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The relationship between economic development and selected economic indicators in the case of Germany

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Abstract:

Purpose: Germany is one of the World's leading industrialized nations, with a highly competitive industrial sector and a skilled labor force and a key player in the global economy. Categorically, several economic indicators which have both positive and negative influences, a striking link have been identified as important drivers of economic development, including GDP per capita, inflation, unemployment rate, foreign direct investment (FDI), export, and agriculture by academics and economists including Klaus Zimmerman and Clemens Fuests in their researches.

The article aims to explore the link among economic development and these key economic indicators in the case of Germany, highlighting trends and patterns over time and identifying potential future challenges and opportunities.

Methodology: This study employed a quantitative research methodology, analyzing secondary data from secondary sources including independent variable and dependent variable. The data obtained from the World Bank and Federal Reserve Economic Data (FRED), covering the period from 1990 to 2021, enabling a thorough investigation of how economic growth and certain economic indicators relate to one another. In this research, the independent variables were inflation, unemployment rate, FDI, exports, and agriculture, with annual time-series data on GDP per capita serving as the dependent variable.

Results: Utilizing multi-factor time-series models, especially the OLS and VAR models analysis, the research demonstrated that it has been discovered that although it is possible to argue that the relationship between GDP per capita and both unemployment and inflation is negative, the other variables have a positive impact on GDP per capita.

Originality: In numerous academic disciplines, including economics, political science, and international relations, there has been an extensive research and study on the topic of the relationship between economic development and several economic indicators such as GDP per capita, inflation rate, unemployment rate, export, FDI and other indicators in the case of Germany. However, this article provides offer original insights and detailed examination of the effects of selected economic variables on Germany's economic progress over the last three decades. original insights into the topic of the relationship between economic development and selected economic indicators in the case of Germany.

KEYWORDS: - Economic development; Germany; GDP per capita; Multiple factor time-series; OLS model; VAR model.

INTRODUCTION: Germany has one the highly advanced social market economy in the World, with a Gross Domestic Product (GDP) of over 4 trillion US dollars in 2021. It has the largest national economy in Europe, ranks fourth globally in terms of nominal GDP, and is fifth overall in terms of GDP. In this context, we provide analyzed the economy over the period of time, and its economic development in relation to several key economic indicators.

The late 19th century marked the beginning of Germany's modern economic history. Germany dramatically industrialized and advanced its economy after its unification in 1871, making it one of the major economies in the world. After World War I, the nation had experienced severe hardships, including high unemployment, enormous debt, inflation, and a sense of general humiliation. The economy grew significantly, however, the hyperinflation was infamous for its devastating impact on the German economy and society in the 1920s during the Weimar Empire period, but the 1930s experienced a terrible economic crisis as a result which played a significant role in the rise of the Nazi Party and the ascent of Adolf Hitler to power. During the 19th century, Germany experienced significant industrialization, which led to the growth of its manufacturing sector. The country became a major player in the production of steel, chemicals, and machinery. This period of growth laid the foundation for Germany's emergence as an economic power in the 20th century.

Germany went through a period of reconstruction and economic expansion after the end of World War II. GDP and living standards rose quickly during the "economic miracle" of the 1950s and 1960s in the nation. Especially, in the production of machinery and autos such as Mercedes Benz and BMW, the manufacturing sector remained a major engine of the economy.

The global financial crisis of 2008 had an effect on Germany's economy, although it was able to weather the crisis better than many other nations thanks to its strong budgetary position and relatively robust financial sector. Nevertheless, the crisis had a sizable impact on the nation's economy, which resulted in a period of slowdown in growth and economic instability in the years that followed.

The country is a global leader in exports, particularly in the automotive, engineering, and chemical sectors as well as the German economy is known for its highly skilled and professional workforce, technological innovation, and strong focus on research and development. After that, the global COVID-19 pandemic significantly affected the German economy, causing it to decline by 4.9% in 2020. In response, the government implemented stimulus programs to aid affected firms and people, which have assisted in stabilizing the economy.

Germany has the largest national economy in Europe, ranks fourth globally in terms of nominal GDP with over $4 trillion, it has a per capita income of approximately $52,680, and is fifth overall in terms of GDP. The largest trade surplus ever, totaling $310 billion, was reported by Germany in 2016. With a total of $1810.93 billion in products and services shipped in 2019, Germany is among the top exporters in the world. Approximately 70% of the GDP is contributed by the service sector, followed by industry (29.1%) and automotive manufacturing accounting for around 7% of GDP and employing over 850,000 people as well as agriculture (0.9%). 41% of national output was accounted for by exports. The top ten exports from Germany are: machinery, automobiles, chemicals, electronics, electrical equipment, medicines, transport equipment, basic metals, food items, rubber, and plastics. Germany exported over 1.2 trillion euros worth of goods (2020), making it the third-largest exporter.

According to 2022, Germany's economy was beginning to recover from the COVID-19 pandemic and show significant signs of growth. The country's GDP is increased to 4.2% annual pace. Unemployment rate in Germany, which was 4.4% in February 2022, remained low. The inflation rate in Germany reached 4.4%, which is the highest level in more than a decade. Additionally, Germany continues to be a popular location for foreign direct investment (FDI), ranking among the top locations in all of Europe. Over 20% of all FDI into the EU was attracted to Germany in 2020, with the automotive, chemical, and pharmaceutical industries seeing the most investment. Also, agriculture remained an important sector in Germany, with the country ranking as the second-largest agricultural producer in the EU after France. Key crops grown in Germany include wheat, barley, and sugar beets, while livestock production is also significant (2021).

In the upcoming years, it is anticipated that Germany's economy would continue to develop moderately, with GDP growth estimated to be about 3% annually. The nation's robust manufacturing industry, as well as greater investment in technology and innovation, will fuel this expansion. Germany will probably keep putting emphasis on decreasing carbon emissions and switching to renewable energy sources. Especially, in fields of renewable energy and green technologies, this transition toward sustainability will open up new opportunities for investment and innovation. Eventually, Germany will probably keep playing a significant role in exports and global trade. Export-driven growth has a long history in the nation, and it is anticipated that it will do so going forward.

This research aims to perform quantitative studies on the long-term and dynamic interaction between Germany's economic development and the selected economic indicators in order to determine whether or not there is a link between the two aspects. In addition, compare to the scientists' research that we mentioned in the beginning, our analysis demonstrates that different methodologies, techniques, and variables were used.

This study is divided into five sections, each of which addresses a different subject. The introduction, which outlines the history and purpose of the study, is covered in the first section. The details of the data and research methods are covered in more detail in the second section. The third section contains the outcomes. The fourth section contains an overview of the discussion. In the end, the last final section presents a summary of the conclusion.

Methods

In this part, we have used a quantitative approach using multivariate time-series model in order to determine the relationship among GDP per capita, inflation rate, unemployment rate, export-import, FDI, and industry.

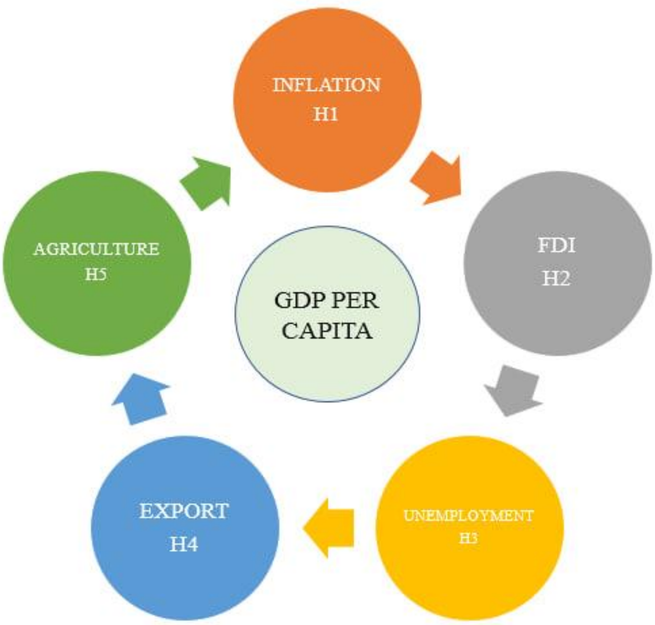
We chose GDP per capita as the dependent variable because we were able to predict how it would vary in response to other independent factors. A number of variables, including FDI and inflation, were chosen as independent variables.

The following variables were chosen to conduct this hypothesis test:

- GDP per capita (GDP per capita) was chosen as a dependent variable;

- Our model's independent variables were selected from the list of economic indicators above, including inflation, unemployment, export, FDI, and agriculture.

Picture. 1. Hypothesis classification



The following is our hypothesis test:

- $H1_0$: 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 FDI.
- $H2_a$: There is a link between GDP per capita and FDI.
- $H3_0$: There is no link between GDP per capita and Unemployment.
- $H3_a$: There is a link between GDP per capita and Unemployment.
- $H4_0$: 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 Agriculture.
- $H5_a$: There is a link between GDP per capita and Agriculture.

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

In this part, we should accept H1a, H2a, H3a, $H4_a$, $H5_a$ as our hypothesis test and to reject $H1_0$, $H2_0$, $H3_0$, $H4_0$, $H5_0$.

Initially, in order to develop an econometric model and equations with the help of multiple factor time-series to make econometric equations, we collected the data about selected economic indicators of Germany from 1990 to 2021. These data were analyzed using a variety of strategies, and statistical software STATA 17 provided the analysis results. We examined the relationship between the economic progress and selected economic indicators of Germany, the following list of the techniques used:

- Dickey-Fuller test: Using this test method, p-values were compared to the criteria and, if they didn't meet them, the data was moved on to the second test.
- Differentiate: In the second test procedure, the values that failed the first test were differentiated and corrected.
- Log-log model: The ln function was used in this strategy to combine all dependent and independent variables into a single unit.

  Dependent variable$_i$ = $\beta 0$ + $\beta 1$*independent variable$_i$ + ε_i (standart error) (1)

  $lnGDPpercapita_i = \beta_0 + \beta_1 \, lnInflation_i + \varepsilon_i$ (2)

  $lnGDPpercapita_i = \beta_0 + \beta_1 \, lnUnemployment_i + \varepsilon_i$ (3)

  $lnGDPpercapita_i = \beta_0 + \beta_i \, lnExport_i + \varepsilon_i$ (4)

  $lnGDPpercapita_i = \beta_0 + \beta_1 \, lnFDI_i + \varepsilon_i$ (5)

  $lnGDPpercapita_i = \beta_0 + \beta_1 \, lnAgriculture_i + \varepsilon_i$ (6)

  Where:

  $lnGDPpercapita_i$: natural logarithm of GDP per capita

  $lnInflation_i$: natural logarithm of Inflation

  $lnUnemployment_i$: natural logarithm of Unemployment

  $lnExport_i$: natural logarithm of Export

  $lnFDI_i$: natural logarithm of FDI

  $lnAgriculture_i$: natural logarithm of Agriculture

  B_0: the intercept of the model

  ε_i: error term.

- All Gauss-Markov technique conditions.
  1. There should be six times as many observations as variables.
  2. The total of the theoretical and empirical data should be the same.
  3. Factor indications shouldn't be connected to residues.
  4. Residues shouldn't be related to one another.
  5. The residuals ought to be evenly spread out.
  6. Connecting factor indicators should be avoided.
- The Vector Autoregression model: The VAR is a popular statistical framework for examining the interactions among many time series variables. To accurately represent this dependent variable, this test was obtained for GDP per capita.

  The VAR model specification is given as follows:

  $$Yt = a + \beta 1 Yt-1 + \beta 2 Yt-2 + \cdots + \beta p Yt-p + \varepsilon i$$

  Where: α is the intercept, a constant and β1, β2 till βp are the coefficients of the lags of Y till order p.

Order ‘p’ means, up to p-lags of Y is used and they are the predictors in the equation.
The ε_{t} is the error, which is considered as white noise.

- The 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 OLS model’s formula below here:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k + \varepsilon$$

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)
- $\beta_1, \beta_2, ..., \beta_k$ 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).

To conclude, it can be maintained that the methods section of the research provided a brief description of each test that was used in the findings part of the article. The next section demonstrates how it works practically. In addition, all tests and methods above examined, then, we forecasted the upcoming next five years the economic condition, progress and some economic indicators in Germany. In discussion section, it will be showed our forecasting insights that we analyzed with a help of statistical tests and econometrics models. It can be maintained that the methods section of the research provided a brief description of each test that was used in the findings part of the article. The next section demonstrates how it works practically.

RESULT

In this part of our research, we will show our practical works with some tests, techniques and STATA.
According to Table 1, FDI and Agriculture fluctuated between 1990 to 2021, while GDP per capita increased as well, from 22303.96133 in 1990 and grew up to two times and reached 51203.55447 by 2021.
Exports, FDI, Unemployment, Inflation, Agriculture were chosen as an independent variable, so GDP per capita (GDP per capita) was taken as a dependent variable in our model.
The primary reason that why we chose these mentioned variables above because they have a huge influence with GDP per capita.
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.

Table 1. The value of variables in various years.

DATES	GDP per capita	Exports	FDI	Unemployment	Inflation	Agriculture
1990	22303,96133	380 859 206 000	2 556 702 846	0,00	2,696	0
1991	23357,75773	422 848 010 000	4 741 534 934	5,32	4,047	27710930000
1992	26438,23039	421 286 110 000	- 2 137 728 434	6,32	5,057	27006450000
1993	25522,62957	396 295 760 000	479 814 189	7,68	4,475	24383300000
1994	27076,60675	427 675 690 000	7 517 248 751	8,73	2,693	18016040000
1995	31658,34938			8,16	1,706	18418010000

		455 931 820 000	12 041 505 213			
1996	30485,86655	482 768 040 000	15 591 797 829	8,82	1,450	19089340000
1997	26964,04947	541 836 130 000	18 638 443 894	9,86	1,939	19257170000
1998	27289,05936	583 439 380 000	29 526 509 277	9,79	0,911	18867630000
1999	26734,94254	614 251 340 000	86 035 665 071	8,85	0,585	20434060000
2000	23694,76048	699 161 710 000	248 007 397 122	7,92	1,440	19636340000
2001	23628,32721	738 777 090 000	56 948 542 387	7,77	1,984	18969160000
2002	25197,2656	769 873 030 000	51 268 214 891	8,48	1,421	18739170000
2003	30310,3576	784 498 070 000	65 401 516 009	9,78	1,034	19118340000
2004	34106,65812	874 946 080 000	- 20 408 419 557	10,73	1,666	24955170000
2005	34520,23965	933 446 200 000	59 835 195 025	11,17	1,547	18208740000
2006	36353,88033	1 048 174 610 000	87 444 159 239	10,25	1,577	17071210000
2007	41640,08087	1 141 320 440 000	50 847 183 837	8,66	2,298	21333310000
2008	45612,71062	1 163	30	7,52	2,628	25355060000

		470 980 000	954 735 498			
2009	41650,36783	997 341 970 000	56 701 916 795	7,74	0,313	24582210000
2010	41572,45595	1 141 036 460 000	86 037 502 102	6,97	1,104	21747710000
2011	46705,8958	1 236 312 150 000	97 535 403 953	5,82	2,075	20773870000
2012	43855,85447	1 272 235 780 000	65 443 087 632	5,38	2,008	21372680000
2013	46298,92292	1 285 014 930 000	67 199 694 459	5,23	1,505	21915540000
2014	48023,86998	1 346 638 850 000	19 488 312 315	4,98	0,907	24035200000
2015	41103,25644	1 419 906 000 000	62 422 464 519	4,62	0,514	20720000000
2016	42136,12079	1 454 977 680 000	64 707 795 193	4,12	0,492	20357400000
2017	44652,58917	1 526 256 960 000	109 505 815 447	3,75	1,509	21596460000
2018	47939,27829	1 560 192 710 000	166 868 434 547	3,38	1,732	17796410000
2019	46793,68676	1 579 929 410 000	71 679 659 389	3,14	1,446	20143980000
2020	46772,82535	1 433 395 110 000	142 778 529 123	3,86	0,507	21760140000
2021	51203,55447	1 572 545	73 654	3,57	3,143	22110310000

		900 000	317 282			

Table 2. GDP per capita in the Dickey-Fuller test

Dickey-Fuller test for unit root Number of obs = 30

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-5.210	-3.716	-2.986	-2.624

MacKinnon approximate p-value for Z(t) = 0.0000

From table 2 we can see Z(t) is negative -5.210 and lower than other critical values (1%, 5%, 10%). In 1% critical value is -3.716, 5% critical value is -2.986 and 10% critical value is -2.624. p value should less than 0.05 and it is 0.0000. we reached this point after two integration.

Table 3. Exports in the Dickey-Fuller test

Dickey-Fuller test for unit root Number of obs = 30

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-6.042	-3.716	-2.986	-2.624

MacKinnon approximate p-value for Z(t) = 0.0000

The statistical test value for the Dickey-Fuller test for Export is -6.042 , which is less than three critical values. The 1 percent critical value is -3.716 , the 5 percent critical value is -2.986 , and the 10 percent critical value is -2.624. These critical values are higher than the statistical test result and show that there is a substantial stationary component as well. This outcome was attained after two integrations. Additionally, the p-value is 0.0000, which is less than 0.05, and it shows a strong stationary relationship.

Table 4. FDI in the Dickey-Fuller test

Dickey-Fuller test for unit root Number of obs = 31

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-3.731	-3.709	-2.983	-2.623

MacKinnon approximate p-value for Z(t) = 0.0037

As we can see from table 4, p value is 0.037 less than 0.050 and we can know about Z(t) from table 4 is -3.731 lower than other 3 critical values. We reached this result only one time doing Dickey-Fuller test

Table 5. Unemployment in the Dickey-Fuller test

Dickey-Fuller test for unit root Number of obs = 30

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-6.492	-3.716	-2.986	-2.624

MacKinnon approximate p-value for Z(t) = 0.0000

From table 5 we know about p-value is 0.0000 is less than 0.050 and Z(t) is -6.492 also less than other 3 Critical values -3.716, -2.986, -2.624. It shows all the indicators turned into stationary from non-stationary.

Table 6. in the Dickey-Fuller test

Dickey-Fuller test for unit root Number of obs = 30

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-4.704	-3.716	-2.986	-2.624

MacKinnon approximate p-value for Z(t) = 0.0001

p-value is 0.0001, it means less than 0.050. the critical values are: 1% is -3.716, 5% is -2.986 and 10% is -2.624. Z(t) is -4.704 less than critical values, we know from this, all of the indications changed from being non-stationary to being stationary.

Table 7. Agriculture in the Dickey-Fuller test

Dickey-Fuller test for unit root Number of obs = 31

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-9.759	-3.709	-2.983	-2.623

MacKinnon approximate p-value for Z(t) = 0.0000

The result of Dickey-Fuller test for the Agriculture, statistic test is -9.759 and smaller than other 3 critical values. 1% critical value is -3.709, 5% critical value is -2.983 and 10% critical value is -2.623. Additionally, the p-value is 0.0006, which is less than 0.05, and it shows a strong stationary relationship. all of the indications changed from being non-stationary to being stationary.

The variables chosen in this scenario were nonstationary, as shown in Tables 2, 3, 5 and 6 but after two integrations, the values of both variables became stationary, satisfying the requirement of cointegration dependence.

Table 8. Correlation of economic indicators(ln) of Germany.

	GDPper~a	Exports	FDI	Unempl~t	Inflat~n	Agricu~e
GDPpercapita	1.0000					
Exports	0.9220	1.0000				
FDI	0.2996	0.4727	1.0000			
Unemployment	-0.4170	-0.4655	-0.1915	1.0000		
Inflation	-0.3116	-0.4129	-0.3963	-0.0889	1.0000	
Agriculture	0.2687	0.1877	-0.0545	0.2432	0.1629	1.0000

These model indicators are correlated, which suggests that there is a long-term correlation between them. All indicators are related if we analyze based on the information in table 14 above. Additionally, there are two types of relationships: negative relationships and positive relationships. A positive relationship means that if the value of one indicator rises, the value of the second indicator rises as directly proportional, and if the value of the first indication falls, the value of the second indicator also falls. In a negative relationship, if the first value's amount rises, the second value's value falls off as an inversely proportional result, and vice versa, if the first value falls, the second value rises.

Initially, According to our calculations, a 1% change in Exports causes a 0.92% change in GDP per capita. It means if exports increase 1 unit, 0.92 unit rise in GDP per capita. FDI and Agriculture has a positive relationship 29.96% and 26.87% with GDP per capita. It means if FDI and Agriculture increase 1 unit, GDP per capita rise 0.2996 and 0.2687 units. Unemployment has a negative relationship 41.70% with GDP per capita. In other words, if Unemployment increase by one unit, GDP per person will decrease by 0.41 unit, respectively. In addition, Inflation has a negative relationship 31.16% with GDP per capita, we can see from this, 1 unit growth affects to GDP per capita with 0.31 unit fall.

Secondly, independent indicators are connected. We can see there is positive 47.27% correlation between Exports and FDI. It means 1 unit increase in FDI, affects to 0.47 unit rise in Exports. Unemployment and Inflation both have a negative -46.55 and -41.29 percent relationship with Exports and with agriculture has a positive 18.77% correlation.

Thirdly, all three indicators have negative relationship with FDI, Unemployment is 19.15%, Inflation is 39.63% and Agriculture has 5.45%.

Fourthly, Inflation shows that it has negative 8.89% relationship with Unemployment rate, however, Agriculture has positive 24.32% relationship.

Finally, we can see that Agriculture has a positive 16.29% correlation with Inflation.

Table 9. Regression model of Germany

Source	SS	df	MS
Model	1.66149085	5	.332298169
Residual	.330728623	23	.014379505
Total	1.99221947	28	.071150695

Number of obs	=	29
F(5, 23)	=	23.11
Prob > F	=	0.0000
R-squared	=	0.8340
Adj R-squared	=	0.7979
Root MSE	=	.11991

lnGDPpercapita	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnExports	.6470573	.0982249	6.59	0.000	.4438635	.850251
lnFDI	-.073244	.0327983	-2.23	0.036	-.1410926	-.0053955
lnUnemployment	.0099872	.0879364	0.11	0.911	-.1719232	.1918976
lnInflation	-.0089542	.0405411	-0.22	0.827	-.0928199	.0749115
lnAgrigukture	.0170524	.2382178	0.07	0.944	-.4757387	.5098434
_cons	-5.965829	5.892709	-1.01	0.322	-18.15583	6.224167

Dependent variable = $\beta 0$ + $\beta 1$*independent variable + ε(standart error)
lnGDPpercapita= -5.966+0.6471*lnExports+0.0982249
lnGDPpercapita= -5.966+(-0.0732)*lnFDI+0 .0327983

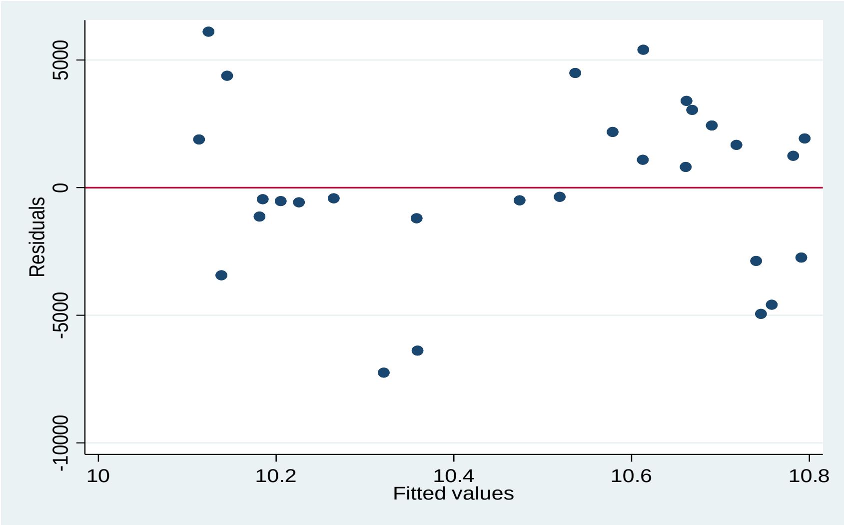
According to the established model's coefficient of determination, the amount of our indicators accounts for 83.4% percent of the variation in the GDP per capita (lnGDPpercapita). A greater R-squared often denotes a better fit for the model. And the remaining 16.6% percent is the result of unaccounted-for other causes. In addition, it was discovered that the GDP per capita component, the coefficient of the amount of influence on the volume of our independent variables, is determined at the significance level of 5%. The likelihood of a P-value in the regression model's Exports ratio (lnExports) FDI ratio is less than 0.05%, indicating that this ratio has an impact on changes in GDP per capita. So that we accept our p value and export.
Our findings showed that the probability of the P-value for the Fisher F-statistic in the built regression model is lower than 0.05, demonstrating that the constant and independent variable factor influences the GDP per capita, which is a dependent variable in our model.
We can see FDI and Inflation has negative relationship. Exports are the main impact the growth of GDP per capita.

Now we will consider each of the Gauss-Markov criteria individually based on our techniques.
The number of observations must be six times as many as there are variables, according to the first requirement. We have 31 observations covering the period from 1990 to 2021. Six variables are also present. Six times six equals 36; however, we only had 31 observations. Although there is a small amount missing right now, we cannot accept it and say that it does not satisfy the first requirement of the Gauss-Markov equation.
The second criterion of Gauss-Markov is that the total of the empirical data and total of the theoretical data must equal one another.
Table 10. Gauss-Markov model of Germany

Variable	Obs	Mean	Std. Dev.	Min	Max
lnGDPperca~a	32	10.45615	.2713712	10.01252	10.84356
model	29	10.48153	.2435959	10.11327	10.79473

We can see from this table the observations somehow equal, for example our mean based on lnGDPpercapita is 10.45615 and for model is 10.48153. so that we are able to accept our indicators as an equal.
The residuals should not be connected to the factor signs, which is the third requirement of Gauss-Markov; if they are, the condition is known as heteroscadastic; if not, it is known as homoscadastic. To meet the third requirement of the Gauss-Markov method, we require a second case. We utilize a graph, the White-test, and the Breusch-Pagan test to verify this.

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



As you can see, this chart does not include outliers for any data that are located between -1000 and 500 or for observations that are located close to the average 0. The first checking method, the graphical way, was fulfilled, and it is good.

Sub table 1. Breusch-Pagan test of Gauss-Markov method.

chi2(1) = 4.38
Prob > chi2 = 0.0365

Probability in this sub table is less than 0.05 when it should be greater since it fails the test. However, it is good if the chi-test is large enough.

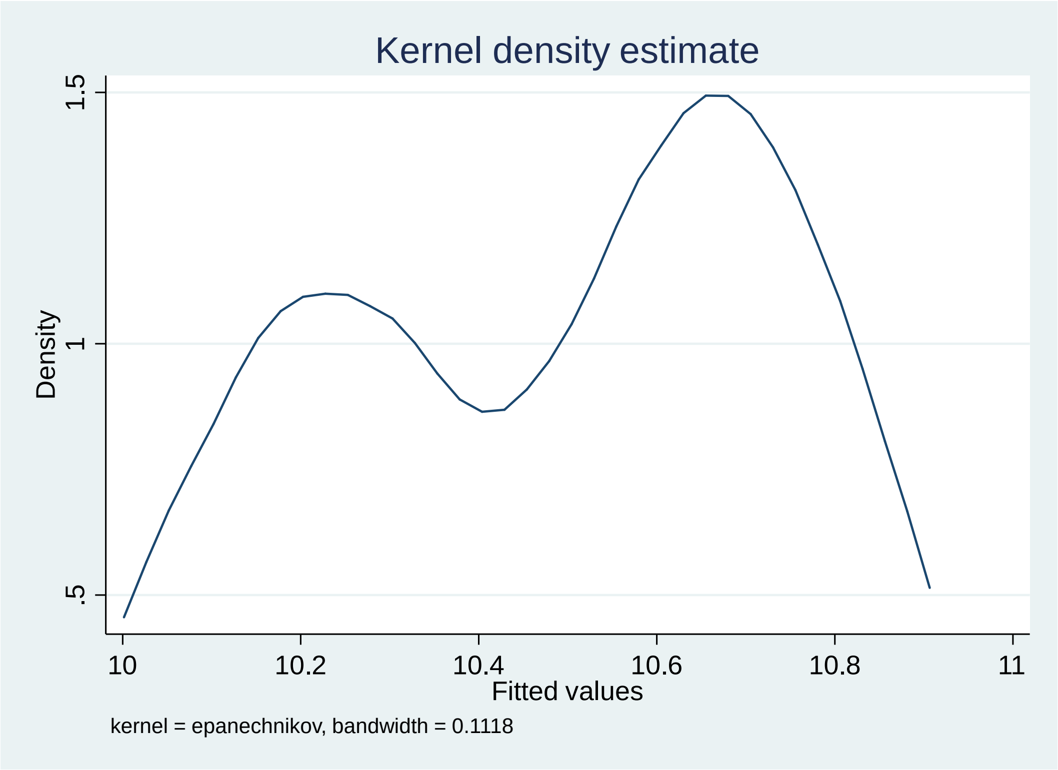
Table 11. Cameron & Trivedi's decomposition of IM-test of Gauss-Markov.

Source	chi2	df	p
Heteroskedasticity	24.24	20	0.2319
Skewness	4.64	5	0.4613
Kurtosis	0.24	1	0.6214
Total	29.13	26	0.3053

All p-values and their total must be greater than 0.05 in this particular Gauss-Markov test. As you can see, the indicators in the table above are reliable and meet the third requirement of the Gauss-Markov equation.

The following is the fourth Gauss-Markov condition: Remaining amounts must be evenly distributed. To check this condition, there are numerous test and graphical methods available.

Figure 2. Kernel density estimate graph.



One of the Gauss-Markov requirements is the Karnel density estimation graph. In this case, we have some fluctuations but the density peaked at 1.5 and then fell, which is unsatisfactory. This ought to be higher than 10%.

Table 12. Skewness/Kurtosis tests for Normality.

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
r	29	0.5484	0.0001	12.56	0.0019

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
qoldiq	32	0.4637	0.9860	0.56	0.7569

The Skewness and Kurtosis tests for determining normalcy are shown in Table 12. In this instance, the probability should be greater than 0.05. indicator's valued for r is less than 0.05, 0.0001 for kurtosis and 0.0019 for chi2, we cannot say that it is stationary. However, for the fifth condition of the Gauss-Markov methodology, the "qoldiq" residual is perfectly stationary.

Subtable 2. Shapiro-Wilk W test for normal data.

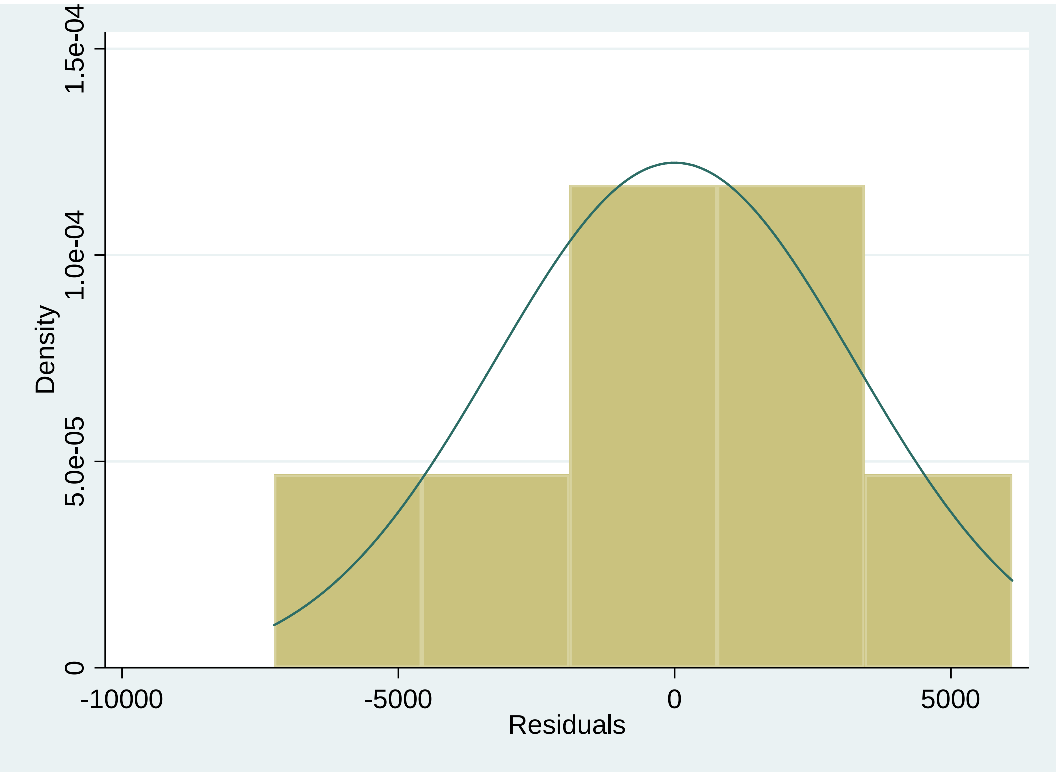
Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
qoldiq	32	0.98041	0.654	-0.883	0.81132

.

Given that only the 'qoldiq' residual was acceptable in subtable 4, we used the Shapiro-Wilk W test for 'qoldiq'. Probability is equal to 0.81132, it means it is higher than 0.05. we will accept this.

Figure 3. Histogram test.



Accordance to this graph, it demonstrates that graph is risen, however, the last column is declined. Other two column in a high position, therefore, we can accept that it satisfied to the fifth condition.

The fifth and final requirement of Gauss-Markov is that the factor's signs should not be related. We do this via STATA and the VIF test.

Table 13. VIF test with the stationary indicators.

Variable	VIF	1/VIF
lnExports	4.00	0.249695
lnFDI	3.25	0.307874
lnUnemploy~t	2.19	0.457416
lnAgrigukt~e	1.49	0.669138
lnInflation	1.31	0.761292
Mean VIF	2.45	

According to the fifth condition of Gauss-Markov, VIF of the independent variables should be less than 10 and all our VIFs are satisfy this requirement. It is stationary and we can accept it to our sixth Gauss-Markov condition.

Sub table 3. Durbin-Watson test analysis of Gauss-Markov method.

```
Number of gaps in sample:  2

Durbin-Watson d-statistic(  6,    29) =  .7669376
```

In this test analysis, the d-statistic value should be between 1.5 and 2.5; otherwise, it will be rejected. In this situation, it is 0.7669376, which does not satisfy.

Sub table 4. Breusch-Godfrey LM test for autocorrelation.

```
Ho: Constant variance
Variables: fitted values of lnGDPpercapita

chi2(1)      =     4.38
Prob > chi2  =   0.0365
```

The probability of this test should be larger than 0.05, but it is 0.0365, and it does not satisfy the fourth criterion of the Gauss-Markov model.

Table 14. Vector autoregression model

```
. var lnGDPpercapita

Vector autoregression

Sample:  1992 - 2021                          Number of obs     =         30
Log likelihood =    32.6663                   AIC               =  -1.977753
FPE            =   .0081075                   HQIC              =  -1.932928
Det(Sigma_ml)  =   .0066334                   SBIC              =  -1.837633

Equation           Parms      RMSE     R-sq      chi2     P>chi2
----------------------------------------------------------------
lnGDPpercapita        3     .085852   0.8955   257.113   0.0000
----------------------------------------------------------------
```

AIC, HQIC and SBIC models are not good, because they are negative, but we can accept. Log likelihood is positive and sigma are satisfactory.

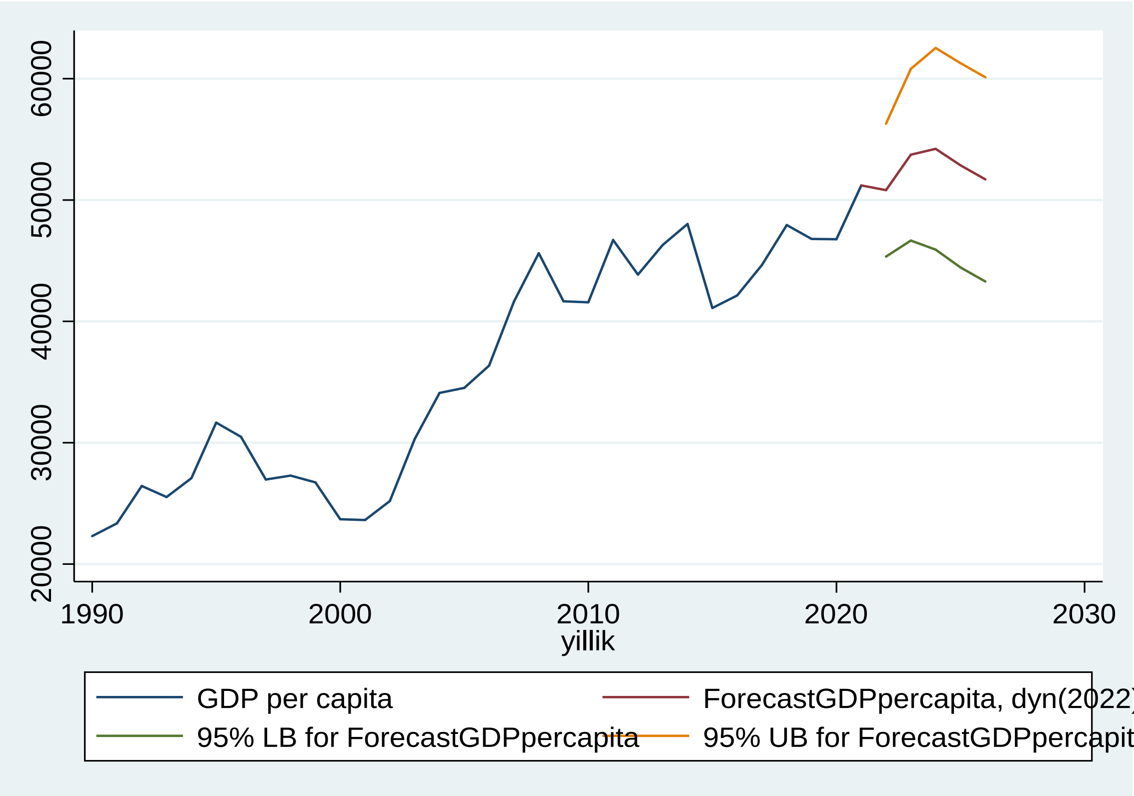
Table 15. GDP per capita based on VAR model.

lnGDPpercapita	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnGDPpercapita						
lnGDPpercapita						
L1.	1.054765	.1846058	5.71	0.000	.6929446	1.416586
L2.	-.1204619	.1803189	-0.67	0.504	-.4738804	.2329566
_cons	.7102446	.614423	1.16	0.248	-.4940025	1.914492

The diagram illustrates all relationships and effects GDP per capita during a two-year period. P-value will be impacted if it is less than 10%. In the first year, the GDP per capita had a slight beneficial effect on itself, but in the second year, it had negative effect.

Discussion

Average version of the factors to be anticipated during the following five years



Average incomes rise as a result of sustained economic expansion, which is also closely related to decreasing poverty. As we emphasized in the methodology part of our article, a basic measure of output value per person is provided by GDP per capita, which serves as an indirect measure of per capita income. GDP growth and GDP per capita are regarded as general indicators of economic growth.

Therefore, we made a strong resolution to consider GDP per capita as a dependent variable and as well as FDI, Inflation, Unemployment, Export, Agriculture are independent variables because they are impacting on each other, there are some positive and negative relationships between them.

	ForecastGDPpercapita	ForecastGDPpercapita_LB	ForecastGDPpercapita_UB
2022	50817.832	45340.584	56295.081
2023	53733.131	46660.506	60805.755
2024	54222.378	45914.564	62530.192
2025	52861.87	44444.904	61278.835
2026	51701.075	43286.497	60115.652

We will demonstrate how I predicted the state of the economy for the next five years during the discussion section.(2022-2026) To test our hypothesis, we used a multi-factor time series to examine how long-term and short-term economic development can affect GDP per capita growth, primarily using the OLS model and VAR model. Our results were tested in five Gaussian Markov conditions, with all models are successfully suitable for five evaluation tests.

In addition, the stationary of our factor indicators and residuals was checked; after one integration, FDI and Agriculture turned into stationary, the other variables became stationary when we integrate them twice and this enabled us to use the aforementioned VAR and OLS models. We chose to employ the VAR model once our models passed the identification and evaluation tests. Because the VAR model provided us with useful predictive findings.

In accordance with forecasting, GDP per capita, GDP per capita LB, and GDP per capita UB are depicted in the graph, indicating the average, least, and largest amount of GDP per capita within the next 5 years. In 2022, GDP per capita will reach average $50817.832, minimum and maximum amount, $45340.584 and $56295.081, respectively. By 2026, these ratios change to minimum $43286.497, average $51701.075 and maximum $60115.652.

CONCLUSION

According to our investigation's findings, it indicates that it is conceivable to say that relationship between GDP per capita and both Unemployment and Inflation is negative, the other variables positively affect to GDP per capita. Nowadays inflation rate in Germany is high which means that it can affect adversely to growth of economy. However, unemployment rate is low. The main reason for that, the job market in Germany is considered to be one of the strongest in Europe, with low unemployment rates and a variety of job opportunities available in various industries.

Furthermore, by running some tests to predict the change in variables, we discovered that without exception, our dependent variable is likely to increase, despite some variations in independent variables.

Acknowledgement

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Contribution

Ashuraxunov Abdufattokh - “Abstract”, “Introduction”, “Methodology”, “Editing”.

Masharipov Dilshod - “Result”, “collecting data”.

Yarashev Bekhruz - “Discussion”, “Conclusion”.

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