

## **ANALYZING INTEREST RATE GAP AND OUTPUT GAP AS INDICATORS OF INFLATION: A TEST OF KEYNESIAN AND WICKSELLIAN PROPOSITION FOR PAKISTAN**

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**Abstract.** This study tries to empirically investigate two theoretical propositions for Pakistan's economy. The first one is the Keynesian output gap and its deterministic impact on the inflation and the second one is the impact of real interest rate gap on inflation proposed by Wicksell. ARDL approach has been utilized to identify the association among the specified series during selected sample period 1974 Q1 to 2017 Q4. The natural rate of interest and potential output are extracted using Uni-variate Unobserved Component Model. The results are suggestive of weak association between inflation and interest rate gap in the short run while strong association has been found in case of output gap. Further, a long run co-integration is found existent among the inflation, interest rate gap and output gap.

**Keywords:** Output gap; inflation; real interest rate gap; ARDL; unobserved component model

**JEL Classification:** E430, E310, E320

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## I. INTRODUCTION

With the demise of Classical ideology after the Great Depression, economic literature witnessed a paradigm shift in terms of economic ideas prevailing before. The footstep of Keynes in this process of ideological evolution marked the beginning of a thought-provoking chain that had unfolded many new dimensions for upcoming intellectuals and researchers. Keynes (1936) removed the skepticism of Classical school on manifold concepts, especially regarding the proper treatment of economy's potential output and gravitational aspect of output around this benchmark. Keynes introduced the concepts of output gap based on these gravitational aspects and linked them with the inflationary and deflationary gaps observed in the economy. Whenever actual output exceeds the potential output it puts a restraint on the economic resources. As a result, the demand pressures generated are translated into inflationary pressures. Propositionally, Keynes treated "Output gap" as an indicator of inflation in the economy. This proposition can safely be regarded as such critical contribution which has laid the foundation for bulk of literature on inflation and its attributes today.

The Keynesian supremacy however does not imply that everything from the Classical stream should go unnoticed and unrecognized. More than a century ago, the concept of "Natural rate of interest" was introduced by a renowned Classical Economist Nut Wicksell (1898, 1906)<sup>1</sup>. This concept has currently become a Hall mark in economic literature, especially in literature relevant to monetary policy design, its relevance and capturing its stance. Any negative or positive deviation of actual interest rate around the natural rate is summarized into inflationary and deflationary pressures. For example, whenever actual interest rate remains below natural level, it presents a stimulus for real variables including investment and consumption. Besides, it positively affects financial/monetary variables

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<sup>1</sup> "Natural rate of interest" is termed as that level of interest rate which keeps the output at its "Potential" and inflation at its "Stable".

like bank lending ratio and money supply and via these potentially transmutes into inflationary pressures.

Having discussed a formal backdrop, this study intends to analyze the validity of these important propositions for Pakistan's economy.

Objectively our study aims at exploring "Output gap" and "Real interest rate gap" as indicators of inflation for Pakistan. Although considerable amount of literature is available focusing on measuring output gap in Pakistan, but it scantily addresses the measurement of interest rate gap. Our study viably contributes to the existing literature by offering a measurement of interest rate gap besides output gap. This contribution is meaningful because real interest rate gap is considered as an indicator of monetary policy stance in literature. A positive interest rate gap suggests tightening of monetary policy while its negative sign indicates loose monetary policy stance. Therefore, this study on the hindsight also reveals aspects of monetary policy stance through calculation of this gap which is not commonly done for Pakistan's economy. Additionally, our study uniquely places these variables (output gap and interest rate gap) in deterministic framework of inflation, which is marginally addressed before. The theoretically consistent and justifiable relation between output gap and inflation is positive while it is perceived as negative between interest rate gap and inflation; however, the exceptions always exist depending upon economy specific credentials. Our study therefore attempts to capture the nature of this relationship for Pakistan's economy utilizing ARDL bound testing approach.

Interest rate and output are among those economic variables which responsibly gauge the economy as per belief of conventional economists<sup>2</sup> Understanding regarding their behavioral dynamics and linkage becomes even more important when they are placed at the deterministic framework of a variable and are supposed to offer a policy guideline in a traditional monetary framework. Policy relevance of the said gaps (output gap and interest rate gap) is well evident from the central bank's objective functions and loss functions specified by economists in monetary literature. These

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<sup>2</sup> Of course, within an "Islamic Economic setup", output plays a key role but interest rate being prohibitive has no role to offer either in theory or in practice.

objective functions are often designated to track optimal level of inflation by assigning respective weights to these gaps in due course of optimization. Even the nominal interest rate rules (Taylor, 1993) proposed as a policy guideline suggest these gaps as feedback variables for central banks to set nominal interest rate at an appropriate level.

What needs to be emphasized is that an issue must be considered in a broad perspective with all its determinants in check. As this should be a generally adopted and accepted principle regarding every economic phenomenon, case is not very much different regarding inflation. The comprehensive review of all determinants of inflation is not the actual subject matter of this paper rather focus is accorded on examining theoretically proposed determinants including output-gap, and real interest rate gap. Rather than replicating an exercise of determining the conventional and traditional determinants of inflation in Pakistan, this paper aims to fill up the literature gap by analyzing these indicators as potential determinants of inflation. Appreciable literature is available on the discussed theme at international level, but studies lack focus on this topic in case of Pakistan.

The remaining sections are organized in following manner: A synoptic review of literature is presented in section II. Section III is specified to introduce the data and discussing variables used in the study. Section IV concretely discusses the used methodology. Section V focuses on estimation and results and the last section (section VI) is specified for presenting a conclusive outlook and policy recommendations.

## **II. REVIEW OF LITERATURE**

### **A BACKDROP ON RELATIONAL ASPECT**

Inflation always has been ranked among the key variables of an economy. Its measurement allows us to examine the real health of an economy by evaluating the growth prospects relative to cost of living. Inflation within the threshold level is not a source of problem but beyond certain limit offers a serious cause of concern for economists and policy makers. The persistent focus of many economists and researchers on topic of inflation and its determinants is owed to the severity of this problem faced by many economies around the world. High levels of inflation are considered as a

course because it erodes the productive capacity of an economy. Various theories about inflation and its determinants have been presented by renowned economists and different school of thoughts historically. About relational aspect, Classical doctrine favors the notion of “Quantity Theory of Money” (QTM), which suggests a proportional relationship between quantity of money and price level.

QTM proposes that for a stable value of output and a constant value of velocity of money, a twofold increase in supply of money leads to a corresponding two-fold increase in price level. Monetarists consider money supply as an active determinant of change in price level. According to monetarists changes in price level in an economy are primarily caused by changes in stock of money. However, they do not believe in an over rigidly defined proposition of one-to-one correspondence like classical in all time periods. In this relevance the famous dictum posited by Friedman is worth noticing; that is “Inflation is always and everywhere a monetary phenomenon not in the short run but in the long run”. Friedman further posits: “Common to all disturbances, is that the price movements reflect changes in the quantity of money”.

With the transition of macroeconomic literature towards a more structural design in economic modeling, the importance assigned to the concept of “Natural rate of interest” introduced by Wicksell (1898, 1907) has reemerged. The simple monetary transmission mechanism sketched by monetarist is assigned a Neo-Wicksellian interpretation by the economists today, who associate the monetary expansions or contractions with the deviations of actual interest rate around its natural level. According to this interpretation, whenever real interest rate falls short (or remains below) of its “natural level”, it stimulates investment, to complement this increased investment demand, credit expansion and money creation is observed on the part of banks, which in turn increases liquidity in the hands of individuals and via that price pressures are built on account of high aggregate demand (Amato, 2005). This indicates that the explicit mechanism through which money operates in monetarist system is visualized and presented as an implicit mechanism in NeoWicksellian framework (Woodford, 1997; Humphrey, 1997). The negative association between real interest rate and inflation is also advocated by the well-known fisher equation.

Keynesian economists hold a different view regarding relationship between “Money supply and Price level”. They claim that changes in prices are not driven by changes in money stock<sup>3</sup>. Unlike Classical who always assume the economy at the full employment level, Keynes points out the deviations of the economy in either direction<sup>4</sup>. Moreover, Classical and monetarist have little intent to accept the role of interest rate in determining the price signals while Keynesians consider interest rate among the strong determinants of inflation. As per natural rate concept we may not find Keynesians in ideological compliance with Wicksellian theory<sup>5</sup>, however, we can find a profound recognition of concept of natural rates and real interest rate gaps in New Keynesian framework, (Laubach and Williams, 2003; Bjornland, 2011; Neiss and Nelson, 2003).

## EMPIRICAL REVIEW

### Inflation in Relation with Output and Output Gap

Though relationship between “Inflation” and “GDP” is a cause of concern for both developed and developing nations but the direction of relation may well be tracked opposite in the two categories. The economies which undergo the phases of increasing economic development (growth) inevitably must face rising inflation in the initial stages of their growth. But only those economies have sustained in terms of growth which keep inflation under check. This belief provokes bulk of literature on what should be the appropriate level of inflation that might prove to be consistent with the features of economic growth or that is deemed acceptable as an accompanying factor of growth. In this relevance a study conducted by Khan *et al.* (2001) scrutinizes the “threshold level” of inflation for the developed and developing economies and suggests it in between the range of 4 to 5% for the developed countries while between 7 to 11% for the less developed countries. In the same context a study performed by Mubarik (2005) using a causality test reports this threshold level as 9% for Pakistan.

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<sup>3</sup> This controversial view point stems from the skepticism of whether to deal money supply as exogenous or endogenous

<sup>4</sup> Above full employment level causing inflationary gap and below full employment level causing deflationary gap.

<sup>5</sup> For detailed discussion see “Treaties of Money”, Keynes (1936)

Their finding supports the report presented by World Economic Outlook (2006), which proclaims that the experienced high growth rate of GDP in Pakistan for the year 2004-2005 in between the range of 7 to 8% was correlated with high rate of inflation with 8 to 9 %.

Thirwall *et al.* (1971) conducted a cross-country study including (industrialized) developed and developing countries to figure out the direction of relationship between “GDP” and “Inflation”. The study reports a positive relationship among industrialized developed countries and negative relationship among developing countries. In another study conducted by Ghosh *et al.* (1998) covering IMF member countries and using the data from 1960 to 1996, finds that at inflation rates around 2 to 3%, inflation and output-growth are positively correlated, however the case is converse for inflation exceeding beyond this level. Ayyoub *et al.* (2011) re-examines the traditional quest of association between inflation and growth for Pakistan. They report a negative relationship between the said variables and suggest a threshold of 7% for sustainability of growth.

Direction of Causality between inflation and output has also remained the subject matter of manifold studies. A study by Mallik *et al.* (2001) performs co-integration analysis of inflation with economic growth for South Asian countries<sup>6</sup> and reports two plausible results. Firstly, it reveals inflation and output-growth as positively linked.

Secondly, it affirms that inflation is more sensitive to the increments in GDP growth rather than GDP to the increments in inflation, thus rendering GDP growth as a significant determinant of Inflation for the developing countries. Likewise, a study by Hussain and Malik (2011) identifies a threshold level of inflation for Pakistan performing cointegration analysis and reports it as 9%. Besides evaluating the threshold, the study also examines the causality aspect between the two variables and finds one way causality from inflation to output growth.

After 1990's, focus of the world switches towards inflation targeting regimes and economists in this era realize the fact that it is not the absolute movements of output growth which defines variations in inflation rather its relative deviations from its potential value. Various studies are found in

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<sup>6</sup> The included countries were Pakistan, Bangladesh, India, and Sri Lanka

literature which primarily focuses on analyzing “Output gap” as a key factor determining inflation. Gali *et al.* (2000) specifies a hybrid Phillip curve in which output gap is portrayed as a crucial factor determining inflation. Claus *et al.* (2000) studies the efficacy of output gap for inflation in New Zealand and contends a strong association between the two variables. Mehra (2004) analyzes output gap as an indicator of inflation for Richmond and finds weak support to track it as critical. Farley *et al.* (2010) examines output gap as driver of inflation for US and Canada and find it significant in case of US but insignificant for Canadian economy. A study by Lann *et al.* (2012) evaluates determinants of inflation for US economy including output gap and reveals weak association between inflation and its covariate (output gap). A relatively recent study by Nabila, *et al.* (2013), tracks a significantly positive relationship between output gap and inflation for Pakistan, however contrasting result has been found in a study by Asjed *et al.* (2014). The most recent study by Sharif and Qayyum (2018) on Pakistan, reports output gap as a significant attribute of inflation in short run but insignificant factor in the long run.

### **Inflation in Relation with Interest Rate/Interest Rate Gap**

The most widely examined proposition in the literature has been the fisher equation, which states a definitional relationship between real interest rate and inflation. King *et al.* (1997) conducts a study to examine the long run neutrality assumption of fisher equation and find insignificant evidence of neutrality of fisher equation in long run and conclude that the continuous inflationary trends are caused by continuously lower real rate of interest. Kugler (1982), studies the link between the interest rate (short-term) and inflation for five countries (Switzerland, USA, UK, Germany, and France). Using an autoregressive model, the study deducts that variations in the real interest rate cause variability in inflation. Bullock *et al.* (1991) conducts a cross country study of industrialized nations to examine the relationship between real interest rate (short term) and inflation over the three decades of 1960's, 70's and 80's. They find the two variables as negatively related in the decades of 60's and 70's while positively related in 80's.

Berzezina (2002) tests the empirical relevance of the linkage between real rate gap and inflation for UK covering the period of 1980 to 2000 using a co-integration technique. The author reports interest rate gap as significant



in terms of its deterministic power. Similarly, Neiss *et al.* (2003) performs a study for testing the validity of real interest rate gap as an important attribute of inflation using DSGE modeling. Their result falls true to their postulated hypothesis as real rate gap proves significant in its role as an indicator of inflation.

### III. METHODOLOGY

#### DEVELOPMENT OF MODEL

We develop our model based on a simple economic proposition as:

$$(\pi_t - \pi^e) = \beta(y_t - y_t^*) \text{ where } \beta > 0 \quad (1)$$

Equation (1) states that any spread of output ( $y_t$ ) around its potential level ( $y_t^*$ ) causes inflation ( $\pi_t$ ) to deviate from its expected level ( $\pi^e$ ).

One can give a backward-looking dimension to the equation (1) in terms of expectation about inflation by assuming that the people hold adaptive expectation as:

$$\pi^e = \pi_{t-1} \quad (2)$$

By including this backward-looking expectation structure into equation (1), we can obtain an equation similar to a traditionally looking Phillip curve.

$$\pi_t = \alpha\pi_{t-1} + \beta(y_t - y_t^*) \quad (3)$$

Equation (3) states that inflation depends upon its own lag, and the deviation of output from its potential level. Equation (3) has been designed to test the validity of Keynesian proposition, which states that inflation takes signal from variations in output gap.

One more economic relation can be brought into the picture for meaningful analysis that is

$$\pi_t = \alpha\pi_{t-1} + \gamma(r_t - r_t^*) \quad (4)$$

Where  $r_t$  and  $r_t^*$  are respectively representing the “real rate of interest” and “natural rate of interest” at a time “t”.

The relationship expressed in (4) has been utilized by economists in studies before. Laubach *et al.* (2003) utilizes this relationship in the establishment of their structural model. Berzezina (2002) estimated the mentioned relationship using SVAR. Svensson (2003), Ness *et al.* (2001) also proposes real rate gap as a prominent indicator of inflation in their study.

By combining (3) and (4) we can write

$$\pi_t = \alpha\pi_{t-1} + \beta \tilde{y}_t + \gamma \hat{r}_t + \xi_\pi \quad (5)$$

where  $\tilde{y}$  denotes the output gap and  $\hat{r}$  represents formulated interest rate gap.

The Auto regressive distributed lag (ARDL) specification of equation (5) is expressed as followed:

$$\begin{aligned} d\pi_t = & \alpha\pi_{t-1} + \beta \tilde{y}_{t-1} + \gamma \hat{r}_{t-1} + \varphi_1 d\hat{r}_t + \varphi_2 d\tilde{y}_t + \\ & \sum_{i=0} \delta_{t-i} d\hat{r}_{t-i} + \sum_{i=0} \delta_{t-i} d\tilde{y}_{t-i} + \sum_{i=0} d\pi_{t-i} + \xi_\pi \quad (6) \end{aligned}$$

To find out relationship of inflation with relevant variables, different models have been employed in the past, including SVAR, VAR, and Cointegration. However, we proceed by utilizing the ARDL bound testing approach developed by Pesaran (2001)<sup>7</sup>. ARDL is a widely accepted and used approach in the existing literature, its main advantage is its flexibility of dealing with a mix of stationary and integrated of order 1 I(1) variables. This advantage is complemented by the ability of this approach to tackle the endogenous nature of the regressors. Furthermore, there is no restriction imposed upon using the same numbers of lags for each regressor as was imposed by some former estimation techniques.

<sup>7</sup> Researchers like Whyte (2011), Qurbanalieva (2013) and use Dabušinskas (2005) also use ARDL technique in their studies.

#### IV DATA AND STRUCTURE OF VARIABLES

For estimation purpose, data on all variables are taken from International Financial Statistics (IFS, 2018) except for real GDP which has been taken from Hanif, *et al.* (2013)<sup>8</sup> Quarterly data has been used over the period of 1974 Q1 to 2017 Q4. We use “Call money rate” (CMR) as a proxy for the nominal interest rate. The ex-post real interest is calculated by adjusting the nominal call money rate with CPI.

To obtain the “Output gap” and “Real interest rate gap”, we have used the “Unobserved Component Model” (UC) introduced by Clarke (1987). This model works by splitting the actual series into trend component and its cycle counterpart. The extracted trend component for current analysis is used as our proxy for “Potential output” and “Natural interest rate”, while cycle is used as proxy for “Output gap” and “Real interest rate gap”. The UC model is specified by a measurement equation and state equations. The measurement equation is given as follow:

$$x_t = x_t^* + \tilde{x}_t \quad (\text{A})$$

The state equations are

$$\begin{aligned} x_t^* &= \alpha + x_{t-1}^* + \varepsilon_t \\ \tilde{x}_t &= \beta_1 \tilde{x}_{t-1} + \beta_2 \tilde{x}_{t-2} + \eta_t \end{aligned} \quad (\text{B})$$

The measurement equation specifies the split of actual series  $x_t$  (which symbolically reflects log of real GDP/real interest rate) into stochastic trend  $x_t^*$  and cycle  $\tilde{x}_t$ . The set of state equations reveals the dynamics of the two unknowns: Trend component is assumed to follow a random walk with drift while cycle assumes an AR (2) process in line with the propositions of Clarke. The error terms  $\varepsilon_t$  and  $\eta_t$  are framed as standard white noise and are

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<sup>8</sup> As the weights of GDP has remained constant in quarterly terms as per findings of Hanif *et al* (2013), the average weight per quarter over the selected time period has been used to project the quarterly GDP beyond 2013, in our selected sample.

assumed as mutually uncorrelated. The above system of equations is estimated by employing Kalman filter.

## V. ESTIMATION RESULTS AND DISCUSSION

In the first step of estimation, we employed Unobserved Component model to measure the two gaps (output gap and real interest rate gap)<sup>9</sup>. The extracted series of these gaps are presented in Figures 1 and 2.

Figure 1

### Real Interest Rate Gap

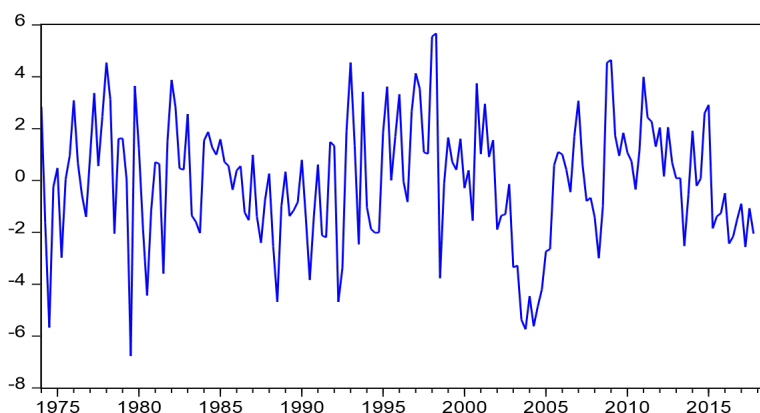


Figure 1 presents the first extracted series (real interest rate gap). The extracted series is observed to be highly volatile across the zero-level benchmark. The amplitude of movements mostly remains between -4% and 4%, except for few quarters. It is visible that the fluctuations are relatively more frequent as compared to what has been observed after 2000. A marginal drift in terms of peak and trough is found in years after 2000.

Figure 2

### Output Gap

<sup>9</sup> The results of likelihood estimate of UC model are reported in table A.1 and A.2 of Appendix A.

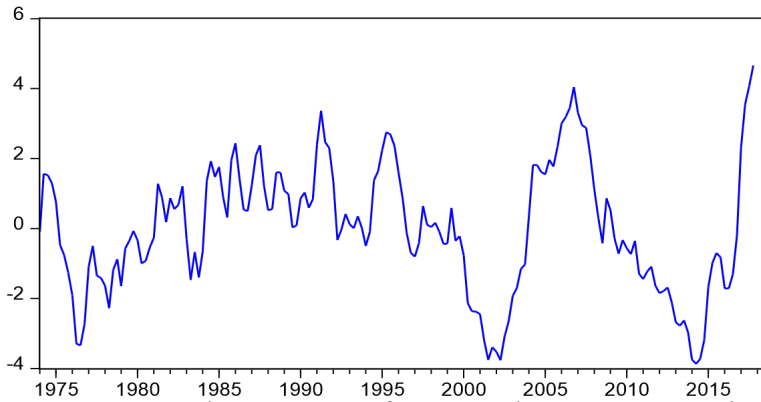


Figure 2 reports the patterns of extracted output gap series for the selected time-period in our study. The series appears to be less volatile as compared to real interest rate gap. If we investigate the movement of this series around the zero-level benchmark, there is a prominent drift in both directions i.e., positive output gap and negative output gap. This suggests that the deviations around 0 % output gap persist for considerable amount of time.

In the second step, we tested order of integration of all three variables used in our designated model. The results of unit root for the three-series involved in our estimation are presented in following Table 1:

TABLE 1  
Results of Unit Root Test

Variable	ADF (Level)	Prob.	Order of Integration
Inflation	-1.572	0.1087	I(1)
Real rate Gap	-4.276	0.0000	I(0)
Output Gap	-2.278	0.4432	I(1)

The unit root testing suggests that both output gap and inflation are integrated of order 1 while real rate gap is stationary at level (integrated of order 0).

After identifying the order of integration, ARDL model specified in equation (6) has been estimated and results are provided in Table 2 and 3.

TABLE 2  
ARDL (4,4,3)

Variables	Coefficient	Std. Error	t-Statistic	Prob.
C	0.341197	0.199358	1.711483	0.0890
$\pi_{t-1}$	-0.186585	0.087612	-2.129672	0.0347
$\hat{r}_{t-1}$	-0.160379	0.054993	-2.916339	0.0041
$\sim y_{t-1}$	0.120628	0.051813	2.328157	0.0212
$d\pi_{t-1}$	-0.410565	0.096307	-4.263075	0.0000
$d\pi_{t-2}$	-0.369049	0.087294	-4.227664	0.0000
$d\pi_{t-3}$	-0.351593	0.075534	-4.654740	0.0000
$d\hat{r}$	-0.472311	0.044538	-10.60469	0.0000
$d\hat{r}_{t-1}$	-0.107299	0.065941	-1.627192	0.1057
$d\hat{r}_{t-2}$	-0.097516	0.061143	-1.594880	0.1127
$d\hat{r}_{t-3}$	-0.124557	0.055423	-2.247385	0.0260
$d\sim y$	-0.041681	0.124954	-0.333568	0.7391
$d\sim y_{t-1}$	-0.014995	0.126754	-0.118302	0.9060
$d\sim y_{t-2}$	-0.353002	0.126054	-2.800404	0.0057
R-square: 0.59      Likelihood: -245.56      DW Statistics: 1.90				
F-Stat: 17.73      Prob: 0.0000      SWC:3.27				

The lag structure of our ARDL model is specified using “Schwartz information criterion (SWC)”. Using results given in Table 2, first we test for the presence of long run relationship between inflation, output gap and

real rate gap using Bound test. Estimated results are summarized in Table 3.

TABLE 3  
Bound Test of Co-integration

				Pesaran <i>et al.</i> (2001)	
Test Statistic	Value	Probability	Significance level	Lower bound	Upper bound
F-statistic	5.019	0.000	5%	3.10	3.87

Results of the Bound test provides us with an evidence on long run relationship between inflation, real rate gap and output gap based on the value of F-Statistics in Table 3. As the computed F-statistics (5.019) is greater than the value specified by the upper bound (3.87), therefore, we contend that the three variables are co-integrated. The long run relationship among included variables is represented by the following equation:

$$-0.186\pi_t - 0.160r^*_t + 0.120\tilde{y}_t = \xi_t \quad (7)$$

Equation (7) can be written by normalizing the coefficients:

$$\pi_t = -0.8595 r^*_t + 0.6465\tilde{y}_t - 5.361\xi_t \quad (8)$$

The results are in line with the theoretically proposed link between the specified variables. Output gap is found positively related with inflation, while negative relationship is observed between real rate gap and inflation. The results suggest that a 1% increase in real interest rate gap results in a 0.86% decrease in inflation, while a 1% increase in output gap leads inflation to increase by 0.65%<sup>10</sup>

Further, the differenced terms in Table 2 captures the short run impacts of independent variables upon inflation. Rather than discussing the

<sup>10</sup> We also estimated an “Error correction model” and found the “Error Correction” term significantly equal to -0.1865. The coefficient of this term suggests that if disequilibrium emerges, a correction of 18% is required in each short-run period to acquire long-run equilibrium.

individual short run coefficients we apply joint coefficient restriction test to examine whether real rate gap and output gap cause inflation in short run or not. Extractions of the Wald test are given in following Table 4.

TABLE 4  
Bound Test of Co-integration Wald Test  
(Joint test upon the short-term coefficients)

Variable	Test Statistic	Value	df	Probability
Interest Rate Gap	F-statistic	1.518557	(4, 158)	0.1993
	Chi-square	6.073787	4	0.1937
Output Gap	F-statistic	3.219592	(3, 158)	0.0244
	Chi-square	9.618778	4	0.0217

The results indicate that we can reject the “null hypothesis” of no Granger Causality between output gap and inflation in short run but cannot reject this null hypothesis for association between real rate gap and inflation. Therefore, we can conclude that output gap Granger causes inflation in the short run but same is not true for short run causality between inflation and real interest rate gap. Our results are coherent with the economic theory and empirics which identify long and variable lags in transmission of monetary policy<sup>11</sup>. As real interest rate gap has been used to capture the effect of monetary policy (stance) upon inflation in our model; its long run significance and short run insignificance is making it evident that the impact of monetary policy operationalizes on inflation with some lag of time in Pakistan. From cost perspective, real interest rate often serves as real cost of borrowing to finance many investment and production processes. As the proceeds of these processes often come in the market with a delay and lag of time, therefore, it is logical to visualize the impact of variations in real interest rate in medium or long run rather than short run. Theoretically, the demand-pull pressures are transmitted to inflation rather quickly, the significance of output gap indicator in short run in our model is in line with the theoretical proposition.

<sup>11</sup> See for reference: Friedman (1961); Teker, *et al.* (2012)



## VI. CONCLUSION

This study aspires to unfold association between inflation and two critical indicators: one from real side (output gap) and other from monetary side (interest rate gap) of the economy. These two gaps are considered as the key determinants of inflation in empirics and theory, and therefore are advocated to be analyzed in the literal world by the economists. As per our knowledge these two indicators have not been examined in terms of their explanatory power for inflation in Pakistan. Thus, this study contributes significantly in terms of filling up this research gap. Our intended idea is pursued firstly by approximating the two unknowns: “Potential output” and “Natural rate of interest” using unobserved component model and secondly employing the generated series of output gap and real rate gap as predictors of inflation in Pakistan. ARDL model has been applied to capture the long run and short run relationships. The results provide evidence for the presence of long run relationship between inflation, output gap and real rate gap. However, the short run relationship was well evident between inflation and output gap while there was no significant existence of this short run relationship in case of real interest rate gap.

Our study theme clearly provokes the need of having a profound knowledge about the concept and appropriate appraisal of the suggested indicators of inflation. Especially, the results regarding the efficacy of real rate gap in terms of inflation provides us a margin to quote a policy recommendation; Policy makers can use the concept of “Natural rate of interest” as a yard stick to guide and stabilize inflation. State bank of Pakistan can target inflation by targeting this gap which does indeed require frequent calculation of this natural rate as a benchmark for setting up the interest rate. The absolute increase or decrease in interest rate does not allow you to judge whether the adopted policy is pro-cyclical or countercyclical. The relative comparison or differential from the benchmark value (information on real rate gap) can be helpful to track counter-cyclicality and pro-cyclicality in proper manner.

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## APPENDIX

TABLE A-1

Kalman Filter Estimates, Output Gap  
State space: Unobserved Component Model  
Method: Maximum likelihood (Marquardt)

	Final State	Root MSE	Z-Statistic	Prob.
Trend (Potential Output)	1458.714	0.823290	1771.811	0.0000
Cycle (Output gap)	3.672752	0.923850	3.975486	0.0001
Log likelihood	-283.1816	Akaike info criterion		3.229337

Parameters	1	Schwarz criterion	3.247351
Diffuse priors	3	Hannan-Quinn criter	3.236643

TABLE A-2

Kalman Filter Estimates, Interest Rate Gap

State space: Unobserved Component Model

Method: Maximum likelihood (Marquardt)

	Final State	Root MSE	Z-Statistic	Prob.
Trend (Natural Rate of Interest)	6.464180	0.584495	11.05492	0.0000
Cycle (Real interest rate gap)	-0.377065	1.953890	-0.192982	0.8470
Log likelihood	-434.4796	Akaike info criterion		4.937268
Parameters	0	Schwarz criterion		4.937728
Diffuse priors	3	Hannan-Quinn criter.		4.937628