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A Study On Economic Analysis of Inflation: The Regime Switching Approach

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ABSTRACT
The main objective of the study is to identify and estimate inflation based on the regime-switching model. The sixty years data set on consumer prices for India is obtained from World Bank. This study employed the Markov regime-switching model using simple switching regression (OPG - BHHH/ Marquardt) rather than legacy methods to forecast the time series. The success of the Markov regime-switching model is prominent due to its unique estimation feature, which is independent of its past records. The Regime- switching model depicts cyclic or periodic attributes, where the variables suddenly switch the direction and magnitude responding to some strong triggers such as economic shocks, which can be presented in various "regimes." The regimes are assumed as the outcome of a stochastic process. The stochastic process estimates four regimes. The estimated equation corresponding to the regime-switching model replicates the actual time series of the Consumer Price Index. The study explains and estimates the effects of underlying triggers such as economic shocks, pandemics etcetera on the movements of inflation. The study reflects the effect of the 1973 oil crisis coupled with the US stock market crash of 1973-74. The impact of the 2008-09 recession and the effect the of Covid-19 pandemic is also evident in inflation. The study concluded that the estimated four regimes can be employed to forecast the impact of similar economic shocks. The rise in the inflation index was witnessed due to the effect of the subprime crisis. The study suggests that a sharp rise in recent inflation was observed due to stringent restrictions of Covid-19. The study also suggests policy measures to anticipate and formulate policies to counter such economic triggers. This research mainly contributes to the existing literature by suggesting the policymakers in formulating suitable policies and directions to tackle inflation leading to a robust economy. It will help the investors make investment decisions consequent to the robust economy and the literature in terms of statistical analysis to estimate the impact of economic shocks on inflation.

Keywords: *Inflation, CPI, Regime switching, Hamiltonian switching, Markov Switching Models*

1. INTRODUCTION

Inflation is the consistent rise in the prices of commodities. There exist several price indexes to measure inflation. Two main indices are Wholesale Price Index (WPI) and Consumer Price Index (CPI). The Wholesale Price Index (WPI) indicates variation in the prices of goods at the Wholesale level, while, the Consumer Price Index (CPI) computes the variation in the prices of goods and services at the retail level. Most consumers of the goods and services belong to the retail segment. Hence monitoring of inflation based on the Consumer Price Index (CPI) provides a better picture of the actual inflation experienced by retail consumers (Bhat Ali Basit, Gupta Nitin Dr, 2022; Nagpal et al., 2024). The Consumer Price Index (CPI) is used to express inflation or deflation in India, the US and many other countries. In India, Wholesale Price Index (WPI) comprises selected items and a limited bouquet of commodities. There was a time when inflation was expressed by Wholesale Price Index (WPI), but gradually with an increase in the relevance of CPI and monthly availability, the Consumer Price Index (CPI) is now preferred over Wholesale Price Index (WPI), despite their co-existence in the Indian context (Muzzamil, 2021). Other techniques to compute price sensitivity include indicators such as Gross National Product (GNP). The Gross National Product (GNP) is defined as the ratio of the Gross National Product (GNP) at the current price to the Gross National Product (GNP) at a constant price. Furthermore, these measurements are computed quarterly, hence very limited observations are

available for Gross National Product (GNP) in India (Rehman et al., 2024). Due to these reasons, Gross National Product (GNP) is not suitable for estimating inflation. Estimating inflation is important due to several factors. It is an important driving factor for the economy. It gauges purchasing power of retail consumers and thereby buying capacity of the money in circulation. The inflation in food prices possesses greater forbearance to economic activities. Inflation plays havoc if not controlled and managed appropriately. History has witnessed the devastating effects of inflation on the economies of Hungary, Yugoslavia, Venezuela, Zimbabwe, etc. Several incidences of shocks in emerging markets were driven by uncontrolled inflation in food commodities. The level of food inflation (Y-o-Y) in Sri Lanka shot up to 93.7% during August 2022 as reported in the press release of the central bank of Sri Lanka. These incidents illustrate the importance of regulating inflation. Uncontrolled inflation may lead to instability of the national economy and depreciation of the valuation of currency. Any nation must monitor inflation to keep the economy on track. Therefore, consumers, investors, corporates, as well as policymakers, keep a close watch on inflation.

The Consumer Price Index (CPI) is defined as the measure of price variation of a bunch of goods and services offered at the current price to the price of the same items during preceding year. The Consumer Price Index (CPI) has numerous items segregated into six categories. These categories (with weights in bracket) include Food & Beverage (45.86%), Housing (10.07%), Fuel & Light (6.84%), Clothing & Footwear (6.53%), Pan, tobacco, & intoxicants (2.38%), miscellaneous components (28.32%), see (MoSPI, 2020). The weights of rural and urban CPI together produce combined CPI weights. The detailed combined weights of CPI components concerning April and May 2020 are mentioned in table- 1.1.

Table- 1.1: weights of CPI components

Group Code	**Sub-group Code**	**Description**	**Combined**		
			Weights	**Apr. 20 Index**	**May 20 Index**
Food and beverages	1.1.01	Cereals and products	9.67	148.7	148.4
Food and beverages	1.1.02	Meat and fish	3.61	169.7 @	183.8
Food and beverages	1.1.03	Egg	0.43	148.8	147.8
Food and beverages	1.1.04	Milk and products	6.61	155.6	155.1
Food and beverages	1.1.05	Oils and fats	3.56	135.1	136.5
Food and beverages	1.1.06	Fruits	2.89	149.9	149.4
Food and beverages	1.1.07	Vegetables	6.04	168.6	150.8
Food and beverages	1.1.08	Pulses and products	2.38	150.4	151.2
Food and beverages	1.1.09	Sugar and Confectionery	1.36	120.3	116.5
Food and beverages	1.1.10	Spices	2.50	157.1	157.4
Food and beverages	1.2.11	Non-alcoholic beverages	1.26	136.8	138.4
Food and beverages	1.1.12	Ready meals, snacks, sweets, etc.	5.55	162.4 @	162.1 @
Total of Food and beverages	1	**Food and beverages**	**45.86**	**154.0** @	**152.7** @
Pan, tobacco and intoxicants	2	**Pan, tobacco and intoxicants**	**2.38**	**173.2** @	**174.4** @
Clothing	3.1.01	Clothing	5.58	153.4 @	153.6 @
Footwear	3.1.02	Footwear	0.95	144.0 @	144.2 @
Total of Clothing and footwear	3	**Clothing and footwear**	**6.53**	**152.0** @	**152.3** @
Housing	4	**Housing**	**10.07**	**155.6**	**155.6**
Fuel and light	5	**Fuel and light**	**6.84**	**144.1**	**142.5**

Miscellaneous	6.1.01	Household goods and services	3.80	148.9 @	149.2 @
Miscellaneous	6.1.02	Health	5.89	150.7	152.9
Miscellaneous	6.1.03	Transport and communication	8.59	132.3 @	132.5 @
Miscellaneous	6.1.04	Recreation and amusement	1.68	146.5 @	146.8 @
Miscellaneous	6.1.05	Education	4.46	159.3 @	159.6 @
Miscellaneous	6.1.06	Personal care and effects	3.89	147.5 @	147.7 @
Total of Miscellaneous	6	**Miscellaneous**	**28.32**	**145.5 @**	**146.2 @**
General Index (All Groups)			**100.00**	**151.4 @**	**150.9 @**

Source: Ministry of Statistics & Program Implementation(MoSPI), National Statistical Office(NSO) India

Note: @: Ascribed Index for the April 2020 and May 2020

 # : CPI(Rural) for Housing is excluded

The Consumer Price Index (CPI) is selected for the study over WPI and GNP due to numerous reasons and relevance in the present scenario. CPI was mandated in 2014 to represent inflation replacing WPI in India. CPI provides inflation at the consumer level, while WPI provides inflation at the wholesale level, so CPI is a better indicator of inflation than WPI. Moreover, CPI also includes services such as education and medical, which are not covered under WPI. CPI is used for referring to an inflator or deflator for the national accounts. In India, RBI is nominated for regulating inflation. The Dearness Allowance (DA) is also calculated with reference to CPI. The CPI follows international norms to have a gap of not more than 10 years in the base year and is updated accordingly. The monetary policy committee is assigned a target range to keep the CPI between 2% to 6%. Hence monetary policy conducts bi-monthly meetings to address and keep a check on inflation.

This research mainly contributes in three ways to the existing study. The main contribution will be to the policymakers in formulating suitable policies and directions to tackle inflation leading to a robust economy. Second, it will help the investors make investment decisions consequent to a robust economy. Third, the literature in terms of statistical analysis to estimate the impact of economic shocks on inflation.

This paper is organized into seven sections. The first section denotes the introduction. The second section presents the review of literature, the research gap and the objective of the study. Section three presents data and descriptive statistics of the study. Section four deals with methodology and research analysis. Section five presents the results and discussion. Section six provides policy implications. Finally, section seven presents the conclusions along with the limitations of the analysis.

2. REVIEW OF LITERATURE

Rohmah *et al.* (2021) compared and predicted the consumer price index (CPI) using Support Vector Regression (SVR) Method. The data was obtained from Indonesian Central Statistics and the Siskaperbapo website. The supported vector data was obtained by the hyper-plane maximized using the SVR model to overcome the over fitting and obtain accurate estimates. The study divided the data into training data from 2016-2019 and testing data from 2017-2020 for predicting the CPI. All four kernels namely the Spline kernel, Gaussian- Radial Basis Function(RBF) kernel, linear kernel and Polynomial kernels were applied in the test and compared with Mean Absolute Percentage Error (MAPE). It was concluded after analyzing the proposed four models, that the G-RBF model method displays utmost consistent results rather than the remaining three models. Hence the Gaussian-RBF kernel was found to be the most appropriate method as it produced a stable MAPE value.

Kasyan and Danchenko (2022) forecasted the CPI of Russia using Analytic Hierarchy Process. The CPI data was obtained for the year 2021 using five models. A qualitative comparison was performed to arrive at the most suitable model. After comparison, it was concluded that the Analytical Hierarchy Process method provides an opportunity to find the utmost appropriate model for estimating the Consumer Price Index(CPI) derived from quantitatively preferred vectors.

Chinatu (2022) explored the consumer price index regarding understanding and meeting various consumer needs in Nigeria. This study identified consumer price statistics, understood the consumer price statistics regarding provisions made for their needs, Sensitization exercises and apt dissemination of the required statistics. Recently, consumers were allowed to provision their needs before the suppliers. In present market scenario sensitization with loads of advertisements were required to keep consumer awake and attached with a specific product. The study Analyzed consumer prices data obtained from the National Bureau of Statistics to make consumer aware and attached with multiple dissemination channels.

Ali and Mohamed (2022) estimated consumer price index(CPI) of a Somalian state named Puntland, for effective monetary and fiscal policy. The monthly data from 2017 to 2021 was obtained from Puntland's consumer price index. The study employed various econometric models like STL decomposition, artificial neural network(ANN), single exponential smoothing(SES), robust exponential smoothing(ROBETS), ARIMA and ARIMAX model. Several precision methods like Akaike Information Criteria(AIC), Corrected Akaike Information Criteria(AICc) and Bayesian Information Criteria(BIC) were applied to assess the prediction ability. The study concluded that STL decomposition and ANN simulations performed well in forecasting consumer price index(CPI) of the Somalian state. It established that consumer price index of Puntland is expected to marginally deteriorate or remain same for the period of estimation. It was found to be consistent with the statistics of the Ministry of Finance (MoF) and State Bank of Puntland (SBP) to check inflation within range.

Research Gap and Objective: Though, there are several studies available for inflation but limited literature is available to estimate the Consumer Price Index (CPI). Moreover, available literature focusses on historical analysis, thus their prediction is based on historical data and estimations solely depend on periodicity of the cyclic movement of the data and not on regime switching method. Here, the intuition is to predict the inflation in response to the economic shocks or other relevant triggers such as Covid- 19 pandemic. Forecast based on historical observations can be effective only if the future is going to follow the historical trends like whether, which need not be always true similar to economic cycle or inflation. Therefore, regime switching method performs better than the historical predictions. Furthermore, such study is not available for India with detailed analysis. Hence this study identifies and estimates Consumer Price Index as an attribute of inflation in India based on regime switching model.

Data: The data set is obtained from World Bank. It has annual data of over sixty years from 1961 to 2021. The data set is transformed for time series analysis. The CPI data set is analyzed using Simple regime switching Markov regime switching methodology. The data set include Inflation observations computed using Consumer Price Index(CPI), which indicates the yearly percentage change in the cost of a group of goods and services based on Laspeyres formula. The data for Consumer Price Index (CPI) in India is released by Ministry of Statistics & Program Implementation (MoSPI), National Statistical Office (NSO) and maintained by National Informatics Centre (NIC). For this study various authentic data sources are referred including NIC, NSO, MoSPI, International Monetary Fund (IMF), International Financial Statistics (IFS) and World Bank. Table-1.2, represents statistical description of samples having about sixty years of data from 1961 to 2021.

Table- 1.2. Statistical Summary of the samples from 1961 to 2021:

Variable	Mean	Median	Minimum	Maximum
y0	7.4676	6.6657	-7.6339	28.599
y1	7.4127	6.6657	-7.6339	28.599
Variable	Std. Dev.	C.V.	Skewness	Ex. kurtosis
y0	4.8955	0.65557	0.95597	5.1512
y1	4.9408	0.66653	0.93973	4.9269
Variable	5% Perc.	95% Perc.	IQ range	Missing obs.
y0	1.7780	13.819	5.9935	0
y1	1.7037	13.819	6.1473	0

[*]Data Source: World Bank, [#]Author calculation

3. METHODOLOGY

The Regime- switching model is cyclic or time-series based model where variables suddenly switch the direction and magnitude responding to some strong triggers such as economic shocks, which can be presented in various "regimes." The regimes are assumed as outcome of a stochastic process. The produced regime shifts are incorporated as part of the models, which facilitates to forecast the inflation based on Simple regime switching and Markov regime switching techniques.

Markov-switching simulations are frequently applied using:

1. Maximum likelihood estimates.
2. Bayesian estimates.

Markov- switching Model using Maximum Likelihood estimates

Markov- switching Model using Maximum Likelihood estimates employs repetitive procedure called expectations-maximization. Here, data analysis method uses an unobserved or underlying variables. John Hamilton proposed this technique in 1990. There are largely two stages involved in expectation- maximization procedure. In the first step, latent or unobserved variables are estimated. This stage is called E- stage. In the second stage, parameters of the expectations-maximization model is estimated corresponding to the values of unobserved variables. The second stage is called M- stage. We have used Kalman filter- smoothing algorithm in Markov Regime Switching model, for the unobserved/ latent variables. Also applied maximum likelihood to forecast the parameters of the model, including transition probabilities. E- M Steps are repeated with updated parameters till it converges.

Markov- switching Model using Bayesian Estimates

Markov regime switching Model using Bayesian Estimates depends on collecting sample from the joint distributions of the transition probabilities, states and attributes through the Markov- Chain Monte Carlo (MCMC) process. The MCMC techniques imputes likelihood function without the need of extended calculation. The Gibbs sampler is most widely used tool for estimating Markov regime switching Model using Bayesian Estimates.

Markov Regime switching Model: Let n_t, denote the trending components of a particular time series y_t, where n_t follows the Markov trends in levels if

$$n_t = \alpha_0 + \alpha_1.x_t + n_{t-1} \quad \ldots.(1)$$

Where x_t= 0 or 1 indicates latent levels of the model. Here, it is presumed that the interchange among the levels follow Markov process of first-order:

Prob $[X_t = 1 | X_{t-1} = 1] = p$,

Prob $[X_t = 0 | X_{t-1} = 1] = 1-p$,

Prob $[X_t = 0 | X_{t-1} = 0] = q$,

Prob $[X_t = 1 | X_{t-1} = 0] = 1-q$, ….(2)

Generalization to a higher-order process and to more than two states is discussed below.

Let's describe $\tilde{n}_t = \exp(n_t)$ as exhibiting a Markov trend in logs. The equation for " $\mathbf{n_t}$ " is defined in equation (1). The stochastic process for X_t as expressed in equation (2) is strictly stationary and admits the following AR(1) representation

$$x_t = (1-q) + \lambda x_{t-1} + v_t, \quad \ldots.(3)$$

$$\lambda = p+q-1, \quad \ldots.(4)$$

Where conditions on X_{t-1} =1, has two outcomes of V_t as,

$V_t = (1-p)$ having probability p,

$V_t = -p$ having probability 1-p,

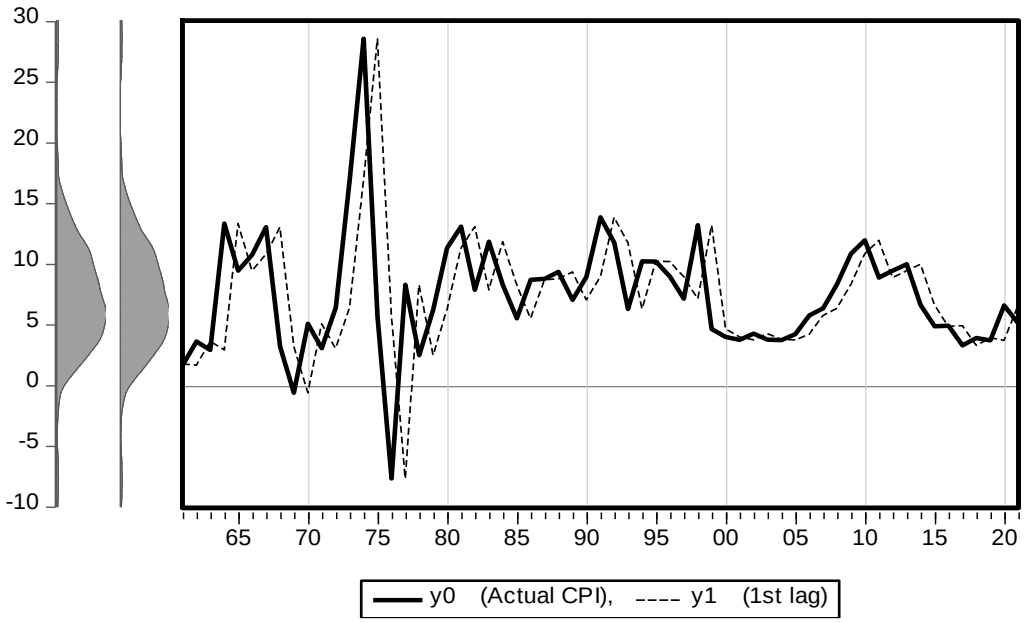
And conditions on $X_{t-1} = 0$, has two outcomes of V_t as,

$V_t = -(1-q)$ having probability q,

$V_t = q$ having probability (1 – q).

The actual observations of Consumer Price Index (CPI) are represented by y_0. First lag of the observation y_0 are indicated by y_1. The y_1 indicates Consumer Price Index (CPI) observation corresponding to time $t = (t-1)$. Both data points of the observations are represented in figure- 1. The figure- 1, shows the impact of great economic shocks like oil crisis of 1973 coupled with US stock market crash, economic slowdown of 2008-09 or Covid- 19 pandemic on the Consumer Price Index(CPI). These observations are used for regime switching and estimating the Consumer Price Index(CPI).

Figure- 1. Time series Graph of Consumer Price Index(CPI):



[*]Data Source: World Bank, [#]Author calculation

Unit root test

As the data set is time series, therefore, we need to examine the time series stationarity. The unit root test will ensure consistency for the dynamic data modeling. If not examined, Unit root may produce unpredictable results. So, we applied two techniques for the unit root test. The first test for unit root testing was performed using Augmented Dickey- Fuller (ADF Test) (Guney and Komba, 2016) followed by Phillips–Perron (PP Test) as second test for robustness (see Table 2). The standard ADF test equation may pre presented as:

$$\Delta y_t = \mu + \alpha_t + \beta y_{t-1} + \sum_{i=1}^{n} c_i \Delta y_{t-i} + c_t \quad \text{--- (5)}$$

Here,

Δ = indicates the first difference operator

y_t = dependent variable of the regression equation

μ = constant

α_t = slope co-efficient on time t

$\boldsymbol{\alpha}$ = co-efficient of lagged y_{t-1} for testing the unit root hypothesis

y_{t-1} = lagged values of the independent variables at lag t-1

yz_{t-i} = lagged values of the independent variables at lag t-i

$c_t \sim \Pi D\ (0, \sigma^2)$.

Table- 2: ADF and Phillips- Perron (PP) Test for stationarity of actual CPI (y0)

Factors	ADF Test results		PP Test results	
	***t*- Statistics**	***p*-Values**	***t*- Statistics**	***p*-Values**
Y0(-1)	-5.8105	0.0000	-5.4758	0.0000
D(Y0(-1))	2.1196	0.0385	0.7716	0.0001
C	5.1681	0.0000	4.6414	0.0000

Source: Author Calculation

Table- 3: Test for stationarity of CPI data at time, t= t-1 represented by (y1)

Factors	ADF Test results		PP Test results	
	t- Statistics	*p*-Values	*t*- Statistics	*p*-Values
Y1(-1)	-5.8208	0.0000	-5.3952	0.0000
D(Y1(-1))	2.1167	0.0387	-8.7726	0.0000
C	5.1926	0.0000	4.5664	0.0000

[*]Data Source: World Bank, [#]Author calculation

Since p values are less than 5%, it indicates that the time series is stationary. The probability value is less than equal to five percent implies that the null hypothesis cannot be rejected. Hence, CPI data series y0 and y1 are stationary and time series analysis such as Autoregressive (AR) or regime switching regression analysis can be exercised.

Markov regime switching analysis based on Hamilton, 1989. The initial coefficients in a Markov switching estimation is created by doing a simple OLS and adding random normal around the coefficients using their respective standard deviation.

Markov four regime switching model using simple switching regression (OPG - BHHH/ Marquardt steps): The convergence criterion, coefficients and number of iterations are specified using binary models, which are already defined in Eviews. These options include various optimization techniques like Newton-Raphson method for estimating parameters. In addition to Newton-Raphson, Broyden- Fletcher- Goldfarb- Shanno (BFGS), ARMA Maximum Likelihood (OPG - BHHH), or EViews legacy methods are also available. But, the default optimization algorithms impact the default techniques of calculating coefficients of co-variances using conventional estimation techniques. The Eviews is equipped with generalized linear model (GLM), quasi-maximum likelihood (Huber/White) and inverse of the estimated information matrix (default method) for estimating standard errors. So, these models are readily available for computing Coefficient of Co-variances for binary dependent variables. However for computing the GLM co-variance, Eviews has provision of various information matrices. The most appropriate estimation is obtained using Outer-Product of the gradients (OPG). The alternative technique involves adopting negatives of log-likelihood of second derivative (Hessian- observed). The co-variances can be estimated with or without degree of freedom (d.f.) Adjustment.

The OPG-BHHH offers better information matrix, so we selected OPG-BHHH method for optimization as indicated in Table-4. The BHHH indicates Berndt- Hall- Hall- Hausman (BHHH), used in conjunction with OPG. Here, the dependent variable is represented by y_0. The adjusted observations are used for the switching regressions to address outliers. The Preliminary probability is found using Ergodic model. The standard error & co-variances are calculated by Hessian observed technique for significant results. This identified four regimes and split the entire observations into four regimes based on significant impact of the triggers on the inflation. Inverted AR roots were also identified and represented in the form of $\alpha \pm \beta i$.

4. RESULTS & DISCUSSION

Table-4, represents regime switching regression with y0 being the dependent variable. The coefficients of independent variables corresponding to the respective regimes are presented in the table- 4. Here, the coefficients of independent variable y1, respective log coefficient and common coefficients of the four regimes are represented in first four blocks. The common error variances are specified by four Autoregressive (AR) process are shown in the middle on the table- 4. The AR(1) specifies the current value as a result of process based on the immediately preceding value, where as an AR(2) designates the present value built on the previous two values, so and so forth. This model also has three probability regressors. The descriptive statistics of the equation are presented in the lowest block of table- 4. The residual- based statistical components are computed using the regime sum based weighted residual method using one step ahead regime probability, see (Maheu and McCurdy, 2000).

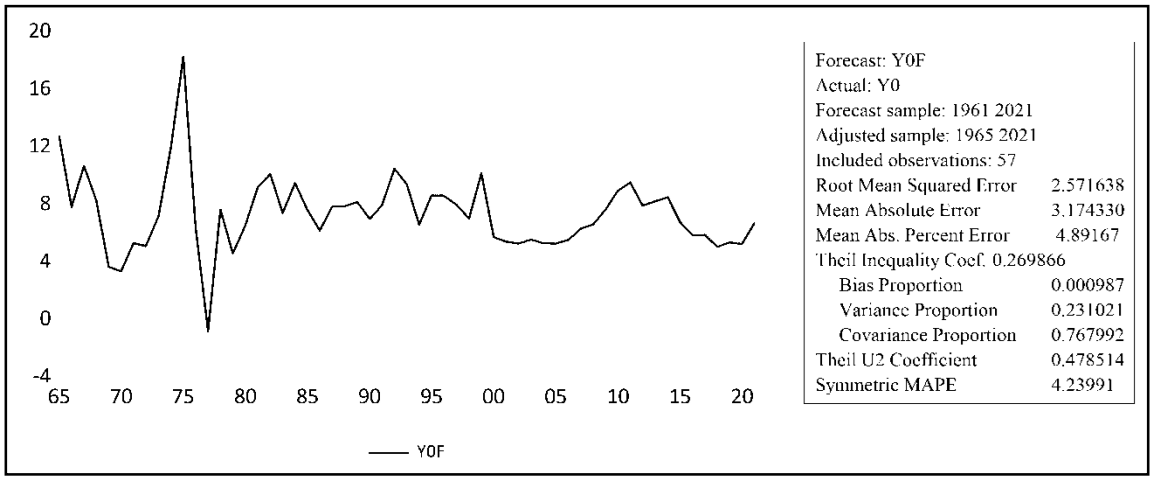
Table- 4: Four Regime Switching Regression (OPG-BHHH/ Marquardt)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Regime 1				
Y1	0.385145	0.019994	19.26263	0.0000
C	3.379759	0.201190	16.79884	0.0000
LOG(SIGMA)	0.068988	0.211021	0.326925	0.7437
Regime 2				
Y1	0.413550	0.005280	78.32445	0.0000

C	5.992397	0.055339	108.2849	0.0000
LOG(SIGMA)	-3.148325	0.217274	-14.49014	0.0000
Regime 3				
Y1	1.299139	0.117950	11.01429	0.0000
C	5.897666	0.977509	6.033363	0.0000
LOG(SIGMA)	1.092698	0.402501	2.714768	0.0066
Regime 4				
Y1	0.142773	0.011418	12.50455	0.0000
C	3.138121	0.135982	23.07740	0.0000
LOG(SIGMA)	1.762530	0.266601	6.611114	0.0000
Common				
AR(1)	0.130640	0.006213	21.02602	0.0000
AR(2)	0.243131	0.005908	41.14977	0.0000
AR(3)	0.182053	0.006522	27.91250	0.0000
AR(4)	-0.234087	0.005711	-40.98977	0.0000
Probabilities Parameters				
P1-C	0.654735	0.473405	1.383032	0.1667
P2-C	0.576523	0.462234	1.247253	0.2123
P3-C	-0.829633	0.670217	-1.237857	0.2158
Mean dependent var	*7.612205*	*S.D. dependent var*		*4.880079*
S.E. of regression	*5.469239*	*Sum squared resid*		*1226.416*
Durbin-Watson stat	*2.024755*	*Log likelihood*		*-120.9779*
Akaike info criterion	*4.911504*	*Schwarz criterion*		*5.592521*
Hannan-Quinn criter.	*5.176171*			
Inverted AR Roots	*0.59+0.30i*	*0.59-0.30i*	*-0.52-0.52i*	*-0.52+0.52i*

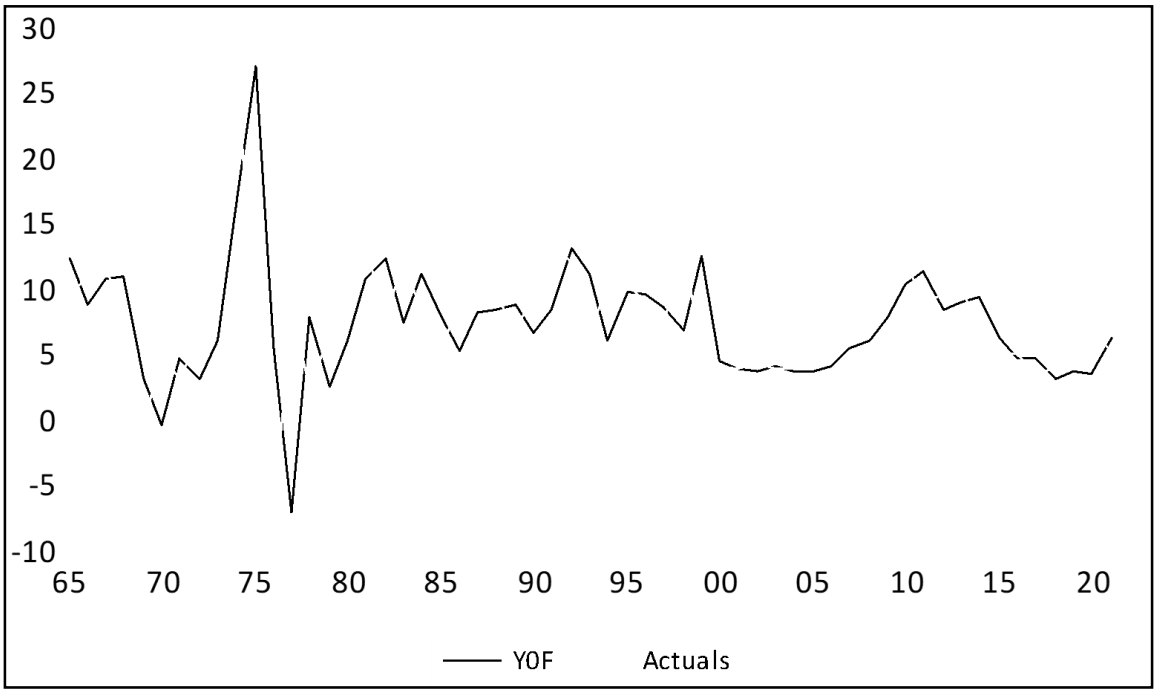
[*]Data Source: World Bank, [#]Author calculation

Figure-2: Estimated CPI represented by y0f



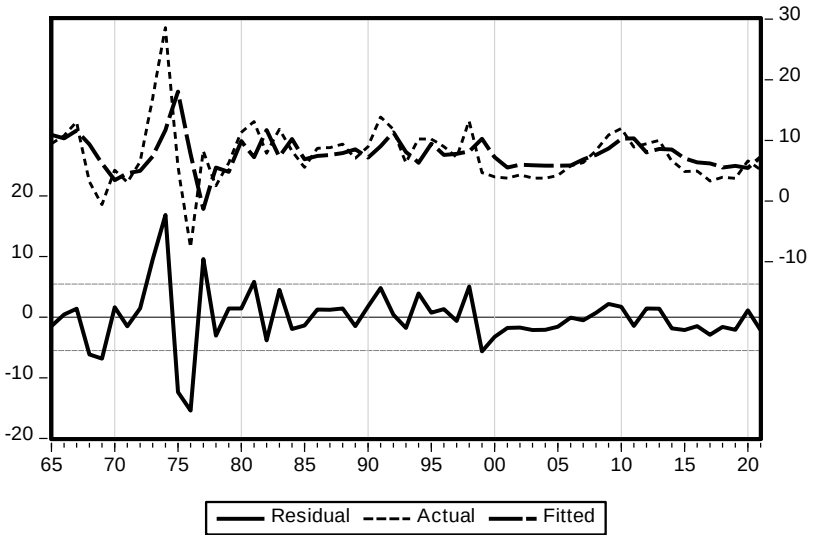
[*]Data Source: World Bank, [#]Author calculation

Figure-3A: Comparison of Actual (y0) Vs. Estimated CPI represented by (y0f)



[*]Data Source: World Bank, [#]Author calculation

Figure- 3B: Comparison of Actual (y0), fitted and residual after smoothening



[*]Data Source: World Bank, [#]Author calculation

The figure- 2 represents forecasted Consumer Price Index (CPI). The quality of forecast is judged according to the values of Mean Absolute Percentage Error (MAPE), Mean Absolute Error (MAE) and Root Mean Square error (RMSE). These values may vary from 0 to ∞, but they are negatively oriented values, hence the lower they are the better it is for the forecast. A RMSE, MAE and MAPE of less than 5% indicates better accuracy and acceptability. From Figure- 2, it is be established that forecast possess MAPE under 5%, hence the forecast is acceptably accurate. Four regime switch predicts better estimate to actuals when compared with two regime switching. The two regime switching model was not accurate due to multiple triggers influenced the sixty years long data set. The coefficients observed for two regime switching models were insignificant, so they were discarded. The figure- 3A, presents comparison of actual CPI (y_0) against estimated (y_0f) Consumer Price Index

(CPI).

The figure- 3B, presents Comparison among Actual CPI (y0), fitted and residual after applying smoothening function. It also indicates that the forecasted CPI resembles the actual trajectory followed by actual CPI (y0). The fitted line establishes the best bit for the forecasted CPI.

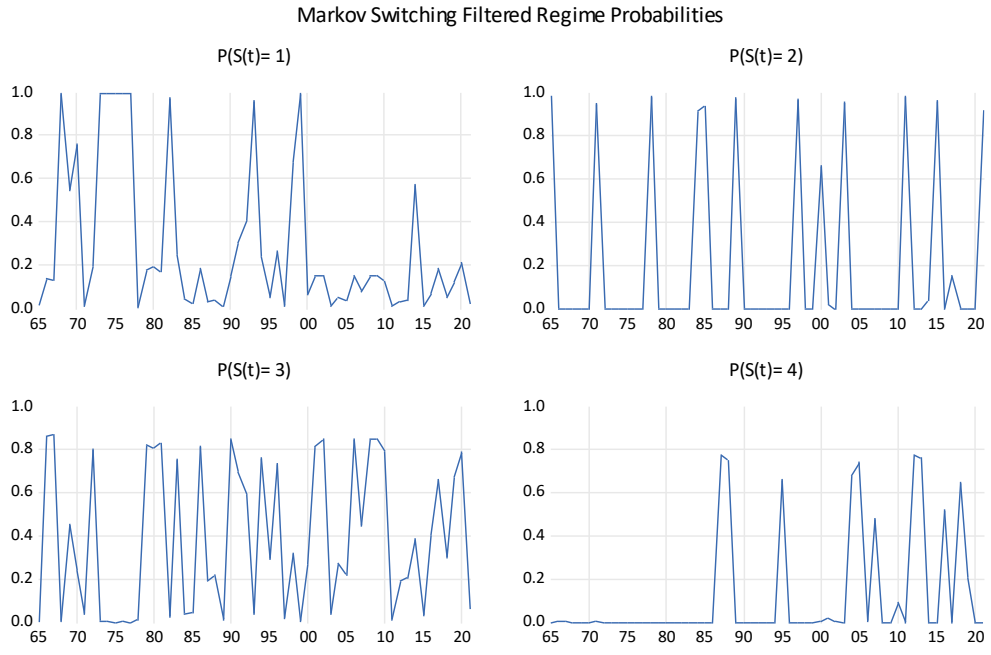
Using Markov Regime Switching technique, the descriptive tabular summary of the four regimes are presented in table- 5 indicated by space time coordinates. Adjusted 57 observations are considered for the Markov regime switching out of 61 observations. Very small magnitude of the standard deviations and sum of square of deviations justify the acceptability of the model. The 1st regime indicates mean of 0.26 with 31% probability, while 4th regime has maximum mean of approx. 0.39 with 75% probability. This shows wider presence of regime- 3. Figure- 4, presents filtered regime probability using Markov Regime switching estimation. Figure- 5, shows smoothed regime probabilities. The smoothening function improves predictability with needed corrections. The positive values of CPI as shown in figure- 1, also establishes that inflation is gradually increasing over the period. Moreover, the sharp rise in the inflation during 1974 was due the oil crisis of 1973, coupled with the US market crash of 1973-74 and its impact observed globally. The succeeding sharp decline in the inflation was result of tightening of the economy and effective monetary policies.

Table- 5: Descriptive Statistics Tabular Summary of four regimes:

	P(S(t)= 1)	P(S(t)= 2)	P(S(t)= 3)	P(S(t)= 4)
Mean	0.266938	0.205831	0.396218	0.131013
Median	0.266938	0.205831	0.396218	0.131013
Maximum	0.266938	0.205831	0.396218	0.131013
Minimum	0.266938	0.205831	0.396218	0.131013
Std. Dev.	6.23E-17	4.30E-17	9.55E-17	2.98E-17
Skewness	-0.418266	-0.224441	-0.026020	-0.151595
Kurtosis	3.531950	3.632407	2.514424	3.701254
Jarque-Bera	2.334045	1.428406	0.566419	1.386244
Probability	0.311292	0.489582	0.753362	0.500013
Sum	15.21547	11.73236	22.58445	7.467717
Sum Sq. Dev.	2.17E-31	1.03E-31	5.11E-31	4.97E-32
Observations	57	57	57	57

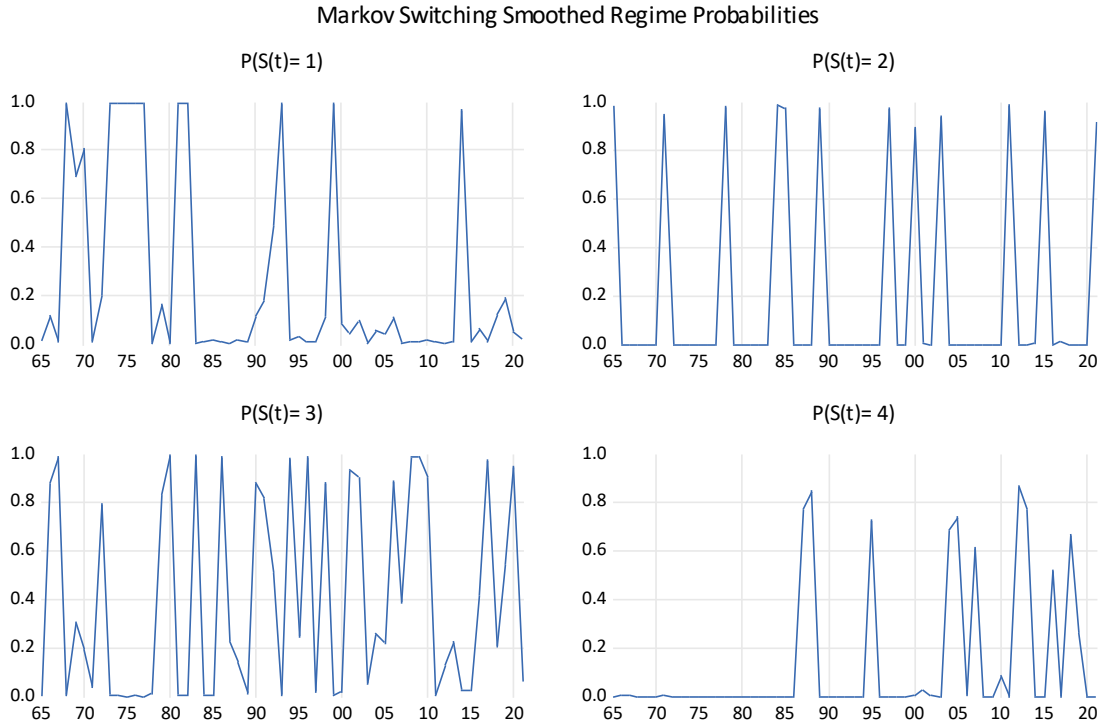
[*]Data Source: World Bank, [#]Author calculation

Figure- 4: Filtered regime probability graphs for P(S(t= 1 to 4):



[*]Data Source: World Bank, [#]Author calculation

Figure- 5: Smoothened regime probability graphs for P(S(t= 1 to 4):



*Data Source: World Bank, #Author calculation

Table- 6: Simple switching transitions probability & estimated duration values:

Constant transition probability values: with P(i, k)= P(s(t)= k | s(t-1) = i), where (row= i/ column= j)				
Regimes	1	2	3	4
1	0.374392	0.346226	0.084854	0.194527
2	0.374392	0.346226	0.084854	0.194527
3	0.374392	0.346226	0.084854	0.194527
4	0.374392	0.346226	0.084854	0.194527
Constant expected durations:				
Regimes	1	2	3	4
Durations	1.598446	1.529581	1.092722	1.241506

*Data Source: World Bank, #Author calculation

The estimation equation corresponding to four regime switching model replicates the actual time series of CPI inflation. Hence this model captures the time series in aggregate. The Regime wise estimated equation is mentioned below:

Regime 1: Y0 = C(1)*Y1+C(2)+ [AR(1)= C(13),AR(2)= C(14),AR(3)= C(15),AR(4)= C(16)]; here, SIGMA = @EXP(C(3)) …. (6)

Regime 2: Y0 = C(4)*Y1+C(5)+ [AR(1)= C(13),AR(2)= C(14),AR(3)= C(15),AR(4)= C(16)]; here, SIGMA = @EXP(C(6)) …. (7)

Regime 3: Y0 = C(7)*Y1+C(8)+ [AR(1)= C(13),AR(2)= C(14),AR(3)= C(15),AR(4)= C(16)]; here, SIGMA = @EXP(C(9)) …. (8)

Regime 4: Y0 = C(10)*Y1+C(11)+ [AR(1)= C(13),AR(2)= C(14),AR(3)= C(15),AR(4)= C(16)]; here, SIGMA = @EXP(C(12)) …. (9)

After Substituting the Coefficients from table- 4 in the equations (6), (7), (8) and (9), following equations are obtained:

Regime 1: Y0 = 0.385144989509*Y1 + 3.37975859852 + [AR (1) = 0.130639883073, AR (2) = 0.243130825119, AR (3) = 0.18205318484, AR (4) = -0.234087289037]; with, SIGMA= @EXP(0.0689879663605) …. (10)

Regime 2: Y0 = 0.41354985418*Y1 + 5.9923970086 + [AR (1) = 0.130639883073, AR (2) = 0.243130825119, AR (3) = 0.18205318484, AR (4) = -0.234087289037]; with, SIGMA= @EXP (-3.1483249652) …. (11)

Regime 3: Y0 = 1.29913916576*Y1 + 5.89766620403 + [AR (1) = 0.130639883073, AR (2) = 0.243130825119, AR (3) = 0.18205318484, AR (4) = -0.234087289037]; with, SIGMA= @EXP(1.09269768307) …. (12)

Regime 4: Y0 = 0.14277312644*Y1 + 3.13812057038 + [AR (1) = 0.130639883073, AR (2) = 0.243130825119, AR (3) = 0.18205318484, AR (4) = -0.234087289037]; with SIGMA= @EXP(1.76253038658) …. (13)

The estimated equations clearly replicates the actual inflation trend, which makes it appropriate to predict the inflation forecast. Here, the equation of each regime comprises of dependent variable, y0, the independent variable y1, common coefficients and the logistic coefficients. The common error variances are specified by four Autoregressive (AR) process indicated by AR(1), AR(2), AR(3) and AR(4). The equation (10) represents regime 1, which is most prominent regime among the four regimes due wider transition probability. The table- 6 indicates regime- 1 has 37% probability, which is highest among four regimes, followed by regime- 2 with approx. 35% probability. The expected constant duration of regime- 1 is 1.6 followed by regime- 2 with 1.5. The regime- 3 has shortest duration. The standard errors against the coefficients of the independent variables are very less, which ensures better acceptability of the estimates.

5. POLICY IMPLICATION

The study observed that inflation shoots up during recession, rise of Covid- 19 pandemic or similar economic shocks. The economic analysis and outcomes of the study indicates suggest policy measures to anticipate and formulate policies such that it can counter such economic triggers. The policymakers need to formulate suitable policies with the intuition to tackle the inflation leading to robust economy. Such policies will boost the confidence of investors for long term investments leading to economic development and inclusive opulence. It will promote investments through Foreign Direct Investments (FDI) and High Net worth Individuals (HNI) which provides impetus to the economic activities. Prompt actions will augment the effective economic policies to efficiently tackle the inflation. Such measure are expected to possess the attributes of isolating the economy from global shocks in the era of integrated trade and interconnectedness. Moreover, appropriate action in time may minimize the adverse impact, if not able to isolate absolutely.

6. CONCLUSION

From the results is established that, various regime are estimated using respective equations, which indicate that the impact of trigger factors on these regimes have been different. Regime one reflects effect of 1973 oil crisis coupled with US stock market crash of 1973-74. The effect is captured in the estimated equation accounts for sharp rise in inflation. The impact of 2008-09 recession is clearly explained by the forth regime. Hence regime four, can be employed to estimate the impact of similar economic crisis (Akula et al., 2024; Rehman et al., 2023). The rise in inflation index is witnessed due to effect of sub-prime crisis. The effect of Covid-19 pandemic is also evident in the fourth regime, which explains sharp rise due stringent restrictions of Covid-19. Also the Markov regime switching model is important because of its unique estimation feature, which is independent of past records (Rehman & Dhiman, 2022). Similarly our regime switching model forecasts tomorrow's estimates based on today circumstances. The model predicts sharp movement in inflation and economic crisis around mid of year 2025.

7. LIMITATION

The study is based on the standard data obtained from World Bank. The data set is assumed to represent the true picture of consumer price index of India. There are several indicators to measure inflation such as Consumer Price Index(CPI), Wholesale Price Index(WPI) etcetera. This research is solely based on CPI as it is quite sensitive and most widely referred to indicate inflation/ deflation level for the consumers. The regimes are identified and relates to the economic shocks, however, further study can be conducted to examine the global factors, domestic factors including macro and micro factors which influence the inflation. This study is focused on India and it may or may not be directly relevant to similar developing economies.

DECLARATION

We declare that:

1. None of the authors have a conflict of interest to disclose. This work is not intended to spurt any conflicts. However, if

any conflicts arise, the research analysis and views presented in this study belong to the author(s). The views presented are derived from the research analysis and not from any interest or relationship, financial or otherwise, which might be perceived as influencing an author's objectivity. This study is devoid of such conflicts of interest.

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REFERENCES

[1] Akula, S. C., Singh, P., Farhan, M., Kumar, P., Cheema, G. S., Rehman, M., Sharma, A., & Kumar, P. (2024). Evaluating the Effectiveness of a Chatbot-Based Workshop for Experiential Learning and Proposing Applications. *Eurasian Journal of Educational Research*, *2024*(109), 32–45. https://doi.org/10.14689/ejer.2024.109.003

[2] Ali, A. O., & Mohamed, J. (2022). The optimal forecast model for consumer price index of Puntland State, Somalia. Quality & Quantity, 1-24.

[3] Baltagi, B. H. (2017). Special issue on forecasting, use of survey data on expectations and panel data applications: editors' introduction. Empirical Economics, 53(1), 1-6.

[4] Bhat Ali Basit, Gupta Nitin Dr, R. M. (2022). *To Study the Effect of Corporate Governance on the Performance of Indian Listed Firms : A Comparative Panel Data Analysis*. *20*(August), 9268–9282. https://doi.org/10.14704/nq.2022.20.10.NQ55908

[5] Chinatu, N. A. (2022). Understanding and meeting different user needs for consumer price index in Nigeria.

[6] Hamilton, J. D. (2010). Regime switching models. In Macroeconometrics and time series analysis (pp. 202-209). Palgrave Macmillan, London.

[7] Kasyan, E. A., & Nemirovich-Danchenko, M. M. (2022, July). Selection of a forecasting model for Russia consumer price index based on the application of Analytic Hierarchy Process. In Journal of Physics: Conference Series (Vol. 2291, No. 1, p. 012006). IOP Publishing.

[8] Maheu, J. M., & McCurdy, T. H. (2000). Identifying bull and bear markets in stock returns. Journal of Business & Economic Statistics, 18(1), 100-112.

[9] Muzzamil, R. (2021). Impact of Corporatr Governance on the Financial Reporting Quality in the Nigerian Banking Industry. *Johuns.Net*, *48*(5). https://johuns.net/index.php/publishing/22.pdf

[10] Nagpal, R., Singh, P., Angra, P. K., Cheema, G. S., & Rehman, M. (2024). Wearable Computing: Canonical Correlation Analysis (CFA) Statistical Method to Validate the Measurement Models Smart Ergonomic Shoes. *International Journal of Intelligent Systems and Applications in Engineering*, *12*(17s), 404–408.

[11] Rehman, M., Dhiman, B., Kumar, R., & Cheema, G. S. (2023). *Exploring the Impact of Personality Traits on Investment Decisions of Immigrated Global Investors with Focus on Moderating Risk Appetite : A SEM Approach*. *8984*(August), 95–110.

[12] Rehman, M., & Dhiman, D. B. (2022). To Study the Impact on the Perception of Banking Customers toward E-Banking (A Case Study of Jk Bank Customers). *Journal of Corporate Finance Management and Banking System*, *26*, 10–20. https://doi.org/10.55529/jcfmbs.26.10.20

[13] Rehman, M., Dhiman, D. B., & Cheema, G. S. (2024). Minds and Machines: Impact of Emotional Intelligence on Investment Decisions with Mediating the Role of Artificial Intelligence. *International Journal of Engineering, Business and Management*, *8*(1), 01-10. https://doi.org/10.22161/ijebm.8.1.1

[14] Rohmah, M. F., Putra, I. K. G. D., Hartati, R. S., & Ardiantoro, L. (2021). Comparison Four Kernels of SVR to Predict Consumer Price Index. In Journal of Physics: Conference Series (Vol. 1737, No. 1, p. 012018). IOP Publishing.

[15] Ministry of Statistics & Program Implementation (MoSPI), 2020. Compilation of Consumer Price Index: - A Technical Note. [Online] Available at https://mospi.gov.in/

[16] National Statistical Office (NSO), 2022. Consumer Price Index Numbers on Base 2012=100 For Rural, Urban And Combined For The Month Of July 2022. [Online] Available at https://pib.gov.in/

[17] U.S. BUREAU OF LABOR STATISTICS, 2022. Consumer Price Index. [Online] Available at https://www.bls.gov/cpi/

[18] Muzzamil, R. (2021). Impact of Corporatr Governance on the Financial Reporting Quality in the Nigerian Banking Industry. *Johuns.Net*, *48*(5). https://johuns.net/index.php/publishing/22.pdf

[19] Nagpal, R., Singh, P., Angra, P. K., Cheema, G. S., & Rehman, M. (2024). Wearable Computing: Canonical Correlation Analysis (CFA) Statistical Method to Validate the Measurement Models Smart Ergonomic Shoes.

International Journal of Intelligent Systems and Applications in Engineering, *12*(17s), 404–408.

[20] Rehman, M., Dhiman, B., Kumar, R., & Cheema, G. S. (2023). *Exploring the Impact of Personality Traits on Investment Decisions of Immigrated Global Investors with Focus on Moderating Risk Appetite : A SEM Approach*. *8984*(August), 95–110.

[21] Rehman, M., & Dhiman, D. B. (2022). To Study the Impact on the Perception of Banking Customers toward E-Banking (A Case Study of Jk Bank Customers). *Journal of Corporate Finance Management and Banking System*, *26*, 10–20. https://doi.org/10.55529/jcfmbs.26.10.20

[22] Rehman, M., Dhiman, D. B., & Cheema, G. S. (2024). Minds and Machines: Impact of Emotional Intelligence on Investment Decisions with Mediating the Role of Artificial Intelligence. *International Journal of Engineering, Business and Management*, *8*(1), 01-10. https://doi.org/10.22161/ijebm.8.1.1