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MULTIPLE REGRESSION ANALYSIS OF INFLATION IN THE REPUBLIC OF UZBEKISTAN

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ABSTRACT
This article employs statistical methods and econometric models to investigate the correlation between inflation and selected factors, including changes in the producer price index and transport tariffs. The obtained results are validated using economic coefficients such as Fisher's statistics and Student's method.
KEYWORDS: *inflation rate, statistical methods, econometric models, correlation coefficient, regression equation, the significance of the regression equation, producer price index, transport tariff changes.*

INTRODUCTION

Inflation, as a critical economic phenomenon, holds significant implications for a country's overall economic stability and welfare. Understanding the determinants and factors influencing inflation is crucial for policymakers and economists alike, as it aids in formulating effective monetary and fiscal policies to mitigate its adverse effects. This study focuses on analyzing the multiple regression analysis of inflation in the Republic of Uzbekistan, a dynamic and rapidly developing nation in Central Asia.

The Republic of Uzbekistan has witnessed substantial economic transformations since its independence in 1991. The country has implemented various structural reforms and policy changes aimed at achieving sustainable economic growth and stability. However, like many other emerging economies, Uzbekistan continues to grapple with the challenges posed by inflation. Identifying the key factors contributing to inflationary pressures is vital for devising appropriate strategies to manage and control inflation effectively.

To this end, this study employs multiple regression analysis, a widely used econometric technique, to examine the relationship between inflation and various selected factors in Uzbekistan. The factors considered in this analysis include, but are not limited to, the producer price index (PPI) and changes in transport tariffs. By incorporating these factors into the analysis, we aim to uncover their individual and collective impact on the inflationary trends observed in the Republic of Uzbekistan.

The utilization of multiple regression analysis allows for the simultaneous examination of several variables and their respective influence on the dependent variable, which in this case is inflation. This approach enables us to isolate the specific effects of each factor while controlling for potential confounding variables, providing a comprehensive understanding of the inflation dynamics in Uzbekistan.

Moreover, this study incorporates various statistical methods and economic coefficients to validate the obtained results. Fisher's statistics and the Student's method are employed to assess the statistical significance of the relationships between inflation and the selected factors. These rigorous validation techniques enhance the reliability and robustness of the findings, ensuring that the conclusions drawn from this analysis hold substantial economic merit.

The outcomes of this research endeavor hold significant implications for policymakers, economists, and stakeholders involved in the economic management of Uzbekistan. The findings will shed light on the underlying factors contributing to inflation in the country, thereby assisting policymakers in formulating targeted measures to address inflationary pressures effectively. Additionally, this study contributes to the existing body of knowledge on inflation analysis, specifically in the context of the Republic of Uzbekistan, and serves as a foundation for further research in this domain.

LITERATURE REVIEW

Multiple regression analysis has long been a pivotal tool in the study of economics, offering a means to quantify the relationships between multiple variables. Its application to inflation forecasting and understanding has been the subject of extensive research over the years, as scholars aim to discern and quantify the predictors of inflation.

Jain and Kumar (2016) applied multiple regression analysis to inflation in India, discovering a significant relationship between inflation and several independent variables, including money supply and gross domestic product. Their study highlighted the power of multiple regression in detecting and quantifying the effects of these predictors on inflation, thereby providing a basis for accurate inflation forecasting.

Abbas, Khattak, and Naeem (2017) conducted a similar study in Pakistan. They examined the influence of exchange rates, GDP, and interest rates on inflation. They found that interest rates and GDP significantly affected inflation, whereas the effect of exchange rates was not significant. The multiple regression model they used allowed for simultaneous consideration of these variables, demonstrating its ability to provide a more nuanced and comprehensive understanding of the factors driving inflation.

Following a different regional focus, Bulíř and Šmídková (2007) investigated inflation in Central Europe using multiple regression analysis. Their study identified a strong association between inflation and factors such as wage costs, exchange rates, and oil prices. Again, their research underlines the power of multiple regression analysis to predict inflation and understand the interplay between it and its predictor variables.

A seminal study by Stock and Watson (2007) identified a significant shift in the predictors of inflation in the United States over time. They employed multiple regression analysis and found that historically potent predictors of inflation, such as money supply and unemployment rates, had decreased in relevance by the 1990s. This study not only highlighted the adaptability of multiple regression analysis to shifting economic conditions but also stressed the need for periodic re-evaluation of inflation models.

Studies have also looked at the issue of multicollinearity, which can hinder the effectiveness of multiple regression analysis. Multicollinearity refers to a situation where independent variables in a regression model are highly correlated. As observed by Gujarati (2003), this can cause problems in estimating the regression coefficients accurately. Researchers must therefore be cautious and vigilant for multicollinearity when employing multiple regression analysis to study inflation.

Despite these challenges, multiple regression analysis has proven to be a valuable tool in the economic sphere for forecasting and understanding inflation. However, it is evident that its utility is contingent upon the accurate identification and incorporation of the appropriate predictor variables.

In conclusion, multiple regression analysis remains a powerful method in the study of inflation, capable of detecting and quantifying the influences of multiple factors. Future research would do well to continue refining the predictor variables for inflation and to develop ways to combat the issue of multicollinearity.

ANALYSIS AND RESULTS

The inflation rate, as one of the main macroeconomic indicators, is simultaneously influenced by many factors. These factors may include various economic phenomena: production and transportation costs, tax and credit rates, the exchange rate of the national currency, and other internal and external factors (1).

Elements of multi-factorial correlation-regression analysis are widely used in inflation rate assessment and forecast. This method helps us evaluate the relationship between the inflation rate and the factors affecting it, and create a mathematical model representing this process and forecast the inflation.

In this article, we will consider the impact of the producer price index (x_1) and transport tariffs index (x_2) on inflation (y). To do this, we will use the time series of these two factors over the years in Table 1 and carry out correlation analysis to discover if there is a relationship between inflation and two variables/datasets, and how strong this relationship is.

The significance of this correlation analysis lies in the fact that, we will be able to assess the strength of relationship and to forecast the prospects of inflation rate for medium and long term period.

Table1. Time series of inflation rate, producer price index and transport tariff index

Year	CPI (Y)	PPI (X1)	Transport tariffs index (X2)
2010	11,7	16,4	22,3
2011	15,1	20,4	28,3
2012	11,6	10,8	17,8
2013	10,3	12,7	27,9
2014	10,4	14,8	16,6
2015	7,6	13,8	17,6
2016	9,8	13,0	7,0
2017	18,8	31,1	15,3
2018	14,3	39,6	10,8

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2019	15,2	28,2	19,0
2020	11,1	7,1	12,0
2021	10,0	13,0	9,2
2022	12,3	17,0	7,4
Total	**311,5**	**507,6**	**597,1**
Average	**14,2**	**23,1**	**27,1**
Standard deviation	**5,7**	**12,1**	**21,5**

A statistical measure of the strength of a linear relationship between two variables is called correlation coefficient. Its values can range from -1 to 1. Correlation coefficient is calculated via following formula (2,3):

$$r_{xy} = \frac{\sum(x_i - \overline{x_i})(y_i - \overline{y_i})}{\sqrt{\sum(x_i - \overline{x_i})^2 \sum(y_i - \overline{y_i})^2}} = \frac{n\sum x_i y_i - \sum x_i \sum y_i}{\sqrt{\left[n\sum x_i^{\,2} - (\sum x_i)^2\right](n\sum y_i^{\,2} - (\sum y_i)^2\right]}}$$

Where r_{xy} – correlation coefficient, x_i and y_i – value of x and y through the years. At the same time $\overline{x_i} = \frac{\sum x_i}{n}$ and $\overline{y_i} = \frac{\sum y_i}{n}$.

A correlation coefficient of -1 describes a perfect negative, or inverse, correlation, with values in one series rising as those in the other decline, and vice versa. A coefficient of 1 shows a perfect positive correlation, or a direct relationship. A correlation coefficient of 0 means there is no linear relationship.

Now let's make some calculations (see table2 below). In this process for convenience and simplicity we use "Correlation" in "Data analysis" instrument of MS Excel (4,5).

Table 2. Strength of relationship between variables

	Y (CPI)	**X1 (PPI)**	**X2 (Transport tariffs)**
Y (CPI)	1,00		
X1 (PPI)	0,74	1,00	
X2 (Transport tariffs)	0,14	-0,03	1,00

From Table 2, we can see that there is a good (strong) relationship between CPI and PPI as the correlation coefficient is higher than 0.7. At the same time, transport tariffs index can be excluded from regression analysis, as the value of correlation coefficient is 0.14 for it. Then our final regression equation may include only one factor (x_1-PPI) which is seen as follows: $y = a_0 + a_1 x_1$ (3).

Now we'll build regression equation using the "Regression" in "Data analysis" instrument of MS Excel. We present the results of the analysis in following tables (see tables 3-5 below):

Table 3. Results of regression analysis

Multiple R	0.76
R-square	0.58
Adjusted R-square	0,49
Standard error	2,11
Sample	13

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Table 4. Results of dispersion analysis

Dispersion Analysis	Degree of Freedom (df)	Dispersion (SS)	Dispersion for per Degree of Freedom (MS)	F-statistics (F)	The significance F
Regression	2	61.022	30.511	6.81	0.013586
Remainder	10	44.785	4.479		
Total	12	105.808			

Table 5. Coefficients of multi-regression equation

	Coefficients	Standard error	t-statistics	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Y (CPI)	6,673	1,980	3,370	0,007	2,261	11,084	2,261	11,084
X 1 (PPI)	0,240	0,066	3,632	0,005	0,093	0,387	0,093	0,387

Using the results in table 5, we are able to write the regression equation as follows: $\tilde{y} = 6.856 + 0.240x_1$. What does this regression equation mean?

It means that 1-percent point change (decline or growth) in the producer price index causes 0.240-percent point (decline of growth) in inflation rate.

Now let's check the statistical significance of regression model via F-statistics and t-statistics. An F statistic is a value you get when you run a regression analysis to find out if the means between two populations are significantly different. It's similar to a T-statistic from a T-Test. A T-test will tell you if a single variable is statistically significant and an F-test will tell you if a group of variables are jointly significant (2,3).

In general, if your calculated F value in a test is larger than your F critical value, (one that is found in a table), it means that your regression model is statistically significant, and if it is vice-versa, your model is statistically insignificant (you cannot use model in your analysis).

From table 4 we find that calculated F=6.81 while critical value of F for degree of freedom df=n-m-1=12-2-1=9 (n-sample size, m- number of variables) is 3.88. Calculations show that calculated F value (6.81) in a test is larger than your F critical value (3.88) which means that regression model we built is statistically significant.

Now we'll check the statistical significance of variable (in our example – PPI). For this we use T-test. From table 5, we find that calculated T for Y (CPI) is 3.370 and for X_1 (PPI) is 3.632. For degree of freedom df=n-m-1=12-2-1=9, critical value of T equals to 2.1788 which is lower than calculated T-values for CPI and PPI (7).

From this analysis, we may come to conclusion that created **regression model and its variables are statistically significant** and can be used in statistical analysis and forecasting of inflation rate.

Another important part of multiple regression analysis of inflation is to check the model for autocorrelation. Durbin-Watson criteria is used to identify the autocorrelation in the regression model via the following formula (2,3):

$$DW = \frac{\sum_{i=2}^{n}\left(e_i - e_{i-1}\right)^2}{\sum_{i=1}^{n} e_i^2}$$, where e_i - regression remainder

After performing the necessary calculations, we get the following numbers: DW=1,87. According to the Durbin–Watson statistics, we take the lower DW_L value as 0.81 and upper DW_U value as 1.58 (see the reference 8).

As the calculated value of DW (1.87) is higher than upper critical value DW_U (1.54), we can conclude that there is no autocorrelation in our model.

Now we have come to the last stage of our regression analysis of inflation in Uzbekistan which is called "**forecasting the inflation rate for medium and long term period".**

Knowing the value of PPI, we can predict the inflation rate value for any period of time by using the received regression model. For example, if PPI forecast is 9.0 percent for 2023, then inflation rate forecast equals to **CPI=6.856+0.240•9.0=9.016 percent which is very close to official forecast indicators (9.0-9.5%) of inflation in Uzbekistan.**

CONCLUSIONS AND SUGGESTIONS

The Ministry of Economy and Finance of the Republic of Uzbekistan is tasked with executing the functions of inflation analysis and forecasting. In recent times, this critical task has been enhanced through the utilization of modern software solutions, leading to substantial improvements in the overall process.

Significantly, food inflation poses a considerable influence on the overall inflation rate, given that the share of food items in the consumer basket exceeds 42%. Consequently, a thorough investigation into both internal and external factors, inclusive of trends in the global food market, becomes imperative in forming precise inflation forecasts.

Bearing these factors in mind, several steps can be proposed to enhance the statistical analysis and forecast of inflation in Uzbekistan:

1. Enhancement of the data collection and processing system for the computation of the inflation rate.
2. Augmenting the trustworthiness and transparency of inflation and price information through the extensive application of modern information technologies during the data collection and processing stages.
3. Encouraging the integration of databases from all state bodies responsible for price analysis.
4. Terminating the state monopoly on price data collection and promoting the role of non-governmental and private research institutes and centers in this activity.

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