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Explaining Economic Growth Using Threshold Inflation and Factors from Growth Theories: Empirical Analysis of Pakistan

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The present study investigates the impact of threshold inflation on economic growth of Pakistan using factors from growth theories. The empirical analysis is based on data from 1973 to 2023. The study used threshold regression to estimate the threshold level of inflation. The estimated threshold levels are 9.3 and 9.6 percent for inflation computed from consumer price index and wholesale price index respectively. The estimates revealed that after reaching the threshold inflation level, labour force growth and trade act as Keynesian theory suggests but the role of money supply contradicts from the Monetarists theory. This study is foremost in using regression trees in the analysis of threshold inflation and growth. The analysis of regression trees indicates that inflation and money supply are the major determinants of the growth of economy. The study concludes inflation above the threshold level of inflation corresponds to very low levels of growth in the country. The study suggests keeping inflation below threshold for the sustainable growth of the country.

Keywords: GDP growth, threshold inflation, CPI, WPI, regression trees

Sustainable growth requires growth of gross domestic product (GDP) for long periods that increase employment and income. The macroeconomic theories explain economic growth by highlighting various factors. Classical growth theory states that the growth of an economy is determined through labour and capital. Endogenous growth theory highlights the role of human capital, innovation and knowledge spillovers (Romer, 1990). In Keynesian theory short-term fluctuations in GDP can occur due to changes in aggregate demand, which is influenced by consumption, investment, government spending, and net exports (Mankiw, 2016). In Monetarist theory, the key relationship is that in long-run the growth in money supply does not affect GDP growth but only cause inflation (Friedman, 1968). However, some studies found the increasing relationship between growth and inflation while others revealed the relationship decreasing (Drukker et al., 2005). Until the late twentieth century, it was hypothesised that the relationship changes its nature after a specific level of inflation that was named as the threshold inflation.

Following this approach, the studies found empirical evidence of the threshold inflation level in cross country analysis, and later the estimates were based on some specific country of interest. The empirical literature investigates the threshold inflation level for Pakistan and found various levels of threshold inflation for Pakistan including 5.5, 7, 8 and 9 percent (Mubarik, 2005; Ayyoub et al., 2011; Arby & Ali 2017; Jacob et al., 2023). However, the studies in Pakistan remained limited to the empirical literature of threshold inflation and growth while defining the variables of the model let alone considering the effect of threshold inflation on factors highlighted

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in growth theories; the present study fills this gap. This study takes the most important factors from the growth theories and check the impact of these factors before threshold level of inflation and after it. Furthermore, empirical investigations of studies exploring threshold inflation in Pakistan were based on consumer price index (CPI). However, the research on the other countries has also used inflation derived from wholesale price index (WPI) in the analysis of threshold inflation and growth (Singh, 2010; Behera & Mishra, 2017; Bhoi & Tabasum, 2024). Following the literature, the present study includes both CPI and WPI as the measures of inflation to check their relationship with economic growth. Moreover, the existing empirical studies on Pakistan use regression analysis and remain limited to the interpretation of its coefficient, but this study use regression tree analyses and found evidence that before threshold level of inflation GDP growth was above than the average growth whereas after the threshold level of inflation GDP growth was below than the average growth of the country. Therefore, the study concludes that inflation must be kept below its threshold level to obtain the sustainable growth in Pakistan.

The study proceeds in the following manner, section 2 indicates the studies from literature, section 3 highlights the method, section 4 explains the empirical results and section 5 provides the conclusion.

Literature Review

Sustainable growth is considered as the key to sustainable environment (Khan et al., 2019). To achieve the goal of sustainable growth the theoretical and empirical literature have focused on the relationship between inflation and growth. This section is divided into two parts for the convenience of the readers. The first part explains theoretical underpinnings and the second part includes empirical literature.

Theoretical Literature on Growth Theories

The classical economists, Adam Smith and his proponents, take the money as medium of exchange only, so real variables like growth have no effect of changes in the price level; in other words, money remains neutral. The economic growth, in these theories, is due to the factors of production namely labour and capital. Later, Solow (1956) found that a large share of growth remined unexplained by the labour and capital which is captured by the residual that later named as the Solow's residual. The theory considers that investment in physical capital and growth of workforce increase production but diminishing returns apply to both capital and labour. Endogenous growth theory added a parameter that elaborate effectiveness of labour and capital to explain the growth of economy (Romer, 1990). This theory focuses on innovation and knowledge as the major component of economic growth; however, money remained neutral and the medium of exchange only. Later, Keynesians argued that short-term variations in GDP can occur due to changes in aggregate demand (Mankiw, 2016). In the Keynesian framework the money in the short run increases consumption, government spending, trade and investment that ultimately increase the growth; hence, the money is not neutral. In the Monetarist's framework, inflation might initially increase output in short run through increased demand, but it eventually leads to higher inflation expectations that undermine long-term growth; therefore, inflation over time can lead to uncertainty, reduced investment, and lower real income growth (Friedman, 1968). Hence, the money is considered neutral in the long run but not in the short run. Therefore, the theory emphasis the role of labour, capital, technology, investment, consumption and money to explain growth. Then, Sarel (1996) found a non-linear relationship of growth and inflation that was not earlier mentioned in the theories. It is followed by the concept of threshold inflation and its effect on growth upon which the enormous empirical literature is present, but it lacks established theoretical

support. The present study used the important factors highlighted in the growth theories for model specification.

Empirical Literature

The extensive literature explores the relationship between threshold inflation and growth in cross countries and panel studies. Historically, the empirical literature has found all viable combinations of growth and inflation relationship: inflation with growth, inflation without growth, no inflation with growth and no inflation without growth (Shughofta, 2022). The cross-country studies dominate the literature exploring relationship of growth and threshold inflation. Ghosh and Phillips (1998) investigated annual data of 145 countries to find threshold inflation. At the low level of inflation, 2 to 3 percent annually, the study found positive relationship of inflation and growth. Finding threshold inflation level, Khan and Senhadji (2001) analysed unbalance panel consisting of 140 countries' data. The study found threshold inflation 3 and 12 percent for industrial and developing economies respectively in yearly data. Drukker et al., (2005) used 5 years averaged data on 138 countries from 1950 to 2000 to analyse relationship of inflation and growth. The study found 19.16 percent as threshold inflation level. Kremer et al., (2013) analysed threshold inflation level from data of 124 countries from 1950 to 2004. The study reported 17 percent as the threshold inflation level for non-industrialized countries. In both studies inflation remained insignificant below the threshold inflation level but negatively associated with growth after threshold inflation level. Similarly, Bick (2010) used data from 40 developing countries for analysing relationship of growth and inflation and found 12 percent as threshold inflation below which inflation was positive and significant and after which inflation lowered growth. Azam and Khan (2022) analysed 27 countries among which 16 were developing and 11 were developed countries. The study reported threshold inflation level was 12.23 and 5.36 percent in developing and developed countries respectively. After the threshold inflation level, inflation decreased growth of the economy. Shughofta (2022) empirically estimated relationship of growth and inflation from 86 countries from 1996 to 2020. The estimated threshold level was 1 to 2 percent for high income, 3 to 28 percent in case of middle income and 9 to 13 percent for low-income economies. Mahsud et al., (2022) examined threshold inflation in South Asian countries from 1980 to 2017. The study found 6 percent as the point after which inflation decreased growth.

Mubarik (2005) analysed Pakistan from 1973 to 2000 and concluded 9 percent as threshold inflation below which inflation spurs growth and after that inflation might harm growth of economy. The study found uni-directional causality indicating that inflation cause GDP growth but not otherwise. The same results of Granger causality were estimated by Hussain and Malik (2011) when the study explored the relationship of growth and inflation in Pakistan from 1960 to 2006. The study concluded that below 9 percent inflation remained helpful for growth, but after 9 percent inflation become detrimental for growth of Pakistan. Ayyoub et al., (2011) analysed Pakistan's data from 1972-73 to 2009-10. The study concluded 7 percent inflation as the threshold inflation level. Arby and Ali (2017) explored Pakistan economy's data from 1976 to 2017. The study used regression kink and quadratic model to identify the relationship. The threshold level estimated from quadratic model was 6.05 while the threshold level estimated from kink model was 5.67. Jacob et al., (2023) analysed Pakistan economy using data from 2000 to 2022. The study highlighted 8 percent as threshold inflation level after which inflation became harmful for GDP growth. The research on GDP growth in Pakistan, which do not include the threshold inflation, have also pointed that the high inflation increases unemployment and decreases the sectoral growth in the economy (Ajmair et al., 2020; Ahmad, 2025). Based on literature, the study has developed the hypotheses which will be tested empirically. There are two null hypotheses for each variable as the threshold

regression provides two coefficients for each variable, one below and the other above the threshold level of inflation.

H_{01}: Inflation does not affect GDP growth below its threshold level.
H_{11}: Inflation affects GDP growth significantly below its threshold level.

H_{02}: Inflation does not affect GDP growth above its threshold level.
H_{12}: Inflation affects GDP growth significantly above its threshold level.
The acceptance of null hypothesis in both cases will means that no threshold exists. If H_{02} is rejected and the coefficient has negative sign that will support the empirical literature that GDP growth decreases after inflation crosses its threshold level.

H_{03}: Investment does not affect GDP growth when inflation is less than its threshold.
H_{13}: Investment affects GDP growth significantly when inflation is less than its threshold.

H_{04}: Investment does not affect GDP growth when inflation exceeds its threshold.
H_{14}: Investment affects GDP growth significantly when inflation exceeds its threshold.
Classical and Keynesian theory indicate that the investment increases GDP growth that means if H_{03} is rejected, and the coefficient has positive sign then an increase in investment will increase GDP growth that conform to the Classical theory given that inflation is below its threshold level. Similarly, the theory will hold for inflation above the threshold level if H_{04} is rejected. If the results are in line with the theory, as in Mazher et al. (2025), then the study will suggest increasing the investment by establishing special economic zones (Hussain et al., 2021).

H_{05}: Labour force growth does not affect GDP growth when inflation is less than its threshold.
H_{15}: Labour force growth affects GDP growth significantly when inflation is less than its threshold.

H_{06}: Labour force growth does not affect GDP growth when inflation exceeds its threshold.
H_{16}: Labour force growth affects GDP growth significantly when inflation exceeds its threshold.
Classical theory emphasis that the labour force increases GDP. The Keynesian view attaches increase in the labour force increase the aggregate demand that raise GDP. Hence, both of theories hold if H_{05} and H_{06} are rejected, for inflation below its threshold level and above it respectively, and the coefficient has the positive sign. Trinh (2024) and Thanh et al., (2024) have found an increasing labour force increases growth.

H_{07}: Money supply does not affect GDP growth when inflation is less than its threshold.
H_{17}: Money supply affects GDP growth significantly when inflation is less than its threshold.

H_{08}: Money supply does not affect GDP growth when inflation exceeds its threshold.
H_{18}: Money supply affects GDP growth significantly when inflation exceeds its threshold.
The acceptance of null hypotheses, H_{07} and H_{08} means that money is neutral, and it will be in line with Monetarists' long run perspective. The rejection of null hypothesis indicate that money is not neutral and then it follows Keynesian perspective. Shughofta (2022) and Maher (2023) have also used broad money to their threshold inflation analysis.

H_{09}: Trade openness does not affect GDP growth when inflation is less than its threshold.
H_{19}: Trade openness affects GDP growth significantly when inflation is less than its threshold.

H_{010}: Trade openness does not affect GDP growth when inflation exceeds its threshold.
H_{110}: Trade openness has significant effect on GDP growth when inflation exceeds its threshold.
In Keynesian perspective, trade increases the income of the people that spurs aggregate demand and GDP. Therefore, the acceptance of H_{09} and H_{010} will contradict the Keynesian perspective. However, Trinh (2024) found negative and significant relationship between these variables while analyzing data from 32 countries of Asia.

Method

The relationship of growth and inflation has investigated using spline regression in much research including Khan and Senhadji (2001), Mubarik (2005), Singh (2010), Behera and Mishra (2017) and Mahsud et al., (2022). Then studies further used some econometric techniques, based on nature of data, like conditional least squares, non-linear least squares, fixed effects, random effects, etc. to get empirical results. However, threshold regression is more advanced technique to estimate the threshold level.

3.1.Threshold Regression Model

The threshold regression provides varying coefficients across regions that extends linear regression. The threshold value identifies the regions with above or below to the threshold level. The estimated model can provide multiple thresholds, or just the single threshold. The threshold regression models in economics are followed by Hansen (2000) and Hansen (2011). When there is single threshold γ then threshold regression with two regions can be stated as,

$$y_t = x_t\beta + z_t\delta_1 + \epsilon_t \qquad if \qquad -\infty < w_t \leq \gamma \qquad (1a)$$
$$y_t = x_t\beta + z_t\delta_2 + \epsilon_t \qquad if \qquad \gamma < w_t < \infty \qquad (1b)$$

where y_t is the dependent variable, x_t is a 1 × k vector of covariates, β is a k × 1 vector of region-invariant parameters, ϵ_t is an independent and identically distributed error with mean 0 and variance σ_2, z_t is a vector of exogenous variables with region-specific coefficient vectors δ_1 and δ_2, and w_t is a threshold variable. Region 1 indicates coefficients below γ (threshold value of w_t) and region 2 provides coefficients after threshold level γ. The threshold regression uses conditional least squares to estimate the parameters of the model; therefore, it is imperative that variables in the analysis be stationary at level. The present study forms the following threshold inflation model:

$$GDPgr_t = D_1\,(\alpha_1 + \beta_1 Inv_t + \beta_2 Lfgr_t + \beta_3 M2_t + \beta_4 Td_t + \beta_5 Inf_t) + D_2(\alpha_2 + \gamma_1 Inv_t + \gamma_2 Lfgr_t + \gamma_3 M2_t + \gamma_4 Td_t + \gamma_5 Inf_t) + \epsilon_t \qquad (2)$$

where,

D_1=1 if inflation is on or below the threshold level
D_1=0 otherwise
D_2=1 if inflation is above the threshold level
D_2=0 otherwise

The dependent variable here is the growth rate of GDP ($GDPgr_t$). The threshold variable is inflation (Inf_t) calculated from consumer price index ($InfCPI_t$) or from wholesale price index ($InfWPI_t$); it is also included as regressor in the model. Inflation is computed as the logged difference of related price indices. D_1 provides the results for the region 1 where inflation is below its threshold level and D_2 indicates the coefficients for region 2 where inflation is above the threshold level. The region variant variables include Inf_t that is inflation, Inv_t that is investment (gross capital formation as percentage of GDP), $Lfgr_t$ is growth of labour force (the population

aged above 14 years) , $M2_t$ is the broad money (sum of currency, demand deposits, savings, foreign currency deposits, travellers' cheques and other securities of resident sectors other than the central government) as percentage of GDP and Td_t is the trade as percentage of GDP (the sum of exports and imports divided by GDP and then multiplied by 100). The ϵ_t is an independent and identically distributed error with mean 0 and variance σ_2. The empirical analysis is based on Pakistan over the period from 1973 to 2023. The data of all the variables is taken from the World Bank, the State Bank of Pakistan and various issues of Pakistan Economic Survey.

3.2.Regression Trees

Regression trees are simple ways to express graphically the problem at hand. This technique splits the values of independent variables and provide its impact on the dependent variables. These are formed with the series of splitting rules, where it starts at the top of tree. The top splits are called branches and the ending values on the bottom of tree are called the terminal nodes. The points along the tree where the predictor space is split are referred to as internal nodes. These nodes of trees divide the data into regions, or boxes, *R*1 *R2, . . ., RJ*. The purpose is to make the regions that minimize the residual sum of squares given by,

$$\sum_{j=1}^{J} \sum_{i \epsilon R_j} (y_i - \hat{y}_{R_j})^2 \qquad (3)$$

where $\hat{y}_{R_j}$ is the mean response for the observations within the *j*th box. However, considering every partition is not feasible so recursive binary splitting is used. The splitting continues where every new splitting is based on dividing the region into two parts until the stopping criterion is met. Although the process usually produces good predictions, it could overfit the data by making trees too complex with meaningless splits. The better strategy considered is to grow, at first, a very large tree then prunes it backwards to get a subtree. Intuitively, the goal is to select a subtree with the lowest test error rate that can be done using cross-validation. The cross-validation error for every tree is estimated, then the tree with smallest cross validation error is selected. The tree methodology used in analysis of this research is taken from James et al., (2017). The present study uses regression tree with the same variables that are used for threshold inflation estimation. The major benefit of using trees is that they highlight the important regressors in the model and check robustness of threshold estimation as well.

Results and Discussions

The study has included the data from Pakistan economy over the period from 1973 to 2023. The descriptive analysis of variables has reported below in table 1. The GDP growth rate provide average value of 4.7 percent, while it has been varied from -1.27 to 10.216 percent. It indicates that Pakistan has observed volatile GDP growth throughout its journey. The measures of inflation are closely related to each other.

Table 1

Descriptive Analysis

Variables	Mean	Standard Deviation	Minimum	Maximum
GDPgr	4.720	2.235	-1.274	10.216
InfCPI	8.992	5.234	0.226	26.217
InfWPI	9.752	6.171	-1.054	28.371
Lfgr	0.227	0.388	-0.613	0.900
M2	43.168	5.652	28.690	54.526
Inv	16.972	1.846	12.812	20.685
Td	31.146	4.167	21.460	38.499

The study has used Augmented Dickey Fuller test to explore stationarity of the variables; its results are provided in table 2. In the test null hypothesis is that the variable is non-stationary, and rejecting this hypothesis means the variables is stationary. Most of variables are stationary at 5 percent significance level. However, Lfgr and Td are stationary at 10 percent significance level; considering the 10 percent significance level it can be stated that all the variables of analyses are stationary.

Table 2

Results of Augmented Dickey Fuller Test

Variables	Test Statistic	P-value
GDPgr	-5.067 ***	0.000
Inf CPI	-3.175 **	0.022
Inf WPI	-3.232 **	0.018
Inv	-4.339 ***	0.003
Lfgr	-2.777*	0.062
M2	-3.127 **	0.025
Td	-2.706 *	0.073

Note: MacKinnon approximate p-value. *, ** and *** indicates significance at 10%, 5% and 1% respectively.

The threshold regression analyses results are reported in table 3. The results of study have found 9.3 and 9.6 percent threshold levels of inflation for InfCPI and InfWPI respectively. The coefficient of inflation before threshold level remained insignificant for both measures of inflation while both coefficients of inflation after the threshold level revealed negative and significant. It indicates that the increase in inflation after its threshold value results in decreasing GDP growth. This threshold result is in line with the Hussain and Malik (2011) and Mubarik (2005) that report 9 percent as the threshold inflation level for Pakistan. Besides inflation there is only one regressor that is the broad money which revealed negative and significant in all the equations after the threshold inflation level which is similar to Shughofta (2022). It is contradictory to, money neutrality, Monetarist theory that the increase of money supply create inflation in the long run but do not affect GDP growth when inflation exceeds its threshold. However, the coefficient of money supply remained insignificant before the threshold level of inflation that indicates money supply remained neutral before the threshold inflation that is in line with the Monetarist point of view. The coefficient of trade as percentage of GDP is significant in equation 1.2 only; the coefficient is negative before the threshold level and positive after threshold inflation. It indicates that before the threshold level of InfWPI an increase in the trade decreases growth that is in line with the findings of Trinh (2024) but is contradiction of Keynesian view. However, after the threshold level of InfWPI the increase in trade increases GDP growth that is in line with the Keynesian view which highlight that expanding trade accelerates the demand for goods that in turn increase growth. Therefore, the trade follows the Keynesian view of thought after reaching the threshold of InfWPI. The labour force growth rate has revealed negative and significant before the threshold inflation and positive and significant after the threshold inflation in equation 1.1. This result, after the threshold inflation, shows that growth of labour force spurs GDP growth after the threshold inflation that is similar with Thanh et al., (2024). The coefficients of investment remained insignificant and positive in all the equations that is contrary to the Classical perspective.

Table 3

Results of Threshold Regression

Variables	Equation 1.1 **(InfCPI)**	Equation 1.2 **(InfWPI)**
Threshold Inflation	**9.299**	**9.550**
Inflation (BT)	0.246	0.273
	(0.167)	(0.171)
Inflation (AT)	-0.260 **	-0.297 **
	(0.119)	(0.117)
Inv (BT)	0.133	0.361
	(0.296)	(0.395)
Inv (AT)	0.318	-0.551
	(0.340)	(0.373)
Lfgr (BT)	-1.899 *	-1.581
	(1.000)	(1.222)
Lfgr (AT)	2.777 **	1.069
	(1.245)	(1.526)
M2 (BT)	-0.020	0.046
	(0.064)	(0.071)
M2 (AT)	-0.428 ***	-0.377 ***
	(0.103)	(0.117)
Td (BT)	-0.102	-0.309 *
	(0.145)	(0.178)
Td (AT)	-0.079	0.378 **
	(0.163)	(0.186)
Constant (BT)	5.898	5.058
	(5.073)	(6.383)
Constant (AT)	22.414 **	21.561 **
	(9.181)	(9.887)
Time Period	1973-2023	1973-2023

Note: *, ** and *** indicates significance at 10%, 5% and 1% respectively. Standard errors are in parenthesis. “BT” stands for “before threshold” and “AT” stands for “After threshold”.

Table 4

Test for Autocorrelation: Portman Test for White Noise

Lags		Equation 1.1 **(InfCPI)**	Equation 1.2 **(InfWPI)**
1	Q Stat	0.027	0.062
	(Prob.)	(0.869)	(0.803)
2	Q Stat	0.047	0.199
	(Prob.)	(0.977)	(0.905)
3	Q Stat	0.588	0.288
	(Prob.)	(0.899)	(0.962)
4	Q Stat	1.807	0.292
	(Prob.)	(0.771)	(0.990)

The next step, after estimating the model, is to test for autocorrelation. The study uses Portman test for white noise where the residuals of the equations are tested for the existence of serial correlation up to 4 lags; its results are shown in table 4. Here, the null hypothesis is that residuals of equations are not serially correlated, and the estimates do not reject it even at 10 percent significance level in any equation. Therefore, it can be concluded that equations do not suffer from autocorrelation.

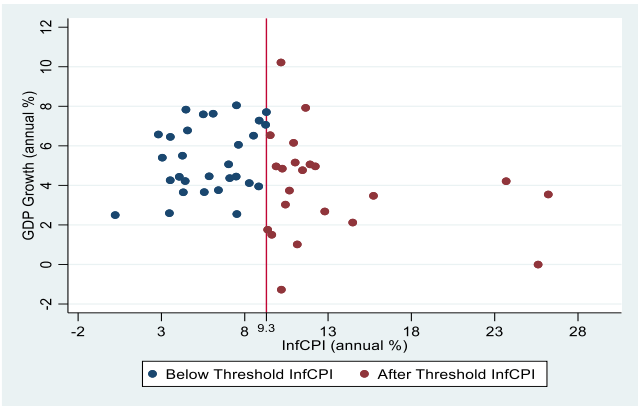

Figure 1.1: Scatter plot indicating the relationship of GDPgr and InfCPI by highlighting threshold value (estimated from equation 1.1) with red line (Author's

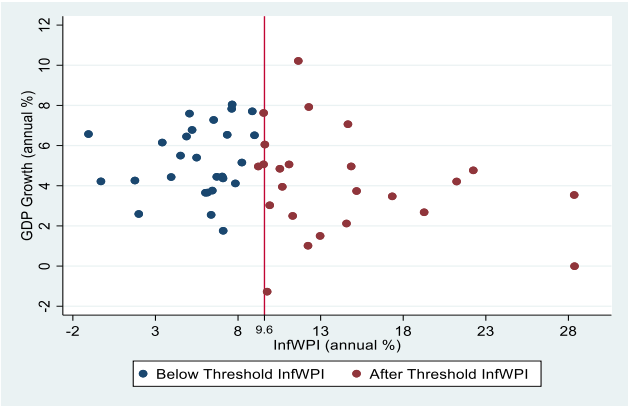

Figure 1.2: Scatter plot indicating the relationship of GDPgr and InfWPI by highlighting threshold value (estimated from equation 1.2) with red line (Author's calculation).

The estimated thresholds can be verified graphically by drawing the scatter diagram of the values of inflation and GDP growth of the country that are represented in figures 1.1 and 1.2 below. The red line indicates the threshold inflation level, the red coloured dots indicate the values of GDP growth above threshold inflation while blue coloured dots highlight the values of GDP growth below threshold inflation. The figures highlighted that GDP growth usually remain lower, less than 4 percent, when the inflation lies above threshold. The values of GDP growth are concentrated at high levels of growth, more than 5 percent, when the inflation level lies below its threshold level. Thus, highlighting the fact that the inflation above threshold level remains detrimental to GDP growth of economy.

After estimating the threshold inflation level, the study investigates implications of threshold inflation on GDP growth rate in Pakistan using the regression trees. This analysis is using the same variables as the independent variables that are used in the threshold regression model. The regression trees when built were the bushy trees that are pruned using the cross-validation criterion; the diagrams showing cross-validation are provided in figures 2.1 and 2.2 respectively. The number of leaves for which the cross-validation error is minimum is selected for the interpretation; hence, the tree includes only the most important factors that affect the economic growth of Pakistan. The regression trees results are reported in figures 3.1 and 3.2. Both regression trees use GDPgr as the dependent variable while inflation, M2, Lfgr, Inv and Td as the independent variables. The figures of tree further highlight the relationships of GDP growth and inflation. The figure 3.1 points out the InfCPI and figure 3.2 describes the InfWPI as the measures of inflation in the regression trees. The regression trees provide broad money as the most important variable in the study. The branches of tree highlight that broad money less than 42 percent of GDP results in providing GDP growth more than 5 percent which is above the average GDP growth of the whole sample. The tree in figure 3.1 second leaf indicates that broad money growth more than 39.95 and less than 42 percent of GDP results in 8 percent GDP growth. However, Ahmed and Hasnu (2009) have found positive relationship of financial development and growth in Pakistan that indicates the money supply could not be controlled otherwise it would hinder the growth of economy if not directly then through various channels. Moreover, in developing countries, broad money must increase for the purpose of investment. Therefore, lower level of broad money could not be a feasible solution for the economy. The right leaf of the inflation branches of trees indicates that when the broad money is

greater than 42 percent and the inflation (InfCPI) is above 9.3 percent (its threshold level) then GDP growth remained 2.7 percent only that is very low. In the inflation branch of the other tree, the figure 3.2, given the same level of broad money if the inflation (InfWPI) is above 9.69 percent GDP growth would be around 2.88 percent. Hence, the regression trees shown in 3.1 and 3.2 concludes that inflation above its threshold level results in very low growth that is less than 3 percent approximately, but inflation below its threshold generates high growth above 5 percent given the broad money is greater than the 42 percent of GDP.

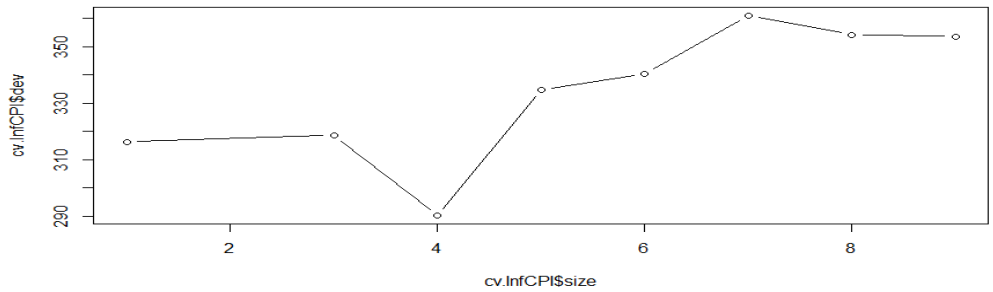

Figure 2.1: The plot of cross validation of figure 3.1

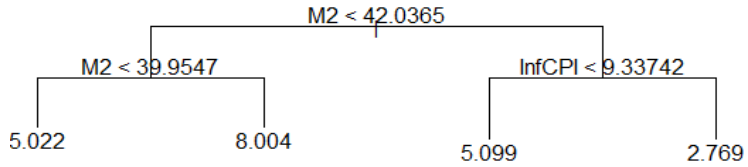

Figure 3.1: Regression tree based on InfCPI where terminal nodes indicate the level of GDP growth.

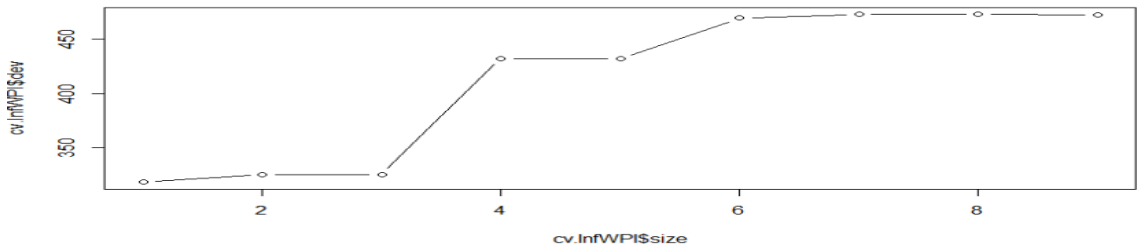

Figure 2.2: The plot of cross validation of figure 3.2

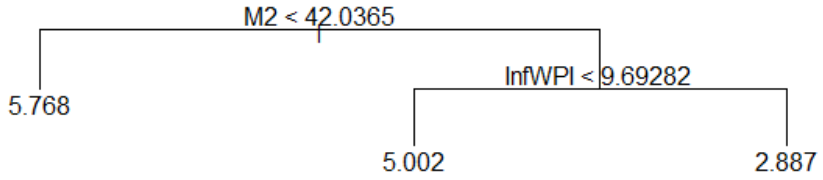

Figure 3.2: Regression tree based on InfWPI where terminal nodes indicate the level of GDP growth.

From the regression tree analysis, the present study found the most important variables in the determination of GDP growth. In order to investigate the impact of particular level of inflation and broad money, the study has constructed region plot in figure 4.1 and 4.2; the region plot of 4.1 and 4.2 are based on the tree findings from figure 3.1 and 3.2 respectively. The GDP growth is divided into three parts: low growth is the GDP growth level less from the first quartile that is 3.54 percent, high growth is the level of GDP growth above the third quartile that is 6.51 percent, and the middle growth is the GDP growth between the upper and lower quartile. In the figures 4.1 and

4.2 the R1 and R2 indicate the region where the inflation is above the threshold level. The R1 region contain a few points. The R2 contain many points indicating low level of GDP growth. The R3 and R4 are the regions below the threshold level. Many points of high growth lie on the region R3 and R4. The average growth points are more in the R4 region. The regional diagrams concludes that R3 and R4 are the suitable regions for the growth of economy where the inflation is below the threshold level.

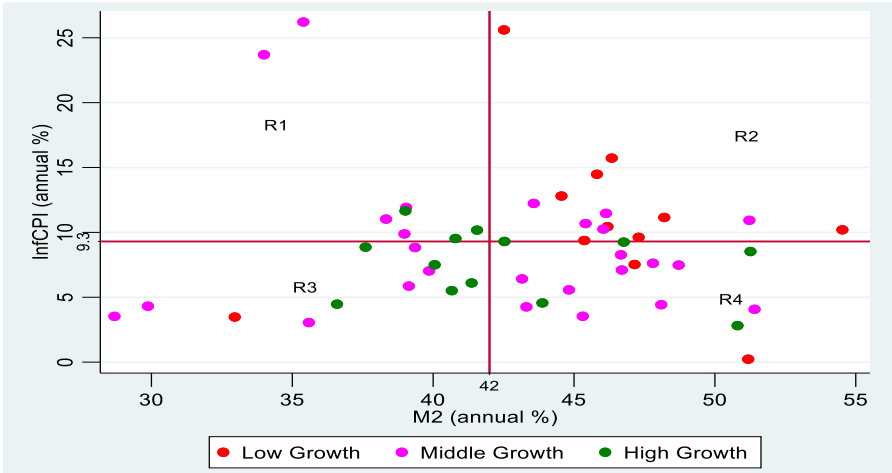

Figure 4.1: Region diagram of the regression tree reported in figure 3.1

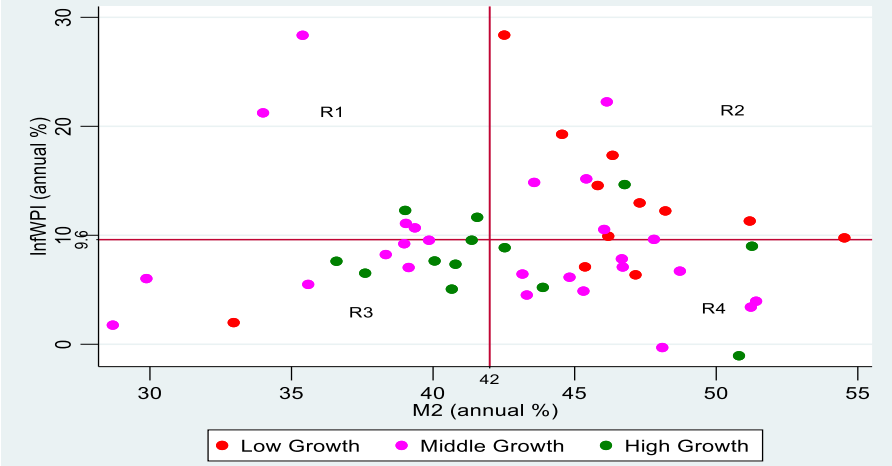

Figure 4.2: Region diagram of the regression tree reported in figure 3.2

Conclusion

The present study investigates the role of threshold level of inflation and various factors from growth theories on GDP growth of Pakistan from 1973 to 2023. The estimated threshold levels are 9.3 and 9.6 percent for inflation computed from CPI and WPI after which inflation becomes harmful to GDP growth. The estimates are robust and do not suffer from autocorrelation. The empirics indicate that increase in money supply after threshold inflation decreases the growth; however, before the threshold level the money supply is insignificant that indicates money neutrality. The empirics provide trade increases GDP growth after the threshold inflation that follows the Keynesian patterns; the labour force growth increases GDP growth after the threshold inflation that affirms the Classical theory of growth. The study further employed regression trees to interpret the implications of inflation exceeding its threshold and concludes that inflation level above the threshold corresponds to less than 3 percent GDP growth in the country. The regression trees highlight broad money, inflation computed from CPI and WPI as the most important factors

determining GDP growth of the country. The results revealed that broad money less than 42 percent of GDP increases growth; broad money higher than 42 percent of GDP results in high GDP growth only when inflation is below its threshold. The region diagrams also suggest that inflation must be kept below its threshold for obtaining sustainable growth in Pakistan. The present research has empirically used data from Pakistan economy, so its results are applicable to the country and the other developing countries sharing similar economic structure intuitively. The future researchers can include any specific country or use other important factors highlighted in the growth theories like technology, knowledge and expenditures to check if these factors act according to theory when inflation is above its threshold level or below it.

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