative 0.8% to GDP per capita. Unemployment rate affected in a small percentage in the first year in a positive way, in the second year it affected 0.6% to GDP per capita negatively. And this is the analysis made according to the var model. This analysis was taken as GDP per capita which is dependent variable.

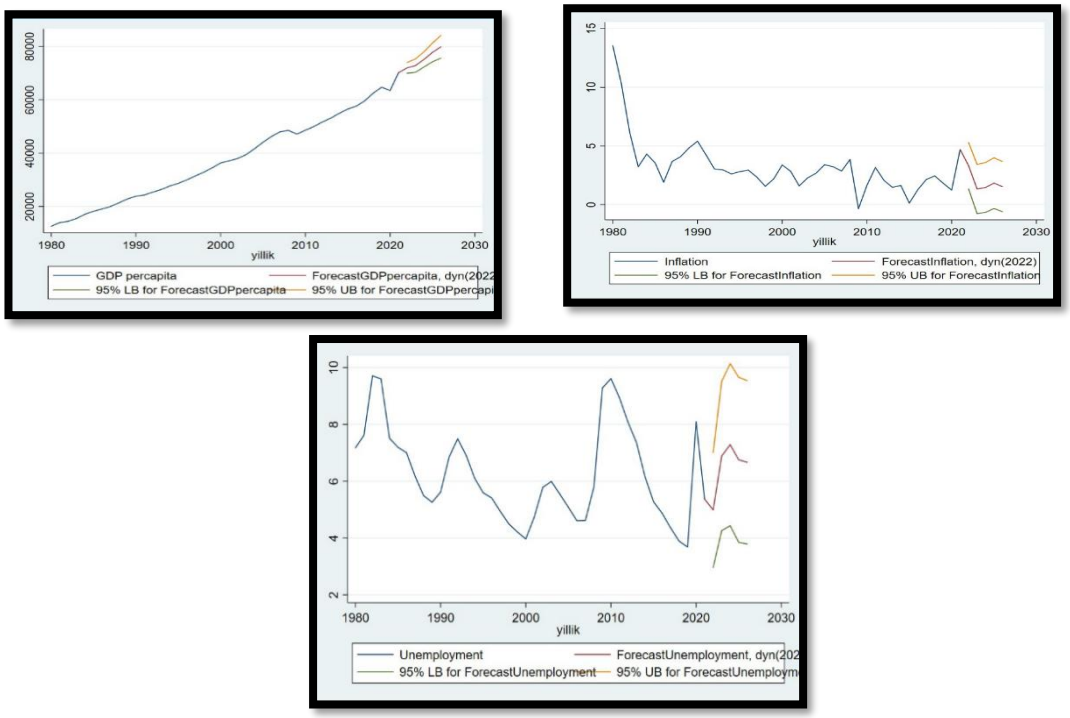

Figure 4. Forecasting of GDP per capita, Inflation, Unemployment in three assumptions: optimistic, normal and pessimistic.

Table 15. Normal version of forecasting variables in the next 5 years.

Years	Forecast GDP per capita	Forecast Inflation	Forecast Unemployment
2022	70152	3.739035399822	4.888711247659
2023	73145.57608688	1.279766583754	6.728587465452
2024	75264.18981759	1.245789815503	7.295945423193
2025	77780.1602343	1.649308582701	6.846214209198
2026	79843.02233476	1.304697282399	6.69445802719

The major goal of the section was to highlight the ways in which various factors affected economic growth throughout the course of the last 42 years, from 1980 to 2021, using 6 independent variables and 1 dependent variable, we took GDP per capita as a dependent variable because it is a shining example to demonstrate living standards of people in country and how the economy is healthy. Precisely, to make hypothesis we analyzed how 6 important factors impacted on GDP per capita in long-term in time-series model using VAR and lag-lag model and checked in the conditions of Gauss-Markov to make sure whether our results were adequate. In addition, we checked our indicators and residuals for stationary using Dickey-Fuller test and then we managed to use VAR and OLS model, for knowing the correlation and forecast of used various variables.

Now let's take a prognosis of change in variables through Forecast. From the Table 15 we can see the normal version of change in three variables (You can also see optimistic and pessimistic versions of forecasting in the Figure 4). According to the table we can assume that in the following years the amount of GDP per capita will see an upward trend increasing from 70152 in 2022 to approximately 79843 USD in 2026, while Inflation is going to have a decreasing rate in the first 3 years from about 3.74 to 1.24 percentage and after a year it will increase to 1.65% following by a fall to 1.30 percentage in 2026. Meanwhile, unemployment rate will seem to increase from the first year until 2024, increasing from about 4.88 to 7.29%, however in the next two years it will drop to 6.69% in an approximate calculating.

Conclusion

According to the findings of our investigation, the GDP per capita, which was used as a dependent variable, was significantly characterized over the past four decades by our dependent variables, having a positive relationship with FDI, Export, and Industry and, an inverse relationship with Inflation, Unemployment, and Import. But through doing some tests it was discovered that Unemployment and Inflation are the two key factors to make reliable analysis the relationship with GDP per capita because other variables have multi-collinearity (the high correlation between variables) case which interrupts us from reliability of our analysis.

Also, by making some tests to predict the change in variables we found out that despite fluctuations in independent variables which were found more reliable, our dependent variable is going to soar without exception cases.

By the way, as we discovered in our research about the USA by some analyses, a research by Lu and Yao (2019) revealed a positive correlation between China's GDP per capita and economic development, while a study by Li et al. (2018) found a positive correlation between China's GDP and exports.

ISSN (E): 2938-3633
Volume 1, Issue 4, July 2023

Acknowledgement
We would like to thank our macroeconomics teacher PhD Zayniddinov Ruhiddin for teaching us how to use software STATA and how to research and to take data while we are writing this article.
We value the feedback our article reviewers provided to help us make our article more thorough and accurate.

Contribution
Jo`rayev Og`abek – "Abstract", "Introduction", "Literature review", " Discussion", "Conclusion".
Axrorov Amirbek – "Methodology", "Results", " Data collecting".

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