

New Keynesian Phillips Curve for Algeria: Output Gap or Real Marginal Cost

منحنى فيليبس الكينزي الجديد للجزائر: فجوة الناتج أم التكلفة الحدية الحقيقية

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Abstract:

This study aims to identify the dynamics of inflation in Algeria from 1990 to 2022 using the New Keynesian Phillips Curve in its narrow and hybrid versions. In addition to forward- and backward-looking components, the output gap and real marginal cost were used to assess economic activity and possible inflationary drivers.

The research concludes that the New Keynesian Phillips Curve, with a backward-looking perspective and a focus on real marginal costs, provides a good description of inflation dynamics. This highlights the importance of the backward-looking viewpoint in Phillips Curve connections, as well as the power of real marginal costs in steering inflationary patterns in Algeria over the research period.

Keywords: Inflation; Phillips Curve; Output Gap; Real Marginal Cost.

JEL Classification Codes: R32.

ملخص:

تهدف هذه الورقة البحثية الى دراسة ديناميكية التضخم في الجزائر خلال الفترة 1990-2022 بالاعتماد على منحنى فيليبس الكينزي الجديد بشكليه الضيق والهجين. حيث تم استخدام كل من فجوة

الناتج والتكلفة الحدية الحقيقية كمقياس مناسب للنشاط الاقتصادي ومحتمل أن يكون محدد مناسب للتضخم.

وتوصلت الدراسة إلى أن منحني فيليبس الكينزي الجديد ذو النظر إلى الخلف والمعتمد على التكلفة الحدية الحقيقية يوفر تمثيل جيد لديناميكيات التضخم، كإشارة إلى أهمية النظرة الرجعية في علاقات منحني فيليبس وقوة التكاليف الحدية الحقيقية في توجيه المسار التضخمي في الجزائر خلال فترة الدراسة. كلمات مفتاحية: التضخم، منحني فيليبس، فجوة الناتج، التكلفة الحدية الحقيقية.

تصنيفات JEL: R32.

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1. INTRODUCTION

Analyzing inflation dynamics and how they interact with economic activity is critical for monetary policy, especially those aimed at inflation targeting. Based on this assumption, and after the work of Gali and Gertler (1999), the New Keynesian Phillips Curve (NKPC) has grown in favour due to its robustness and resistance to Lucas' critiques. Its structure, based on microeconomic principles and assuming nominal rigidity, renders its structural characteristics impervious to changes in economic policy.

Algeria, a developing country, has been intimately associated with inflation since the early 1970s, experiencing the catastrophic consequences. Following the economic slump that occurred shortly after independence, which had an influence on several basic structures and productive sectors, Algeria was forced to implement rigorous and profound development plans in order to rebuild its economy and join the ranks of advanced countries. Funding its projects primarily through external borrowing, monetary issuance, and tax deductions inevitably resulted in inflationary effects caused by discrepancies between monetary issuance and the supply of goods and services, lowering individuals' living standards, particularly those with low incomes.

Despite having achieved acceptable economic development rates in recent years, Algeria must maintain regular inflation monitoring to prevent

detrimental repercussions on the national economy. These impacts may undermine the potential advantages of economic growth rates, which are expected to boost people's living standards in all sectors of life. Thus, continual monitoring of this phenomena and identification of its causes is required for developing economic strategies and establishing economic stability.

Problem Statement:

Given the multiplicity of inflation reasons in Algeria, which range from demand-side and supply-side variables to structural factors particular to the Algerian economy, the aim of this study is to determine the causes and drivers of inflation in Algeria using the New Keynesian Phillips Curve (NKPC). The problematic will be addressed as follows:

Can the New Keynesian Phillips Curve be relied upon to explain inflation dynamics in Algeria from 1990 to 2022?

Subsidiary Questions:

Within this problem statement, the following subsidiary questions are considered:

- How is the New Keynesian Phillips Curve derived?
- Does the New Keynesian Phillips Curve provide a good explanation for inflation dynamics in Algeria?

Study Hypotheses:

To address the problem statement and subsidiary questions, the following hypotheses are proposed:

- The New Keynesian Phillips Curve, relying on real marginal cost, provides a good representation of inflation in Algeria due to the moral contribution of wages to the total costs of institutions.
- The backward-looking component plays a fundamental role in determining the path of inflation, as institutions continue to rely on retrospective view when setting prices.

Research Methodology:

A statistical method was used to address the primary problem statement and subsidiary problems, as well as to assess the hypotheses' validity. This included calculating the output gap and real marginal cost and analyzing their development. Standard analytical approaches were also used to

evaluate the New Keynesian Phillips Curve's effectiveness in explaining inflation dynamics in Algeria.

2. Derivation of the New Keynesian Phillips Curve:

The New Keynesian Phillips Curve could be developed by analyzing the dynamic optimization behavior of economic agents in an economy with a group of customers and a diverse range of enterprises competing in a monopolistic environment.

Several approaches have been attempted to articulate the notion that prices could potentially be sticky. Among the most prominent formulations are those related to Taylor's works. (1979) (John, 1979, pp. 108 - 113) and Fischer (1977) (Stanly, 1977, pp. 191 - 205) during the end of the 1970s, which helped to shape the New Keynesian macroeconomics.

2.1 Optimal Pricing Formula by Calvo:

The New Keynesian Phillips Curve will be calculated using a well-known model based on Calvo's (1983) pricing. In this paradigm, companies pick prices not only based on present aggregate demand and marginal cost, but also according to the predicted development of their marginal costs throughout the time during which prices cannot be adjusted. . (Guillermo , September 1983, pp. 383 - 398).

According to the Calvo model, the probability that a firm adjusts its prices during a given period is $(1 - \theta)$, where θ is the probability remains constant or adjusts to the underlying inflation Ω . These probabilities are independent of the firm's previous price changes, therefore the fraction of companies establishing prices at any one time is random. The average period when prices remain unchanged gives $(1/1 - \theta)$, and the probability that prices remain unchanged in period $t+s$ as in period t is θ^s . (Patrick, 2015, p. 194)

The company that lowers its pricing at the start of period t increases its market value by solving the following equation:

$$\max_{P_t^*(s)} E_t \sum_{i=0}^{\infty} (\theta\beta)^i \lambda_{t+i} [P_t^*(s)\Omega^i Y_{t+i}(s) - CT(Y_{t+i}(s))] \dots (1)$$

Where:

- $(1 - \theta)$: Represents the probability that a firm will adjust its prices at the beginning of the given period.
- β : Self-discount factor
- λ_{t+i} : Marginal utility of consumption in period $t + i$.
- Y_{t+i} : Production of the firm in period $t + i$.
- $CT(Y_{t+i}(s))$: Nominal total costs as a function of production.
- μ : Constant demand elasticity for production.

Solving this issue yields optimal price adjustment rules, which relate the firm's optimal price to the real marginal cost of production and the predicted future optimal price. Consequently, for an enterprise changing its pricing in time t , the optimal new price is provided by:

$$P_t^* = (1 - \theta\beta)E_t \sum_{j=0}^{\infty} (\theta\beta)^j cm_{t+j,t} \dots \dots (2)$$

Where: $cm_{t+j,t}$: Represents the real marginal cost relative to the fixed optimal price in period t .

Equation (2) above links the optimal price to the present value flows of the real marginal cost for the firm. This can be expressed as follows:

$$cm_{t+j} \approx cm_{t+j,t} + \frac{\partial cm_{t+j,t}}{\partial Y_{t+j,t}} \frac{\partial Y_{t+j,t}}{\partial P_t^*} (P_{t+j} - P_t^*) \dots \dots (3)$$

Where: $cm_{t+j,t}$, $Y_{t+j,t}$ represent the real marginal cost of the firm and the firm's production, respectively, in period $t + j$ when prices are fixed in period t .

Equation (3) can be reformulated as follows:

$$cm_{t+j,t} \approx cm_{t+j} - \eta\mu(P_t^* - P_{t+j}) \dots \dots (4)$$

Where:

- η : Elasticity of marginal cost concerning production.
- μ : Elasticity of demand encountered by the firm.

The Calvo model calculates the overall price level as a weighted average of the recent and new generated price levels, with the weighting controlled by θ . Therefore, we write:

$$P_t = \theta P_{t-1} + (1 - \theta)P_t^* \dots \dots (5)$$

By combining equations (2), (4), and (5), we obtain the following equation:

$$\pi_t = \lambda cm_t + \beta E_t \pi_{t+1} \dots \dots (6)$$

Where :

$$\lambda = \frac{(1 - \theta)(1 - \theta\beta)}{\theta - \theta\eta\mu} \quad \pi_t = \log \frac{P_t}{P_{t-1}}$$

Equation (6) is defined as **the New Keynesian Phillips Curve model**, where inflation is a function of two factors:

1. Expected inflation rate for the next period $E_t \pi_{t+1}$
2. The gap between the optimal frictional price level and the current price level demonstrates that inflation relies positively on the real marginal cost.

However, why is the real marginal cost a driving force behind inflation? According to the Calvo model, enterprises endeavour to maintain their prices at a fixed margin above the marginal cost. If the marginal cost-to-price ratio keeps increasing, it causes inflationary pressures since enterprises that modify their prices will raise them on average.

2.2 Real Marginal Cost and Output Gap

One of the obstacles in using the New Keynesian Phillips Curve model, as demonstrated by equation (6), is the lack of reliable data on actual marginal costs. National accounting often provides information on elements influencing average costs, such as wages, but does not immediately provide us of the cost of producing an extra output unit. Marginal costs are more cyclical than prices. When production levels rise with higher potential output, there is more competition for available production elements, resulting in higher actual costs. This ultimately leads to increased pricing. Overtime compensation, for example, often raises the marginal cost of labour when production quantities are large enough to need more than regular weekly hours.

For these reasons, many economists implement the new Keynesian Phillips Curve, which uses the output gap as a relevant measure of economic activity rather than actual marginal costs. According to Henzel and Wollmershauser (2006) (Henzel S, March 2006, p. 12), real marginal

cost is a linear function of the output gap under the assumption of a frictional labor market that does not change over time.

Let us define:

y_t is the logarithm of output,

y_t^* is the logarithm of the natural level of output (potential output),

Thus, the output gap can be calculated as the natural logarithm of the deviation of actual output from its potential level as follows (Jordi, 2011, p. 42):

$$x_t = y_t - y_t^* \dots \dots (7)$$

Therefore, we can write:

$$mc_t = k x_t \dots \dots (8)$$

Where k represents the output response's elasticity to marginal cost. By combining the link between marginal cost and output gap represented by equation (7) with equation (6), we get the following Phillips curve relationship:

$$\pi_t = \lambda k x_t + BE_t\{\pi_{t+1}\} \dots \dots (9)$$

As with the traditional Phillips curve, inflation rises with the production gap, and cost-push pressure represents the predicted inflation impact.

Aside from the theoretical possibility of a link between real marginal cost and output gap, some economists argue that the output gap is not an appropriate and representative alternative to the real marginal cost. According to New Keynesians, a straightforward structural link between these variables can be identified only when the labour market is in perfect competition. (Katharine S & Edward, 2005, pp. 1019 - 1045). Fuhrer (1995) (J.Fuhrer, Inflation persistence, 1995, pp. 127 - 159) criticized their positive relationship in the Phillips curve due to the lack of a cyclical pattern between these variables. Iterating equation (9) forward reveals that inflation is a forward-looking phenomenon with no delays, relying only on the discounting of present and future output gap series, shown below:

$$\pi_t = \lambda k \sum_{k=0}^{\infty} B^k E_t\{x_{t+k}\} \dots \dots (10)$$

In theory, the prior equation (9) indicates that current inflation and the lagged output gap are negatively correlated.

To demonstrate this, we lag this equation by one period and assume that $B = 1$, we obtain:

$$\pi_t = -\lambda k x_{t-1} + \pi_{t-1} + \varepsilon_t \dots \dots (11)$$

$$\text{With } \varepsilon_t = \pi_t - E_{t-1}\pi_t$$

According to Fuhrer (1995), within the framework of the new Keynesian Phillips curve, inflation ought to respond to the output gap across the business cycle, which means that any increase (decrease) in current inflation should result in an increase (decrease) in the output gap.

However, Gali and Gertler (1999) found contradictory findings when they empirically tested this equation using data from the United States and employed the departure of output from its trend as a measure of the output gap. They revealed a positive correlation between present inflation and the lagged output gap, implying that the current output gap rises with future inflation and falls with lagged inflation. As a consequence, the estimate results of equation (11) corresponded to the traditional Phillips curve.

2.3 Labor Income Approach

In the new Keynesian Phillips curve, as shown in equation (6) above, the variable real marginal cost is regarded as a major indicator of economic activity that generates inflationary pressures. In other words, the measure of inflationary pressure caused by real sector activity is a stream of discounted real marginal costs.

The reason for utilizing the output gap as a measure of real marginal costs, as outlined in equation (9), is the unavailability of data for this variable. According to Gali and Gertler (1999), the difficulty in estimating potential output is a drawback of using the output gap, which may lead to discrepancies and inconsistent theoretical conclusions. Furthermore, empirical research indicates that the deviation of real output from its trend is an inadequate proxy for the output gap. In general, there are two main reasons why real marginal costs may move relatively with known measures of the output gap (Yahyat, 2007, p. 274):

- The real output deviation from its trend may be an insufficient output gap measure. The underlying assumption for deviation from trend output implies that the natural output level may be represented by a time-invariant sticky determination function.
- Even if the output gap is measured correctly, the relative movement in real marginal costs may not be as assumed.

Based on the above, Gali and Gertler (1999) proposed an alternate method, suggesting that real average costs might be used as a more accurate estimate of real marginal costs. Assuming that labour is the only factor involved in the process of production, real average costs could be determined as follows:

$$s_t = \frac{wL}{Y} \dots \dots (12)$$

Where: s_t illustrates the real marginal cost, also known as "labor income share". W : Wage rate. L : Labor inputs.

Thus, the New Keynesian Phillips Curve equation is written as follows:

$$\pi_t = \beta\pi_{t+1} + \gamma s_t - \beta\epsilon_t \dots \dots (13)$$

Consider equation (13) as a very sensitive form of the New Keynesian Phillips Curve, which shows that inflation changes positively with the labor income share. ($\gamma > 0$).

However, this approach has also encountered criticism. According to (Rudd & Whelan, 2005, pp. 1167-1181), real marginal cost and labor income share often exhibit contrasting cyclical features. As an illustration, during economic downturns, the labour income share rises because the labour force is underutilized, but real marginal cost falls owing to lower wages for overtime. Rudd and Whelan's empirical investigation, which used both the output gap and labour income share as explanatory factors for inflation, found that labour income share was not statistically significant, albeit demonstrating a positive sign as theoretically anticipated. Meanwhile, the output gap was not statistically significant and was the opposite of what is suggested by the theory.

3. The Hybrid New Keynesian Phillips Curve

Representing nominal rigidity in general equilibrium models allows for the derivation of the New Keynesian Phillips Curve relationship, as seen in equation (6) above. This relationship between inflation and economic activity is similar to the expectations-augmented Phillips curve (or Lucas supply function), but it differs significantly from the traditional Phillips curve in that it views inflation solely as a forward-looking phenomenon caused by firms' dynamic optimization behavior.

According to the forward-looking inflation theory, companies who set prices in monopolistic competition are aware that they will not be able to change them until a later time. Therefore, in order to determine present pricing, they take into account their assumptions about future marginal production costs. (Andreas, 2008, p. 304).

The narrow version of the New Keynesian Phillips Curve (NKPC), which is forward-looking, totally rules out any inflation persistence, as shown in equation (6) above. As expectations are self-fulfilling, Ball (1994) argues that if the central bank works to close positive output gaps in the future, measures aimed at lowering inflation may be successful and have no negative effects on economic activity.

Firms will instantly drop current pricing to reflect their expectation that inflation would decline tomorrow, decreasing inflation from today without leading to an a recession. This theoretical scenario, however, is quite different from reality: whereas inflation tends to respond to monetary shocks gradually and persistently, measures aimed at controlling inflation often result in contraction.

To align the New Keynesian Phillips Curve with observed reality, some economists like Fuhrer (1997) (J.Fuhrer, 1997, pp. 338 - 350) and Robert (1998) proposed introducing a lagged inflation variable to demonstrate inflation persistence. Works by Gali & Gertler (1999) are pivotal in this field, as they expanded this new curve to enable some firms to form their prices utilizing backward-looking rules. As in the basic model of Calvo (1983), each firm adjusts its price in any given period with probability $(1 - \theta)$. According to the Calvo model, the proportion δ of firms are forward-looking (P_t^f), while the proportion $(1 - \delta)$ are backward-looking (P_t^b). Thus, the aggregate price level becomes of the form:

$$P_t = \theta P_{t-1} + (1 - \theta) \bar{P}_t^* \dots \dots (14)$$

Where $\bar{P}_t^*$ represents the newly formed aggregate price level in period t , calculated as follows (Patrick, 2015, p. 200):

$$\bar{P}_t^* = \delta P_t^f + (1 - \delta) P_t^b \dots \dots (15)$$

Firms that fix their prices according to backward-looking rule follow the following law:

$$P_t^b = P_{t-1}^* + \pi_{t-1} \dots \dots (16)$$

Where P_{t-1}^* refers to the average price set in period $1-t$ by all firms with both backward- and forward-looking behavior, equations (15), (16), and (14) allow us to derive the following **hybrid New Keynesian Phillips Curve**:

$$\pi_t = \alpha c m_t + \gamma_b \pi_{t-1} + \gamma_f E_t(\pi_{t+1}) \dots \dots (17)$$

Where: $\gamma_f = \beta \theta \phi^{-1}$ illustrates the forward-looking component, $\gamma_b = \delta \phi^{-1}$ represents the backward-looking component.

$$\alpha = \sigma \left(\frac{1}{(1 - \eta \mu)} \right), \sigma = \left(\frac{(1 - \delta)(1 - \theta)(1 - \theta \beta)}{\theta} \right) \phi^{-1}$$

$$\phi = \theta + \delta[1 - \theta(1 - \beta)]$$

The relationship (17) above, which depicts the new hybrid Phillips curve, is considered one of the most often used models in empirical monetary policy research. It reveals that predicted inflation, backward-looking inflation, and the real marginal cost, a measure of economic activity, all contribute to inflation.

Furthermore, including backward-looking inflation was meant to capture inflation persistence and indicate that measures aimed at lowering inflation are very expensive and cause economic contraction.

The parameters γ_f , γ_b , and α are explicit functions of three structural parameters: θ , measures price rigidity, δ , measures inflation persistence, and the discount factor β .

The ability of monetary policy to monitor inflation through reliance on the New Keynesian Phillips Curve is associated with the value and statistical significance of γ_f , γ_b , and α . Monetary policy can impact inflation through its influence on the real marginal cost. The smaller the α , the smaller the impact of policy on inflation. In the special case where $\alpha =$

0, inflation evolves independently of monetary policy and of all other economic activities. The cost of reducing inflation is related to the relative value of the expected inflation coefficient and the lagged inflation coefficient, γ_f and γ_b . If γ_b is large, inflation is largely driven by its lagged values, and the effect of policy on inflation will have long time delays.

The New Keynesian Phillips Curve's capability to define the inflation process and identify its connection to output varies over time as monetary policy changes. As a result, the link between projected inflation and lagged inflation varies across monetary policy regimes, making this curve an unreliable tool for analyzing policy effects.

In situations when the central bank has inadequate credibility, inflation expectations are based on current and previous inflation behavior rather than the central bank's formal declarations. However, if the central bank has high credibility and publicly established a precise inflation goal, lagged inflation values play a minimal influence in the expectations-building process.

4. Estimating the New Keynesian Phillips Curve

We shall estimate the equation of the New Keynesian Phillips Curve in its narrow and hybrid versions for the Algerian economy from 1990 to 2022, using real marginal cost and output gap as leading variables.

4.1. Estimating the New Forward-looking Keynesian Phillips Curve

4.1.1. Study Variables: Based on the theoretical aspects addressed in the New Keynesian Phillips Curve, the following variables were used to estimate the curve and investigate its applicability in explaining the dynamics of inflation in Algeria:

- **Inflation rate $\inf_t$:** This measures the yearly change in the Consumer Price Index's logarithm. Although the typical measure of inflation in most empirical studies of the Phillips Curve that we have previously addressed is changes in the GDP deflator, we used changes in the Consumer Price Index in our research. This is because, in the Algerian economy, evaluating changes in the GDP deflator involves significant disruptions. Furthermore, changes in the Consumer Price Index reflect the desired inflation, justifying our choice of this index as appropriate for analyzing inflation dynamics.

Expected inflation rate $\inf_{t+1}$: Expected inflation was computed using the premise of adaptive expectations, which states that expectations of a variable's future value are derived from its past values. (Lyman, 2012, p. 04). This suggests a backward-looking paradigm in which economic actors consider both current inflation and previous data. Hence, we calculated the Cagan model equation and utilized it to determine the expected inflation values:

$$p_t = \frac{1}{1 + \alpha(1 - \lambda)} m_t + \frac{\alpha\lambda}{1 + \alpha(1 - \lambda)} \sum_{i=1}^{\infty} (1 - \lambda)^i p_{t-i}$$

M_t : Money supply. **P_t : General price level.**

The real marginal cost rmc_t : is the ratio of labor's contribution to income, which is represented the logarithm of the ratio of workers' compensation to gross domestic product (GDP).

- **The output gap y_t :** is the natural logarithm of the deviation of real output from its potential level.

This study will use the Hodrick-Prescott filter to estimate potential output since it is simple and easy to use, making it a suitable tool for research, especially in emerging and developing nations. The output gap is calculated as follows: (Cadoret & al, 2009, p. 107) :

$$y_t = \left(\frac{Y_t - Y_t^*}{Y_t^*} \right) * 100$$

Where: Y_t : Represents actual output, Y_t^* : Illustrates potential output.

4.1.2. Estimating a forward-looking Phillips curve utilizing the output gap as a leading variable: The Phillips curve relationship is written as follows:

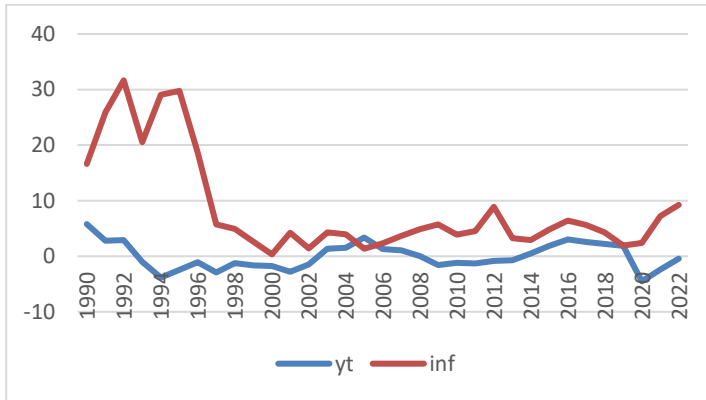
$$\inf_t = \lambda y_t + \beta E_t \inf_{t+1} \dots \dots (18)$$

Whereas INF represents the inflation rate, y_t illustrates the output gap, λ and β are parameters to be estimated.

We plot the evolution of the inflation rate and output gap in Algeria to provide a preliminary understanding of the relationship between these variables and to determine whether it initially agrees with the theoretical foundations of the new Keynesian Phillips curve in its narrow form, prior to estimating and statistically testing this equation for the Algerian economy.

Figure (01) depicts the connection between inflation and the output gap from 1990 to 2022. The figure shows that these variables move closely together over the research period, as seen by a general downward trend from 1992 to 2000 and 2016 to 2020, followed by an upward trend from 2002 to 2004, 2010 to 2016, and 2020 to 2022.

Figure (01): The relationship between inflation and the output gap during the period 1990-2022



Source: Prepared by the researchers based on data from the National Statistics Office.

Output Gap: Calculated by the researchers.

To confirm the validity of the preceding hypothesis, which was obtained from Figure (01), we use the Generalized Method of Moments (GMM) to estimate Equation (18). Identifying the moment conditions that satisfy the orthogonality criterion is one of the most essential conditions for using GMM.

$$E[(inf_t - \lambda y_t - \beta E_t inf_{t+1})Z_t] = 0$$

The instrumental variables utilized in the estimation will all be observed in period (t-1) or earlier, for two reasons:

1. There is a possibility of error in computing the variables - real marginal cost and output gap - and we assume that this error is uncorrelated with previous information.
2. Not all current information is publicly available when individuals are forming their expectations.

We utilized the following list of instrumental variables Z_t : one-period lag of inflation and the output gap. The estimation results of Equation (18) for inflation were as follows:

Table (01): Estimation Results of Equation (18)

Parameters	Value	Prob (t)
λ	-0.77	0.67
β	2.99	0.01
<i>J_statistic</i>	0.08	
R^2	-0.09	

Source: Prepared by the researchers using Eviews 13 software

The above table shows that estimating the New Keynesian Phillips Curve from a forward-looking perspective offers findings that contradict the theoretical literature on this curve. Theoretically, the discount factor β is expected to be less than one, and the coefficient λ associated with the output gap is expected to be positive. However, contrary to these theoretical propositions, the discount factor was greater than one with high statistical significance, and the coefficient λ demonstrated a negative sign and was not statistically significant.

Therefore, from a forward-looking perspective, the New Keynesian Phillips Curve uses the output gap as a leading variable, which does not accurately reflect Algerian statistical data from 1990 to 2022.

4.1.3. Estimating the New Keynesian Phillips Curve using Real Marginal Cost as a Leading Variable:

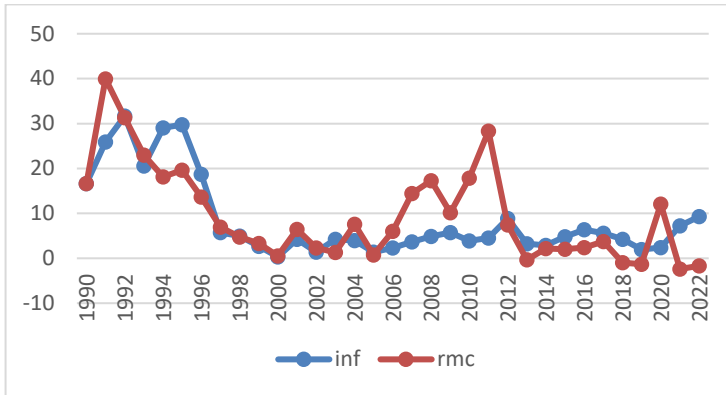
The forward-looking Phillips curve relationship is written as follows:

$$\inf_t = \lambda rmc_t + \beta E_t \inf_{t+1} \dots \dots \dots (19)$$

Where: *INF* represents the inflation rate, *rmc* illustrates the real marginal cost, λ and β are parameters to be estimated.

Furthermore, before estimating and statistically evaluating this equation using Algerian economic data, we demonstrate the evolution of both the inflation rate and the real marginal cost to determine the link between the two variables. As indicated in Figure (02) below, there is a close movement between inflation and real marginal cost during 1990-2022, demonstrating that inflation is related to movements in real marginal cost. According to this first demonstration, the inflation process in the Algerian economy is consistent with the theoretical Phillips Curve model, indicating that inflation is positively correlated with changes in real marginal costs in the present and the future.

Figure (02): Relationship between inflation and real marginal cost during the period 1990-2022.



Source: Prepared by the researchers based on data from the National Statistics Office.

Real Marginal Cost: Calculated by the researchers.

To test the possibility that the real marginal cost can be a leading indicator of the Algerian economy's inflation trend as a measure of inflationary pressures originating in the real sector, we approximated equation (19) using the Generalized Method of Moments (GMM) method. We used the following set of instrumental variables: one inflation and real marginal cost lag. The estimated findings are as follows.

Table (02): Estimation results of equation (19)

Parameters	Value	Prob (t)
λ	0.66	0.02
β	0.92	0.01
<i>J_statistic</i>	0.05	
R^2	0.06	

Source: Prepared by the researcher using Eviews 13.

The above table shows that the narrow version of the New Keynesian Phillips Curve, based on actual marginal cost, provides good outcomes. The estimated coefficient of real marginal cost was positive, as demonstrated by the theoretical model, and the discount rate coefficient β was close to one. Statistically, the model coefficients significantly is different from zero, with a $prob < 0.05$ for each coefficient, demonstrating statistical significance.

Therefore, the forward-looking New Keynesian Phillips Curve, which is based on real marginal cost, accurately depicts inflation in Algeria. To

verify this finding, we will calculate the hybrid version of this curve as follows:

4.2. Hybrid New Keynesian Phillips Curve Estimation

We write the hybrid version of the New Keynesian Phillips Curve as follows:

$$\text{inf}_t = \alpha \text{rcm}_t + \gamma_b \text{inf}_{t-1} + \gamma_f E_t(\text{inf}_{t+1}) \dots \dots \dots (20)$$

Where:

- inf : Represents the inflation rate.
- inf_{t-1} : Represents the lagged inflation component.
- inf_{t+1} : Represents the forward-looking inflation component.
- rcm : Represents the real marginal cost.
- $\alpha, \gamma_b, \gamma_f$: Parameters to be estimated.

When estimating equation (20) for Algerian statistical data, the following results were obtained:

Table (03): Results of estimating equation (20)

Parameters	Value	Prob (t)
α	0.35	0.10
γ_b	0.89	0.00
γ_f	0.40	0.66
<i>J_statistic</i>	0.045	
R^2	0.41	

Source: Prepared by the researchers using Eviews 13

From the previous table, we note the following:

- The coefficient α is positive and statistically significant at the 10% level, aligning with the theoretical basis of the new hybrid Phillips curve based on real marginal cost. However, it is quantitatively weak.
- The coefficient γ_b (lagged component) is positive, statistically significant, and essential quantitatively.
- The coefficient γ_f (forward-looking component) is positive but not statistically significant and is quantitatively weak, contradicting the theoretical basis of the new hybrid Keynesian Phillips curve.

Based on the aforementioned information, as well as the sign and magnitude of parameter estimations and their statistical significance, we

deduce that the new Keynesian Phillips curve is consistent with Algerian data. Moreover, the lagged component's substantial presence indicates its quantitative significance, in contrast to the forward-looking component's weak role in predicting inflation behavior.

5. CONCLUSION

After demonstrating the new Keynesian Phillips curve for the Algerian economy in its narrow and hybrid versions between 1990 and 2022, the following findings were reached:

1. Output Gap as Leading Variable: The output gap is not considered an appropriate leading variable in the new Keynesian Phillips curve. We obtained a negative coefficient for the output gap. This could be explained in terms of Algeria's small open economy, which is vulnerable to foreign trade shocks that affect alternative real marginal economic costs. Consequently, determining the output gap proves to be complicated. Hence, using real marginal cost as an alternative for the output gap, as proposed in the new Keynesian Phillips curve literature, could offer a more precise representation of this curve.

2. Income Contribution to Real Marginal Cost: Income's contribution to real marginal cost is an adequate estimate and a major driver of inflation. The findings supported the theoretical basis of the new Keynesian Phillips curve, with both the expected sign and statistical significance. However, the narrow and hybrid variants produced low quantitative findings. The substantial contribution of labor to total costs for all economic entities may help explain why the real marginal cost was selected.

3. Role of backward-looking Component: Unlike the forward-looking component, the backward-looking component had a considerable impact on the hybrid Phillips curve, suggesting an expected sign and strong statistical significance. The low importance of forward-looking behavior in the Algerian economy can be linked to the requirement for previous announcements and public disclosure of scheduled policies and goals. Economic policies in Algeria are often implemented immediately without previous disclosure, resulting in low credibility . Furthermore, the

increased relevance of the lagged component in the Algerian economy might be attributed to inflation in recent years serving as a substitute for other leading factors not included in the model, such as the exchange rate, which analyses the dynamic impact of foreign trade.

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