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Model Specification and Inflation Forecast Uncertainty in the Case of Pakistan

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ABSTRACT

Making a better estimate of Inflation can enable us to make a better guesstimate about its economic repercussions. In modern monetary economics, the standard Phillips Curve model (PCM), the New Keynesian Phillips curve model (NPCM), and the incomplete competition model (ICM) are the alternative econometric models specified to forecast Inflation. The present study intends to identify the appropriate inflation model based on its forecasting performance with its different specifications for Pakistan's Economy. PCM includes the output gap and unemployment rate, NPCM has forward-looking expectations and uses labor income share instead of the output gap, and ICM identifies the importance of incomplete information on labor and product markets and uses some error correction term (ECT) to forecast Inflation. The relevant ECT has overcome the omitted variable bias. ICM is better in visualization forecasting and has lower root mean square error and mean absolute percentage error than other inflation models. In conclusion, the wage-price dynamics model (ICM) offers the best prospect of a successful inflation forecast in the case of Pakistan.

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1. Introduction

Economists often debate the correlation between inflation and uncertainty over inflation. Friedman (1977) initially discussed inflation and uncertainty in inflation forecasts. Inflation is widely disliked by the public due to its welfare cost and indirect impact on uncertainty, which reduces overall wellbeing. Since 1970, controlling Inflation has been a significant phenomenon for policymakers. This is because of persistent inflation's high and adverse effects, which are essential to control. For a developing country like Pakistan, uncontrolled Inflation is even more detrimental because of the high proportion of the population that falls in the lower and middle-income groups. The Phillips curve shows the inverse relationship between Inflation and unemployment. Phillips (1958a) showed that wages have an inverse relationship with unemployment. There is a negative correlation between inflation and unemployment (Samuelson & Solow, 1960). According to Friedman (1977), the trade-off between inflation and unemployment is only relevant in the short run. However, in the long run, the vertical aggregate supply curve means that inflationary measures will have no effect on the unemployment rate. Expected Inflation was a new variable that Phillips developed to help close this gap.

Regarding monetary policy, the essential instrument for controlling unemployment and boosting economic growth in a country is the ability to keep inflation under control. According to several economists, an increase in Inflation leads to an increase in inflation uncertainty, ultimately leading to an increase in unemployment. Because an increase in the unemployment rate leads to a drop in economic growth, there is a relationship between unemployment and growth that is inversely proportional. Inflation uncertainty is crucial in determining the present inflation level, which forecasting determines. Therefore, improved forecasting plays a significant role in the management of Inflation. When policymakers can do accurate forecasting, they can better manage the uncertainty associated with Inflation and maintain control over the level of Inflation. This, in turn, allows them to address the issue of unemployment and boost the growth of the Economy. Batini and Haldane (1999) Multiple theoretical studies have sought to elucidate the relationship between inflation uncertainty and inflation rate. Specific and restricted types of uncertainty have been discussed thus far. For example, when the exact details of the inflation process are identified, but the parameters are unknown and require estimation, it represents a particular and limited type of uncertainty. On the other hand, uncertainty is highly pervasive since policymakers are confronted with various models, each of which asserts that it accurately represents the model of the Economy. Consequently, there is a significant connection between policy analysis and forecasting. The conditional prediction serves as an operational aim since it is based on the statistical principle that the predictions are determined as conditional unbiased. This means that no other predictor, based on the same information, has a root mean square error (RMSE) and a mean absolute percentage error (MAPE).

When it comes to inflation targeting, two indicators are essential. First, the Inflation process should be recorded with the highest possible precision. In the second place, the forecast should consider the possibility of structural shifts. Regarding the first point, policymakers are confronted with some economic statements that are complementary to one another and sometimes compete with one another in the Inflation process. According to C. W. Granger (1999); C. W. J. Granger (1990), usually, the selection procedure place was not only the econometric tests but also the conviction that it plays an important role. However, the inflation growth rates are not only of other growth rates but also by the amount of the combination of cointegration variables. The literature review is missing. A debate on the similarities, dissimilarities, advantages, and disadvantages of already existing models must be given here. Then, identify the research gap that the current study would fill.

This study looks at inflation models that are made by specifying prices and wages. We used three different types of Phillips curve models: the standard Phillips curve, the new Phillips curve, and the imperfect competition models. The standard Phillips curve model, denoted by PCM, incorporates an error correction mechanism and a differenced vector autoregressive dVAR method, which considers the output gap and unemployment rate. The New Philips Curve model (NPCM) emphasizes forward-looking expectations in the study of Inflation and suggests that using real labor costs instead of the output gap is more suitable (Galı & Gertler, 1999). The contemporary theory of wage and price structuring is based on the In-complete Competition Model (ICM) and the pay curve model, which incorporates the ECM error correction mechanism. The ICM model addresses incomplete competition and information in price and labor markets. This study's results on the Phillips Curve, New Keynesian Phillips Curve, and Incomplete Competition Model will assist monetarists, policymakers, investors, and enterprise owners in predicting Inflation and selecting suitable specifications. The rest of the paper proceeds: Methodology is discussed in Section 2. The results of PCM, NPCM, and ICM and which model has good forecasting are discussed in Section 3. Section 4 discussed forecasting and the plan for forecasting. In the end, Section 5 concludes the article, and some policy implications are also discussed.

2. Literature Review

The literature is reviewed from national and international studies. For inflation forecasting, many studies have used different variables and methodologies. These studies analyzed Inflation based on the Univariate models from the family of Autoregressive Moving Average (ARMA) and family, Auto-Regressive Conditional Heteroskedasticity (ARCH) and family, Ordinary Least Square (OLS), Vector Autoregressive (VAR), Generalized method of movements and one study used P-star methodology. In addition to that, the research that were examined included the most well-known Philips curve model for forecasting inflation. Consumer price index (CPI) was utilized in most investigations. The wholesale pricing index (WPI) and one or more other macro variables were utilized in certain research. In his Nobel lecture, Friedman (1977) initially discussed the adverse effects of inflation uncertainty and Inflation on economic growth.

Further, Friedman said that an increase in the inflation rate will lead to inconsistent price stabilizing responses by the monetary authority, leading to future inflation uncertainty. His idea was that this increase in uncertainty would complicate the stabilization of the relative policy that interferes with the efficient and accurate allocation of economic resources. Later, L. Ball (1992) confirmed that Inflation raises instability about future Inflation. Genuine and expected inflation is low, which is the agreement that the monetary authority will attempt to keep them low. The essential thought behind this situation is fundamental: high Inflation creates vulnerability in the Economy regarding future monetary policy. Okun contended that if the Fed acknowledges high Inflation to suit a shock, the public feels trepidation that Inflation will rise again if there is another shock. Fountas (2001) examined Inflation and inflation uncertainty for the US the results of the GARCH methodology confirmed that positive bi-directional relationship between Inflation and Inflation uncertainty Nas and Perry (2000) in the case of Turkey, Kontonikas (2004) and Fountas (2001) in case of UK, Fountas (2001) for European countries which include France, Germany, Italy, Spain and Netherland, Thornton (2006) in case of India, Fountas (2001) and Daal et al (2005) for G7 region, Ajevskis (2007) in case of Latvia, Rizvi et al (2009) in cases of Pakistan.

Berument and Dincer (2005) used the Full Information Maximum Likelihood Method (FIML) methodology to investigate inflation and inflation uncertainty in the G7 countries. Their findings were published in 2005. Inflation uncertainty for G7 countries was significantly proven by the results, which supported Friedman's claim that inflation produced inflation uncertainty. According to Chan, Fung, and Chien (2013) the typical variations that solely use stochastic volatility produce inferior outcomes in terms of sample fitness and out-of-sample forecast performance when compared to the moving average stochastic volatility models that are used for US inflation. Salam et al. (2006) used the Autoregressive Integrated Moving Average (ARIMA) methodology to investigate inflation forecasting in developing nations. The results confirmed a positive association between Inflation and inflation uncertainty moreover Caporale, Onorante, and Paesani (2012); Hwang (2001); Payne (2008) also discussed inflation and inflation uncertainty for the Euro area and Caribbean region, Karahan (2012) for Turkish. Korobilis (2017) investigated the efficacy of Bayesian model averaging (BMA) techniques in predicting Inflation in the United States. The findings substantiate that the predictive densities of quantile regression BMA (QR-BMA) outperform and exhibit better calibration than those of BMA in the conventional regression model. As an additional point of interest, Asghar et al. (2011) utilized the EGARCH methodology in order to evaluate the link between inflation and uncertainty for SAARC organizations. On the other hand, Buth, Kakinaka, and Miyamoto (2015) for Cambodia, Lao People's Democratic Republic, and Vietnam, Arabi (2014) for Sudan, and Nazar, Ambreen, and Sabtain (2020) for Pakistan. Czudaj (2011) investigated inflation and inflation estimates for the euro region using a P-star as a reference point. For the purpose of achieving short-term inflation estimates, the result of the P-star is effective. L. M. Ball and Mazumder (2011) employed the Generalized Method of Moments (GMM) technique to assess the empirical validity of the New Keynesian Phillips Curve Model (NKPC). This study calculates the model for each survey's inflation prediction using the labor income share and manufacturing's marginal cost as proxies for marginal cost. The labor income share was utilized as a proxy for the real marginal cost in that approach. This study analyzed the New Keynesian Phillips Curve Model (NKPC), various inflation projection surveys, and a pro-cyclical marginal cost variable. The inflation forecast survey indicated that the NKPC had a statistically significant negative impact on pro-cyclical marginal cost. Rumler and Valderrama (2010) performed a study that compared the New Keynesian Phillips Curve with various time series models in Australia. The New Keynesian Phillips curve model exhibited the lowest root-mean-squared error (RMSE) across all other models in the study. Bauer and Neuenkirch (2017) revised a Taylor rule in a New Keynesian model to incorporate uncertainty in Inflation and GDP growth forecasts.

Baciu (2015) examined Romania's Inflation and inflation forecast and suggested that the ARCH model provides the best predictions. Moser, Rumler, and Scharler (2007) discussed forecasting Inflation and inflation uncertainty for the Austrian Economy. The results suggested that the VAR and Factor model had the best inflation forecasting. Duarte and Rua (2007) forecast Inflation through a bottom-up approach, and the results indicated an opposite relationship exists between inflation forecast and information used. Several studies about inflation and inflation forecast uncertainty were reviewed, and most studies used one of the traditional methods to estimate inflation and inflation forecasts. The Philips curve and In-complete Competition models will apply for Pakistan relevant to wage and price specifications.

3. Methodology

This section discusses the main differences between the alternative's inflation model specifications.

3.1. Standard Phillips Curve

According to price and wage macroeconomic models, which determine the natural rate of price and wage equations. The price equation, equivalent to the relationship of the demand and supply wage equation, shows the linkage between the supply of wages and employment. The equation of the Standard Phillips Curve Model (PCM) according to Aukrust (1977); Blanchard and Katz (1996); Nymoen (1991) is expressed below:

$$\Delta inflation_t = \eta_1 \Delta wages_t + \eta_2 outputgap_t + \eta_3 \Delta importprices_t + \mu_t \quad (1$$
$$\Delta wages_t = \gamma_1 \Delta inflation_t + \gamma_2 unemployment_t + \mu_t \quad (2$$

According to the Galı and Gertler (1999) argued that wages cause Inflation, the output gap, and import prices. The CPI is used as the proxy of Inflation and the output gap is measured by the quadratic trend method and import prices (which make the model for open Economy) which is also given mentioned in equation 1. Meanwhile, in the 2nd equation, wages depend on inflation and unemployment.

3.2. New Phillips Curve Model

The New Phillips Curve Model (NPCM) by Galı and Gertler (1999) is given as

$$\Delta infaltion_t = \delta_1 \Delta inflation^e_{t+1} + \delta_2 wagesahre_t + \delta_3 \Delta importprices_t + \mu_t \quad (3$$

According to Equation 3, the expected value of inflation, wage share, and import prices all have an effect on inflation. As unemployment falls closer to its natural rate and inflation is determined by money growth, the Philips curve shows that there is no long-term association between the two variables, while there is a short-term correlation. To bridge the gap, we are utilizing inflation expectations expressed in terms of reasonableness. The expectation term $\Delta p^e{}_{t+1}$ is supposed to obey rational expectations[1], and we used the lag of Inflation CPI for the expected Inflation. Wage share is used instead of the output gap (Galı & Gertler, 1999).

3.3. Incomplete Competition Model

The Incomplete Competition Model (ICM) (Bårdsen, Jansen, & Nymoen, 2002; Kolsrud & Nymoen, 1998a; Sargan, 1964) currently looks like an equilibrium error correction model, which;

$$\Delta wages = \lambda_1 \Delta inflation_t + \lambda_2 (wageshare - \lambda_3 unemployment)_{t-1} + \mu_t \quad (4$$
$$\Delta inflation_t = \pi_1 \Delta wages_t + \pi_2 (importprices + \pi_3 wageshare)_{t-1} + \pi_4 outputgap_{t-1} + \mu_t \quad (5$$

In equation 4, wages depend upon the inflation level and real wage share, and according to equation 5, inflation depends on wages and the ECM, which is the combination of import prices, wage share, and output gap. The distinction among Philips curve models is in the fact that NPCM incorporates forward-looking expectations, labor unit cost, or wage share, rather than the traditional output gap. The incomplete competition model (ICM) handles the expectations through the error correction mechanism, so that is the main difference between ICM and NPCM, while PCM has an exclusion in error correction mechanism, which is derived from the models of Kolsrud and Nymoen (1998b); Rowthorn (1988); Sargan (1964). How can the ICM be modified as an error correction mechanism. The PCM assumes a static unemployment rate to demonstrate this. Therefore, in order for the PCM to maintain internal coherence, it must be supplemented with an equation that links with μ_t, such as the wage share WS_{t-1}. To get the explicit ECM for the wage equation, plug the μ_t equation into the wage Phillips curves. The

[1] With perfect foresight, and |δ1| > 1, there exist a unique backward solution, see e.g., Gourieroux and Monfort (1997, Chapter 12.4).

fundamental distinction between PCM and ICM is not cointegration per se but rather the causal links that support it.

3.4. Wage share

According to Galı and Gertler (1999), including the real unit labor cost instead of the output gap. It is calculated by minimizing the effect of Inflation and the average labor productivity from the wages and getting the real unit labor cost instead of the output gap. The formula is given below.

$$ws = w - p - pr \qquad (6$$

In equation 6, "w" is wages, "p" is a consumer price index, and "pr" is the average productivity of labor. At the same time, the average labor productivity is measured by the ratio of gross domestic product and employed labor force.

$$Average\ Productivity\ of\ Labor = \frac{Gross\ Domestic\ Product}{Employment\ Labor\ Force}$$

3.4.1. Labour Income Share

Galı and Gertler (1999)Describe the labor income share. They contended that the ratio of the marginal product of labor to the real wage W is the real marginal cost (MC).

$$MC = \frac{w}{\partial y/\partial l}$$

We start with the Cobb-Douglas production function for the formal derivation of labor income share.

$$Y = AK^{\alpha}L^{1-\alpha}$$

In the above equation, K is capital, and L is labor input. Then, we get the equation for marginal cost MC as follows.

$$MC = \frac{W_t/P_t}{\partial Y_t/\partial N_t}$$

In the above MC equation, the ratio between the wage rate and the marginal product of labor is called the marginal cost.

4. Results and Discussion

4.1. Incomplete Competition Model

Bardsen et al. (1998) argue that the first step is to estimate the model with its steady-state condition.

$$\begin{array}{l} w = 0.98P + 0.39pr - 0.12u - 1.33 \\ \quad (29.7) \quad (2.97) \quad (-4.70) \qquad (7 \\ P_t = 0.25(w - pr + t_1) + 0.13pb + 0.18t_3 - 0.03 \qquad (8 \\ \quad (9.12) \qquad\qquad (3.29) \quad (3.50) \end{array}$$

First, we estimate this steady-state model for the ECM terms and then move to ICM model specifications[2]. So, the model is based on two equations: one is the wage equation, and the second one is the price equation. In the parenthesis, a t-stats value is given; according to it, all variables have significant effects. According to equation 7, wages are based on Inflation, the average labor productivity, and the unemployment rate. Wages are estimated by Galı and Gertler (1999). When estimating the wage system, we apply the assumed steady-state condition to a sub-system that includes additional lags of average productivity, unemployment rate, direct taxes, and indirect taxes for wage and Inflation—incorporated production gap and working hours of labor to account for short-term impacts. Here is the resulting model.

[2] According to Bardsen et al. (1998).

Table 1: Wage Equation for Incomplete Competition Model

Variable	Coefficient
Δp	1.039***
	(4.80)
Δpb_{t-2}	-0.126
	(-1.17)
$\Delta t1_{t-2}$	-0.128*
	(-1.78)
Δh	-0.914**
	(-2.10)
ECM	-0.009**
	(-1.73)
Heteroscedasticity F(1,22)	0.567 [0.459]
Normality test: Chi^2(2)	2.613 [0.270]
over-identifying restrictions	[0.000] **

Dependent variable: Δw

The t-value is provided in parenthesis, with ***, **, and * denoting significance levels of 1%, 5%, and 10%, respectively. Table 2 indicates that Inflation, the price of imports, and taxes influence wage growth. This model encompasses both short-term and long-term impacts of factors influencing wage increase. Each variable has a statistically significant impact on pay growth. The results of Table 2 indicate that inflation growth has a positive and significant effect on wage growth in the short run. If Inflation goes up, then there will be an increase in wage growth. According to "wage push inflation," if there is an increase in the price level of goods, purchasing power decreases, and workers ultimately require an increase in wages to compensate for the cost of living. Wage growth is negatively and significantly affected by taxes. A 1% increase in tax rate decreases wage growth by 12%. Taxes influence labor activity directly through the channels of supply and demand for labor and indirectly through the responses of government spending to the tax revenues available. The higher tax rate on labor income and consumption expenditures means less work in the legal area market, more time in the household, a large underground economy, and a share of lower domestic production and employment in industries that heavily rely on labor in low-wage and low- Cost leave (Davis & Henrekson, 2005). Finally, the error correction[3] term has significant negative sign effects on the wage growth rate, as expected from theory. The coefficient of the ECM term is the speed of adjustment, which tells about the speed of convergence of the model to its equilibrium stage, which is almost 1%, showing that the model will converge to its equilibrium at 1% annually. At the end of Table 2, the diagnostics show no heteroscedasticity; residuals are typically distributed and fulfill the over-identified restriction's condition.

Table 2: Price Equation for Incomplete Competition Model

Variable	Coefficient
$\Delta w_t + \Delta t1_{t-1}$	0.214***
	(4.90)
gap_{t-1}	-0.252
	(-0.873)
Δpb_{t-2}	-0.002
	(-0.032)
$\Delta t3_{t-2}$	0.037
	(0.687)
ECM	-0.421***
	(-2.75)
Heteroscedasticity F(1,22)	6.536 [0.018] *
Normality test: Chi^2(2)	4.420 [0.109]
over-identifying restrictions	[0.000] **

Dependent variable: Δp Note: In parenthesis, t value I is given while ***, **, and * show 1%, 5%, and 10% significance levels, respectively.

[3] Error correction term consists of $w_{t-1} - 0.98p_{t-1} - 0.39pr_{t-1} + 0.12u_{t-1}$ which is derived from equation 1 according to Bardsen et al. (1998).

The findings in Table 3 indicate that real wage growth and the output gap significantly impact the inflation rate, which is consistent with the theoretical model's predictions. There is a positive relationship between real wage and inflation growth, which indicates that a change of one percent in wage has a twenty-one percent impact on Inflation. Although much evidence suggests that an increase in the wage level generates Inflation, wages also tend to increase, which tends to cause a combination of demand-pull and cost-push Inflation. According to the theory of demand-pull Inflation, as the Economy progresses along Phillip's curve, aggregate demand of the Economy rises to the point where it surpasses aggregate supply. This causes Inflation to grow along with gross domestic product and decreases the unemployment rate. It is described here that an excessive amount of money was spent on a small number of commodities, which led to a rise in demand for those goods, generating Inflation (Barth & Bennett, 1975). On the other hand, according to the cost-push inflation theory, an increase in the costs of the factor of production results in a drop in the supply of those commodities, but the demand for those goods remains the same. There is a general upward trend in the prices of commodities, which results in an extension of the price level. The second and most crucial significant factor is the ECM[4] of inflation growth. The coefficient of ECM is -0.42. It has a negative sign, which shows the model moves toward convergence with a speed of 42%. This also shows that cointegration exists between inflation and its determinants. So, the overall conclusion of this model is that a relationship exists between inflation, inflation uncertainty, and unemployment. It also holds Phillip's curve hypothesis that a trade-off relationship exists between inflation and unemployment level and holds the hypothesis of Friedman, which is that there is a positive relationship between inflation and inflation uncertainty. At the end of Table 3, the diagnostics, there is no Heteroscedasticity; residuals are typically distributed and fulfill the over-identified restriction's condition.

4.2. Standard Philips Curve

According to price and wage macroeconomic models, PCM determines the natural rate of price and wage equations. The price equation is equivalent to the relationship of demand and wage and, according to the wage equation, that links the supply of wages and employment. The wage equation depends on Inflation, import prices, direct and indirect taxes, unemployment rate, and working hours.

Table 3: Wage Equation for Standard Phillips Curve

Variable	Coefficient
Δp	0.990*** (3.88)
Δpb	0.081 (0.836)
$\Delta t1$	0.144** (2.07)
$\Delta t1_{t-1}$	0.073 (1.03)
$\Delta t1_{t-2}$	-0.243** (-2.31)
Δu	-0.052* (-1.90)
$\Delta t3$	-0.127 (-1.62)
$\Delta t3_{t-2}$	0.076 (1.29)
Δh	-0.527 (-1.19)
Heteroscedasticity F(1,22)	0.113 [0.740]
Normality test: Chi^2(2)	1.892 [0.388]
over-identifying restrictions	[0.000] **

Dependent variable: Δw The t-value is provided in parenthesis, with ***, **, and * denoting significance levels of 1%, 5%, and 10%, respectively.

[4] Inflation ECM is derived from equation 4.2, error correction term is equal to $p_{t-1} - 0.25(w_{t-1} - pr_{t-1} + t_{1,t-1}) - 0.13pb_{t-1} - 0.18t_{3,t-1}$, according to Bardsen et al. (1998).

While estimating the PCM model, we start with the same set of information used in the ICM model, but here, we use more lags in the dynamics. Table 4 shows a positive correlation between Inflation and wages, indicating that an increase in inflation growth results in a corresponding increase in pay growth, as noted by Asghar, Ahmad, Ullah, Zaman, and Rashid (2011); Barnett, Jawadi, and Ftiti (2020) as discussed in model 2. Taxes harm pay growth. An increase in tax levels results in a fall in wage levels, as indicated in Table 2. Unemployment significantly and negatively impacts wage growth. This demonstrates the trade-off relationship between pay growth and the amount of unemployment inflation. A decrease in the unemployment rate results in an increase in wage inflation. If the unemployment level decreases by 1%, it results in a 5% increase in the inflation level when there is low unemployment, indicating a situation where the demand for labor surpasses its supply. During a competitive labor market, companies may increase wages to attract workers, leading to wage inflation, as described by Phillips (1958a). The price equation depends on the wage rate, import prices, average labor productivity, and the number of lags of Inflation and explanatory variables. The result for the Standard Philips curve of the price equation is given in Table 4.

Table 4: Price equation for Standard Phillips curve

Variable	Coefficient
Δw	-0.574
	(-1.36)
Δw_{t-1}	0.496***
	(2.83)
Δp_{t-1}	0.829***
	(3.10)
Δpb	0.211*
	(1.91)
Δpr_{t-1}	0.331*
	(1.80)
$\Delta outputgap_{t-1}$	2.956***
	(2.41)
Heteroscedasticity F(1,22)	0.084 [0.774]
Normality test: Chi^2(2)	4.642 [0.098]
over-identifying restrictions	[0.000] **

Dependent variable: Δp

The t-value is provided in parenthesis, with ***, **, and * denoting significance levels of 1%, 5%, and 10%, respectively. According to the results, a positive relationship exists between wage growth and inflation, the economic phenomena discussed in Table 3. In the second variable, inflation uncertainty, a positive relationship exists between inflation and inflation uncertainty. This means that an increase in inflation uncertainty leads to an increase in inflation growth. If the uncertainty of inflation increases, the monetary authorities adopt opportunistic behavior to stimulate growth production by increasing the amount of money, thereby generating higher Inflation (Cukierman & Meltzer, 1986; Okun, 1971). Wage growth has significant and positive effects on inflation growth. An increase in wages leads to an increase in inflation level, which we already discussed in Table 3. Phillip's, which is discussed in Table 4, indicated that a decrease in the unemployment level leads to increasing demand for labor by its supply, and in a tight labor market, employers offer high wages to employees, which leads to an increase in Inflation. So, unemployment has a negative and positive relationship between wages and inflation levels.

Wage growth is negatively correlated with unemployment and positively correlated with inflation growth. This indicates a negative relationship between inflation growth and unemployment, as suggested by the Phillips curve hypothesis, which posits a trade-off between Inflation and the unemployment rate. An increase in the output gap positively affects inflation growth and uncertainty, resulting in higher Inflation with increased growth. An increase in growth of 1%, according to the output gap, results in inflation growth or inflation uncertainty rising by 2.95%. Dotsey and Sarte (2000) suggest that higher inflation uncertainty can lead to a boost in output growth. The conventional linear growth model incorporates the introduction of Cash in advance money. Research findings indicate that elevated inflation rates have a detrimental effect on output growth, while an escalation in inflation uncertainty has a beneficial influence on production growth due to precautionary saving behavior. They suggested that increased uncertainty about Inflation has led to worries about investment decisions, resulting in reduced demand for real money balances due to the need for additional resources to be invested. Increased resource investment leads to higher investment spending in the Economy, which is crucial in fostering growth and favorably impacting output growth. Higher output results in higher inflation rates, raising inflation uncertainty (Phillips, 1958a). An increase in import prices has a substantial and favorable impact on inflation growth, indicating that a rise in import prices leads to a rise in inflation levels. A 1% rise in import prices results in a 21% increase in inflation growth. Various transmission pathways, such as oil prices, might impact economic activity and Inflation. For instance, fluctuations in crude oil prices impact the prices of petroleum products, resulting in higher energy bills for consumers. This also increases unit costs during production, ultimately contributing to higher inflation rates (Lescaroux & Mignon, 2008; Malik, 2016). A rise in average productivity has a notable and beneficial effect on inflation growth, resulting in higher wage levels due to the correlation between increased productivity, higher wages, and inflation levels, as outlined in Table 4. The results align with the Phillips curve hypothesis, indicating a trade-off between Inflation and unemployment levels under the PCM model. Okun (1971) proposed a causal link between Inflation and uncertainty in inflation forecasts.

4.3. New Keynesian Phillips Curve

According to the new Keynesian Philips curve (NKPC), unemployment maintains monetary expansion (where there is an output gap) and is a cause of inflation in full employment. Galı and Gertler (1999) Modified the Phillips curve to the Hybrid Phillips curve for the US. Their new model suggested real unit labor cost instead of output gap because labor cost is more relevant to measuring expected Inflation. While estimating the New Keynesian Phillips curve model, we followed Galı and Gertler (1999) with an increase in the specification with the growth rate of import prices.

Table 5: New Keynesian Philips curve

Variable	Coefficient
Δp_{t+1}	0.584054***
	(7.845213)
Δws	0.077781*
	(1.726429)
Δpb	-0.071149*
	(-1.702177)
R-squared	0.307138
Durbin-Watson stat	2.249501
Adjusted R^2	0.232903
J-statistic	0.735949

Dependent variable: Δp

The t-value is provided in parenthesis, with ***, **, and * denoting significance levels of 1%, 5%, and 10%, respectively. We used a lag of Inflation for expected Inflation. Because we do not have future inflation value, we took the lag of Inflation for expected Inflation according to (the Bank of England, 1999)[5]. Expected Inflation has a positive impact on Inflation, and if there is a 1% change in expectations of inflation uncertainty, Inflation will rise by 58%. We used labor income wage share instead of the output gap because it is an applicable measure for Inflation (Galı & Gertler, 1999)[6]. According to the Phillips curve, there is a trade-off relationship between Inflation and unemployment. This indicates that if there is a 1% shift in wage share, it will increase the level of Inflation. In the meantime, wage share has a positive effect on Inflation, which means it will increase Inflation. According to wage share, if wages move to increase, it will reduce the unemployment level, so people's purchasing power increases. The demand for that commodity increased compared to supply, leading to an increase in price, which caused Inflation. Import prices also have a significant and negative impact on inflation growth, which

[5] Bank of England (1999)][5] investigated the empirical evidence on forward looking Phillips curve and they take the lag of inflation as a proxy of expected future inflation.

[6] Gali and Getler (1999) recommended that marginal cost rather than output gap is applicable measure of inflation. And according to that marginal cost and expected inflation are the main determinants of inflation.

shows that if there is an increase of 1% in import prices, then Inflation decreases by 7%. Finally, a positive and significant relationship exists between Inflation and inflation uncertainty (Okun, 1971). It shows trade-off results between inflation and unemployment (Phillips, 1958b). At the end of Table 6, the diagnostics, R-square, and Adjusted R-square show the goodness of fit index of the model, and both values are good. Durbin Watson's value is more significant than 1.65, indicating no serially correlated problem between independent and dependent variables. Finally, the J-stats values showed that the instruments used to estimate the model are valid.

5. Forecasting

Forecasting is the technique for making statements about future events. Econometric forecasts allow researchers to evaluate historical data trends and predict how the current economic changes will change. To estimate the performance of the above models, we will compare the forecasting accuracy of the above-estimated models.

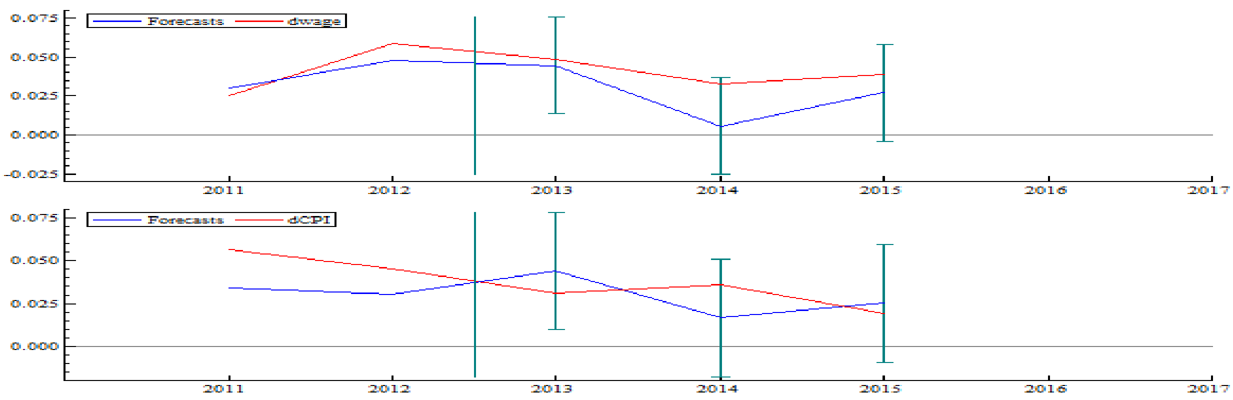
5.1. Tools for Forecasting

We used one step ahead of the forecasting approach because it utilizes all available information. We divide data into 1981 - 2012 and 2012 - 2018. Firstly, ICM and PCM models were estimated from 1982 – 2012 and forecasted for 2013. Then, we estimate the model from 1981 to 2013 and forecast for 2014. After that, we estimate the model from 1981 to 2014 and compute a forecast for 2015, which will continue till 2018. The PCM and ICM models are superior to the NPCM model because, in the Inflation process, the NPCM model is too established and particular to represent the inflationary process. In addition, the PCM and ICM models use simultaneous equations to represent wage and price calculations. The estimation that FIML carried out indicates that these models had utilized the (rational) expectations explanation concerning the current wage and price increases in the past. However, incorporating predictions for periods t+1 and t+2 of the same variables into the models should be cautiously approached because the identification problem arises (Blake, 1991; Moghadam & Wren-Lewis, 1990). Similarly, the variables now being used, specifically $\Delta wage$ and $\Delta Inflation$, in the equation representing consumer prices can predict $\Delta wage_{t+1}$ and $\Delta inflation_{t+1}$. as independent variables. The process of predicting is relatively straightforward, as evidenced by the equation. $\Delta\Delta w_{t+1}^{e} = 0$. This indicates that agents typically rely on rules of thumb when confronted with complicated uncertainty, as stated by Shleifer in 2000. Elementary uncertainty is a compelling characteristic in economic time series data because the unit root and deterministic changes impact it. This makes elementary uncertainty a persuasive feature. According to Eitrheim, Jansen, and Nymoen (2002), the comparison of forecasting rules reveals that the resilient instrument of forecasting is $\Delta\Delta w_{t+1}^{e} = 0$. This is because it makes it possible to remedy the sound effects of deterministic changes while still maintaining accuracy.

5.2. Incomplete Competition Model

We used a recursive forecasting approach to forecast the model for ICM. The specification for ICM is discussed above. Here, we forecast the ICM model of the above specification by a recursive forecasting approach.

Figure 1: Incomplete Competition Model

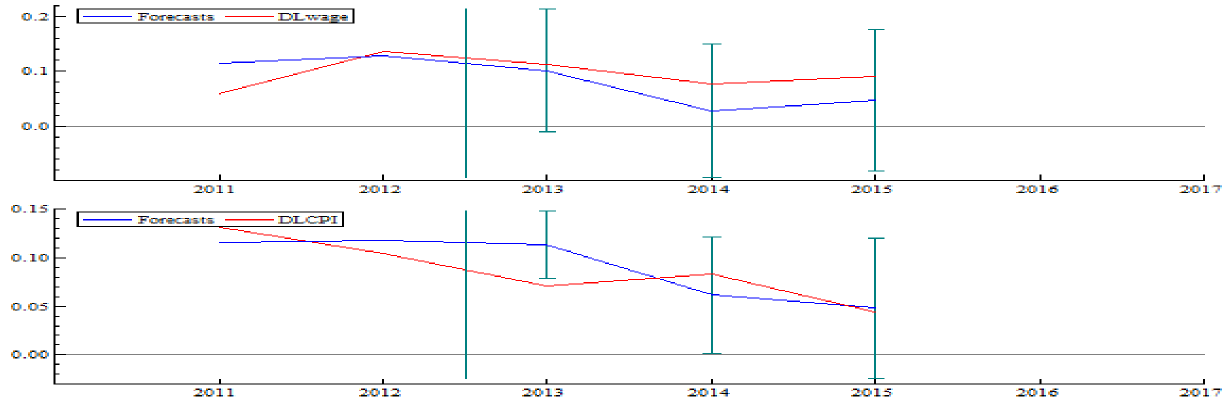


In Figure 1, the upper portion above represents forecasting according to the wage equation of the incomplete competition model. Using the time spam of the forecasting period on the X-axis, we estimate the model till 2012 and the remaining years for forecast, and on Y-axis, we have standard Errors. The blue line shows the forecasting series, and the red line represents the actual series. The graph shows we have excellent forecasting because the forecasted line is between the ± 2SE [7]. In the forecasting period 2013 to 2015, both lines move together between the +2SE and -2SE. So, from the above diagram, the result of forecasting is excellent. While the lower portion of Figure 1 represents the forecasting for inflation series. According to the graph, there is good forecasting because both lines lie in between the ± 2 standard errors.

5.3. Phillips Curve Model

We used a recursive forecasting approach to forecast the model for PCM. The model specification of PCM is discussed above. Here, we forecast the ICM model of the above specification by a recursive forecasting approach.

Figure 2: PCM



In Figure 2, the upper portion above represents forecasting according to the wage equation of the Standard Phillips curve model. On the X-axis, use the time spam of the forecasting period; we estimate the model till 2012 and the remaining years for forecast, and on the Y-axis, we have standard Errors. The blue line shows the forecasting series, and the red line represents the actual series. In the forecasting period, 2013 2015, both lines move together between the ± 2SE. So, from the above diagram, the result of forecasting is outstanding. While the lower portion of Figure 2 represents the forecasting for inflation series. According to the graph, we do not have a good forecast. The forecasted line is between the ± 2SE because the 2013 forecasting line does not lie between SE and SE. After that, it lies between them.

5.4. Measuring Forecast Results

To assess the comparative effectiveness of the forecast. We will utilize Root Mean Square Error (RMSE) and mean absolute percentage error (MAPE). Table 7 provides the RMSE values for both the ICM and PCM models.

Table 6: Forecasting result

Models	RMSE	MAPE
ICM	0.013990	41.681
PCM	0.037897	52.932

Table 6 shows that ICM has the lowest RMSE and MAPE dynamic forecasting. ICM visibly overtakes the forecasting. ICM model has the minimum RMSE and MAPE value as compared to PCM

6. Conclusion

The process of forecasting and the examination of policy are closely related. At the same time, econometric models are also considered to be of great significance in the areas of forecasting and policy analysis. It is the primary goal of those who make decisions regarding monetary policy to develop a "conditional forecast of the central bank," which is one to two years in the future. In order to successfully do these tasks, decision-makers require a wide

[7] Standard errors of forecasting.

variety of models. Furthermore, the presence of non-stationarity in the data makes it impossible to avoid making inevitable conciliations between the benefits and the significance of the appropriate structural modeling and the costs associated with the robustness of the forecasting performance. Within the scope of our investigation, we investigated the most influential parameters for predicting Inflation.

For this reason, we utilized various classes of inflation models in Pakistan. These models include the Standard Phillips Curve (PCM), the New Keynesian Phillips curve (NPCM), and the Incomplete Competition Model (ICM). Additionally, we utilized annual time series data spanning from 1980 to 2018. With that in mind, we have investigated the significance of this component of inflation estimates. We considered the most significant models of Inflation, which are the Phillips curve and the wage curve, respectively, along with their respective parameters. As far as this is concerned, the PCM takes into account both the output gap and the unemployment rate; the NPCM takes into account expectations for the future and employs the labor income share rather than the output gap, according to Galı and Gertler (1999); and the ICM recognizes the significance of imperfect information both the labor and product markets. On the other hand, in imperfect competition, ICM and ECM are used to forecast Inflation. The applicable ECM eliminates a bias caused by the omitted variable. We compare the forecasting performance of each inflation model with its various specifications and pick the one that works best. The mean absolute percentage error (MAPE) and root mean square error (RMSE) were the criteria employed. Among the available methods, ICM yields the best results in terms of RMSE and MAPE. Finally, the best chance for an accurate inflation prediction is provided by the wage-price dynamics model (ICM).

6.1. Policy Recommendations

The uncertainty of the future allows the researchers to depict and forecast it to reduce its risk. In the same way, for policymaking, forecasting inflation is an important goal to control. In the case of Pakistan, we suggest that the In-complete Competition Model (ICM) enables us to handle incomplete information on the price and labor market. ICM is a well-specified model as it is better in visualization forecasting, root mean square error, and mean absolute percentage error (the lower root mean square and mean absolute percentage error, which specifies the model at its best level) than other inflation models. Meanwhile, for investors, the fundamental objective is to minimize the inflation uncertainty risk, and the primary motive of the firms' owners is to earn a profit, so their main objective is to measure the fundamental inflation uncertainty in the future. The study shows that the ICM model specification provides more accurate forecasts, improved visualization, and reduced root mean square and mean absolute percentage error for Pakistan. We suggest appointing an incomplete competition model to forecast the inflation uncertainty, as this model overcomes the drawbacks of the other two inflation models through the mechanism.

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