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Inflation Dynamics and New Keynesian Phillips Curve: A Reassessment for Pakistan

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Abstract

This study tests empirical consistency of the NKPC for its standard and hybrid versions over the period 1972 to 2012. Empirical findings of the standard NKPC show that both expected inflation and output gap play important role in explaining inflation behavior in Pakistan. As the standard NKPC does not generate inflation persistence, so, we tested the hybrid version of NKPC. The estimates of the hybrid NKPC reveal that although both the lagged period inflation and expected future inflation are statistically significant but the coefficient of lagged inflation is quantitatively larger than that of the expected inflation which means that the price setting behavior is dominantly backward looking in Pakistan. Furthermore, the output gap is found to be significantly and positively affecting inflation in the country. The findings of this study suggest that the NKPC can be used as a benchmark model for understanding the inflation behaviour in Pakistan.

Keywords: New Keynesian Phillips Curve, inflation, output gap.

1. Introduction

Short run inflation dynamics are usually analyzed by using the so-called Phillips curve which originated towards the end of 1950s when A. W. Phillips described a negative empirical relationship between nominal wage inflation and unemployment in the United Kingdom (Romer, 2006). Similar

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empirical link between price inflation and unemployment was also found by Samuelson and Solow (1960) for the United States which provided significant support to the Phillips curve phenomenon. Hence, during 1960s the Phillips curve got started to serve as a menu for the monetary policy makers, since it gave them the opportunity to choose between high inflation and low unemployment or low inflation and high unemployment (Hornstein, 2008).

Journey towards the modern Phillips curve began with the critique of Sargent and Lucas in 1970s. In their hypothesis of rational expectations, agents' behavior is based not on the past information only but on all available relevant information, including past and current information as well as expert predictions of the future. Individuals create their expectations in such a manner that they cannot be systematically wrong and their overall expectation is accurate. Technically speaking, this means that subjective expectations of agents are equal to the conditional expected value based on the relevant information (Benes, 2000).

The New Keynesian Phillips Curve (NKPC) was developed as a response to the New Classical critique that the Keynesian macroeconomics lacked micro-foundations. The NKPC provides theoretical microeconomic foundations that explain nominal price rigidities in the economy, which also makes the NKPC useful for the conduct of monetary policy. Theoretical foundations of the NKPC date back to Fischer (1977), Taylor (1980) and Calvo (1983). The NKPC is a widely used structural model of inflation dynamics which describes how nominal rigidities can lead to intuitive relationship between inflation and marginal cost or output gap. The reason that NKPC has drawn more attention of policy makers is that it can explain the situation of inflation persistence by emphasizing the role of inflation expectations. In the standard NKPC, current inflation depend mainly on future expectations of inflation and output gap. Gali and Gertler (1999) improved the NKPC by incorporating lagged inflation and named the resulting model as hybrid NKPC. The idea is to let inflation depend on a combination of expected future inflation and lagged inflation.

Inflation rate has been fluctuating between single and double digits since 1970 in Pakistan (see table 1). In the 1970s its average crossed the figure of double digits, in the 1980s the average fell to 7.2 percent and in 1990s it rose again to almost 10 percent. Nonetheless, during 2000s, inflation rate was relatively low in Pakistan but increased steadily during 2004-05 and 2010-11. Later in 2011-12, a slight fall in inflation rate is noted. On the whole, inflation has become a widely debated issue in the country (see table 1). Increase in the world oil prices, money supply, credit availability to private sector, wheat shortage and growth rate in commercial banking are the highlighted factors of rising trend of inflation in the country. With this background it seems vital to analyze the inflation dynamics in Pakistan using the NKPC framework.

Table 1
Trends in CPI and WPI Based Inflation (1970-71 to 2012-13)

Year	CPI	WPI	Year	CPI	WPI
1970-1974	12.76	13.25	2004-05	7.44	8.49
1975-1979	10.51	11.17	2005-06	9.06	8.70
1980-1984	8.43	9.59	2006-07	7.92	8.50
1985-1989	6.10	6.86	2007-08	7.60	8.20
1990-1994	10.54	11.57	2008-09	20.29	25.38
1995-1999	8.89	8.93	2009-10	13.65	7.20
2000-2001	4.41	4.08	2010-11	13.88	21.36
2001-2002	3.54	4.46	2011-12	11.92	10.4
2002-2003	3.29	3.10	2012-13	7.7	7.92
2003-2004	4.57	6.40			

Source: Pakistan Economic Survey (Various issues).
CPI: Consumer price index, WPI: Wholesale price index,
Note: All values are averaged over five years up to figures for 1999.

Since our aim is to capture inflation dynamics in Pakistan with a reasonably simple model, the closed economy specification of NKPC is a natural choice. In the present study, both the purely forward-looking Phillips curve and the hybrid Phillips curve (which is distinguished by the presence of the lagged inflation term) are applied to Pakistan's data by using the Ordinary Least Squares (OLS), the Two Stage Least Squares (2SLS) and the

Generalized Method of Moments (GMM). The estimation of a closed economy version of NKPC will help to identify the relative significance of determinants of inflation dynamics in the economy. The study will also enable us to find whether inflation is caused by real economic activity, forward looking or backward looking decisions of firms in Pakistan. This exercise will be productive for policy makers to properly understand the nature and role of expectations in determining inflation in the country.

Rest of the study is structured as follows: section 2 present a brief literature review on the empirical validity of NKPC; section 3 illustrate the theoretical framework that yields the NKPC along with data and econometric methodology used in the study; section 4 contain empirical results and discussion on the estimated models; and finally section 5 concludes the study with some policy recommendations.

2. Literature Review

Existing literature on the validity of NKPC has reported mixed evidence across the countries. For example, Gali and Gertler (1999), Leith and Malley (2003), Gali, Getler & Lopez-Salido (2005), Suzuki (2006), Dua and Gaur (2009), Krznar (2011) and Abbas(2012) provide empirical evidence in favor of the NKPC. Whereas, the studies by Linde (2005) and Rudd and Whelan (2005) show that inflationary process cannot be well explained by using the NKPC framework.

In Pakistan so far only two significant attempts have been made to analyze fluctuations in inflation using the NKPC. In this regard the first study is conducted by Satti, Haq, Malik & Saghir. (2007) aiming to investigate the inflation behavior in Pakistan over the time period 1976 to 2005. They use both the output gap and real marginal cost as a proxy of real economic activity and GDP deflator based measure of inflation. They estimate the inflation equation by using the GMM technique. For the standard NKPC, the study finds that the real economic activity and future expected inflation are significantly associated with inflation. The estimation of hybrid NKPC also

supports the results of its standard counterpart. However, the coefficient of inertial inflation bears correct sign but it is statistically insignificant in the hybrid NKPC. No doubt, this study seems to be a vital endeavor to implement the NKPC framework in Pakistan, however, it is beset with certain limitations that give rise to some doubts on the findings of the study. Firstly, the authors do not mention how they generate expected inflation. The expected inflation is either constructed or some proxy is used for it but despite the fact that it is one of the main variables in the NKPC no discussion regarding the construction of this variable has been incorporated in the study. Secondly, the structural adjustment program (SAP) of the International Monetary Fund (IMF) was initiated in Pakistan in 1987-88 under which different trade and financial reforms were introduced in the economy. Therefore, there is a chance that a structural change has taken place in the country .But the study does not incorporate this aspect of the economy. In the presence of any structural shift in the data, the GMM estimation technique may yield misleading results. Finally, unit root properties of the time series used in the study have not been checked. Stationarity is a key concept underlying the time series empirical analysis. Results of a regression analysis may be spurious in the presence of non-stationary time series.

In their study of a quarterly sample from 1970:1 to 2010:4, Saeed and Khalid (2012) estimate the standard and hybrid versions of NKPC by using the GMM technique. They use the output gap as proxy of marginal cost and output gap is calculated by de-trending the de-seasonalised GDP. The findings of standard NKPC indicate that the coefficient of expected inflation is highly significant and it is almost closer to 1 and the coefficient of output gap appears insignificant. They also estimate the hybrid NKPC to check the relative importance of backward and forward looking inflation behavior. Their results show that the output gap does not appear significant and interestingly the coefficient of lagged inflation is larger than the expected inflation which predicts that in Pakistan the adaptive expectation inflation behavior is dominant. The study suggests that both the expected and lagged inflation play an important role for explaining inflation behavior in Pakistan. However, this study is also plagued with the same problems discussed in the

case of Satti, Haq, Malik & Saghir (2007).

Thus, on one hand we find dearth of literature on this topic in the context of Pakistan while, on the other hand, existing studies suffer from econometric problems due to which their findings cannot be relied upon. Therefore, we find it productive to implement the NKPC model incorporating all the deficiencies of the previous studies in order to provide more reliable estimates for inflation dynamics inflation in Pakistan. Thus, the present study is an attempt in this direction.

3. Model and Specification

The Phillips curve derivation begins with the environment of monopolistically competitive firms that face some type of constraints on the frequency of price adjustment. Calvo (1983) provides a simple solution to this infrequent adjustment of prices where each firm is subjected to geometric distribution of price delays. Under this specification, there is a constant probability $(1-\theta)$ that a firm is able to reset its price in any time period t. Therefore, θ represents the probability that a firm will leave its price unchanged, i.e., the degree of nominal rigidity. When a firm is able to change the price of its differentiated product, it has to set it optimal in order to maximize expected profits. Thus, under such a price set the "loss function" will be as follow:

$$L(z_t) = \sum_{k=0}^{\infty} (\theta\beta)^K E_t (z_t - p^*_{t+k})^2 \qquad (1)$$

where β is the discount factor and its value ranges between zero and one i.e. $0 < \beta < 1$.[1] The losses are the discounted sum of the difference between the chosen price z_t and the optimal price p^*_{t+k}. This difference describes the loss in profits of the firm. Furthermore, the firm only considers the expected

[1] When $\beta < 1$ it implies that the firm places less weight on future losses than today's losses.

future loss that is why future losses are discounted at rate $(\theta\beta)^k$, not by β^k. The optimal choice for a firm is to set the price which is weighted average of all the expected future prices. To get this price we take the derivative of equation (1) w.r.t z_t and after applying first order condition and solving the model after linearizing around steady state we get the following equation[2]:

$$\pi_t = \beta \mathrm{E}_t \pi_{t+1} + \frac{(1-\theta)(1-\theta\beta)}{\theta}(\mu + mc_t - p_t) \qquad (2)^3$$

Expression (2) actually represent the standard NKPC where the current period inflation depend upon expected future inflation ($\mathrm{E}_t \pi_{t+1}$) and the gap between frictionless optimal price level ($\mu + mc_t$) and the current period price level P_t. It is also possible to restate this and say that the current period inflation is positively related with the real marginal cost $(mc_t - p_t)$. The above expression can be denoted as:

$$\widehat{mc}_t = \mu + mc_t - p_t \qquad (3)$$

The NKPC can be written as:

$$\pi_t = \beta \mathrm{E}_t \pi_{t+1} + \frac{(1-\theta)(1-\theta\beta)}{\theta} \hat{mc}_t \qquad (4)$$

The only problem with implementing the NKPC given in equation (4) empirically is the non-availability of data on the real marginal cost variable. It is very difficult to collect data on the cost of production of each additional unit of output. The national accounts data contain information about factors such as wages that affect the average costs but it does not provide information related to marginal costs. For these reasons many researchers use

[2] For detailed derivation and discussion see Rudd and Whelan (2005).
[3] In equation (2) μ is a markup parameter that depends on consumer preferences.

the output gap which is the deviation of actual output from its potential level as a proxy of real marginal cost in the NKPC.[4] In other words, they assume the following relationship between marginal cost and output gap.

$$\widehat{mc}_t = \rho Y_t \tag{5}$$

Substituting this value of marginal cost in equation (4) yields a standard NKPC of the form as follows:

$$\pi_t = \beta E_t \pi_{t+1} + \gamma Y_t \tag{6}$$

where $\gamma = \rho \dfrac{(1-\theta)(1-\theta\beta)}{\theta}$ and ρ is the output elasticity of marginal cost. For checking the validity of NKPC empirically, equation (6) is converted into econometric form as:

$$\pi_t = \beta E_t \pi_{t+1} + \gamma Y_t + \varepsilon_t \tag{7}$$

In the standard NKPC there is no role of lagged inflation while a number of studies like Gali and Gertler (1999), Christiano, Martin & Charles (2005) and Cogley and Sbordone (2008) use lagged inflation in the standard NKPC. They report that lagged period inflation show high persistence, which means that lags of inflation play an important role in explaining the current period inflation dynamics. However, the inclusion of lagged inflation has started a new debate on whether the economic agents are more forward looking or backward looking. In this context, the values of lagged and expected future inflation coefficients play a significant role. To analyze how well the NKPC can explain inflation inertia Gali and Gertler (1999) introduce lagged inflation in the standard NKPC along with the expected future inflation and the marginal cost and named the resulting model as the Hybrid NKPC.

[4] For more details see Rudebusch (2002) and Furher and Giovanni (2010).

The econometric form of the hybrid NKPC is as follows:

$$\pi_t = \beta_f \mathrm{E}_t\{\pi_{t+1}\} + \beta_b \pi_{t-1} + \gamma Y_t + e_t \qquad (8)$$

where, $\beta_f = \frac{\beta\theta}{\phi}$, $\beta_b = \frac{\omega}{\phi}$, $\gamma = \frac{(1-\omega)(1-\theta)(1-\beta\theta)\rho}{\phi}$ and $\phi = \theta + \omega[1-\theta(1-\beta)]$.

All the coefficients of the hybrid NKPC are the explicit function of three model parameters; θ, measures the degree of price stickiness; β, the discount factor; and ω, the degree of price backwardness in the price setting. When ω becomes zero, the hybrid version of the NKPC converges to the standard NKPC where all firms are forward looking.

All the required data have been sourced from Pakistan Economic survey (various issues), International Financial Statistics, the IMF and World Development Indicators (WDIs), the World Bank. In this study, inflation rate has been measured by the growth rate of consumer price index (CPI). For expected inflation rate one period ahead we have used growth rate of inflation as its proxy. The output gap is calculated by using the Hodrick-Prescott (HP) filter.

Most studies in the present area of research have used the GMM technique for estimation. The present study besides this technique also employs two other alternative techniques, namely, the ordinary least squares (OLS) and the two stage least square (2SLS) to estimate the models. The only purpose behind the use of three estimation methods is to check the robustness of results.

The 2SLS method is based on two stages. At the first stage each endogenous regressor is regressed on all the endogenous and lagged endogenous variables by using the OLS technique. This will provide us the fitted values of the endogenous variables of these regressors. In stage two,

the fitted values obtained from first stage are used as instruments for the endogenous regressor in the structural form equations. The advantage of this method is that this is an appropriate method even in the presence of over identified equation.

The GMM estimation technique, formalized by Hansen (1982) and further developed by Arellano and Bond (1991), can also eliminate the simultaneity bias problem between the explanatory variables and the instruments. The extensive use of the GMM has been mainly due to two main reasons. Firstly, the GMM nets many useful estimators and provides a useful framework for their evaluation and comparison. Secondly, it provides a "simple" alternative to other estimators, especially when it is difficult to write the estimates of maximum likelihood method [Johnston and Dinardo (1997)]. The GMM expresses the variable as a function of an instrument set without referring to the structure of the process driving the forcing variable. The use of instrument set avoids the possibility of correlation between the error term and the explanatory variables. As in our NKPC model, the expected inflation is uncorrelated with the information of the current period t and earlier, it follows the following equation

$$\mathrm{E}_t\{(\pi_t - \alpha_1 \mathrm{Y}_t - \gamma_b \pi_{t-1} - \gamma_f \pi_{t+1})\mathrm{Z}_t\} = 0 \tag{9}$$

where Z_t is a vector of variables used as instruments that are assumed to be orthogonal to the inflation surprise in the period $(t+1)$ [Le (2011)].

The C-test also known as Eichenbaum, Hansen and Singleton (EHS) test is used to check the orthogonality condition $\mathrm{E}(\mathrm{Z}'U(\beta)) = 0$. The orthogonality test (C_t) is the difference between the J-statistic of the original model that uses the original set of instruments (Z) and the J- statistic of the model which considers the subset of the instruments which satisfy the orthogonality condition (Z_1).

$$C_t = J\left(\beta, \hat{W}_T\right)_Z - J\left(\beta, \hat{W}_T\right)_{Z_1} \qquad (10)$$

where Z stands for the entire set of instruments and Z_1 is the subset of instruments for which the condition of orthogonality is assumed to hold. The test statistic must be less than the χ^2 with degrees of freedom equal to the subset of instruments that does not fulfill the orthogonality condition (Z_1).

4. Results and Discussion

It is common to maintain that typical assumptions of regression model apply to all observations in the sample. However, regression coefficients are likely to be different in different subsets of data, making it implausible to apply thesame regression model to all subsets of data. The main source of instability in the data is structural change that can be accessed through various tests. Here, stability analysis is performed by applying the Chow breakpoint stability test[5]. The break- point is taken at 1988 when structural adjustment program (SAP) was launched in Pakistan under the IMF terms and conditions. Results of the Chow test reported in table 2 indicate that we fail to reject our null hypothesis of no structural break in the data at 5 percent level of significance and we can say that both the time series remained

Table 2
The Chow Test for Structural Stability

Variables	H_o	F-Stat.	Prob. F (1, 39)	Decision
INF	Parameter is structurally stable	0.098	0.761	Do not reject H_o at 5% level of significance
Y	Parameter is structurally stable	0.299	0.588	Do not reject H_o at 5% level of significance

[5] The mechanism of Chow breakpoint test is to fit the equation separately for each sub-sample and to see whether there are significant differences in the estimated equations. A significant difference indicates a structural change in the relationship.

structurally stable during the sample period of the study. Thus, there is no evidence of structural instability in any of the time series used in the present study.

As a preliminary step, the study has employed the Dickey-Fuller generalized least squares (DF-GLS) test for checking the stationarity properties of the time series, results of which are reported in table 3. It is obvious that both inflation rate and output gap are stationary at level, i.e. both the variables are integrated of order zero [*I*(0)].

Table 3
Dickey-Fuller GLS Unit Root Test: (1972-2012)

Variable	Level	First Difference	1%	5%	10%	Result	Order of Integration
INF	-4.078	--	-3.770	-3.190	-2.890	Stationary at level	I(0)
Y	-5.915	--	-3.770	-3.190	-2.890	Stationary at level	I(0)

4.1 Estimates of the Standard NKPC

The reduced form estimates of the standard NKPC with the OLS, the 2SLS, and the GMM estimation techniques are reported in table 4. The signs of estimated coefficients of the explanatory variables are in line with the predictions of the NKPC theory. The OLS estimates depict that the expected inflation (EINF) has positive relationship with the current period inflation (INF). The coefficient of the EINF is statistically significant although quantitatively small effect is obtained i.e. 0.335 showing that one percent increase (decrease) in expected inflation will result in 0.335 percent increase (decrease) in current period inflation rate. This finding is consistent with the results of Funke (2006), Sing et. el. (2011) and Turunen (2012) that the expected inflation is positively related to the current period inflation using the OLS technique. Similarly, the coefficient of the driving force variable output gap (Y) having the coefficient value of 0.406 is positively related with the current period inflation and is statistically significant. It implies that one percent increase (decrease) in current period output gap results in 0.406

percent increase (decrease) in current period inflation. This finding is in line with the results of Khattak and Tariq (2012) that the output gap positively affects the current period inflation in Pakistan. Although, both the parameters obtained by using the OLS technique are statistically significant with theoretically correct signs but due to the presence of endogeneity problem[6] the results are more likely to be inconsistent.[7] In general, the 2SLS technique is used to replace the stochastic endogenous regressor which is correlated with the error term and cause bias with the one that is non-stochastic and consequently independent of the error term. So, in order to overcome the issue of endogeneity, the 2SLS technique has been applied and again both the regressors are statistically significant with theoretically correct signs. The coefficients of expected inflation and output gap improved to 0.462 and 0.438 respectively. This outcome supports the evidence documented by Funke (2006), Dua and Gaur (2009), Sing *et. al.,* (2011) and Abass (2012), using the 2SLS technique that both the expected inflation and the output gap play a significant role in explaining the current period inflation in an economy.

The 2SLS provides consistent results but the problem with this technique is that it does not take into account the variance covariance matrix. In order to check robustness of the results we mainly apply the GMM technique. The GMM is an estimation method where the estimates are robust to heteroskedasticity and autocorrelation of unknown form. The GMM is also useful if there are measurement errors in the variables. Moreover, the GMM technique helps in avoiding the endogeneity bias (Asterious and Hall, 2011).

The probability of J-test statistic reported in the last column of table 4 is 0.913 which implies that the null hypothesis of over identifying restriction imposed by the instrument cannot be rejected. Thus, on the basis of results of

[6] We apply Durbin-Wu-Hausman (D-WH) test to check regressors' endogeneity. The null hypothesis in this test is that a given regressor is exogenous. Results are reported in table A1 in Appendix where it can be seen that expected inflation is an endogenous regressor which justifies the application of the 2SLS and the GMM techniques.

[7] Since the expectation term is correlated with the error term in the standard NKPC given in equation (7) which leads to endogeneity problem.

J-test, it is safely concluded that the estimated standard NKPC model is correctly specified. The reduced form estimate of expected inflation (EINF) is 0.421, which is statistically significant. Contrary to the findings of Gali and Gertler (1999), Woodford (2005), Cogley and Sbordone (2008) and Satti, Haq, Malik & Saghir (2007), it can be seen from table 3 that the coefficient of output gap (i.e. 0.172) is statistically significant. This shows that the output gap is a good proxy of real economic activity (or real marginal cost) in Pakistan. This outcome is also consistent with the findings of Genberg and Pauwels (2005), Funke (2006), Guimarães-Filho and Crichton (2006), Paloviita (2006), Suzuki (2006), Dua and Gaur (2009), Sevcik (2010), Le (2011), and Turunen (2012) who, using the GMM technique, report that output gap is a significant factor for explaining the current period inflation dynamics. The results presented under different estimation techniques indicate the consistency of standard NKPC with Pakistan's data.

Table 4
Estimates of Reduced Form Standard NKPC

Regressors	OLS	2SLS	GMM
C	-3.691 (-0.790)	1.145 (0.438)	3.180 (1.304)
EINF	0.335*** (9.311)	0.462*** (2.658)	0.421*** (3.164)
Y	0.406*** (5.020)	0.438*** (3.834)	0.172*** (3.117)
R^2	0.830	0.228	0.487
Adjusted R^2	0.802	0.153	0.359
J-statistic (Prob)			0.912
Durbin-Watson stat.	1.955		

Dependent Variable: INF
Notes: [1] Figures in the parentheses are t values.
[2] *** significant at 1% .
[3]Instrument List: 2SLS: INF (-2), EINF (-1 to -2), BD[8].
GMM: INF (-1 to -2), EINF (-1 to -2), BD.

To evaluate the instrument orthogonality condition, C-test has been applied on a number of sub-sets of instruments used in our study.[9] In the

[8] BD is budget deficit as percentage of GDP.

underlying model, we have applied the C-test on the instruments EINF (-1), EINF (-2), INF (-1), INF (-2), and BD one by one. Results of the C-test in case of the standard NKPC reveal that these instruments are valid (see table 5) and the standard NKPC model is correctly specified.

Table 5
Instrument Orthogonality C-Test for the Standard NKPC

Instruments List	Difference in J-stats		Decision
	Value	p-value	
EINF(-1)	0.009	0.926	Do not reject H_o at 5% level of significance
EINF(-2)	0.005	0.946	Do not reject H_o at 5% level of significance
INF(-1)	0.155	0.694	Do not reject H_o at 5% level of significance
INF(-2)	0.185	0.666	Do not reject Ho at 5% level of significance.
BD	0.000	0.989	Do not reject Ho at 5% level of significance.

*Ho: the specified variable is a proper instrument.

4.2 Dynamics of Inflation in Pakistan and the Hybrid NKPC

There is no role of lagged inflation in the standard version of the NKPC. However, a number of studies including Fuhrer and Moore (1995), Gali and Gertler (1999) and Cespedes et. al. (2005) provide empirical evidence in favor of inflation persistence which means that the previous period inflation significantly cause the current period inflation. The standard NKPC does not generate inflation persistence which may lead to its poor empirical fit. Therefore, lagged inflation is incorporated in the standard NKPC which gives rise to a hybrid version of the NKPC.

Results obtained from the hybrid version of NKPC using all the three estimation techniques reveal that both the expected inflation and the lagged inflation are statistically significant. The significant coefficient of lagged inflation reflects the persistence of inflation dynamics in Pakistan. However,

[9] Eichenbaum et. al., (1988) named the "difference in Sargan" test as C-test

the coefficient of lagged inflation is quantitatively greater than the coefficient of expected inflation (see table 6). This implies that the economic agents are more backward looking than forward looking in Pakistan. Banerjee and Batini (2004) show that in France and Italy the backward looking inflation behavior is more important ranging between 0.5 and 0.7, while in Germany the forward looking pricing behavior is dominant. Similarly, Funke (2006) also finds that in China backward looking inflation behavior is a dominant factor in explaining current inflation. Jondeau and Le (2006) also report that backward looking component of inflation is somewhat larger than its forward looking counterpart for the euro area. On the other hand, Galí et. al. (2005) and Paloviita (2006) provide evidence in favor of forward looking inflation behavior for the US economy and the OECD countries respectively.

Table 6
Reduced form Estimates of the Hybrid NKPC

Regressors	OLS	2SLS	GMM
C	-5.692	-4.841	0.822
	(-1.599)	(2.718)	(0.553)
EINF	0.358***	0.373***	0.491***
	(8.443)	(2.856)	(21.02)
INF(-1)	0.426***	0.527***	0.584***
	(3.944)	(3.851)	(8.057)
Y	0.222***	0.505**	0.237***
	(3.005)	(2.00)	(5.129)
R^2	0.894	0.648	0.781
Adjusted R^2	0.871	0.602	0.752
J-statistic (Prob)			0.801
Durbin-Watson stat.	1.872		

Dependent Variable: INF
Notes: [1]Figures in the parentheses are t values.
[2] ** significant at 5%; *** significant at 1%.
[3]Instrument Specification: 2SLS: INF (-2 to-3), EINF (-1 to-2), BD, Cons.[10]
GMM: EINF (-1 to -2), INF (-2), Y (-1 to -2), BD.

Earlier, in case of Pakistan, Saeed and Khalid (2012) find that the backward looking inflation is quantitatively more important than the forward

[10] Aggregate consumption

looking inflation while Satti, Haq, Malik & Saghir (2007) show that inflation is mainly determined by expected future inflation. Both of these studies employed the GMM estimation technique. However, using the three alternative techniques including the GMM technique our results suggest that in Pakistan inflation behavior is predominantly backward looking. It contradicts the supposition that people in developing countries are forward looking while making economic decisions.[11] Thus, both the expected inflation and lagged inflation play an important role in determining inflation, hence, inflation is a hybrid phenomenon in Pakistan. According to Paloviita (2006) in a low inflation country the forward looking expectations about inflation usually dominate, while in a high inflation country the backward looking inflation behavior is the one that dominates.

In contrast to the findings of Satti, Haq, Malik & Saghir (2007) and Saeed and Khalid, Pakistan's inflation is sensitive to changes in the output gap (see table 6). This result is consistent with the NKPC theory which suggests that there is a positive relationship between inflation and output gap (Scheibe and Vines, 2005). This finding implies that excess demand pressure has a statistically significant impact on current period inflation in Pakistan. Intuitively, higher output gap is associated with an increase in marginal costs which translates into price pressure. Our findings support the results of Paloviita (2006), Suzki (2006), Mehrotra (2007), Le (2011), Montoya and Dohring (2011) and Turunen (2012) that output gap is a significant determinant of inflation in various developed and developing countries within the framework of the hybrid NKPC. On the basis of a significant role of output gap in determining inflation it can safely be stated that inflation is mainly a structural phenomenon in Pakistan. Overall, we see that inflation dynamics can be well explained by using the hybrid NKPC in case of Pakistan.

When we test the validity of some instruments individually for the hybrid version of NKPC, we find that all the instruments satisfy the orthogonality condition and the null hypothesis is not rejected at 5 percent level of

[11] For more details see Sati et. al. (2007)

significance (see table 7). Hence, this subset of instruments is quite suitable for being used in the estimation of a hybrid NKPC for Pakistan.

Table 7
Instrument Orthogonality C-Test for the Hybrid NKPC

Instruments List	Difference in J-stats		Decision
	Value	p-value	
EINF(-1)	0.353	0.572	Do not reject H_o at 5% level of significance
EINF(-2)	0.147	0.702	Do not reject H_o at 5% level of significance
Y(-1)	2.165	0.138	Do not reject H_o at 5% level of significance
Y(-2)	2.353	0.125	Do not reject H_o at 5% level of significance
BD	0.449	0.502	Do not reject H_o at 5% level of significance.

*Ho: the specified variable is a proper instrument.

4.3 Degree of Price Stickiness

An interesting finding of the NKPC concerns about the assumption of price rigidity parameter θ i.e.,$(0 < \theta < 1)$. When the value of θ is exactly equals to one it shows that all firms keep their prices unchanged at their previous levels. In such a situation the value of output coefficient becomes zero and the current period inflation is independent of the real economic activity. In other words, the current period inflation purely depends on the discounted expectation of future inflation. Since all firms are not changing their prices, so, the expectations will also be zero and inflation is eliminated altogether. When the value of θ becomes zero, it shows perfect flexibility of prices and the aggregate price level will be equal to the optimal price level. Therefore, NKPC depends on the assumption that $0 < \theta < 1$ and it does not rest on the assumption of perfect flexibility or rigidity of prices; rather, the NKPC model fundamentally requires some degree of price stickiness.

Table 8 shows that for the standard NKPC, the estimated value of the nominal price rigidity is 0.78 which implies that 78 percent of all Pakistani firms do not change their prices during a given year. Thus, the average duration of price being fixed in Pakistan is almost 14 months.[12] In case of a hybrid version of the NKPC, 84 percent of all Pakistani firms keep their prices unchanged during a given year and prices remain fixed for almost 19 months.

Table 8
Degree of Price Stickiness in the NKPC

NKPC Specification	θ	Duration of Price Stickiness(Months)
Standard NKPC	0.78	13.64
Hybrid NKPC	0.84	18.75

Under the standard NKPC, the above reported value of price rigidity parameter (i.e. 0.78) is smaller than those estimated by Satti, Haq, Malik & Saghir (2007) i.e. 0.906. However, for another developing country, Lithuania, results show that the value of price rigidity parameter ranges from 0.539 to 0.609 corresponding to average price duration of 6.5 to 8 months (Virbickas, 2012). While in case of hybrid NKPC specification, the average price duration of almost 19 months in Pakistan is larger than the findings of Rumler (2007) for Austria, Belgium, Spain, Finland, France, Greece, Italy, Netherland and the Euro Area countries. The estimates of price rigidity in Rumler's study range from 0.51 to 0.65 for Austria with approximately an average price duration of 6 to 9 months, 0.47 to 0.73 for Belgium corresponding to an average price duration of 5.5 to 11.5 months, for Spain it ranges between 0.49 to 0.70 with an average price duration of 5 to 10 months, 0.35 to 0.65 for Finland (corresponding to an average price duration of 4.5 to 8.5 months), 0.32 to 0.71 for France with an average price duration of 4.5 to 10 months, 0.32 to 0.65 for Greece with approximately 4 to 8 months price duration, 0.40 to 0.72 for Italy corresponding to 5 to 11 months of average price duration, for Netherland it ranges between 0.39 to 0.62 with

[12] Note: the average price duration in months is computed by using the formula: $\left(\frac{1}{1-\theta}\right)*3.$

an average price duration of 4.5 to 8 months and 0.58 to 0.68 for the Euro Area countries with average price duration of 6 to 13 months.

Similarly, the reported values of price rigidity parameter by Ribon (2004) for Isreal (0.77), Maturu et, al.,(2006) for Kenya(0.74) and Virbickas (2012) for Lithuania(0.58 to 0.64) also show that the average price duration in Pakistan which is almost 19 months under the hybrid NKPC is larger than the average price duration (7 to 13 months) reported by these studies. While the findings of Gali and Gertler (1999) and Gagnon and Khan (2005) suggest that the prices remain fixed on average for 10 to 24 months in case of the US. For Chile and selected euro area countries Cespedes, Marcelo & Claudio (2005) and Rumler (2007) respectively reported that on average, prices remain fixed for 21 and 10 to 21 months.

5. Conclusion

There is an ongoing debate regarding the ability of NKPC to fit the data. The present study investigates to what extent dynamics of inflation in Pakistan are well described within the framework of NKPC. The study has accomplished its task by covering the time period from 1972 to 2012 using three alternative estimation techniques, namely, the ordinary least squares (OLS), the two stage least square (2SLS) and the generalized method of moments (GMM). The findings of this study reveal that the standard and hybrid specifications of the NKPC have the ability to explain the dynamics of inflation in Pakistan. Furthermore, backward looking inflation is relatively more important than the expected inflation in determining current period inflation behavior. Thus, inflation has emerged as a hybrid phenomenon i.e. both backward looking and forward looking in Pakistan. Finally, output gap also proved to be a significant determinant of inflation in the country.

Policy implications of the study are straight forward. *Firstly*, the inertial inflation and the expected inflation both highly affect inflation, explaining high inflation persistence. Thus, one of the major objectives of the monetary policy should be to control inflation expectations in Pakistan because

controlling expectations is the first step in managing inflation. *Secondly*, the finding that the output gap is a significant contributor towards the inflation rate suggests that for curbing price hike the government should take measures to address all those challenges which inhibit the optimal and maximum utilization of resources in the economy so that the difference between actual GDP and potential GDP remains minimum.

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Appendix

Table A1
Regressors' Endogeneity Test: The Standard NKPC

Variables	D-WU test statistic	p-value	Decision
EINF	0.334	0.032	Reject Null hypothesis at 5% level of significance
YGAP	0.624	0.429	Do not reject H_o at 5% level of significance

Ho: Regressors are Exogenous

Table A2
Regressors' Endogeneity Test: The Hybrid NKPC

Variables	D-WU test statistic	p-value	Decision
EINF	4.410	0.0357	Reject Null hypothesis at 5% level of significance
INF(-1)	0.862	0.353	Do not reject H_o at 5% level of significance
YGAP	6.037	0.021	Reject Null hypothesis at 5% level of significance

Ho: Regressors are Exogenous