IRANIAN ECONOMIC REVIEW
Print ISSN: 1026-6542
Online ISSN: 2588-6096
https://ier.ut.ac.ir/
University of Tehran

Investigation of the Relationship between the Unemployment Rate and the Inflation Rate of Pakistan

Abbas Ali Ghoto[a,*], Ghulam Hyder Mir Talpur[b], Shakeel Ahmed Kamboh[3]

a, c. Department of Mathematics and Statistics, Quaid-e-Awam University of Engineering, Science and Technology, Nawabshah, Pakistan
b. Department of Mathematics and Statistics, Institute of Business Management, Karachi, Pakistan
* Corresponding Author, E-mail: ghotoabbas@quest.edu.pk

Article Info

Article Type: Research Article

Article History:
Received: 27 January 2022
Received in revised form: 16 March 2022
Accepted: 04 April 2022
Published online: 03 December 2023

Keywords:
Forecasting Trends, Inflation Rate, Regression Analysis, Statistical Modeling, Unemployment Rate.

JEL Classification:
C15, C53, E24, E31.

ABSTRACT

Unemployment is one of the most challenging problems faced by governments, particularly in developing countries. Due to the rapid increase in the population of Pakistan and less number of job opportunities the government needs to properly forecast the unemployment rate to make future policies. This paper aims to model statistical relationships between the unemployment rate and the inflation rate for the determination of any feasible trend of unemployment in the country. About twenty different interrelationships between unemployment and inflation have been investigated by using the curve fitting approach and their goodness of fit was analyzed. The unemployment trend of Pakistan depending only on inflation does not appear homogeneous; as there is an unexpected increase or decrease. The scattered nature of the data shows that there is a negative correlation between the unemployment rate and the inflation rate of Pakistan. However, the Fourier model with three terms, the Gaussian model with two terms, and the sum of the sine model with four terms appear to fit the data moderately.

Cite this article: Ghoto, A. A., Talpur, G. H. M., & Kamboh, S. A. (2023). Investigation of the Relationship between the Unemployment Rate and the Inflation Rate of Pakistan. *Iranian Economic Review, 27*(4), 1307-1325. DOI: 10.22059/IER.2022.88369

DOI: 10.22059/IER.2022.88369
Publisher: University of Tehran Press.

1. Introduction

Both the unemployment rate and the inflation rate are considered to be the important indicators for the socio-economic condition of any country. The unemployment rate is a ratio of the individuals from a total labor force that are willing to work but do not have any job. Generally, inflation refers to a situation where supply of money exceeds to its demand or prices of commodities increase steadily (Mahmood et al., 2013). The unemployment rate and inflation rate can be estimated normally as mentioned in Ghoto et al. (2021). It is inevitable for a

government of any country to monitor the inflation rate and the unemployment rate aiming to measure both the misery index and the health of their economy. For the quantitative measure of these economic performance indicators the statisticians play their vital role to develop quantitative models that may help to propose the monetary policies to asses and reduce the inflation and unemployment in the forthcoming years. However, if the monetary and fiscal policymakers reduce aggregate demands and economy beside the short-run aggregate demand curve, they can reduce inflation leading to the temporary increase in unemployment (Arshad and Ali, 2016).

Since the unemployment rate of any country is essential indicator for the assessment of the economic growth hence the proper future forecasting of this rate is required for the government to create more jobs. Policy makers are perturbed to develop such policies that can effectively decrease unemployment without bringing more inflationary pressure. Pakistan is the 6th largest population of the world and ranking with 10th largest labor force (ILO, 2017). The main purpose of this study is to reinvestigate the relationships among unemployment rate and inflation rate in Pakistan.

Many researchers have focused the impacts of different economic and social factors in determining the unemployment. Ziang and Zhang (2014) investigated that Forecasting the rate of unemployment is highly attended by the researchers in these days because of its importance in evaluating the economy of a country, in this context; various studies have been done to propose and suggest the measures to model the unemployment by incorporating the various factors affecting this economic situation. Kooros (2010) found cubic functions are most accurate functions comparatively to other regression functions i.e. linear regression functions, quadratic regression functions in their study based on objective of validating empirically long-held theories of unemployment. He concluded that GNP, globalization, employment of government, minimum wages and many other variables other than unionization are predictive. Just like the impact of literacy on unemployment rate; the impact of inflation on unemployment is also investigated through various studies. Phillips (1967) observed a negative statistical relation between inflation and unemployment and devised the indices; i.e. misery, prosperity to understand their relationship. A study was conducted by using time series data from of 33 years. Aladkhani (2003) examined the factors that influence in Iran. This study revealed that the unemployment rate confirmed negative correlation with sizeable growth rates of real investment and inflation, positively to deliver gap and growing economic uncertainty. Qayyum (2007) Investigated that determinants i.e. gross domestic product, untimely marriages, small numbers of industries, advancement in technology, education, small income, low-wage job and government policy effect on unemployment in Khyber Pakhtun Khawah, Pakistan. Subhan and Hayat (2008) used annual data (from 1980 to 2008) of foreign direct investment, growth rate of agriculture, balance of trade, growth of GDP, inflation (CPI), import volumes, export volumes, contribution of service sectors in GDP, gross fixed capital formation by government and private sectors, large scale manufacturing's share in GDP, and total consumption to know the effect of economic growth and price instability on unemployment; identified that

positive correlation between instability and economic growth and positive with unemployment. Rafiq et al. (2008) used simple single-equation linear regression model to establish the unemployment trend in Pakistan economy for the period from 1998 to 2008. CPI based inflation rate, Growth of population and FDI are used as predictor variable. Hussain et al. (2010) examined the causality between unemployment and economic growth in Pakistan, from the period 1972 to 2006. They observed that there is negative correlation between the economic growth and unemployment in Pakistan. Other studies - including Aurangzeb and Asif (2013); Khan and Gill (2010); Ali and Rehman (2015); Maqbool et al. (2013); McIntyre et al. (1981); Phelps (1995); Tintner (1965); Rivera-Batiz (1992); Rosholm (2000); Rosholm (2001a); Rosholm (2001b); Stiglitz (1975); Streb (2002); Jensen and Verner (1996); Kelley (1999) - have discussed the effect of different factors i.e. social, economical to find out the rates of literacy, inflation, unemployment and interest. The main objective of this study is to relook into the relationships between unemployment and inflation rate in Pakistan.

2. Methodology

The secondary data of first 19 fiscal years of 21st century for the parameters involved in the THIS study availed from the official website of Government of Pakistan (2020), PBS (2020), SBP (2020), and ILO (2020).

In order to analyze the trends of unemployment rate in Pakistan extensive statistical and mathematical works have been done and the empirical relationships (models) between the unemployment rate and the inflation rate have been investigated by using the Method of Least Squares (MLS). Let in general Y represents the Unemployment rate (measured) and Y^* be the approximated (Fitted values by model) values of unemployment rate with inflation rate X as independent variable. Then the assumption of least squares method states that the sum of the squares of the residual (error) is minimum, i.e.

$$E_i = \min \sum_{i=1}^{N} (Y_i^* - Y_i)^2, \text{where } i = 1,2,...,N = 19 \tag{1}$$

Since the data used in the statistical modeling covers N=19 fiscal years therefore 18 gradient equations are required to minimize the error as [30-35];

$$\frac{\partial E_i}{\partial B_j} = 2\sum_{i=1}^{N} r_i \frac{\partial r_i}{\partial B_j} = 0, \text{where } r_i = (Y_i^* - Y_i). \tag{2}$$

In a nonlinear system, the partial derivatives $\frac{\partial r_i}{\partial B_j}$ depend on both the independent variable and the parameters. In general these gradient equations may not have a closed form of the solution therefore the initial values must be chosen for the parameters to solve iteratively. The linearization is applied at each iteration to approximation to a first-order Taylor polynomial expansion about b_j^k where the

index *k* is the iteration. The most commonly used algorithm called the Levenberg–Marquardt algorithm (LMA or just LM) is applied to solve non-linear least squares problems (Dennis and Welsch, 1978). The coefficients of the twenty different types of models have been approximated at 95% level of statistical significance. The MATLAB and the SPSS computational recourses are used to process and implement the fitted models. For the sack of brevity the all twenty different types of models have been listed in the following Table 1.

Table 1. Fitted models for U_r versus I_r

S. No	Type of Model	Model Equation
01	Polynomial of degree 1	$U_r(I_r) = -0.1076(I_r) + 7.141$
02	Polynomial of degree 2	$U_r(I_r) = 0.005705(I_r)^2 + (-0.2098)(I_r) + 7.497$
03	Polynomial of degree 3	$U_r(I_r) = -0.001162(I_r)^3 + 0.03988(I_r)^2 - 0.5011(I_r) + 8.179$
04	Polynomial of degree 4	$U_r(I_r) = 0.0003825(I_r)^4 - 0.0161(I_r)^3 + 0.2401(I_r)^2 - 0.1575(I_r) + 10.08$
05	Polynomial of degree 5	$U_r(I_r) = -4.543\times10^{-5}(I_r)^5 + 0.002512(I_r)^4 - 0.05315(I_r)^3 + 0.5359(I_r)^2 - 2.648(I_r) + 11.5$
06	Polynomial of degree 6	$U_r(I_r) = -0.0001746(I_r)^6 + 0.009811(I_r)^5 - 0.2166(I_r)^4 + 2.386(I_r)^3 - 13.66(I_r)^2 + 37.91(I_r) - 32.85$
07	Rational model	$U_r(I_r) = \frac{3.082\times10^4(I_r) + 1.919\times10^5}{(I_r)^2 + 7265(I_r) + 3.0\times10^4}$
08	Power model	$U_r(I_r) = 8.087(I_r)^{-0.1315}$
09	General power model	$U_r(I_r) = 4.791(I_r)^{-0.3072} + 3.607$
10	Exponential model	$U_r(I_r) = 7.215e^{-0.01769}(I_r)$
11	Exponential model with 2 terms	$U_r(I_r) = 5.945e^{-0.7816}(I_r) + 6.752e^{-0.01177}(I_r)$
12	Fourier model with 1 terms	$U_r(I_r) = 6.067 - 0.6598\cos(1.084.I_r) - 0.4764\sin(1.084.I_r)$
13	Fourier model with 2 terms	$U_r(I_r) = 6.055 - 0.0608\cos(0.5361.I_r) + 0.1606(\sin(0.5361.I_r) - 0.6859\cos(2\times0.5361.I_r) - 0.3365\sin(2\times0.5361.I_r)$
14	Fourier model with 3 terms	$U_r(I_r) = 6.306 - 0.2319\cos(1.293.I_r) - 0.5638\sin(1.293I_r) + 0.2836\cos(2\times1.293.I_r) - 0.8508\sin(2\times1.293I_r) + 1.486\cos(3\times1.293.I_r) + 0.1394\sin(3\times1.293I_r)$

15	General Gauss model with 1 term	$U_r(I_r) = 1.368 \times 10^{25} e^{\left(\frac{-I_r+6333}{847}\right)^2}$
16	General Gauss model with 2 terms	$U_r(I_r) = -2999e^{\left(\frac{-I_r-4.032}{0.04262}\right)^2} + 2.189 \times 10^{19} e^{\left(\frac{-I_r+3217}{493.7}\right)^2}$
17	Sum of sines model with 1 term	$U_r(I_r) = 31.32\sin(0.003494.I_r + 2.912)$
18	Sum of sines model with 2 terms	$U_r(I_r) = 29.52\sin(0.0641I_r + 1.9) + 20.46\sin(0.08536I_r + 4.88)$
19	Sum of sines model with 3 terms	$U_r(I_r) = 8.903\sin(0.04835I_r + 1.698) + 2.081\sin(0.1407I_r + 4.178) - 0.5524\sin(1.708I_r + 1.015)$
20	Sum of sines model with 4 terms	$U_r(I_r) = 81.64\sin(0.3249I_r - 1.828) + 76.75\sin(0.3517I_r + 1.015) + 2.382\sin(1.465I_r - 1.055) + 2.013\sin(2.158I_r + 1.284)$

Source: Research finding.

3. Results and Discussion

A variety of regression models have been investigated for interdependence of I_r with U_r individually. The investigated twenty different types of regression models as listed in Table 1 were fitted to see the dependence of unemployment rate on the inflation rate The following Figures 1to 20 exhibit the graphical visualization of the univariate regression models presented in the Table 1. The aim of the presentation of these models is to know how best the unemployment rate is associated with inflation rate and which type of model may be more suitable to relate the unemployment rate with the inflation rate of Pakistan. Figures 1 to 6 show the fitting of linear polynomial model between the unemployment rate and inflation rate. It appears that the polynomials of degrees 1, 2, 3, 4, 5, and 6 respectively may not be suitable to fit the unemployment rate based on the inflation rate as there are many data points which do not fall on the fitted curves. Figure 7 shows the fitting of rational model between the unemployment rate and inflation rate. It appears that the rational model may not be suitable to fit the unemployment rate based on the inflation rate as there are many data points which do not fall on the fitted curve. Figures 8 and 9 show the fitting of power models between the unemployment rate and inflation rate but there is no satisfactory fitting of data points as there are many data points which do not fall on the fitted curve. Similarly, the exponential model with one term and with two terms; Fourier model with one term and two terms also do not appear suitable for fitting the unemployment depending upon inflation rate as shown in Figures 10-13 respectively. However, From Figure 14 it can be seen that Fourier model with three terms exhibit more fluctuations and may be suitable to fit the unemployment rate based on the inflation rate as there are many data points which do fall on the fitted curve. Figure 15 exhibits the fitting of the Gaussian model with one term between the unemployment rate and inflation rate and it can be seen that there is no good relationship using such model. Figure 16 shows the fitting of the Gaussian model with two terms and it is revealed that Gaussian model with two terms exhibits ill posed results at inf_rate=4, thus may not be suitable to fit the unemployment rate based on the inflation rate. Figures 17-19 show the fitting of the sum of the sine model with one, two and three terms respectively and such relations also do not appear best. Finally, the Figure 20 shows the fitting of the sum of the sine model with four terms between the unemployment rate and inflation rate. It appears that the sum of the sine model with four terms exhibits may be suitable to fit the unemployment rate based on the inflation rate as there are many data points which do fall on the fitted curve. The summarized comparison of the fitting of the all twenty models is illustrated by Figure 21. The comparison reveals that due to the varied nature of the data of unemployment rate and inflation rate of Pakistan the conventional Least Squares Models may not provide satisfactory relationship between the unemployment rate and inflation rate. Moreover, after analyzing the curve fitting trends of the investigated relationships their goodness of fit was also determined and is listed in the Table 2.

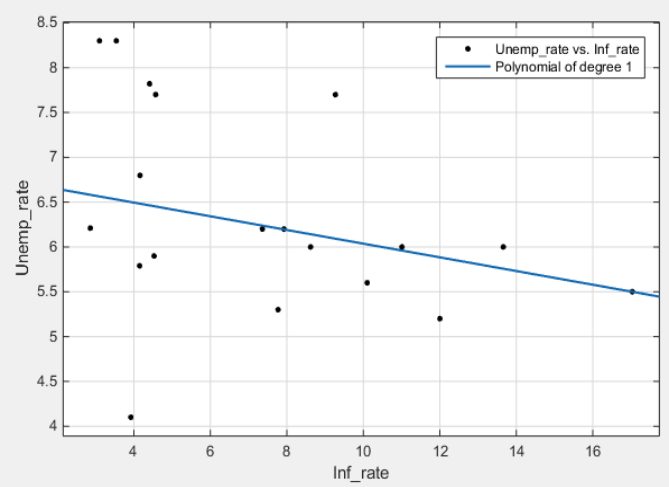

Figure 1. Fitting Polynomial of Degree 1 Model between Unemployment Rate and Inflation Rate
Source: Research finding.

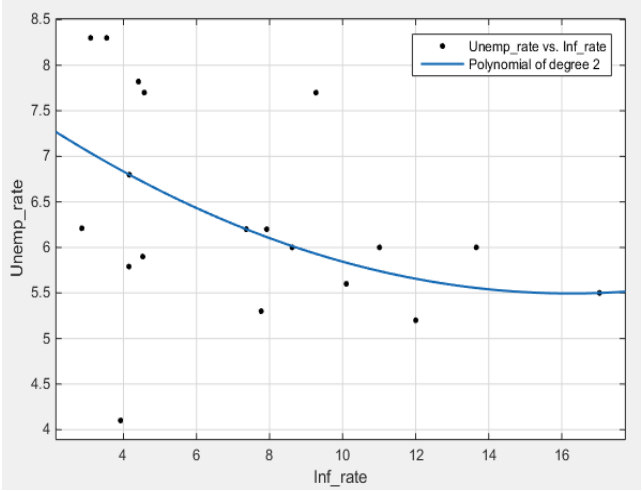

Figure 2. Fitting Polynomial of Degree 2 Model between Unemployment Rate and Inflation Rate
Source: Research finding.

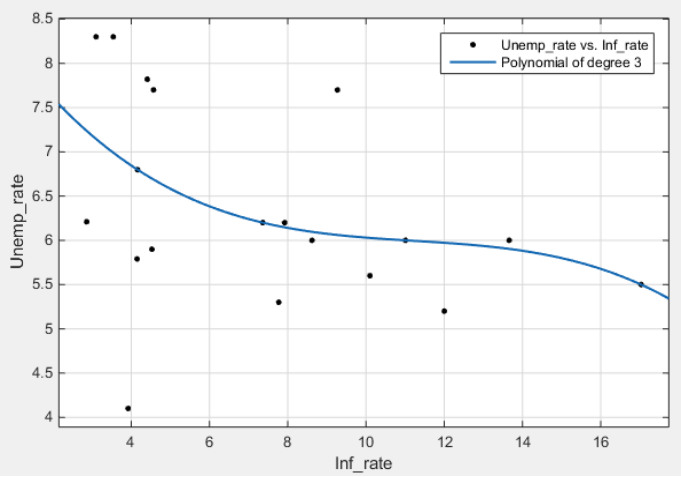

Figure 3. Fitting Polynomial of Degree 3 Model between Unemployment Rate and Inflation Rate
Source: Research finding.

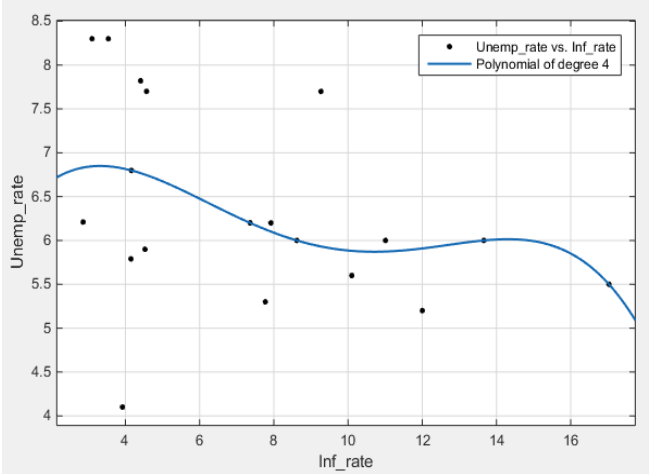

Figure 4. Fitting Polynomial of Degree 4 Model between Unemployment Rate and Inflation Rate
Source: Research finding.

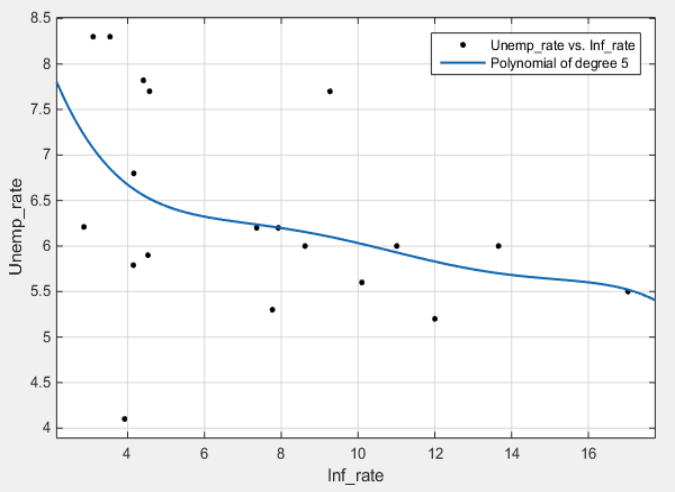

Figure 5. Fitting Polynomial of Degree 5 Model between Unemployment Rate and Inflation Rate
Source: Research finding.

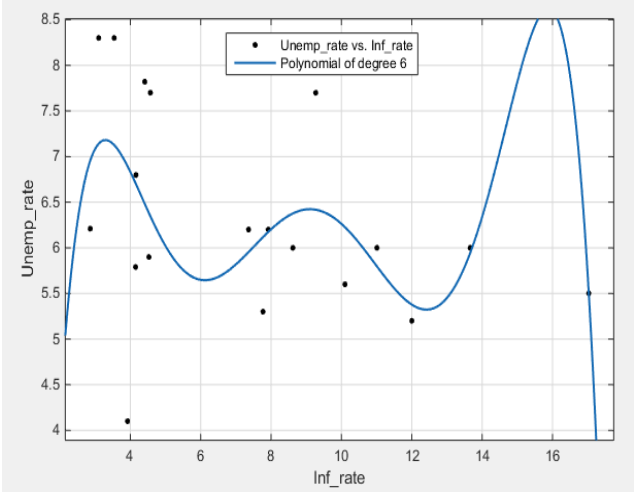

Figure 6. Fitting Polynomial of Degree 6 Model between Unemployment Rate and Inflation Rate
Source: Research finding.

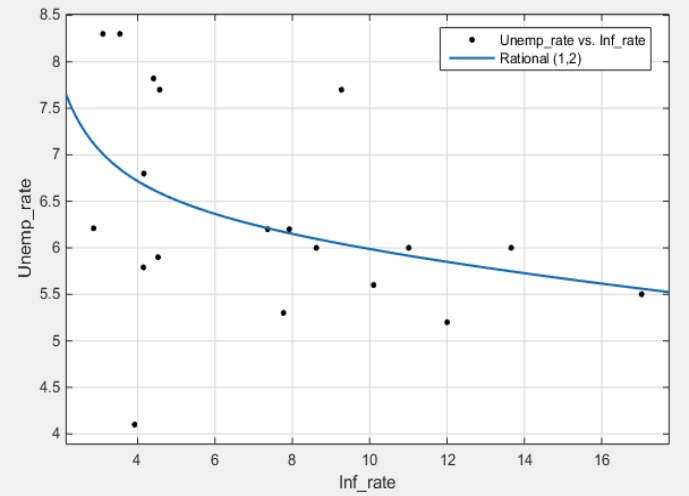

Figure 7. Fitting Rational Model between Unemployment Rate and Inflation Rate
Source: Research finding.

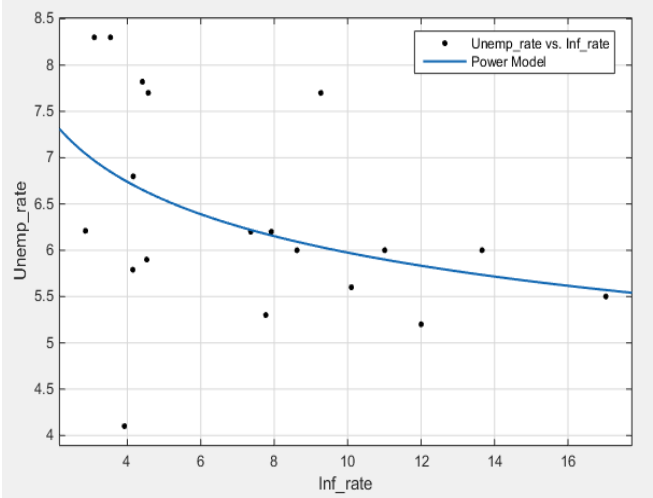

Figure 8. Fitting Power Model between Unemployment Rate and Inflation Rate
Source: Research finding.

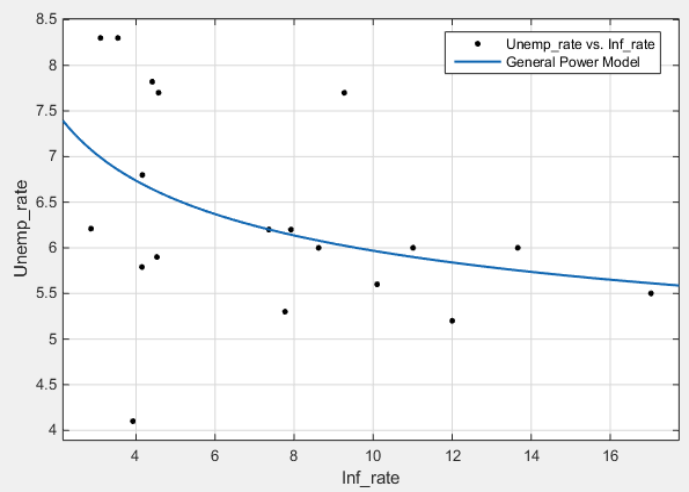

Figure 9. Fitting General Power Model between Unemployment Rate and Inflation Rate
Source: Research finding.

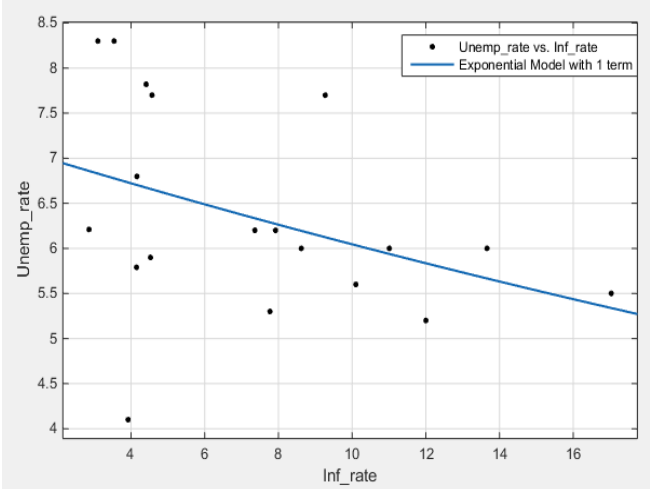

Figure 10. Fitting Exponential Model with 1 Term between Unemployment Rate and Inflation Rate
Source: Research Finding.

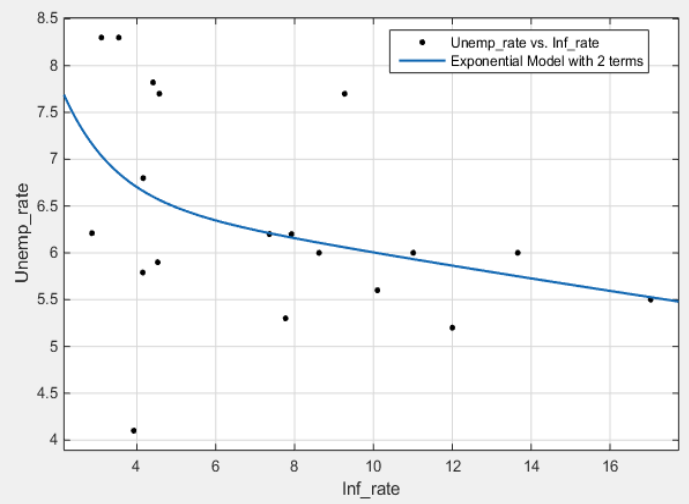

Figure 11. Fitting Exponential Model with 2 Terms between Unemployment Rate and Inflation Rate
Source: Research finding.

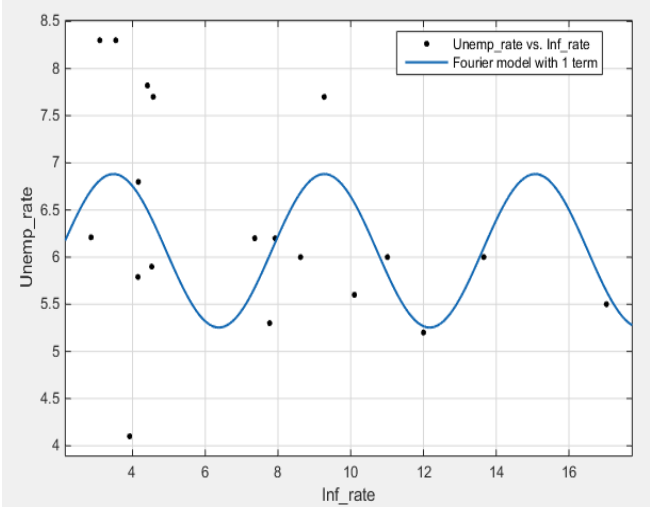

Figure 12. Fitting Fourier Model with 1 Term between Unemployment Rate and Inflation Rate
Source: Research finding.

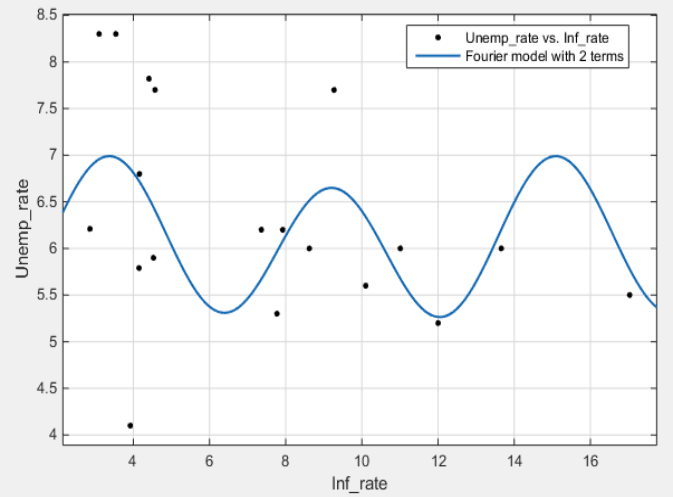

Figure 13. Fitting Fourier Model with 2 Terms between Unemployment Rate and Inflation Rate
Source: Research finding.

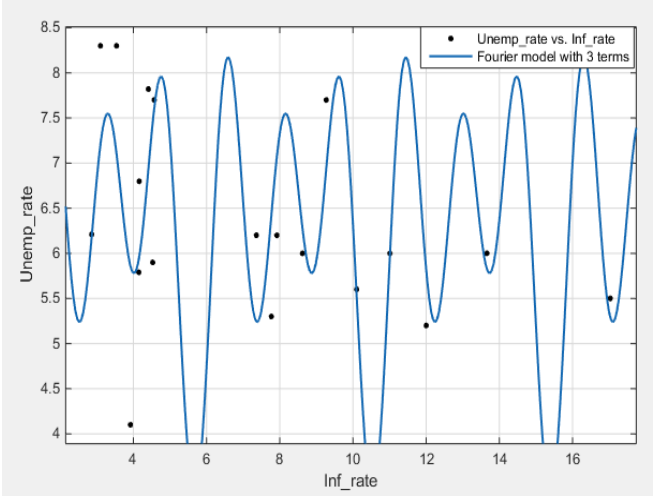

Figure 14. Fitting Fourier Model with 3 Terms between Unemployment Rate and Inflation Rate
Source: Research finding.

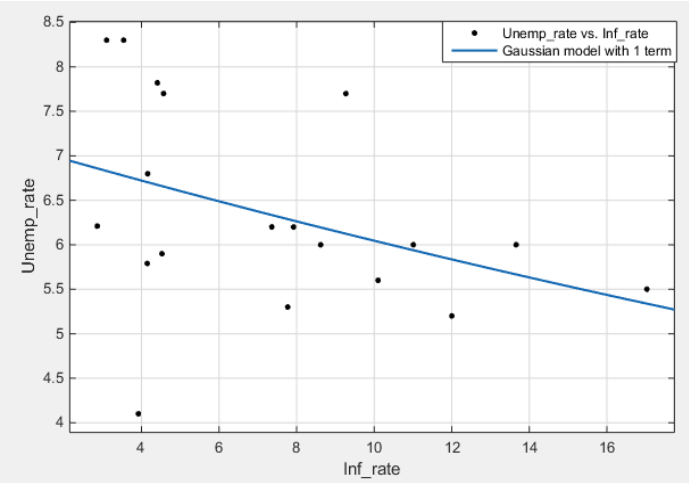

Figure 15. Fitting Gaussian Model with 1 Term between Unemployment Rate and Inflation Rate
Source: Research finding.

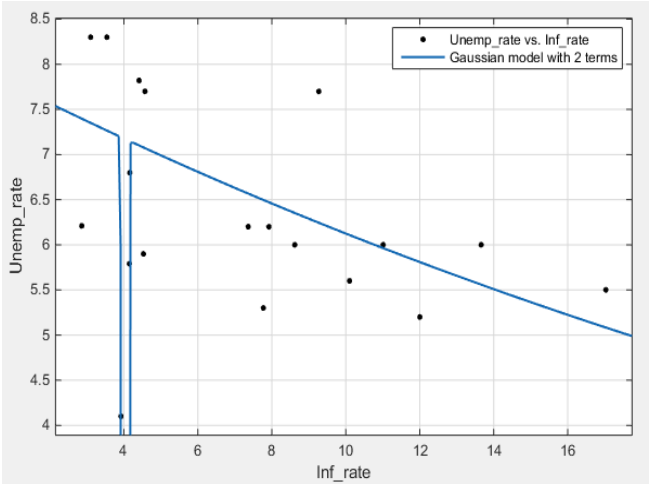

Figure 16. Fitting Gaussian Model with 2 Terms between Unemployment Rate and Inflation Rate
Source: Research finding.

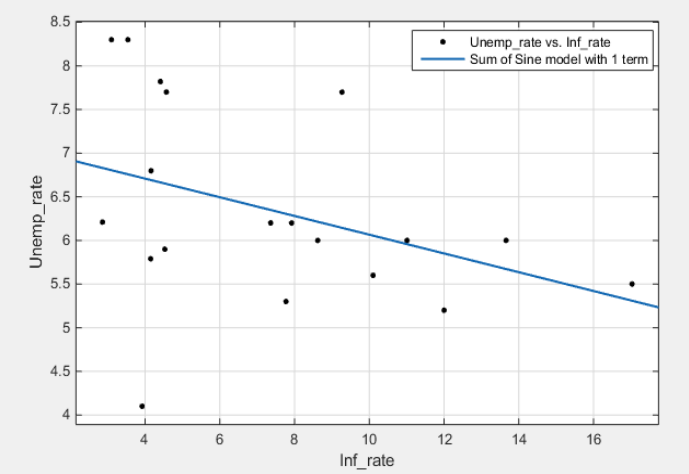

Figure 17. Fitting Sum of Sine Model with 1 Term between Unemployment Rate and Inflation Rate
Source: Research finding.

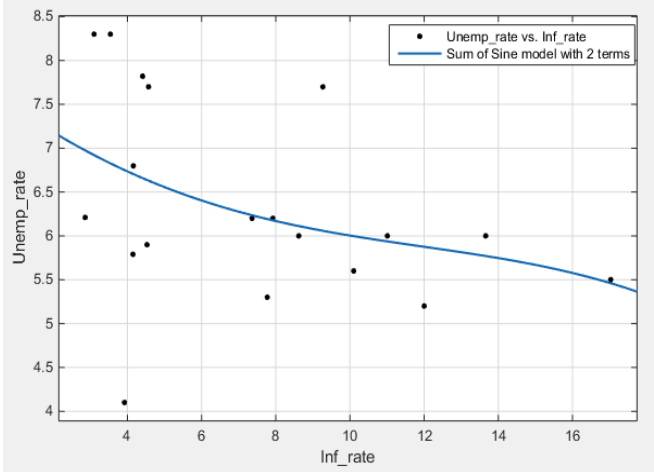

Figure 18. Fitting Sum of Sine Model with 2 Terms between Unemployment Rate and Inflation Rate
Source: Research finding.

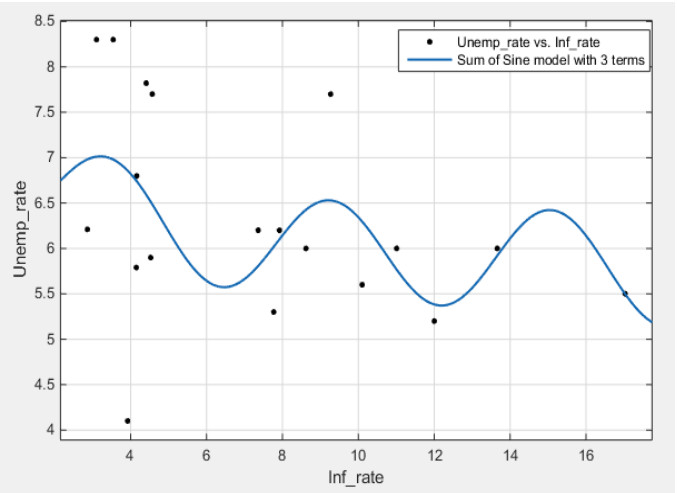

Figure 19. Fitting Sum of Sine Model with 3 Terms between Unemployment Rate and Inflation Rate
Source: Research finding.

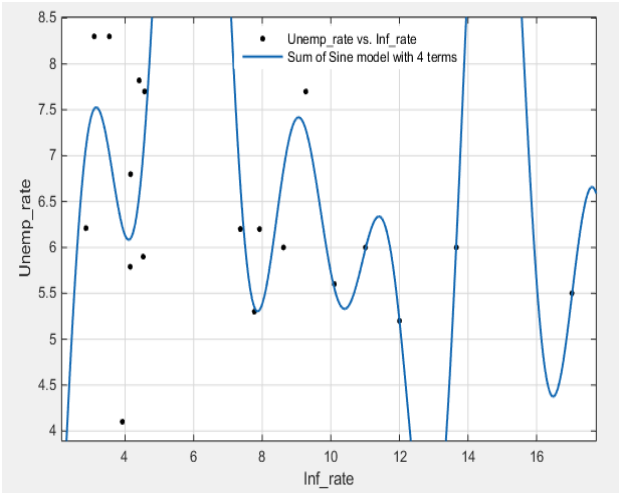

Figure 20. Fitting Sum of Sine Model with 4 terms between Unemployment Rate and Inflation Rate
Source: Research finding.

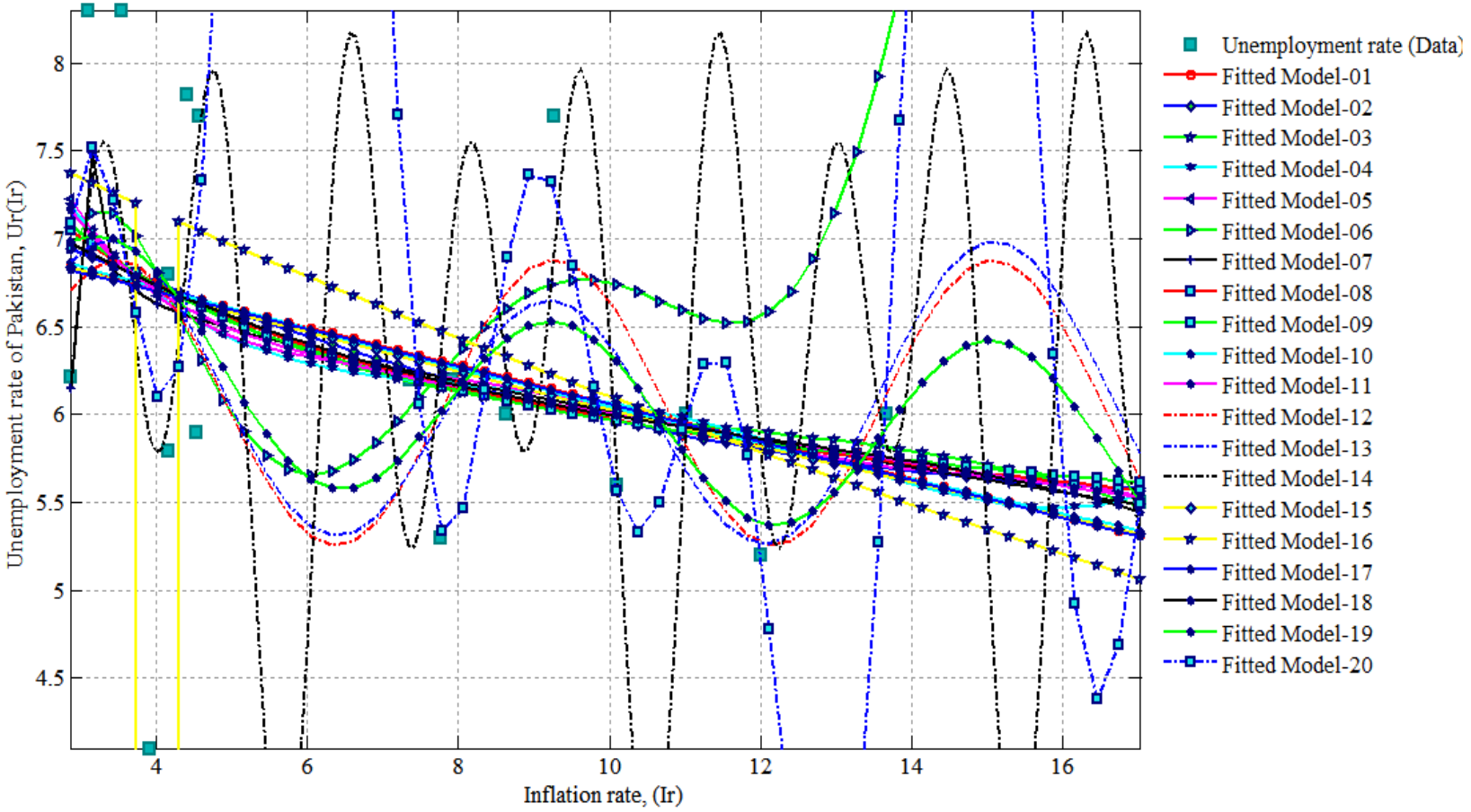

Figure 21. Comparison of Fitting of the Various Twenty Regression Models for the Unemployment Rate Depending Upon Inflation Rate
Source: Research finding.

After analyzing the curve fitting trends of the investigated relationships their goodness of fit was also determined and is listed in the Table 2. Related to the goodness of fit the Figure 22 shows goodness of fit using the SSE of. It is observed that the Fourier model with three terms, the general Gauss model with two terms and the sum of the sine model with four terms provide less SSE. Figure 23 shows goodness of fit using the RMSE and it is observed that the Gauss model with two terms provides less RMSE. Figure 24 shows goodness of fit using the R^2 and is observed that the Fourier model with three terms, the general Gauss model with two terms and the sum of the sine model with four terms provide weakly moderate values of coefficient of determination R^2. Figure 25 shows goodness of fit using the adjusted R^2 of various models between the unemployment rate and inflation rate. It is observed that only the Gaussian model with two terms provides moderate value of adjusted R^2.

From the overall analysis goodness of fit of various models between the unemployment rate and inflation rate it can be deduced that the among the twenty different types of fitted models the Fourier model with three terms, the Gaussian model with two terms and the sum of sine model with four terms may moderately fit the relationship between unemployment rate and inflation rate but may not be more significant for the forecasting of the unemployment rate based on inflation rate due to the behavior of data.

Table 2. Goodness of Fitted Regression Models for U_r versus I_r

S. No	Type of Model	SSE	RMSE	R^2	Adjusted R^2
01	Polynomial of degree 1	19.96	1.084	0.1445	0.09414
02	Polynomial of degree 2	19.8	1.112	0.1516	0.04553
03	Polynomial of degree 3	19.72	1.147	0.1549	-0.01411
04	Polynomial of degree 4	19.61	1.183	0.1596	-0.08051
05	Polynomial of degree 5	19.59	1.228	0.1602	-0.1628
06	Polynomial of degree 6	18.77	1.251	0.1955	-0.2068
07	Rational model	19.75	1.148	0.1534	-0.01596
08	Power model	19.71	1.077	0.1552	0.1056
09	General power model	19.71	1.11	0.1554	0.04986
10	Exponential model	19.91	1.082	0.1466	0.09644
11	Exponential model with 2 terms	19.65	1.145	0.1579	-0.01054
12	Fourier model with 1 terms	19.22	1.132	0.1764	0.01169
13	Fourier model with 2 terms	18.95	1.207	0.188	-0.1243
14	Fourier model with 3 terms	13.71	1.116	0.4123	0.03835
15	General Gauss model with 1 term	19.91	1.116	0.1466	0.03995
16	General Gauss model with 2 terms	10.56	0.9015	0.5472	0.373
17	Sum of sines model with 1 term	19.96	1.117	0.1444	0.03741
18	Sum of sines model with 2 terms	19.75	1.232	0.1537	-0.1717
19	Sum of sines model with 3 terms	18.69	1.367	0.1991	-0.4416
20	Sum of sines model with 4 terms	13.16	1.371	0.4362	-0.4498

Source: Research finding.

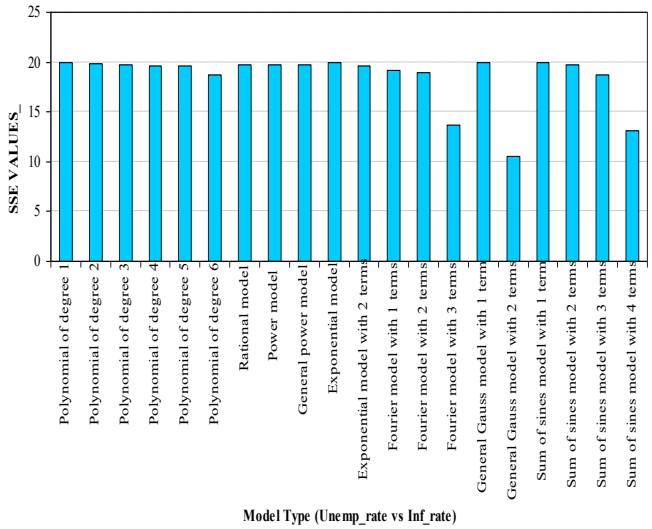

Figure 22. SSE Comparison of Different Fitted Models between Unemployment Rate and Inflation Rate
Source: Research finding.

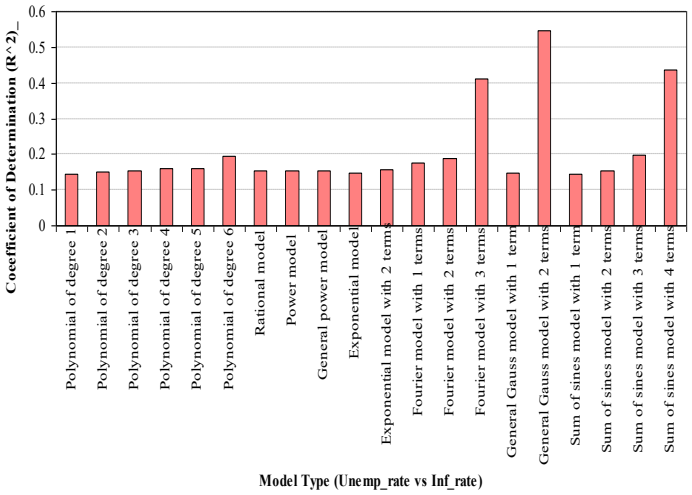

Figure 23. R^2 Comparison of Different Fitted Models between Unemployment Rate and Inflation Rate
Source: Research finding.

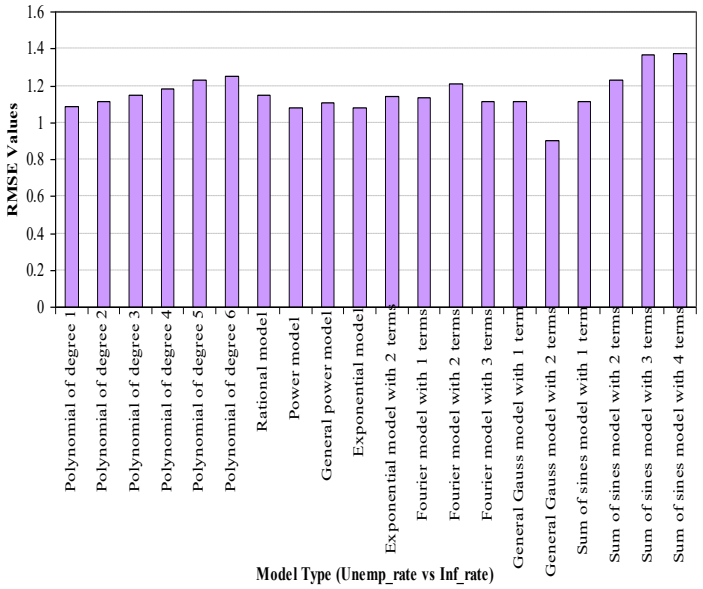

Figure 23. RMSE Comparison of Different Fitted Models between Unemployment Rate and Inflation Rate
Source: Research finding.

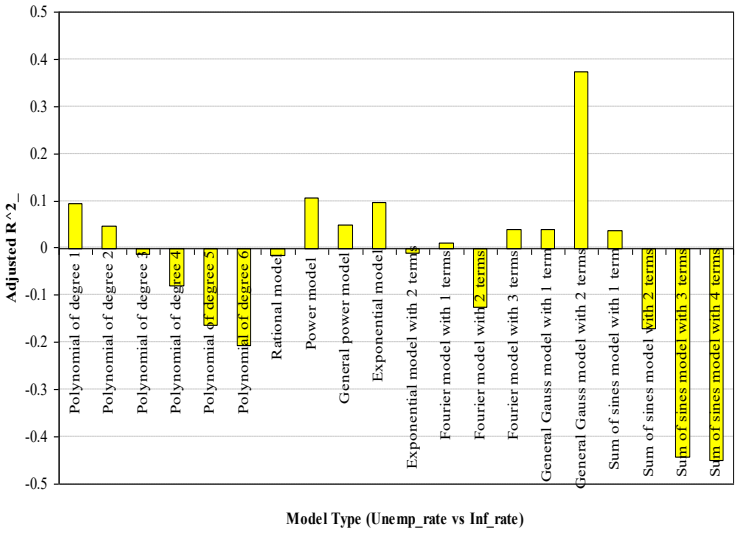

Figure 24. Adjusted R^2 Comparison of Different Fitted Models between Unemployment Rate and Inflation Rate
Source: Research finding.

4. Conclusion

From the extensive curve fitting analysis of twenty different types of regression models it come into view that there is no such satisfactory relationship between the unemployment rate and inflation rate of Pakistan. Only the Fourier model with

three terms, the Gaussian model with two terms and the sum of sine model with four terms may moderately fit the relationship between unemployment rate and inflation rate. Due to the scattered nature of data the ordinary least squares models may not provide satisfactory causal relationship between the unemployment rate and inflation rate of Pakistan. The future work may focus on other methods such as time series models.

Acknowledgement
We acknowledge the University of Sindh Jamshoro and the Quaid-e-Awam University of Engineering, Science and Technology, Nawabshah for providing the facilities and resources to conduct this research.

References

Mahmood, Y., Bokhari, R., & Aslam, M. (2013). Trade-Off between Inflation, Interest and Unemployment Rate of Pakistan: A Cointegration Analysis. *Pakistan Journal of Commerce and Social Sciences*, *7*(3), 482-492.

Ghoto, A. A., Talpur, G. H. M., & Kamboh, S. A. (2021). Estimation and forecasting of the Inflation, Interest, Literacy and Unemployment Rate of Pakistan Using Nonlinear Regression Models. *Indian Journal of Science and Technology*, *14*(3), 251-258.

Arshad, S., & Ali, A. (2016). Trade-off between Inflation, Interest and Unemployment Rate of Pakistan Revisited. *Bulletin of Business and Economics, 5*(4), 193-209.

Pakistan Bureau of Statistics (PBS). (2020). Retrieved from http://www.pbs.gov.pk

International Labor Organization (ILO). (2020). Retrieved from https://www.ilo.org/islamabad/areasofwork/skills-and-employability/lang--en/index.htm

Official Gateway to Gouvernement of Pakistan. (2020). Retrieved from http://www.pakistan.gov.pk

The State Bank of Pakistan (SBP). (2020). Retrieved from https://www.sbp.org.pk/ecodata/kibor_index.asp

Ziang, L., Xu, W., & Zhang, L. (2014). An Ontology - based Web Mining Method for Unemployment Rate Prediction. *Decision Support Systems, 66*(2014), 114–122.

Kooros, S. K., & Biberman, A. A. (2010). *The Theory of Unemployment Reassert Year Book.* New York: University Press.

Phillips, A. W. (1967). The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957. *Journal of Economica New Series, 25*(1958), 283-299.

Aladkhani, A. V. (2003). The Causes of Unemployment in Iran. *International Journal of Applied Business and Economic Research, 1*, 21-33.

Qayyum, W. (2007). Causes of Youth Unemployment in Pakistan. *The Pakistan Development Review, 46*, 611-621.

Subhan, Q. A., & Hayat, M. A. (2010). Impact of Price Instability on Unemployment and Economic Growth in Pakistan. An Econometric Approach. *8th International Conference*, Retrieved from www.umconference.um.edu.my

Rafiq, M., Ahmad, I. A., & Khan, Z. (2008). Determinants of Unemployment. A Case Study of Pakistan Economy (1998-2008). *Abasyn Journal of Social Sciences, 3*(1), 1-20.

Hussain, T., Siddiqi, M. W., & Iqbal A. (2010). A Coherent Relationship between Economic Growth and Unemployment: An Empirical Evidence from Pakistan. *International Journal of Human and Social Sciences, 5*(5), 1-15.

Aurangzeb, & Asif, K. (2013). Factors Effecting Unemployment: A Cross-Country. *International Journal of Academic Research in Business and Social Sciences, 3*(1), 219-230.

Khan, R. E. A., & Gill, A. R. (2010). Determinants of Inflation: A Case of Pakistan (1970-2007). *Journal of Economics, 1*(1), 45-51.

Ali, A., & Rehman, H. U. (2015). Macroeconomic Instability and Its Impact on Gross Domestic Product: An Empirical Analysis of Pakistan. *Pakistan Economic and Social Review, 53*(2), 285-316.

Maqbool, M. S., Sattar, T. M. A., & Bhalli, M. N. (2013). Determinants of Unemployment: Empirical Evidences from Pakistan. *Pakistan Economic and Social Review, 51*(2), 191-207.

McIntyre, S. H., Montgomery, D. B., Srinivasan, V., & Weitz, B. A. (1981). The Statistical Significance of Stepwise Regression Models Developed by Forward Selection: A Monte Carlo Calibration. *Journal of Marketing Research, 20*(1), 1-11.

Phelps, E. (1995). The Structuralism Theory of Unemployment. *American Economic Review, 85*(2), 22-26.

Tintner, G. (1965). *Econometrics*. New York: Wiley

Rivera-Batiz, F. L. (1992). Quantitative Literacy and the Likelihood of Employment among Young Adults in the United States. *The Journal of Human Resources, 27*(2), 313-328.

Rosholm, M. (2001a). Cyclical Variations in Unemployment Duration. *Journal of Population Economics, 14*, 173-191.

---------- (2001b). An Empirical Analysis of the Processes of Exclusion and Inclusion. *IZA Discussion Paper, 332*, 1-20.

---------- (2000). An Empirical Study of the Duration and Duration Dependence of Unemployment. *National Economic Journal, 138*, 314-328 (In Danish).

Stiglitz, J. E. (1975). The Theory of Screening, Education and Income Distribution. *The American Economic Review, 65*, 283-300.

Streb, J. M. (2002). Job Market Signaling Under Two-dimensional Asymmetric Information. Retrieved from http://sedici.unlp.edu.ar/bitstream/handle/10915/57453/Documento_completo.pdf-PDFA.pdf?sequence=1&isAllowed=y.

Jensen, A. M., & Verner, M. (1996). The Importance of Social Assistance Benefits to the Extent of Unemployment in Denmark. *National Economic Journal, 134*, 238-256 (In Danish).

Kelley, C. T. (1999). Iterative Methods for Optimization. *SIAM Frontiers in Applied Mathematics, 18*, 1-20.

Strutz, T. (2016). *Data Fitting and Uncertainty; A Practical Introduction to Weighted Least Squares and Beyond* (2nd Ed.). Berlin: Springer.

Gavin, H. P. (2006). The Levenberg-Marquardt Method for Nonlinear Least Squares Curve-fitting Problems. Retrieved from https://msulaiman.org/onewebmedia/LM%20Method%20matlab%20codes%20and%20implementation.pdf.

Dennis, J. E, & Welsch, R. E. (1978). Techniques for Nonlinear Least Squares and Robust Regression. *Communications in Statistics Simulation and Computation, 7*(4), 345–359.

Björck, Å. (2015). *Numerical Methods in Matrix Computations*. Berlin: Springer.

Kemmer, G., & Keller. S. (2010). Nonlinear Least-squares Data Fitting in Excel Spreadsheets. *Nature Protocols, 5*(2), 267–281.