

# The Phillips Curve and Oil Prices

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## Abstract

This paper investigates the “Phillips curve”, a controversial topic in macroeconomics. Many economists claim the Phillips curve is unreliable; recent evidence suggests economists should reconsider the Phillips curve. In particular, this paper investigates a modified Phillips curve, broadly consistent with the 1958 paper by Phillips: it includes import prices as an important influence on inflation. Analysis begins with UK data, as a case study: three Figures are shown, with a discussion on effects of OPEC global oil prices-rises in 1970s. This paper reports regression evidence, for nine countries, which support the idea that the Phillips curve is clearer if we control for import prices.

**Keywords:** Phillips curve, OPEC, import prices, unemployment, inflation

## 1. Introduction

This paper investigates possible links between unemployment and inflation (there are many other possible influences on inflation; this paper does not investigate all of them). Links between inflation and unemployment have been studied by many economists; an influential example is the “Phillips curve” (Phillips, 1958). Akerlof (cited in Mankiw & Reis, 2010, p. 3) stated “Probably the single most important macroeconomic relationship is the Phillips curve”. Many universities teach the Phillips curve “Today, in mainstream textbooks, the Phillips curve—or, equivalently, the aggregate supply relation—is the key connection between real and nominal variables” (Mankiw & Reis, 2010, p. 3). Marsilli (2017, p. 73) claimed “good results on the recent recovery period obtained using time-varying specifications, suggest that augmented Phillips curve model is still of particular use for inflation tracking”.

Economic analysis reported in this paper shows that the Phillips curve is more complicated than some economics textbooks suggest. Some analysts claim the Phillips curve is vertical; others claim it is horizontal; and others claim it forms “loops” (Sloman et al., 2015, pp. 597-618). Some writers suggest the Phillips curve is the worst kind of economic analysis: a form of “data mining”, in which an economist notices an apparent correlation between unemployment and wage inflation, and turns this into a hypothesis (Hetzel, 2013, p. 86).

The Phillips curve is often associated with Keynesian or New Keynesian economics (Mankiw & Reis, 2002, p. 1295), associated with policy advice to governments. Many non-Keynesian economists have used the Phillips curve to criticise Keynesians, claiming that government attempts to reduce unemployment is futile: unemployment cannot be reduced below equilibrium in the long term, and a government using fiscal and/or monetary stimulus may cause inflation—which can only be solved when a subsequent government imposes “shock therapy”, to reduce inflation.

This literature review gives an overview of various questions related to the “Phillips curve” hypothesis. This paper does not address all aspects of the Phillips curve, which would require many books; Forder (2014) gives many insights. Despite continuing criticism, the Phillips curve—and related ideas, such as the “new Keynesian Phillips curve”—is widely used in theoretical analysis of monetary policy (Mankiw & Reis, 2002, p. 1295). This paper adds to the debate on whether or not the Phillips curve is academically respectable, in the early 21st century.

## 2. Literature Review

In this paper, the “Phillips curve hypothesis” refers to the claim that inflation and wage rises tend to be higher,

when unemployment is lower. Phillips curve analysis is usually based on a figure with wage-rises or inflation on the vertical axis, and unemployment on the horizontal axis—as in Figure 2 below. Phillips (1958) shows several charts, each suggesting a downward-sloping line: steeper on the left, and flatter on the right.

Many writers express concern about a lack of precision, when discussing the Phillips curve. Forder (2014, p. 8) wrote “Another important point concerns the numerous ways the expression ‘Phillips curve’ is used. There is not even consistency as to whether it is a relation of wage change or price change to unemployment”. Mankiw and Taylor (2017, p. 343) wrote “it should be noted that Phillips examined inflation in nominal wages rather than inflation in prices, but for our purposes that distinction is not important”; other economists disagree, claiming that the exact specification makes a big difference to research (Mavroeidis et al., 2014, p. 172).

One controversy is who should receive the credit—or blame—for the Phillips curve. There is widespread agreement that Phillips (1958) is an important paper in economics. But several writers claim a negative relationship between inflation and unemployment known before Phillips (1958): for example, the basic idea was suggested by Hume in 1752; and empirical evidence was reported by Fischer in 1926; Tinbergen in 1937; Brown in 1955; Klein and Goldberger in 1955; Clark in 1957; Sultan in 1957 (Bildirici & Özaksoy, 2016, p. 368; Forder, 2014, pp. 11-12). It has been suggested that Lipsey, in 1960, was the true source of “Phillips curve literature” (Forder, 2014, p. 16).

The point where the Phillips curve crosses the horizontal axis (where wages neither rise or fall) is sometimes called the “natural rate of unemployment” by New Classical and Monetarist economists; this is considered the *equilibrium* rate of unemployment—but because of market imperfections and frictions, Keynesians often prefer to call it the “non-accelerating-inflation rate of unemployment” (NAIRU) (Sloman et al., 2015, pp. 597, 604).

### 2.1 What Causality Does the “Phillips Curve” Claim?

A central issue in Phillips curve debates is causality: if there is a relationship between unemployment and inflation, which is the cause and which the effect? Diagrams in Phillips (1958) show unemployment on the horizontal axis, and wage-rises on the vertical axis; this suggests unemployment is a *cause* of falling wages. Most economists who accept the Phillips curve appear to imply that wages tend to fall if unemployment is high, or rise if unemployment is low. For example, Milton Friedman claimed unemployment causes wages to fall, rather than falling wages causing unemployment (Forder, 2014, p. 9). But Schwarzer (2012, p. 994) claimed Phillips had a different interpretation of causality “whereas for Phillips changes in the rate of unemployment induced changes in wages and prices, for economists like Friedman ... unperceived changes in inflation are the driving force of quantity changes”. There could be a feedback process, in which unemployment affects *and is affected by* inflation.

Conventional Phillips curve analysis considers the level of unemployment; another consideration is *rate of change* of unemployment. Phillips (1958, p. 283) wrote “in a year of rising business activity, with the demand for labour increasing and the percentage unemployment decreasing, employers will be bidding more vigorously for the services of labour than they would be in a year during which the average percentage unemployment was the same but the demand for labour was not increasing”.

### 2.2 Is the Phillips Curve Vertical, Horizontal, or Upward-Sloping?

Empirical evidence on the Phillips curve is inconsistent. Ormerod, Rosewell and Phelps (2013, p. 1519) claimed that the Phillips curve sometimes shifts. “It is likely that the factors which govern the inflation/unemployment trade-off are so multi-dimensional that it is hard to identify periods of short-run Phillips curves which can be assigned to particular historical periods with any degree of accuracy or predictability. The analysis shows that reliance on a trade-off between inflation and unemployment for policy purposes is misplaced even in the short run”. Bildirici and Turkmen (2016, p. 366) found “the USA Phillips curve is not stable”. Blanchard et al. (2015, p. 24) report “the slope of the Phillips curve has decreased over time in most countries. Most of the decline, however, took place from the mid-1970s to the early 1990s. Since then, the coefficient has remained roughly stable”.

In the long run, the Phillips curve is seen by Monetarists such as Milton Friedman as being vertical (Mankiw et al., 2016, p. 483), “In the long run, therefore, the Phillips curve will be *vertical* at the rate of unemployment where real aggregate demand equals *real* aggregate supply” (Sloman et al., 2015, p. 604). Nevertheless, many non-Keynesians accept the idea of a short-run Phillips curve sloping downwards.

There is some evidence that the UK Phillips curve may have become almost horizontal in recent years (Sloman et al., 2015, p. 606). Marsilli (2017, p. 65) wrote “there is a consensus on the economic literature about the instability of Phillips Curve over time and its flattening since the 1980’s”. This may be due to inflation targeting,

by central banks and/or by governments: many central banks (such as the Bank of England, ECB, and USA Federal Reserve) are instructed by governmental agencies to keep inflation close to a particular target (Sloman et al., 2015, p. 600)—often 2% inflation per year. If so, and if central banks are able to keep inflation close to the target, we might expect to see little vertical variation in the Phillips curve for the foreseeable future.

We could interpret the Phillips curve as a thermometer, to tell us the state of an economy. If we are at the lower-right-hand corner of the Phillips curve, the economy appears to be in recession or slump; whereas the top-left-corner of the Phillips curve suggests a growth or boom period. Even if we use *wage* rises on the vertical axis (rather than inflation measured by a Consumer Price Index), there are more than two possibilities: an economy could be in recession, but experience wage-rises in response to external forces such as OPEC oil-price rise—a pattern sometimes called “stagflation”. Sloman et al. (2015, p. 605) wrote “In the 1970s, many countries experienced ‘stagflation’—a simultaneous rise in unemployment and inflation”. This suggests there may be periods when the Phillips curve slopes *upward*—a topic discussed below. This appears to be incompatible with the Phillips curve hypothesis.

### 2.3 Are There Loops in the Phillips Curve?

The idea of “loops” in the Phillips curve was mentioned by Phillips (1958). The existence of loops may be related to “hysteresis”, which refers to “the lagging or persistence of an effect, even when the initial cause has been removed” Sloman et al. (2015, p. 598). A related explanation for loops is delayed effects—Phillips (1958, pp. 297-298) found the loops in data he studied could be resolved by using unemployment data lagged by 7 months.

If there are loops, they may be explained by the “expectations-augmented Phillips curve”, associated with Milton Friedman (Sloman et al., 2015, p. 602), shown here as equation 1.

$$\pi = f(1/U) + \pi^e + k \quad (1)$$

In “adaptive expectations”, people expect inflation in the near future to be similar to recent inflation rates. Some economists claim Phillips, rather than Friedman, deserves credit for the concept of adaptive expectations (Sloman et al., 2015, p. 602; Schwarzer, 201, p. 995). In this non-Keynesian approach, *expectations* about inflation are important, “The higher inflation is expected to be, the higher it will be” (Sloman et al., 2015, p. 601). This can lead to the Phillips curve shifting vertically upwards over time: if inflation rises, people come to expect inflation to remain high, hence explaining clockwise loops in the Phillips curve. Mankiw et al. (2016, p. 487) do not refer to loops, but use similar analysis.

### 2.4 Is There a Trade-off Between Inflation and Unemployment?

Another question is how to interpret the “Phillips curve”. Charts in Phillips (1958) may be claimed to imply a trade-off between unemployment and inflation. However, perhaps most of the influential research on this idea of a trade-off occurred long after Phillips’ paper was published in 1958. Forder (2014, p. 1) wrote “Phillips (1958) discovered a negative relation between inflation and unemployment; then, either under the influence of Samuelson and Solow (1960) or otherwise, policymakers treated it as offering a selection of inflation-unemployment combinations from which they could choose”. Hetzel (2013, p. 88), referring to the global oil-price-rise period in the 1970s, wrote “At the heart of the activist policy pursued during the Great Inflation was the belief in an ‘exploitable’ Phillips curve, that is, a Phillips curve allowing the policymaker to trade off between the achievement of unemployment and inflation objectives”.

If the Phillips curve is interpreted as a “menu of choices”, a government can choose economic policy to reduce inflation, or reduce unemployment, but cannot achieve both simultaneously (Forder, 2014, p. 34)—a view apparently accepted, but later rejected, by the UK Labour government (Maloney, 2011). Norman Lamont (the Conservative UK Chancellor of the Exchequer) said “Rising unemployment and the recession have been the price that we have had to pay to get inflation down. That price is well worth paying” (Hansard, 1991).

Bildirici and Özaksoy (2016, p. 368) discuss monetary policies by governments and central banks, claiming the Phillips curve “implies a fundamentally empirical relation between labor markets and monetary policy”. Other economists disagree: Hetzel (2013, p. 89) claimed the “common understanding of the nature of the Phillips curve and activist policy rested on two basic assumptions. First, inflation is a nonmonetary phenomenon. That is, inflation springs from a variety of real factors rather than from the failure of the central bank to control money creation”. Keynesians suggests a government can use “demand management” to reduce unemployment, by increasing government spending (fiscal policy).

The Phillips curve appeared to shift in the decades after Phillips (1958) was published; this offered even greater hope for Keynesian economists, “It is easy to see how the idea could appear to be to shift the Phillips curve with

incomes policy and simultaneously move round it with demand policy” (Forder, 2014, p. 147). Such optimism seemed unjustified when “stagflation” occurred in the 1970s: the Phillips curve appeared to promise that we cannot have high inflation and high unemployment, but both were higher than expected (in UK and USA, for example). Stagflation can be seen in Figure 2 below, perhaps most clearly in 1975 and 1980-1981.

Bildirici and Turkmen (2016, pp. 361-362) discuss the “New Classical” Phillips curve, and the “New Monetarist” Phillips curve; both claim there is an inverse relationship between inflation and unemployment, but only in the short run. Such non-Keynesian economists use the Phillips curve to criticise government attempts to control the economy: such control attempts, they suggest, cannot succeed. Inflationist policy was pursued in some countries, until Phelps and Friedman pointed out in 1967-1968 that continuous inflation changes expectations and shifts the Phillips curve, so there is no long-run trade-off, “although this was initially disputed, in due course it was accepted” (Forder, 2014, p. 1). This is part of the “accelerationist theory of inflation” (Sloman et al., 2015, p. 603, 606; Forder, 2014, p. 14), in which the Phillips curve is used to argue against Keynesian government intervention such as demand management.

### 2.5 Do Import Prices Influence the Phillips Curve?

Perhaps the Phillips curve hypothesis can be improved by including an additional influence on inflation. Phillips (1958, pp. 298-299) considered cost-push and demand-pull inflation, and investigated import prices, “Import prices rose very rapidly during 1950 and 1951 as a result of the devaluation of sterling in September 1949 and the outbreak of the Korean War in 1950. In consequence the retail price index rose rapidly during 1951 and 1952”. Schwarzer (2012, p. 986) wrote “Wage changes in Phillips’ analysis are driven by export and import prices, cost of living adjustments ... and by the demand for labour”, suggesting a simple chart of inflation against unemployment is oversimplified. In general, “the rate of change of money wage rates can be explained by the level of unemployment and the rate of change of unemployment, except in or immediately after those years in which there is a sufficiently rapid rise in import prices to offset the tendency for increasing productivity to reduce the cost of living” (Phillips, 1958, p. 299). Marsilli (2017, p. 66) analysed effects of oil prices on inflation, and claimed “inflation is buffeted by many other supply factors. In this respect, energy related variables are particularly suitable to track price evolution”.

### 2.6 Can We Rely on the Phillips Curve?

Economists disagree about many things; but debates on the Phillips curve are especially heated, because they are central to policy recommendations given by many economists. We can interpret the Phillips curve as a thermometer: if we are at the top-left end of the Phillips curve, the economy may be “overheating” (at the peak of the business cycle, where excess demand raises wages and prices). Alternatively, an economy at the bottom-right end of the Phillips curve may be in recession. The Phillips curve (especially versions including expectations) can also be predictive, “Despite its instability over time and across countries ... the Phillips curve offers a reliable framework for forecasting purposes” (Marsilli, 2017, p. 64).

Economists who support Keynesian “demand management” (active fiscal policy, to smooth out the business cycle) might use the Phillips curve to inform the government when and how to act: whether to raise or cut government spending this month. For example, several UK governments accepted that there is a trade-off between inflation and growth; this “was interpreted as a choice between operating at the bottom of the curve—a ‘preserve the pound’ strategy that looked attractive to Tories—versus operating at the top of the Phillips curve—a ‘go for growth’ strategy more attractive to Labour” (Bollard, 2011, pp. 7-8).

Neoclassical and Monetarist economists see the Phillips curve very differently. Many non-Keynesian economists accept there is a downward-sloping short-term Phillips curve, but claim the long-term Phillips curve is vertical (Sloman et al., 2015, pp. 602-606). If a government used Keynesian “demand management” to reduce unemployment, Sloman et al. (2015, pp. 604-605) state “The implication for government policy is that expansionary monetary and fiscal policy can reduce unemployment below  $U_n$  only in the *short* run. In the long run, the effect will be purely inflationary” ( $U_n$  is the “natural rate of unemployment”).

This paper does not attempt to offer a definitive answer on Phillips curve controversies discussed above, but seeks to improve understanding by focusing on an important but often-neglected confounding variable: import prices. In particular, it builds on previous research such as Marsilli (2017), that global oil prices are relevant to the Phillips curve. Mankiw et al. (2016, p. 488) wrote “Friedman and Phelps had suggested in 1968 that changes in expected inflation shift the short-term Phillips curve, and the experience of the early 1970s convinced most economists that Friedman and Phelps were right. Within a few years, however, the economics profession would turn its attention to a different source of shifts in the short-term Phillips curve: shocks to aggregate supply ... A large increase in the world price of oil”. This paper widens the topic from OPEC oil price-rises in particular, to

import prices in general, as a possible explanation of the apparent upward shift in the Phillips curve in 1970s (shown in Figure 2).

The remainder of this paper is organised as follows. The next section explains the data used, and the number of countries and years examined. Then, regression methods are outlined: a simple Phillips curve model, followed by the same model with the addition of import prices. The following section reports findings, beginning with figures for UK (a case study), and then regression results. The concluding section attempts to reconcile diverse findings on the Phillips curve, and suggests directions for future research.

### 3. Data and Methods

Marsilli (2017, p. 64) discusses the Gordon “triangle” methodology, which typically relies on three elements (sometimes lagged): inflation, unemployment rate, and a supply shock variable. This paper uses a similar approach: the “shock” variable in this paper is import prices, which is associated in some years with global oil-price rises. Hence, this paper follows Phillips (1958) by including a measure of import prices. All data used in this paper are annual.

Inflation data are from the World Bank “World Development Indicators” database; it might be preferable to use wage inflation, as a more accurate reflection of Phillips (1958); but they are not reported by World Bank (2017). Consumer Price Index data are available from World Bank (2017, series FP.CPI.TOTL.ZG), but data do not start until 1989 for UK (the case study). UK figures in this paper focus on the 1970s, when OPEC prices rises led to higher inflation, “the period from the mid-1960s through the end of the 1970s (the Great Inflation) is important in that the characterization of monetary policy—the economists’ proxy for an experiment—was unusually clear” (Hetzl, 2013, p. 83). Hence, this paper uses “Inflation, GDP deflator (annual percentage increase)” from World Bank (2007, series NY.GDP.DEFL.KD.ZG). Unemployment data used here are “Unemployment, total (% of total labor force) (national estimate)” from World Bank (2017, series SL.UEM.TOTL.NE.ZS). Data availability is more complete for UK than ILO estimates of unemployment (World Bank, 2007, series SL.UEM.TOTL.ZS). Data on import prices are “Import Price Index, All Commodities” from IMF (2017). This index is set to 100 in a reference year (which varies between countries). The author attempted to study all countries, for all available years, for the selected variables. To produce reliable regression results, a country is excluded if the effective sample is below 40 years; hence, most countries are removed due to missing data, leaving nine countries in Tables 1 and 2. All nine countries have data from 1975 to 2015; a few countries have more data (the earliest data used is for 1962, and the latest for 2016). For UK, in Figure 3, the real annual GDP growth-rate is calculated from “GDP (constant LCU)” (World Bank, 2017, series NY.GDP.MKTP.KN).

Marsilli (2017, p. 68) compared four empirical models:

- augmented Phillips curve, where oil price variable is daily sampled within MIDAS weighting scheme
- Augmented Phillips curve, with monthly oil price supply shock variable
- Phillips curve model that only includes both unemployment gap and lagged inflation
- Autoregressive model

This paper uses some aspects of Marsilli’s approach: it includes import prices (intended to control for oil price-rises, as well as other import price shocks), as a possible influence on inflation; uses ARIMA regression to take account of auto-regression in the data; and uses lagged data in regressions. The author carried out Auto-Correlation Function (ACF) analysis of data used, and found very strong first-order autocorrelation in inflation and unemployment. Hence, ARIMA (1, 1, 0) regression analysis is used, with the following specification:

$$\pi = a + b[\text{AR}(1)] + d \text{Log}(U) + \xi \quad (2)$$

In equation 2,  $\pi$  represents annual inflation;  $[\text{AR}(1)]$  is a first-order autoregressive term, calculated by SPSS;  $U$  is unemployment (percent); and  $\xi$  is a random error term. The Log of unemployment is widely used by researchers such as Phillips (1958, p. 290)—it helps to reduce errors associated with the curved (rather than straight) nature of the Phillips curve. Terms  $a$ ,  $b$  and  $d$  are constants, estimated by the ARIMA command in SPSS. Results using the above regression are reported in Table 1 below. A different regression specification, used for Table 2 below, is shown in equation 3:

$$\pi = a + b[\text{AR}(1)] + cM_{-1} + d \text{Log}(U) + \xi \quad (3)$$

Equation 3 uses the same terms as equation 2, with the addition of  $M_{-1}$  which is an index of import prices, lagged by 1 year. Unemployment is not lagged (in equations 2 and 3): Phillips (1958, p. 298) used a lag of 1 year for import prices, but a lag of 7 months for unemployment. This paper, using annual data, can only lag by 1 year or

use unlagged data. Using lagged import prices, but non-lagged unemployment, can be justified by the horizontal lines in Table 1 of Phillips (1958, p. 298), and his subsequent comment “From Table 1 we see that in 1948 the cost push element was considerably greater than the demand pull element, as a result of the lagged effect on retail prices of the rapid rise in import prices during the previous year”.

This paper does not attempt a “definitive” test of the Phillips curve: economists referred to in this paper use many different regression methods, and “seemingly innocuous specification changes lead to big differences in point estimates” (Mavroeidis et al., 2014, p. 172). The two regression specifications in this paper have a simple aim: do we find a clearer Phillips curve relationship, if (in Table 2) we add import prices to the regression?

#### 4. Results

Empirical evidence begins with three figures, using UK as a case-study. Figure 1 shows annual percentage rises in inflation and import prices. Import price rose in 1974 and 1980; both years were associated with global oil price rises (not shown in Figure 1). At around the same times (1975 and 1980), there were fairly large rises in inflation (shown by the GDP deflator). The exact timing of these price-rises is not clear in Figure 1, due to use of annual data; but Figure 1 is consistent with the sequence of events from rising global oil-prices, to rising import costs for UK, and to rising inflation in UK. This suggests that the two big OPEC oil-price rises in 1970s were causes of high UK inflation in 1975 and 1980.

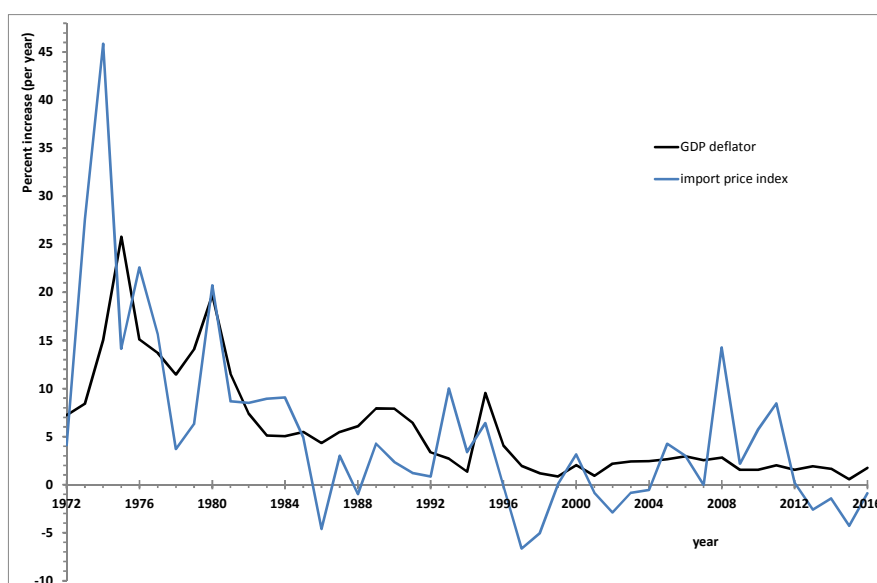


Figure 1. Growth in GDP deflator and import prices, for UK

The next empirical evidence is Figure 2, which shows evidence the Phillips curve for UK: for selected points, the year is identified. A key question is whether or not there are “loops” in Figure 2. The most persuasive loop is from 1972 to 1978; another loop occurs from 1978 to about 1983. After 1983, the existence of loops is less persuasive; if there is doubt about the 1972-1978 and 1978-1983 loops, we might reject the idea of loops in the Phillips curve.

Figure 2 shows dashed lines from 1974 to 1975, and from 1979 to 1980 (years of large global oil-price rises); both show an upward slope, implying rising prices and rising unemployment—apparently rejecting the Phillips curve hypothesis. But in Figure 1, 1974-1975 and 1979-1980 are special cases, presumably caused by OPEC price-rises. Without these two loops, the case for the existence of clockwise loops in the UK Phillips curve seems unconvincing (the period 1981-1988 looks like a loop, but is anti-clockwise: this is incompatible with explanations of loops explained in the literature review).

Focusing on the two dashed line-segments in Figure 2 (1974-1975 and 1979-1980), we can explain increased *inflation* in terms of rising import prices (using Figure 1). But why do these two dashed line-segments also show rising *unemployment*? Figure 3 may explain why: there are noticeable periods of negative growth around 1974 and 1980: periods of recession, which are associated with high unemployment. It is possible that the two large oil price-rises in the 1970s caused high inflation and caused recession/high unemployment. In summary, Figures

1 to 3 are consistent with the hypothesis that “loops” in Figure 2 are artefacts of the data: oil price-rises caused inflation, and also raised unemployment—hence taking the UK economy upwards and to the right in Figure 2, which can be mistaken for part of a “loop”.

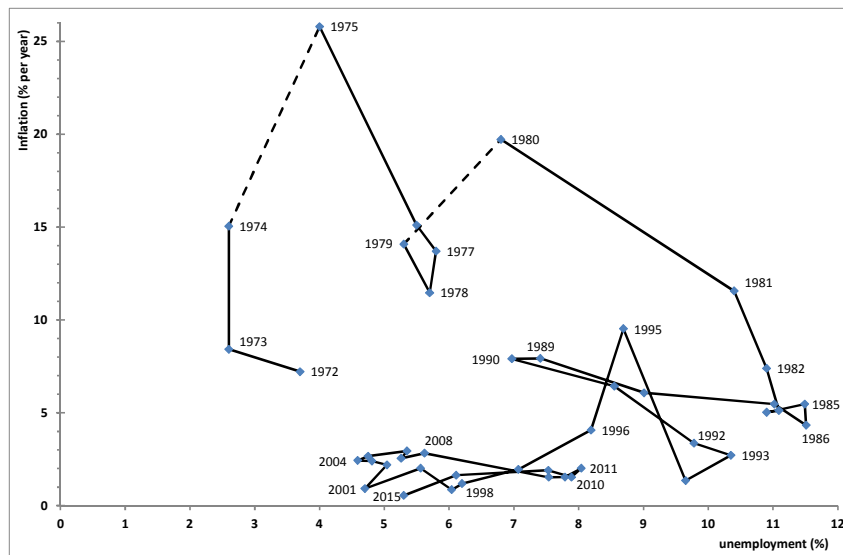


Figure 2. Possible loops in the Phillips curve, 1972 to 2015, for UK

The preceding discussion, based on UK as a case study, suggests several lessons. The theory attempting to explain “loops” in the Phillips curve—discussed in the literature review—may be incorrect. Figure 2 is far from a smooth downward-sloping line (as the Phillips curve is often drawn in textbooks). There may be one or more “confounding” variables, which shifted the Phillips curve vertically: if so, the periods 1974-1975 and 1979-1980 may help us identify a confounding variable, because they were years when the UK behaved least like the Phillips curve predicts. The UK cases study suggests OPEC oil prices-rises may be a helpful explanation of apparent loops.

However, a convincing case requires more evidence than these three Figures. Regression is the standard technique in economics, as Marsilli (2017) carried out using oil prices. This paper now turns to ARIMA time-series regression, explained in the “Data and methods” section; but uses an index of import prices (for each country), rather than oil prices in particular.

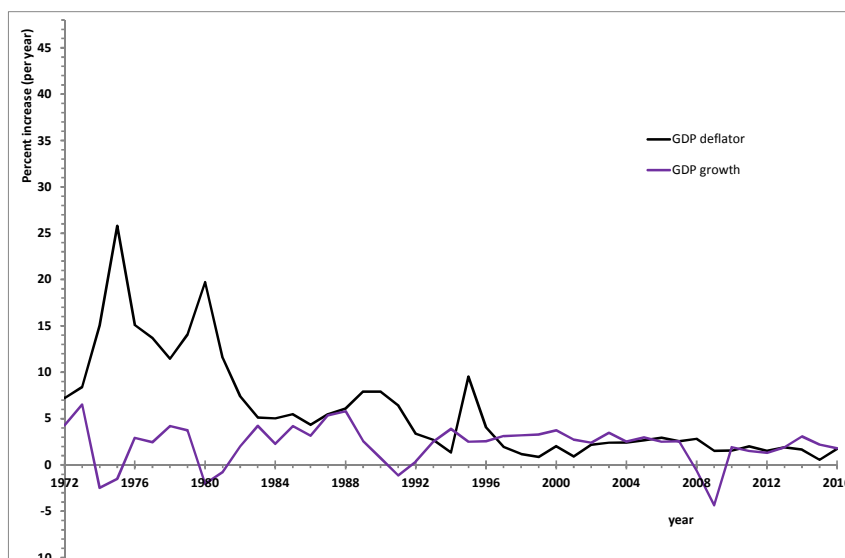


Figure 3. Inflation and GDP growth, 1972 to 2016, UK

Regression results in Table 1 (based on equation 2) show a simple test of the Phillips curve, in which the dependent variable is inflation, and the independent variable is Log of unemployment. Focusing on the right-hand column, most unemployment coefficients are negative, consistent with the Phillips curve; but two countries (Denmark and South Korea) have positive coefficients—implying an upward-sloping curve, incompatible with the Phillips curve hypothesis. These results offer little encouragement to economists building their analysis on a version of the Phillips curve (as many economists do—see literature review). Figures 1 to 3 in this paper may suggest a possible improvement: if we control for import costs, there is less risk of OPEC oil-price rises in 1970s distorting evidence on the Phillips curve. Many other variables could be added to regressions (such as global interest-rates, or a dummy variable to control for the global financial crisis around 2008), but they are beyond the scope of this paper.

Table 1. ARIMA regression results, not including import prices

Country	AR(1)		constant	Log of unemployment	
Austria	-0.38	***	-0.02	-4.05	**
Denmark	-0.32	**	-0.28	1.74	
Finland	-0.20		0.08	-11.77	***
Greece	-0.12		-0.22	-13.86	**
Japan	-0.46	***	0.07	-27.39	**
Korea, South	-0.12		-0.27	0.11	
Sweden	-0.43	***	0.05	-9.96	***
United Kingdom	-0.11		-0.14	-6.52	
United States	0.03		-0.01	-3.30	

Table 2 is based on equation 3, which adds an import price index: this may be better than oil prices used by Marsilli (2017), if other international “shocks” have similar effects as oil price-rises have. By controlling for import prices, Table 2 may be more reliable than Table 1. For this paper, the key point is that Table 2 has a negative unemployment coefficient (implying a downward-sloping Phillips curve) for all nine countries: the unemployment coefficients in Denmark and South Korea (*positive* in Table 1) are *negative* in Table 2. In addition, the number of statistically significant coefficients or unemployment has risen from 5 countries (in Table 1) to 6 countries (in Table 2). In Tables 1 and 2, \* indicates statistically significant at 10%; \*\* indicates statistically significant at 5%; and \*\*\* indicates statistically significant at 1%.

Table 2: ARIMA regression results, including import prices

Country	AR(1)		constant	import prices (lagged by 1 year)		Log of unemployment	
Austria	-0.41	***	-0.02	0.04		-3.79	**
Denmark	-0.59	***	-0.23	0.11	**	-0.54	
Finland	-0.24		0.08	0.03		-11.22	***
Greece	0.02		-0.21	-0.05		-16.60	***
Japan	-0.46	***	0.15	0.01		-29.66	**
Korea, South	-0.19		-0.48	0.04		-1.40	
Sweden	-0.69	***	0.03	0.16	**	-8.69	***
United Kingdom	-0.25	*	-0.09	0.19	**	-9.80	
United States	-0.23		-0.01	0.08	**	-4.55	**

This paper does not attempt to offer a definitive test of the Phillips curve hypothesis: for example, recent empirical research (see literature review) often considers expected inflation. Future research could improve the



above regression results, by adding more variables: a possible candidate is money supply—central to the Quantity Theory of Money—because some countries (such as Zimbabwe) have been accused of causing inflation by printing excessive amounts of banknotes. Increasing the sample-size would be desirable; this might be achieved by using other data sources (for example, using quarterly data).

Mavroeidis et al. (2014, pp. 172-183) argue against making small changes in regression specifications for the Phillips curve, “Issues related to the choice of explanatory variables, instruments, alternate data constructions, and small modifications of the model are likely to be dwarfed by identification problems. Instead, we think it will be more fruitful to explore fundamentally new sources of identification, such as micro/sectoral data, cross-country models, information from elasticity of intertemporal substitution in large datasets, and stability restrictions. Some recent papers have taken up this challenge, and we hope more will follow”. This paper is innovative, in using data on nine countries to test a claim (made by several authors discussed in the literature review, including Phillips himself) that we can understand the Phillips curve better if we treat import prices as a confounding variable. In the Phillips curve, import prices are too important to ignore—especially in the 1970s, when OPEC changed the rules of the game.

## 5. Conclusions

The Phillips curve is important in contemporary economics. Pedrosa and Farhi (2015, pp. 239-240) claim the Phillips curve is one of three equations which are central to New Keynesian economics (the others are an aggregate demand equation, in which output depends on expected future output and real interest rate; and a “Taylor rule”, identifying the interest rate to keep inflation on target). The Phillips curve is also used by “New Classical” and “New Monetarist” economists (Bildirici & Turkmen, 2016).

This paper discusses some controversial aspects of the Phillips curve. There were thought to be “loops” in the Phillips curve; this paper suggests apparent loops in 1970s and 1980s are “artefacts of the data” (during global economic downturns caused by OPEC oil price-rises in 1970s, several events occurred simultaneously: increasing cost-push inflation; and recession which led to increased unemployment).

Robust evidence requires persistent relationships, “The discipline of looking at the entire set of historical experiences rather than isolating individual episodes favorable to one hypothesis ... reveals whether real instability arises in contexts of monetary stability as well as in contexts of extreme monetary instability” (Hetzel, 2013, pp. 86-87). By using data from all available years and all available countries, this paper provides some reassurance that the Phillips curve can be relied on. However, there is considerably more data available from sources such as World Bank (2017), if different variables are used—or if countries with less than 40 years’ data are included.

Evidence in this paper suggests economists are justified in continuing to use the Phillips curve, to interpret the state of an economy. It can be argued that the Phillips curve needs more research. New insights will help economists make sense of the relationship between unemployment and wage-rises, by controlling for other influences such as import prices.

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