The Phillips Curve – Uk Case

Author: Malva Govori

Inflation, as a monetary phenomenon, is viewed by monetarists occurring as a result of supply of currency growing faster than the economic output. Research endeavours aimed at understanding the inflationary process among countries have witnessed major advancements in modelling short-term inflation dynamics”. The literature on the Phillips Curve, which is the “modern view of inflationary process”, continues to increase. This paper, therefore, provides an empirical analysis of testing the Phillips Curve in the case of the UK. An econometric regression of the traditional Phillips Curve, the New Keynesian Phillips Curve and the New Hybrid Keynesian Phillips Curve has been conducted, using the UK time-series data starting from 1956 to 2010. I have used the output gap, Hodrick-Prescot Filter and Generalized Methods of Moments measures to estimate the results. Some of the results are quite robust, whereas the NKPC and the hybrid NKPC do not fit the UK data.

Keywords: inflation, monetary phenomenon, method, econometric regression

Introduction

Inflation, as a monetary phenomenon, is viewed by monetarists occurring as a result of supply of currency growing faster than the economic output. The fundamentals of monetarism are based on the Quantity Theory of Money (QTM) – respectively known as Irving Fisher’s work. The QTM identifies “the direct relationship between the quantity of money in an economy and the price level of goods and services” (Maturu et al. 2006). “Research endeavours aimed at understanding the inflationary process among countries have witnessed major advancements in modelling short-term
inflation dynamics”. Alongside, the literature on the Phillips Curve, which is the “modern view of inflationary process”, continues to increase.

The Phillips Curve represents the relationship between inflation and the level of economic activity (which is measured by the level of unemployment or GDP) in a particular economy. The Phillips Curve is an essential element used to conduct macroeconomic policy. It was first advocated by Phillips (1958), whose analysis was focused on the traditional relationship between the level of economic activity and the general level of prices. More specifically, he chose the United Kingdom to analyze the relationship between the level of unemployment and the nominal wages; and concluded that there exists an inverse relationship between them (Maturu et al. 2006).

The emphasis shifts from the traditional Phillips Curve to the New Keynesian Phillips Curve (NKPC), because of the traditional Phillip’s curve failure to explain the “developments in inflation among several countries”. In contrast, the NKPC adjourns coefficients that are robust to any changes in policy regime. This model assumes monopolistic price setting and price rigidity.

The estimation of the New Hybrid Keynesian Phillips Curve initiated “to capture the inflation persistence”. “It allows a subset of firms to use the backward-looking rule of thumb to set prices and introduce the lagged inflation term”. The empirical research of Gali e al. (1999, 2001) supports the use of this model as “the dynamics of inflation can be understood with models derived from microeconomic foundations” (Neiss et al. 2002).

This paper therefore draws light upon this rhetoric by conducting an econometric regression of the traditional Phillips Curve, the New Keynesian Phillips Curve and the New Hybrid Keynesian Phillips Curve, using the United Kingdom as the country analysis. The time-series data start from 1956 to 2010. I have used the output gap, Hodrick-Prescot Filter and Generalized Methods of Moments measures to estimate the results. Some of the results are quite robust, whereas the NKPC and the hybrid NKPC do not fit the UK data.

First, this dissertation proceeds by doing a very thorough literature review (chapter 2), followed by an elaboration of the UK’s economic background and how different policy regimes affected the country’s economy (chapter 3). Then it presents the methodology used for the data
estimation (chapter 4) and the obtained results (chapter 5). Finally, it concludes with a summary of possible findings from the conducted analysis.

**Literature Review**

A.W. Phillips (1958) presented an empirical evidence on negative correlation between the rate of unemployment and inflation (rate of change of money wage rates) in United Kingdom over 1861-1957. The research supported the hypothesis that: “rate of change of money wage rates can be explained by the level of unemployment and the rate of change of unemployment”. This trade-off relationship became known as the Phillips Curve hypothesis. The rationale behind this relation, as explained by Phillips (1958) in his fundamental article, is that excess demand for a commodity trigger an increase in its price. Conversely, when the demand of the commodity is low relatively to the supply, price is expected to fall. Phillips also argued that the level of unemployment could be an important determinant of wages. In the case of low unemployment (high demand for labour), the bidding power of an employee tends to rise, as firms needs to offer a premium in addition to the prevailing wage rates to attract new employees. On the other hand, it appeared to Phillips that when the demand for labour is declining, workers are reluctant to adjust their wage expectations downwards; therefore the relation between unemployment and the rate of change of wage rates was argued to be highly non-linear. Since then, many researchers have conducted various studies in order to confirm or to refute Phillips’ findings.

Samuelson and Solow (1960) openly supported the hypothesis, by making explicit the link between inflation and unemployment: “when inflation was high, unemployment was low and vice-versa”. By examining these two macroeconomic variables in the case of the United States, they concluded that there is an inverse relationship between unemployment and inflation in the country.

Solow (1970) and Gordon (1971) further confirmed the existence of a negative trade-off relationship between unemployment and inflation in US macroeconomic data of both pre-1970s and post-1970s. These findings are known as the “Solow-Gordon affirmation” of the Phillips curve hypothesis.

Friedman and Phelps (1967) distinguish between the short-term and the long-term Phillips Curve, which is based on the hypothesis of the “natural level” of unemployment, later exerted as NAIRU (non-accelerating
inflation rate of unemployment). The Friedman’s hypothesis assumes that NAIRU is the unique rate of unemployment succeeded by stable inflation rate. They argue that nominal wages are largely irrelevant, and that worker behavior responds only to inflation-adjusted-wages. In their view, real wages would adjust to make the quantity supplied of labor equal to the quantity demanded, and the unemployment rate would then stand at a level uniquely associated with that real wage—the "natural rate" of unemployment, often also called the "non-accelerating inflation rate of unemployment" or NAIRU. In the expectations-augmented Phillips curve proposed by Friedman and Phelps, unanticipated inflation results in a temporary depression of the real wage, making labor a relatively cheap factor of production, and facilitating lowered unemployment. This short-run trade-off between inflation and unemployment disappears as soon as workers learn to expect the prevailing rate of price inflation and start demanding higher nominal wages. When workers thus restore the real wage to its pre-inflation level, labor ceases to be an especially cheap resource, and unemployment rises back to its natural rate. The more quickly worker expectations of price inflation adapt to changes in the actual rate of inflation, the more quickly unemployment will return to the natural rate, and the less successful the government will be in reducing unemployment through monetary and fiscal policy. They represented the Phillips Curve in the following formula: \( \pi_t - \pi_{t-1} = \alpha(U_t - U^*) \), where \( U_t \) is empirically observed rate of unemployment, and \( U^* \) represent the natural unemployment rate or NAIRU; whereas, \( \pi_t - \pi_{t-1} \) represents the expected inflation proxied by a distributed lag on past inflation.

Lucas (1976) strongly criticized the existence of the “Phillips curve”. He argued that there could be a trade-off relationship between unemployment and inflation if workers do not expect that policy makers will try to create an artificial situation of high-inflation with low-unemployment. Otherwise, workers would foresee the high inflation in the future and would ask their employers to increase their wages. In this case, there could be coexistence of unemployment and a high inflation rate. This criticism is known as the "Lucas critique". After the Lucas’s harsh criticism in the 1970s, many economists lost interest in conducting research on the topic. As Debelle and Vickery (1998:384) wrote, “The Phillips curve fell into a period of neglect in academic circles during the 1980s, while remaining an important tool for policy makers”.


Lucas and Sargent (1981) reproached the “ignorance of expectations on behavior” theory. They argued that in order to proceed with this theory it should be assumed that people form rationale expectations based on the information they. Keynesian economists responded to these theoretical critiques by emphasizing that there should be built models that incorporate reasonable expectations and which provide “a microeconomic justification for monetary policy having at least short-run effects”. According to them, such models should be ensued from the observed relationships between various macroeconomic quantities over time. In addition they stated that these relations vary depending on the type of the macroeconomic policy regime that is being used. “In the context of the Phillips curve, this means that the relation between inflation and unemployment observed in an economy where inflation has usually been low in the past would differ from the relation observed in an economy where inflation has been high”. In addition, they stress out that the outcomes of a new policy regime cannot be foreseen by using an empirical forecasting model based on the previous periods when that policy regime was not in place.

Lucas argued that economists would not be able to predict the consequences/effects of new policies without building models on economic fundamentals, such as budget constraints, preferences and technology, which should not be affected by the policy changes. “This combination of rational expectations and micro-foundations is known as Neo-Keynesian macroeconomics which relies crucially on the term sticky prices or the so-called price rigidities”. “Without some type of price rigidity, it is difficult to rationalize the idea that there can be periods during which factors of production, such as labour, are under-utilized, with aggregate output being below its so-called potential level. Once it is assumed that at least some prices are rigid, then not all markets are clearing instantaneously and aggregate output may sometimes be below what would obtain when all prices move flexibly. Also, with sticky prices, an increase in the money stock can produce a short-run increase in real spending power and thus can boost real output”.

The Lucas quote: “Given that the structure of an econometric model consists of optimal decision rules vary systematically with changes in the structure of series relevant to the decision maker, it follows that any change in policy will systematically alter the structure of econometric models” (Lucas, 1976, p.41)
Fischer (1997), Taylor (1980), Rotemberg (1982), and Calvo (1983) developed the theory of the microeconomic foundations of New Keynesian Phillips Curve (NKPC), as a response to the New Classical critiques that Keynesian macroeconomics lacked micro-foundations. The NKPC provides “theoretical micro-foundations that attempt to explain, inter alia, nominal rigidities and, explicitly price stickiness” (Abbas and Sgro, 2011).

Gali and Lopez-Salido (2008) state that, the New Keynesian Phillips Curve (NKPK) consists of two different features that describe the relationship between inflation and economic activity. The first feature describes its forward-looking character of inflation that firms set prices based on their expectations about the “future development of demand and cost factors”. “The second feature involves the link between inflation and real activity, which comes through the potential effects of the latter on real marginal cost”.

As stated by Mankiw (2001), the most elegant formulation of the NKPC is based on Guillermo Calvo’s (1983) model of random price adjustment. In the Calvo model, firms follow “time-contingent price adjustment rules”. The price time adjustment comes randomly and it is not tagged along a deterministic schedule. In every time period, a fraction λ of firms adjust prices. In spite of its last price adjustment period of time, each firm has the same probability of being one of the adjusting firms.

Mankiw (2001) presents that in order to derive the NKPC, three basic relationships are needed. The first relation involves the firm’s desired price, which is “the price that would maximize profit at that moment in time”. The formula of the desired price is as follows:

\[ p_t^* = p_t + \alpha(Y_t - Y^*) \]

Firm’s desired price \( p^* \) depends on the overall price level \( p \) and the deviation of unemployment from its natural rate \( U - U^* \); which means that the firms desired relative price, \( p^* - p \), rises in booms and falls in recessions. When the economy goes into a boom (represented by low unemployment \( U \)), each firm experiences increased demand for its products. Because marginal cost rises with higher levels of output, greater demand means that each firm would like to raise its relative price.
The second relation, that Mankiw (2001) presents, involves the firm’s price choice which is equivalent to the “average desired price” among “identical monopolistically competitive firms”. However, firms change their desired price hardly ever, because of the “staggered price adjustment”. The adjustment price $x$ is determined as a weighted average of the current and all future desired prices:

$$x_t = \lambda \sum_{j=0}^{\infty} (1 - \lambda)^j E_t p^*_t + j$$

Mankiw (2001), further, states that desired prices are given less importance in the upcoming time period, since the firm may experience an additional price adjustment between the current period of time and the future date. This possibility makes “the future desired price less relevant for the current pricing decision”. “The rate of arrival for price adjustments, $\lambda$, determines how fast the weights decline”.

The third key equation, that Mankiw (2001) presents, determines the overall price level $p$:

$$p_t = \lambda \sum_{j=0}^{\infty} (1 - \lambda)^j x_{t-j}$$

The equation shows that the overall price level is the weighted average of all prices that firms have set in the past. By solving the model we obtain the modern NKPC relationship of the form:

$$\pi_t = E_t \pi_{t+1} + \beta(Y_t - Y^*)$$

Where $\pi_t = p_t - p_{t-1}$ is the inflation rate, $\beta = \frac{\alpha^2}{1 - \lambda}$ and the expectations are assumed to be formed rationally. The model depicts the value of actual inflation (as a function of output) and inflation expected to prevail in the forthcoming time period. In the case of constant inflation, increase in output leads to higher inflation.

Mankiw (2001) presents three features of this model. First, it gives some microfoundations to the idea that “the overall price level adjusts slowly to changing economic conditions”. Second, he states that: “it produces an expectations-augmented Phillips curve resembling the model
that Milton Friedman and Edmund Phelps pioneered in the 1960s and that remains the theoretical benchmark for inflation-unemployment dynamics”. Third, he further states that: “it is simple enough to be useful for theoretical policy analysis”.

Mankiw (2001), however, states that: “despite the well-defined theoretical framework, the NKPC is completely at odds with the facts”. In this model, even though, the price level is sticky on the other hand the inflation rate is completely elastic – hence the model fails to explain and justify the deferred shocks to monetary policy and the gradual effects on inflation.

Sbordonne (2001) argues that the NKPC “yields a prediction about inflation and output only insofar as standard measures of the output gap are good measures of marginal costs”.

Gali and Gertler (1999) extend the basic Calvo model to allow a subset of firms to use a “backward-looking rule-of-thumb to set prices and introduce the lagged inflation term”. The result is a hybrid Phillips curve:

\[ \pi_t = \phi \pi_{t-1} + (1 - \phi) E_t(\pi_{t-1}) + \gamma y_t + \varepsilon_t, \]

Gali and Gertler (1999) state that the public/population in this empirical model consists of both forward-looking and backward-looking agents and that, in this model, the current inflation depends on both past inflation and expected future inflation. However, they state that there is not much distinction between the forward-looking model of NKPC and the hybrid NKPC model, since “future inflation is always proxied by some transformation of past inflation”. This means that the influence of inflations is divided between future expected inflation and lagged inflation rather than being entirely directed through future expected inflation. Further, they claim that “if there are enough backward-looking members of the population, then forward-looking members cannot ignore the persistence introduced by backward-looking agents”.

Many researchers have estimated this model both as a single equation and as a general equilibrium model. Fuhrer and Moore (1995) have argued that the New Keynesian model (which consists of sticky prices and rational expectations) did not fit the U.S. postwar data. On the other hand, Fuhrer (1997) and Roberts (1997) have argued that by including inflation lags in the model allows the data to be fit adequately.
Gali and Gertler (1999) and Gali, Gertler and Lopez-Salido (2001, 2003, 2005) estimate the “hybrid” version of the New-Keynesian Phillips curve, with both forward-looking and backward-looking elements, with Generalized Method of Moments (GMM). They have conducted a study to test both models of NKPC and the NHKPC for the Euro area, over the period 1970-1998. Their study showed that the Euro area data fit with both of the models, NKPC and NHKPC. They also compare the characteristics of European inflation dynamics with those observed in the US and they conclude that “the NHKPC fit Euro area data better and has a stronger forward-looking component than in the U.S.”.

These papers led to a lot of discussion, in particular by Rudd and Whelan (2005) and Linde (2005). They claimed that they find the estimation methods of these papers quite suspicious and that the results of these papers are “the products of specification bias”. They argued that the GMM approach to the NHKPC suffers from "identification problems and weak instrument bias". Lindé (2005) suggests the use of the “Full Information Maximum Likelihood Estimators” (FIML) to avoid the possible bias in GMM estimations.

Nason and Smith (2005) also support the idea that there are problems identified within the GMM methods. They present an alternative method, known as the “Structural Vector Autoregressive (SVAR)”. This system of the hybrid NKPC is estimated by introducing an additional error. They conclude that “the output gap is assumed to follow a first-order autoregressive process and does not depend on current inflation, which is described by the hybrid NKPC”.

Batini, Jackson and Nickell (2005), furthermore, point out the issue of the “possible omitted variable bias of the standard NKPC, especially for open economies such as the UK, including proxies for material input prices, foreign competition and employment adjustment costs”. “They find that marginal cost is inaccurately proxied by the labour share if employment adjustment costs are not accounted for and that inflation in the UK is significantly explained by shifts in real import prices and foreign competition”.

Gali et al. (2005) disagree with most of the above mentioned claims. They demonstrate that their estimates are robust to a variety of econometric measures (“including the GMM estimation of the closed form as suggested by Rudd and Whelan (2005) and nonlinear instrumental variables based on
Linde’s (2005) empirical research”). They conclude that their results are quite similar with the results obtained by GMM estimations and other econometric approaches used by other scientific researchers.

Mankiw and Reis (2002) have “proposed the sticky information model as a response to some of the failures of the standard forward looking new Keynesian Phillips curve model”. Prices in this model are always changing; hence the decision-makers are slow in updating their pricing strategies. They further argue that the sticky price model and the sticky information model could be easily compared to each other, since they are both based on the assumption of “monopolistic competition framework”. However, they differ in the “mechanism that explains imperfect price adjustment”: “the assumption of sticky prices brings forth the New Keynesian Phillips Curve (NKPC), while the assumption of sticky information yields the sticky information Phillips curve (SIPC)”. The sticky price model assumes that the price adjusts slowly in the economy as a result of the “price adjustment costs” faced by firms. In contrary, in the sticky information model the price adjustments have no restrictions. In this model, only a small part of the agents have to update their information of the current period. Mankiw and Reis (2002) prompt this assumption by stating that “information diffuses slowly throughout the population as a result of the existence of costs of acquiring new information or re-optimization”.

Mankiw and Reis (2002) present three different views of the sticky-information model. In their first view, they claim that disinflations are always contractionary, even though the announced disinflations are less costly than the unanticipated ones. In the sticky-information model, the anticipated disinflations do not cause booms. In this model, the output or the inflation does not change until the initiation of the disinflationary policy of slower money growth – in which case the disinflation causes a recession. By contrast, in the sticky-price model, the announced disinflation causes a boom. As Ball (1994) emphasizes, “inflation in this model moves in anticipation of demand”. However, inflation falls when a slowdown in money growth is anticipated. This fall in inflation results in higher output and leads to the increase of real money balances.

Mankiw and Reis (2002) second view is that in the sticky information model, the maximum effect of the monetary shocks on inflation occurs only after seven quarters. This result of the time period is estimated
by the central bankers. On the other hand, in the sticky price model the maximum effect of a monetary shock in inflation occurs immediately.

The third view presented by Mankiw and Reis (2002) is that the sticky information model can explain that “vigorous economic activity is positively correlated with rising inflation”. In the sticky-information model, when a monetary shock is caused inflation adjusts gradually. In addition, when a contractionary shock lowers output it leads to a longer period for the inflation to fall. This, therefore, generates a positive correlation between the change in inflation and output. In the contrary, when the economy experiences a contractionary monetary shock in the sticky price model, inflation falls immediately and then starts to increase again; whereas output falls for a while. In this way, low output overlaps with falling inflation at first; but then overlaps with the rising inflation for a long period of time. “This generates the small negative correlation”.

Mankiw and Reis (2002) further state that the sticky information model has one theoretical advantage since it succeeds to survive McCallum critique.

McCallum (1998) criticizes the standard sticky-price model, since based on his view, “it violates a strict form of the natural rate hypothesis”, according to which "there is no inflation policy – no money creation scheme - that will keep output high permanently." McCallum argues that "it seems a priori implausible that a nation can enrich itself in real terms permanently by any type of monetary policy, by any path of paper money creation." The sticky price model fails the theory of a policy that a permanently falling inflation will keep the output permanently high; however, “it satisfies the theory of the natural rate hypothesis.

**The Uk Economic Background**

By the mid-19th century, Britain was characterized as the country with the highest productivity and per capita income in the world. It was also the first nation which went through an industrial revolution. However, by the late 19th century, it fell behind the economic development of Germany and the United States.

During most of the 20th century, the British economy declined considerably against its competitors. Its economy was characterized with
low growth rates and some of its major industries “entered a period of decline”, which also started to become a major policy problem. The issue of the low growth rates heightened during the post-war period. By the end of the war, the United States was the worldwide leading power, both economically and politically, putting Britain out of place. By 1970, the growth of the British living standards was overtaken by German’s living standards; followed by France in 1975; and Italy and Japan in 1980. As one could notice, while other countries were catching up with the United States, Britain was not able to be in the same level as they were. (Backhouse, 2002).

**Figure 1:** International comparisons of living standards, 1960± 85

The period of 1970s was known to be as the worldwide economic havoc, being also characterized by the rise of the energy prices (1973 – 1974 and 1979). However, in the case of Britain a number of policy decisions added to this turmoil. The first one is that the newly elected government of the Conservatives led by Ted Heath (1970) introduced the policy of laissez-
fare. This new policy resulted in the removal of “subsidies to the industries that were deteriorating, the removal of price and wage controls, reforming the tax system and changed the system of agricultural support in preparation for entry into the European Economic Community (EEC)”. At the beginning of 1972, the number of unemployed people in the UK reached to 1 million. The government’s act in response to this was by starting to use expansionary fiscal policy. By using this ‘expansionary fiscal policy’, the government’s aim was to get unemployment down to half a million (by the end of 1973). “Since previous ‘expansionary policies’ did not function because of the balance of payments constraints, it was decided that even if a balance of payment deficit emerged, sterling would be allowed to float”. In this way the government would be able to maintain a high rate of growth. “The main objective of this ‘rush for growth’ to solve the long-term problem of low growth and the short-term problem of rising unemployment”. “These expansionary policies resulted in an increase of the growth rate by 5% per annum, and a decrease of unemployment to 518,000 by the end of 1973”. However, the expansion had occurred too quickly, by increasing the GDP (at an annual rate) over 10% in the first quarter of 1973, whereas in the next two quarters the rate was over 7%. “In addition to this, industrial policy was changed to one of subsidizing investment; income policies were introduced to control inflation; whereas a large balance of payment deficit had emerged” (Backhouse, 2002).

The situation got worsened with the rise in energy prices caused by the Organization of the Petroleum Exporting Countries’ (OPEC). This led to a strike by coal miners and electrical power engineers over the increase of wages higher than the amount allowed by the ‘government’s income policy’. As a result, limitations were placed on the energy usage and in order to save even more energy the rule of three-day working week was introduced. In addition, inflation has increased significantly. “The major reason for this was that, in order to get acceptance of its incomes policy, the government had offered to index-link wage settlements if the retail price index rose above an agreed threshold level”. The rise of the energy prices led the threshold to exceed, and the wages did automatically linked to the retail price index. By the first quarter of 1975, wages grew over 30% (at an annual rate). As a result of the high cost of energy imports, the balance of payment deficit was over 4% of GDP. The government’s response to this was by seeking support to the International Monetary Fund (IMF), which led to the
imposition of massive cuts in public spending and the introduction of ‘monetary targets’. The government, also, concluded an agreement with the Trade Unions, known as the ‘Social Contract”, which objective was to control inflation. As shown in Figure 2, these policies resulted in a dramatic fall of inflation rate (1976-1977) and a rise in unemployment (Backhouse, 2002).

**Figure 2**: Inflation and unemployment, 1950-1993
Source: Economic Trends, Annual Supplement, 1996, Table 1.1.

“Since the date of the general election was coming closer (it had to be called no later than 1979), “policy relaxed, output grew more rapidly, and unemployment fell slightly””. Unions became more reluctant to accept the Social Contract, and a series of strikes, particularly in the public sector, occurred from the end of 1978, which came to be known as the “Winter of Discontent”. In addition, inflation began to rise again (Backhouse, 2002). The ‘Winter of Discontent’ in 1979 was a key event.

The sudden increase of strikes against the labour government’s income policies showed the perfect example of a country which is ungovernable and that no government had an answer to inflation. “These
events destroyed the government’s reputation for prudent economic management and its ability to gain the cooperation of the unions” (Kavanagh, 2003).

A new period of neo-liberal economics began in 1979 with the election of Margaret Thatcher. “Margaret Thatcher’s party called for the restriction of trade union leaders’ power, less government intervention in the economy, the restriction of local government spending and the reform of local government finance, the reduction of income tax rates, the privatization of nationalized enterprises and public housing, and the closer integration of the British economy with those of the European Community”. Among these, the newly elected government took the following actions to control inflation. The elimination of exchange control was the first action - that was taken by the newly-elected government. As the goal was to create ‘a tight monetary policy’ to reduce inflation, the government also undertook some steps in tax and supply policies, by raising the VAT from 8% to 15%, which instantly added to about 4% to the retail price index. The second action taken, in order to control the inflation rate, was the introduction of the Medium Term Financial Strategy (MTFS). This provided for “a planned, gradual reduction in growth rate of £M3, the government’s preferred measure of the money supply, and the ratio of the public sector borrowing requirement”. MTFS was a policy of gradualism which provided that the inflation would be reduced over a period of several years. In 1985, however, “the idea of monetary target was abandoned” (Backhouse, 2002).

Backhouse (2002) gives two reasons for the abandonment of monetary target. The first is that “the government persistently failed to hit its money supply targets, even though these specified only broad ranges, and they were adjusted over time”. The monetary base, “Mo grew only 8% in 1980 when inflation was 18%; in early 1979 it had been growing at 13% against inflation of 10%”. However, this sharp tightening of monetary policy was not the gradualism that Mrs. Thatcher intended (Matthews and Minford, 1987). The second reason that Backhouse (2002), states is that “the deregulation of the financial system meant that monetary aggregates lost their significance”. “For example, one aspect of deregulation was that building societies were allowed greater freedom, both in the way they raised funds and in the type of lending they could undertake. Building society deposits, therefore, became much more like bank deposits, but they were not a part of £M3”. (Backhouse, 2002)
Various economists, such as Matthews (1987), Minford (1987), Backhouse (2002), Benati argue that these macroeconomic policies of the Conservative government brought the country into a deep recession. “Since the second quarter of 1979, GDP had fallen by 6%, manufacturing production by 18%, and unemployment had nearly doubled from 5.4% to 10.4%. Inflation rose to a peak of 21.5% per annum in the second quarter of 1980” (Backhouse, 2002).

Between the period of 1981 to 1989, Britain was characterized with sustained economic growth. There were high levels of productivity growth, especially in manufacturing. At this time, sterling was allowed to fall, ‘improving the competitiveness of British industry and stimulating demand’. There were also cuts on the income tax. The basic rate of tax was reduced from 30% to 29% in 1986; 27% in 1987; and 27% to 25% in 1988. In October 1990, sterling entered the ERM (at a parity of 2.95 Deutschmarks). This was a time-period of recession and significant volatility in the world economy. In November 1990, Margaret Thatcher left the office of the Prime Minister, leaving it to her successor John Major (Backhouse, 2002).

The period of 1990s was considered as the period of the longest depression in Britain, since the Great Depression. Even though, this was the longest depression that Britain has ever experienced, the fall in output was not as sharp as it was during the Great Depression. It lasted until April 1993, by which time nearly 3,000,000 were unemployed. “The British pound was tied to EU exchange rates, using the Deutsche Mark as a basis, as part of the Exchange Rate Mechanism (ERM); however, this resulted in disaster for Britain”. Black Wednesday in 1992 ended British membership of the ERM. The integrity of the Conservatives’ economic management was damaged. Despite all these turbulences and downfalls that occurred, “unemployment had fallen by more than 1,000,000 since the recession to 1,700,000 by the time of their election defeat” (Backhouse, 2002).

In May 1997, the Labour Party, led by Tony Blair won the election. The 10 years rule of the Labour Party brought 40 successive quarters of economic growth. The new government enacted “new laws on labor union recognition, introduced a national minimum wage, enhanced employment protection legislation, strengthened anti-discrimination legislation, and imposed many new obligations on employers”. In order to foster employment in the country, the new government introduced a variety of labor market programs, known as the ‘New Deal’. “Many new obligations
have been placed on employers-for example, to provide longer paid holidays and parental leave, to consider requests for shorter hours, and to inform and consult with employees over major business changes”. One of the most important acts that the new Labour government undertook, was giving the power to the Bank of England to set interest rates, “which successfully ended the use of interest rates as a political too”. This played a crucial role in the stability of the British economy (Schakleton, 2007).

According to the IMF data, annual growth rates averaged 2.68% and inflation leveled off at around 2%, between the periods of 1992-2007. This period was considered to be as the most stable and the wealthiest period of the British economy. This lasted until 2008 when it entered the recession brought by the global financial crisis.

The recession of 2008-2009 resulted in a larger amount of lost UK output than in any of the recessions that have occurred previously. Unemployment also attained its lowest level during this recession, especially comparing to the previous ones.

“A combination of lower inflow rates into unemployment, allied with a relatively higher outflow rate into employment, underlies this”. The GDP also fell by over 6%, which was worse than during the recessions of the 1980s and 1990s; “with six quarters of falling output, it was both longer and deeper than the previous two”. (Gregg and Wadsworth, 2011)

“As the financial crises developed, the interest rates began to fall to very low levels. In March 2009, the MPC cut interest rates to 0.5% and maintained the same rate ever since. Since, the Bank Rate was approaching to 0%, which is the limit, to which the nominal interest rates can be lowered; further reductions are likely to be less effective in terms of the impact on market interest rates, demand, and inflation. Therefore, the MPC needed to provide further incentives to support the demand in the economy. It boosted the supply of money by purchasing assets like government and corporate bonds”. This policy is known as “quantitative easing”, which goal is to inject money directly into the economy, instead of lowering bank rate to increase the amount of money in the economy. (Duck, 2006)

Econometric Methodology

Before carrying out any empirical estimation of the Phillips curve, it is important to identify and understand the premise which the estimation is
based on, as well as identifying other key economic factors that make the estimation possible. The major assumption of any empirical estimation of the Phillips curve is that inflation has a positive relationship with output, as it deviates from its natural rate. This implies that inflation estimates depend on fluctuations in real activity gaps. Before going into the more complex measures of estimating the Philips curve, I will start by looking at the basic measures of real activity gap. I will also be taking a look at inflation measures. Once I have laid the foundation by establishing these measures, I will then be able to link them together in a bid to estimate the Phillips curve. I will be taking a look at three estimates of the Phillips curve, namely, the Backward-looking model, the New Keynesian Phillips Curve (NKPC) model, as well as the Hybrid NKPC model. These will be discussed in more detail in due course.

There are several alternatives when it comes to measuring real activity gap. I will be addressing four of such measures. In order to measure these real activity gaps, it is essential to use a data-smoothing tool which will split up the time series data into a cyclical component and raw data. This is a process known as de-trending. I intend to use the Hodrick-Prescott Filter (HP Filter) to de-trend the data required to measure the real activity gaps. Although the HP-Filter is a commonly used de-trending instrument, it has its flaws. It is known to be unreliable at the end-points and it relies on the rate of adjustments of the parameters it makes use of, in terms of the level of deviation from their equilibrium points in an economy.

The first alternative measure of real activity gap I will observe has to do with the log of real GDP and its trend. In this measure, I will attempt to compare the log of real GDP with the trend of GDP. By making use of the HP-Filter, I will de-trend the log of real GDP data and then compare the raw data (the trend) with the actual log of real GDP. I will plot a graph of both components and observe for patterns between them. I will also run a correlation test in order to see how closely related the log of real GDP is to the trend.

The second alternative measure of real activity gap I will look at has to with establishing two output gaps of log of real GDP. I will carry out a simple non-linear regression on the log of real GDP in order to establish a regression line which will be fitted with residuals. This regression line will then be plotted alongside the cyclical component of the log of GDP data in order to compare both components and observe patterns. A correlation test
will also be run between the two output gaps in order to determine how closely related they are.

The third alternative measure of real activity gap which I will observe is the labour share. In Gali and Gertler’s literature on the New Keynesians Phillips Curve (NKPC), they used labour as a measure of real marginal cost. This will be looked at in more detail in the NKPC section of this chapter. As for using labour share as a proxy of real activity gap, I will employ a similar method as in the second alternative measure above. I will carry out a simple non-linear regression on labour share in order to establish a regression line which will be fitted with residuals. This regression line will then be plotted alongside the cyclical component of the labour share and log of GDP data in order to compare all three components and observe patterns. A correlation test will also be run between the three output gaps in order to determine how closely related they are.

The final measure of real activity gap I will be observing is the unemployment rate. I will also be estimating the natural rate of unemployment rather than assume it is constant. Similar to the second and third alternative measures, I will be carrying out a simple non-linear regression on unemployment rate in order to establish a regression line which will be fitted with residuals. This regression line will then be plotted alongside the cyclical component of the unemployment rate in order to compare both components and observe patterns. A correlation test will also be run between the three output gaps in order to determine how closely related they are.

Now that I have highlighted the alternative measures of real activity gap, I will now take a look at the inflation measures that help me in my attempt to estimate the Phillips curve. I will be making use of two inflation measures. The first measure of inflation is the GDP Deflator. This is an aggregate measure of prices of all domestically produced goods and services within an economy. The second measure of inflation is the Consumer Price Index (CPI). This is the measure of prices of goods and services purchased by consumers. Unlike the GDP deflator, the CPI is based on a fixed basket of goods and services and not all goods and services in the economy. In order to compare both measures of inflation, I will plot them in a graph and observe for patterns. I will also carry out a correlation test to see how much they differ from each other.
After reviewing the alternative measures of real activity gap as well as the inflation measures, we now have the necessary components to proceed with the estimation of the Phillips curve. As mentioned earlier, I will be taking a look at three estimates of the Phillips curve, namely, the Backward-looking model, the New Keynesian Phillips Curve (NKPC) model, as well as the Hybrid NKPC model.

I will be estimating the three models of the Phillips curve using the Generalized Method of Moments (GMM) estimator. This is because the GMM estimator is known to be very robust and does not depend too much on information regarding the distribution of the disturbances. It is also useful in generating the expected inflation variable by making use of forward expectations from historical data, which is used to determine the predicted inflation by the NKPC model. However, one of the drawbacks of GMM according to many authors is that it does not always make efficient use of the information in the sample. Furthermore, it has been demonstrated that the GMM estimators are severely biased in small samples.

In order to estimate the Backward-looking model, I will use the GMM estimator alongside alternative measures of output gap, as well as alternative measures of inflation. This is to ensure robustness of the results. I will then observe the signs of the alternative output gaps, to see if they are consistent with theory. I will also compare the actual inflation measures (GDP Deflator and CPI) with the predicted inflation by the Backward-looking model, by plotting graphs and carrying out correlation tests.

For estimating the NKPC model, I will employ a similar measure to Gali and Gertler (1999). I will make use of the GMM estimator alongside alternative measures of output gap, as well as alternative measures of inflation, in order to ensure robustness of the results. I will also use labour share as a proxy of real marginal cost similar to Gali and Gertler (1999). I will then compare the actual inflation measures (GDP Deflator and CPI) with the predicted inflation by the model, by plotting graphs and carrying out correlation tests.

In terms of estimating the Hybrid NKPC, I will make use of the GMM estimator alongside using labour share as a proxy for real marginal cost, just as in the case of the NKPC model, as well as alternative measures of inflation, in order to ensure robustness of the results. I will then compare the actual inflation measures (GDP Deflator and CPI) with the predicted inflation by the model, by plotting graphs and carrying out correlation tests.
Estimation Results

There are several ways of measuring the real activity gap, and as of yet, researchers have not been able to come to a compromise on the most suitable measure of this economic indicator. Hence, I will now attempt to address a few alternative measures of the real activity gap.

The first alternative measure of the real activity gap is using the Hodrick-Prescott (HP) filter. In this measure, we compare the trend with the log of real GDP (which approximately linearizes the data). As shown in figure 1, the log of real GDP and the trend are both upward sloping, with the log of real GDP fluctuating slightly from the trend. These fluctuations in the log of real GDP indicate slight deviations from the steady growth rate.

![Figure 1: Log of GDP v The Trend](image)

The second alternative measure involves using the HP filter to de-trend the log of real GDP data in order to establish the output gap, also known as the cycle. At the same time, we carry out a simple non-linear regression in order to determine an output gap as well. A regression line, with three residuals fitted around it gives an R² of 0.9922, which indicates
that the residuals are all statistically significant. These two output gaps that have now been established (the cycle and the residuals) are plotted alongside each other for comparison (see figure 2 below).

![Figure 2: Alternative Measures of Output Gap (Residuals v Cycle)](image)

From figure 2, the outcomes observed from both output gaps are quite similar. It should come as no surprise that the two measures plotted above have a correlation coefficient of 0.64, which somewhat validates the results shown above.

Another way of measuring the real activity gap is by using the labour share. Gali and Gertler, in their New Keynesian Phillips Curve literature, viewed labour share as a measure of real marginal cost, to be used to measure the output gap. By fitting the residuals of the labour share on a regression line, with the same technique used for the log GDP, we get an R2 of 0.6170. In figure 3, both labour share and the de-trended GDP are used as proxies of real activity gap. Due to limited ‘n’ data, I was only able to compare the two measures from the late 1990s. In figure 3, the labour share started to increase in 2008, while the de-trended GDP started to fall in the
same year (this fall in de-trended GDP is more clearly depicted in figure 2 above). This period coincides with the recession in the UK. During recessions, marginal costs should be decreasing and not increasing but in figure 3, the labour share, which is a real measure of the marginal cost, as indicated by Gali and Gertler, increased. This pattern displayed by the labour share is considered to be countercyclical according to Rudd and Whelan, rendering this measure to be less reliable in measuring real economic activity.

**Figure 3:** Output gaps using log GDP and Labour Share Proxy

As seen from figure 3 above the correlation between the de-trended GDP and both the de-trended labour share and residual labour share are negative. This is shown in table 1 below.
**Table 1:** Correlation Coefficients between De-trended GDP and Labour Share

<table>
<thead>
<tr>
<th></th>
<th>De-trended GDP</th>
<th>De-trended Labour Share</th>
<th>Labour Share (residuals)</th>
</tr>
</thead>
<tbody>
<tr>
<td>De-trended GDP</td>
<td>1.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>De-trended Labour Share</td>
<td>-0.1749</td>
<td>1.0000</td>
<td></td>
</tr>
<tr>
<td>Labour Share (residuals)</td>
<td>-0.3081</td>
<td>0.9654</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

One other way of measuring the real activity gap is by using the unemployment rate. In this case, the Natural Level of Unemployment was estimated, rather than assuming it was constant. Just as in the case of the log GDP, the HP filter was used to de-trend the unemployment rate. A simple regression was also carried out on the unemployment rate, with the residuals fitted around it to yield an R2 of 0.6610, indicating that the residuals are partially statistically significant. The de-trended unemployment rate and the residuals are plotted in figure 4 below.

![Figure 4: Unemployment gaps (Residuals v De-trended)](image-url)
From Figure 4, it is clear that both measures produce very similar patterns. This observation is also reflected in the high correlation coefficient of 0.7447 between both measures, which somewhat validates the results shown above.

Having analysed several alternative measures of deriving real economic activity, none of them stood out in particular as the preferable option, as a result of the variation observed amongst the different measures. See table 1 below showing the correlation coefficients between the alternative measures of economic activity.

**Table 2: Correlation Coefficients of Alternative Measures of Economic Activity**

<table>
<thead>
<tr>
<th></th>
<th>Log GDP</th>
<th>Log GDP (HP)</th>
<th>Labour Share</th>
<th>Labour Share (HP)</th>
<th>Unemployment Rate</th>
<th>Unemployment Rate (HP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log GDP *</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log GDP (HP)</td>
<td>-0.0841</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour Share*</td>
<td>-0.3881</td>
<td>-0.3081</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour Share (HP)</td>
<td>-0.5607</td>
<td>-0.1749</td>
<td>0.9654</td>
<td>1.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unemployment Rate*</td>
<td>-0.4692</td>
<td>0.4086</td>
<td>0.1211</td>
<td>0.2911</td>
<td>1.0000</td>
<td></td>
</tr>
<tr>
<td>Unemployment Rate (HP)</td>
<td>0.4573</td>
<td>-0.0922</td>
<td>-0.0615</td>
<td>0.0256</td>
<td>1.0000</td>
<td></td>
</tr>
</tbody>
</table>

*denotes residuals

Similar to the case of output gap, there are several ways to measure inflation. In this scenario, we compare the Consumer Price Index (CPI) inflation with the inflation measure using the GDP deflator. Figure 3 below shows these two inflation measures plotted on the same graph.
Figure 5: Alternative Measures of Inflation (CPI v GDP Deflator)

We can observe from figure 3 that both inflation measures seem to be moving in identical patterns with very slight variations. The CPI inflation and inflation measure using the GDP deflator have a very high correlation coefficient of 0.96, which suggests that the data is very reliable.

Estimation of the Backward looking Phillips Curve

By using quarterly UK data over the period 1957Q1 – 2011Q1, I was able to estimate the Phillips Curve using the backward looking model. The following equation was used in my estimation, yielding the results in table 2.

\[ \pi_t = \beta \pi_{t-1} + \gamma \hat{y}_{t-1} \]

\( \beta \) represents the intercept of the Phillips Curve, \( \gamma \) represents the slope of the Phillips curve, while \( \hat{y} \) represents economic measures such as GDP or unemployment. In this model, a 1 percent change in output, either above or below the natural level of output will lead to a change in the inflation rate the size of \( \gamma \) if measured using a quarterly rate. Regardless of the measure of inflation used for the estimation, the coefficients estimated yielded the expected signs. The same expected signs were also observed by using either the GDP or unemployment measures for the estimation.
Table 3: Estimates of the Backwards Looking Phillips Curve

<table>
<thead>
<tr>
<th>GDP Deflator Inflation Measure</th>
<th>( \hat{y} )</th>
<th>( \beta )</th>
<th>( \gamma )</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GDP (Residuals)</strong></td>
<td>0.958</td>
<td>7.36</td>
<td>0.9161</td>
<td></td>
</tr>
<tr>
<td><strong>Unemployment</strong></td>
<td>0.947</td>
<td>-0.13</td>
<td>0.9291</td>
<td></td>
</tr>
<tr>
<td><strong>Unemployment (Residuals)</strong></td>
<td>0.939</td>
<td>-0.24</td>
<td>0.9297</td>
<td></td>
</tr>
<tr>
<td><strong>CPI Inflation</strong></td>
<td>0.970</td>
<td>21.42</td>
<td>0.9378</td>
<td></td>
</tr>
<tr>
<td><strong>GDP (Residuals)</strong></td>
<td>0.967</td>
<td>7.76</td>
<td>0.9364</td>
<td></td>
</tr>
<tr>
<td><strong>Unemployment</strong></td>
<td>0.948</td>
<td>-0.15</td>
<td>0.9386</td>
<td></td>
</tr>
<tr>
<td><strong>Unemployment (Residuals)</strong></td>
<td>0.943</td>
<td>-0.25</td>
<td>0.9382</td>
<td></td>
</tr>
</tbody>
</table>

As mentioned earlier, the estimated coefficients using the model above yielded the expected signs regardless of the measure of inflation used for the estimation. To further illustrate this observation, I plotted the actual inflation (using both the CPI and GDP deflator measures) alongside the inflation predicted by the backward looking Phillips Curve.
From figure 6 it is clear to see that the predicted inflations by the backward looking model follow a similar pattern to the actual inflations. Table 4 below shows the correlation between the inflation measures.

**Table 4:** Correlation Coefficients between Actual Inflations and Predicted Inflation (Backward Looking Phillips Curve)

<table>
<thead>
<tr>
<th></th>
<th>CPI Inflation</th>
<th>GDP Deflator inflation</th>
<th>Predicted CPI Inflation</th>
<th>Predicted GDP Deflator Inflation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPI Inflation</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP Deflator Inflation</td>
<td>0.9598</td>
<td>1.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predicted CPI Inflation</td>
<td>0.9663</td>
<td>0.9360</td>
<td>1.0000</td>
<td></td>
</tr>
<tr>
<td>-------------------------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td>Predicted GDP Deflator Inflation</td>
<td>0.9402</td>
<td>0.9557</td>
<td>0.9594</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

From table 4, the correlation coefficients show that the backward looking model predicts inflation quite well. However, this model has been subject to several criticisms, most famously the ‘Lucas Critique’. One of the issues raised is that the coefficients on the lagged inflation terms may possibly embed expectations of future inflations. The model’s stability in predicting inflation in the euro zone as a result of changes in policy regime is still a cause for concern. As a result of these drawbacks and the weak microeconomic base of the model, considering it relies heavily on historical data, other models need to be explored.

**Estimation of the New Keynesian Phillips Curve (NKPC)**

The New Keynesian Phillips Curve (NKPC) estimates current inflation using expected inflation and the output gap. In a very basic form of the model, the NKPC can be expressed using the following equation:

$$\pi_t = \beta E_t \pi_{t+1}^e + \gamma \hat{y}$$

$\beta$ represents the discount factor, $E_t$ is the expectation operator, $\hat{y}$ is the output gap, while $\gamma$ is the slope of the Phillips curve. Similarly to Gali and Gertler (1999), I used the Generalized Methods of Moments (GMM) estimator, alongside alternative measures of output gap including GDP and unemployment, as well as alternative measures of inflation to ensure the robustness of the results. Table 4 summarizes my findings.
### Table 5: GMM Estimates of the New Keynesian Phillips Curve (NKPC)

<table>
<thead>
<tr>
<th>GDP Deflator Inflation Measure</th>
<th>$\hat{y}$</th>
<th>$\hat{\beta}$</th>
<th>$\gamma$</th>
<th>Centred $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GDP (Residuals)</strong></td>
<td>1.024 ($0.032$)</td>
<td>-22.92 ($7.033$)</td>
<td>0.9152</td>
<td></td>
</tr>
<tr>
<td><strong>GDP (Residuals)</strong></td>
<td>1.019 ($0.034$)</td>
<td>-5.60 ($2.617$)</td>
<td>0.9129</td>
<td></td>
</tr>
<tr>
<td><strong>Unemployment</strong></td>
<td>1.029 ($0.034$)</td>
<td>0.023 ($0.043$)</td>
<td>0.9215</td>
<td></td>
</tr>
<tr>
<td><strong>Unemployment (Residuals)</strong></td>
<td>1.039 ($0.034$)</td>
<td>0.106 ($0.076$)</td>
<td>0.9217</td>
<td></td>
</tr>
<tr>
<td><strong>CPI Inflation</strong></td>
<td>1.019 ($0.034$)</td>
<td>-23.99 ($6.413$)</td>
<td>0.9377</td>
<td></td>
</tr>
<tr>
<td><strong>GDP (Residuals)</strong></td>
<td>1.012 ($0.034$)</td>
<td>-5.47 ($2.309$)</td>
<td>0.9344</td>
<td></td>
</tr>
<tr>
<td><strong>Unemployment</strong></td>
<td>1.008 ($0.036$)</td>
<td>0.094 ($0.035$)</td>
<td>0.9348</td>
<td></td>
</tr>
<tr>
<td><strong>Unemployment (Residuals)</strong></td>
<td>1.017 ($0.036$)</td>
<td>0.173 ($0.078$)</td>
<td>0.9339</td>
<td></td>
</tr>
</tbody>
</table>

From the estimates above, the signs produced for the slope coefficient for GDP and Unemployment are not consistent with previous economic theory. Take for example, by using the de-trended GDP as a proxy for output gap and applying it to the UK quarterly data over the period 1957Q1 – 2011Q1, a negative and significant coefficient (-22.92) was yielded by the NKPC. Other authors including Gali, Gertler and Lopez-Salido (2005),
and Rudd and Whelan (2007) have carried out similar test on the NKPC using several instrument sets, various measures of inflation, as well as other GDP de-trending techniques, yielding the same result as I did. Using unemployment as a proxy for output gap and applying the same UK quarterly data yielded a positive coefficient, which is also inconsistent with prior theory.

In addition to the economic indicators mentioned above, labour share was also used as a proxy for output gap yielding the following results in table 6 below. Gali et al (2003) suggest the use of labour share rather than de-trended GDP as a proxy for marginal cost.

Table 6: GMM Estimates of the New Keynesian Phillips Curve (NKPC) – Labour Share

<table>
<thead>
<tr>
<th>GDP Deflator Inflation</th>
<th>( \hat{\gamma} )</th>
<th>( \beta )</th>
<th>( \gamma )</th>
<th>Centred R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>De-trended Labour Share</td>
<td>1.388 (0.251)</td>
<td>-0.489 (0.182)</td>
<td>-0.015</td>
<td></td>
</tr>
<tr>
<td>Labour Share (Residuals)</td>
<td>1.417 (0.261)</td>
<td>-0.537 (0.173)</td>
<td>-0.029</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CPI Inflation</th>
<th>( \hat{\gamma} )</th>
<th>( \beta )</th>
<th>( \gamma )</th>
<th>Centred R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>De-trended Labour Share</td>
<td>1.15 (0.107)</td>
<td>0.997 (0.180)</td>
<td>0.6951</td>
<td></td>
</tr>
<tr>
<td>Labour Share (Residuals)</td>
<td>1.17 (0.115)</td>
<td>0.931 (0.256)</td>
<td>0.6807</td>
<td></td>
</tr>
</tbody>
</table>

From table 6, using Labour share as a proxy of output gap yielded negative coefficients from the NKPC by applying the GDP deflator inflation measure. However, using the CPI inflation measure yielded positive coefficients. I carried out a correlation test between the GDP deflator inflation and the de-trended labour share which revealed a coefficient of 0.2209. The correlation coefficient between the GDP deflator inflation and the residual labour share is 0.1910. These are extremely low correlation coefficient figures. The same was observed when after carrying out correlation tests with both labour
share proxies. Correlation coefficient between de-trended labour share and CPI inflation was 0.1635 while correlation coefficient between residual labour share and CPI inflation was 0.0036. This helps explain the inconsistent estimations of the NKPC model.

Similar to the case of the backward looking Phillips Curve, I plotted the actual inflation (using both the CPI and GDP deflator measures) alongside the inflation predicted by the NKPC in figure 7. This was done in order to observe how closely fit the NKPC predicted inflation was to the actual inflation measures.

![Figure 7: Actual Inflations and Predicted Inflations (NKPC)](image)

From figure 7 it is clear to see that the predicted inflations by the NKPC model follow a similar pattern to the actual inflations. Table 7 below shows the correlation between the inflation measures.
Table 7: Correlation Coefficients between Actual Inflations and Predicted Inflation (NKPC)

<table>
<thead>
<tr>
<th></th>
<th>CPI Inflation</th>
<th>GDP Deflator inflation</th>
<th>Predicted CPI Inflation</th>
<th>Predicted GDP Deflator Inflation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPI Inflation</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP Deflator Inflation</td>
<td>0.9594</td>
<td>1.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predicted CPI Inflation</td>
<td>0.9663</td>
<td>0.9402</td>
<td>1.0000</td>
<td></td>
</tr>
<tr>
<td>Predicted GDP Deflator Inflation</td>
<td>0.9360</td>
<td>0.9557</td>
<td>0.9598</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

In spite of the NKPC contradicting previous theoretical findings, Gali et al (2003) suggest that the model reasonably predicts inflation dynamics in Europe and the United States. This claim is clearly backed up by the high correlation coefficients amongst the actual and predicted UK inflation measures shown in table 6, as well as the pattern of movement of the actual and predicted inflation measures observed in figure 7.

Estimation of the Hybrid NKPC Model

NKPC and traditional backward-looking Phillips curve are two alternative models of inflation. Hybrid specification of the Phillips curve can be seen as an attempt to test the hypothesis whether inflation is principally a backward looking phenomenon, as implied by the traditional Phillips curve analysis, or arises from the rational expectations behaviour. In contrast to the NKPC, hybrid model allows fraction of firms to set prices according to the backward looking rule of thumb.

The hybrid NKPC model can be expressed using the following equation below:

$$\pi_t = \gamma \hat{y} + \beta f(\pi_{t+1}) + \beta b(\pi_{t-1})$$
\( \gamma \) represents the slope, \( \beta f \) represents expected inflation, while \( \beta b \) represents lagging inflation. The results of the GMM estimation of the hybrid NKPC are summarized in Table 8 below. Considering Labour share was thought to be a reasonable proxy for marginal cost in the NKPC, I decided to use it as a proxy for the GMM estimation of the hybrid NKPC model. Two measures of inflation (GDP Deflator and CPI) were used in order to ensure the robustness of the estimation.

Table 8: GMM Estimates of the Hybrid NKPC

<table>
<thead>
<tr>
<th></th>
<th>( \hat{y} )</th>
<th>( \beta f )</th>
<th>( \beta b )</th>
<th>( \gamma )</th>
<th>Centred ( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GDP Deflator Inflation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>De-trended Labour Share</td>
<td>0.599 (0.292)</td>
<td>0.478 (0.155)</td>
<td>-0.167 (0.149)</td>
<td>0.6704</td>
<td></td>
</tr>
<tr>
<td>Labour Share (Residuals)</td>
<td>0.648 (0.345)</td>
<td>0.449 (0.176)</td>
<td>-0.199 (0.175)</td>
<td>0.6595</td>
<td></td>
</tr>
<tr>
<td><strong>CPI Inflation</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>De-trended Labour Share</td>
<td>0.396 (0.1107)</td>
<td>0.655 (0.086)</td>
<td>0.443 (0.122)</td>
<td>0.928</td>
<td></td>
</tr>
<tr>
<td>Labour Share (Residuals)</td>
<td>0.386 (0.098)</td>
<td>0.689 (0.077)</td>
<td>0.395 (0.1301)</td>
<td>0.09249</td>
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</tbody>
</table>

Just as in the case of the NKPC, the coefficient of marginal cost when using the GDP deflator inflation measure is negative, while the coefficient is positive for the CPI inflation. As mentioned earlier, the correlation coefficients between both measures of inflation and both labour share proxies are very low and could help explain the inconsistencies in the prediction of this model, just as in the case of the NKPC model. Another observation is that the coefficients of both the expected inflation and lagged inflation are statistically significant under both inflation measures. However, the expected inflation coefficients seem to be slightly higher than the lagged inflation coefficients when using the GDP Deflator inflation, suggesting a forward looking pattern in terms of price setting. However, the opposite
occurs when using the CPI inflation measure. In this case, the lagged inflation coefficients seem to be slightly higher than the expected inflation coefficients, suggesting a backward-looking price setting pattern. These GMM estimates seem to be rather inconclusive. One of the drawbacks of GMM according to many authors is that it does not always make efficient use of the information in the sample. Furthermore, it has been demonstrated that the GMM estimators are severely biased in small samples. In this case, the number of observations was 44, which might explain some of the indifferences above.

Conclusions

This paper has provided an empirical analysis of testing the Phillips Curve in the case of the UK. An econometric regression of the traditional Phillips Curve, the New Keynesian Phillips Curve and the New Hybrid Keynesian Phillips Curve has been conducted, using the UK time-series data starting from 1956 to 2010. The three models of the Phillips curve have been estimating using the Generalized Method of Moments (GMM) estimator. This is because the GMM estimator is known to be very robust and does not depend too much on information regarding the distribution of the disturbances. It is also useful in generating the expected inflation variable by making use of forward expectations from historical data, which is used to determine the predicted inflation by the NKPC model.

In order to estimate the Backward-looking model the GMM estimator has been used alongside alternative measures of output gap, as well as alternative measures of inflation. I then observed the signs of the alternative output gaps, to see if they are consistent with theory. I also compared the actual inflation measures (GDP Deflator and CPI) with the predicted inflation by the Backward-looking model, by plotting graphs and carrying out correlation tests. The correlation coefficients showed that the backward-looking model predicts inflation quite well.

For estimating the NKPC model, I employed a similar measure to Gali and Gertler (1999), alongside alternative measures of output gap including GDP and unemployment, as well as alternative measures of inflation to ensure the robustness of the results. I also used labour share as a proxy of real marginal cost. I then compared the actual inflation measures
(GDP Deflator and CPI) with the predicted inflation by the model, by plotting graphs and carrying out correlation tests.

In terms of estimating the Hybrid NKPC, I used the GMM estimator alongside using labour share as a proxy for real marginal cost, just as in the case of the NKPC model, as well as alternative measures of inflation, in order to ensure robustness of the results. I will then compare the actual inflation measures (GDP Deflator and CPI) with the predicted inflation by the model, by plotting graphs and carrying out correlation tests.

Just as in the case of the NKPC, the coefficient of marginal cost when using the GDP deflator inflation measure was negative, while the coefficient was positive for the CPI inflation. As mentioned earlier, the correlation coefficients between both measures of inflation and both labour share proxies are very low and could help explain the inconsistencies in the prediction of this model, just as in the case of the NKPC model.

Another observation is that the coefficients of both the expected inflation and lagged inflation are statistically significant under both inflation measures. However, the expected inflation coefficients seem to be slightly higher than the lagged inflation coefficients when using the GDP Deflator inflation, suggesting a forward looking pattern in terms of price setting. However, the opposite occurs when using the CPI inflation measure. In this case, the lagged inflation coefficients seem to be slightly higher than the expected inflation coefficients, suggesting a backward looking price setting pattern. These GMM estimates seem to be rather inconclusive.

References


