Zeitschrift für Wirtschafts- u. Sozialwissenschaften (ZWS) 109 (1989), S. 19 - 47
Duncker & Humblot, Berlin 41

A Generalization of the Phillips Curve

By Fritz Breuss

Die Phillips-Kurve hat viele Interpretationen. Sie ist ein wichtiger Bestandteil der Makroökonomik. Dreißig Jahre nach ihrer Entdeckung wird hier eine Verallgemeinerung vorgenommen, die für alle bisher bekannten theoretischen Interpretationen offen ist. Die Lucas-Angebotsfunktion wird als Spezialfall der verallgemeinerten Phillips-Kurve abgeleitet.

1. Introduction

Thirty years ago Professor *Phillips* (1958) gave (macro) evonomics a new paradigm: the relationship between inflation and unemployment, later called "Phillips curve".

Since 1958 Phillips curve analysis "has evolved under the pressure of events and the progress of economic theorizing, incorporating at each stage such new elements as the 'natural rate hypothesis'[1], the 'adaptive expectations mechanism'[2], and most recently, the 'rational expectations hypothesis'[3]. Each radically altered its policy implications. As a result, whereas the Phillips curve was once seen as offering a stable enduring trade-off for the policymakers to exploit – a sin comitted by *Samuelson / Solow* (1960) – it is now widely viewed as offering no trade-off at all. In short, the original Phillips curve notion of the potency of activist fine tuning has given way to the revised Phillips curve notion of policy ineffectiveness"[4].

The time has come to attempt a generalization. The purpose of this article is therefore not to review again the vast theoretical and empirical literature about the inflation-unemployment trade-off which accumulated in the last thirty years[5], but to present a generalized model of the phillips curve which is able to incorporate all possible theoretical interpretation known hitherto and hence pushes the Phillips curve analysis to the extreme.

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[1] Expectations augmented Phillips curve; see *Phelps* (1967) and *Friedman* (1968).

[2] See *Gordon* (1976) and *Wachter* (1976).

[3] See *Lucas* (1972, 1973).

[4] See *Humphrey* (1985), 3.

[5] This was done repeatedly by *Frisch* (1977, 1980), *Santomero / Seater* (1978) and *Humphrey* (1985).

2. Inflation and Unemployment as "Stylized Facts" of the Business Cycle

It is common sense that in capitalist economies, aggregate variables undergo repeated (but no regular) fluctuations about trend, a phenomenon called business cycles. *Lucas* (1981) 217, with reference to *Burns / Mitchell* (1946) mentions some "stylized facts"[6] about the main qualitative features of economic time series which one calls "business cycle". Technically, movements about trends in reference series (e.g., gross national product) in any country can be described by a stochastically distributed difference (or differential) equation of low (at least second) order[7].

For our purpose the behaviour of price and wage inflation and unemployment in the business cycle is of interest. Lucas and his followers argue that money wages and prices generally are procyclical. No such clear cut statement is given about the behaviour of labour market series. Yet the National Bureau of Economic Research (NBER) in its traditional business cycle analysis includes the series for employment and unemployment rate (inverted = proxy for excess demand for labour) in the list of "roughly coinciding" indicators, which are seen to be procyclical[8]. Whereas there is unanimity that money wages and prices move "normally" pocyclically and unemployment countercyclically, there is no unequivocal view concerning the behaviour of real wages. Some[9] believe that they are procyclical, others[10] think that "observed real wages are not constant over the cycle".

In order to exemplify the aforesaid the behaviour of prices, money wages and the unemployment rate over the business cycle for the "aggregate economy" of 24 OECD countries (Total OECD) for the post World War II period is shown in Figure 1. From the viewpoint of the "stylized facts" approach to the business cycle one can deduce the following tentative conclusions:

1. If the business cycle is "normal", prices and wages move procyclically and the unemployment rate contercyclically. Plotting the time series for inflation against those for unemployment (which is done in Figure 2 by using the data from Figure 1)[11] the result for "normal" business cycle is a

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[6] For an empirical test of this approach, see *Schebeck / Tichy* (1984).

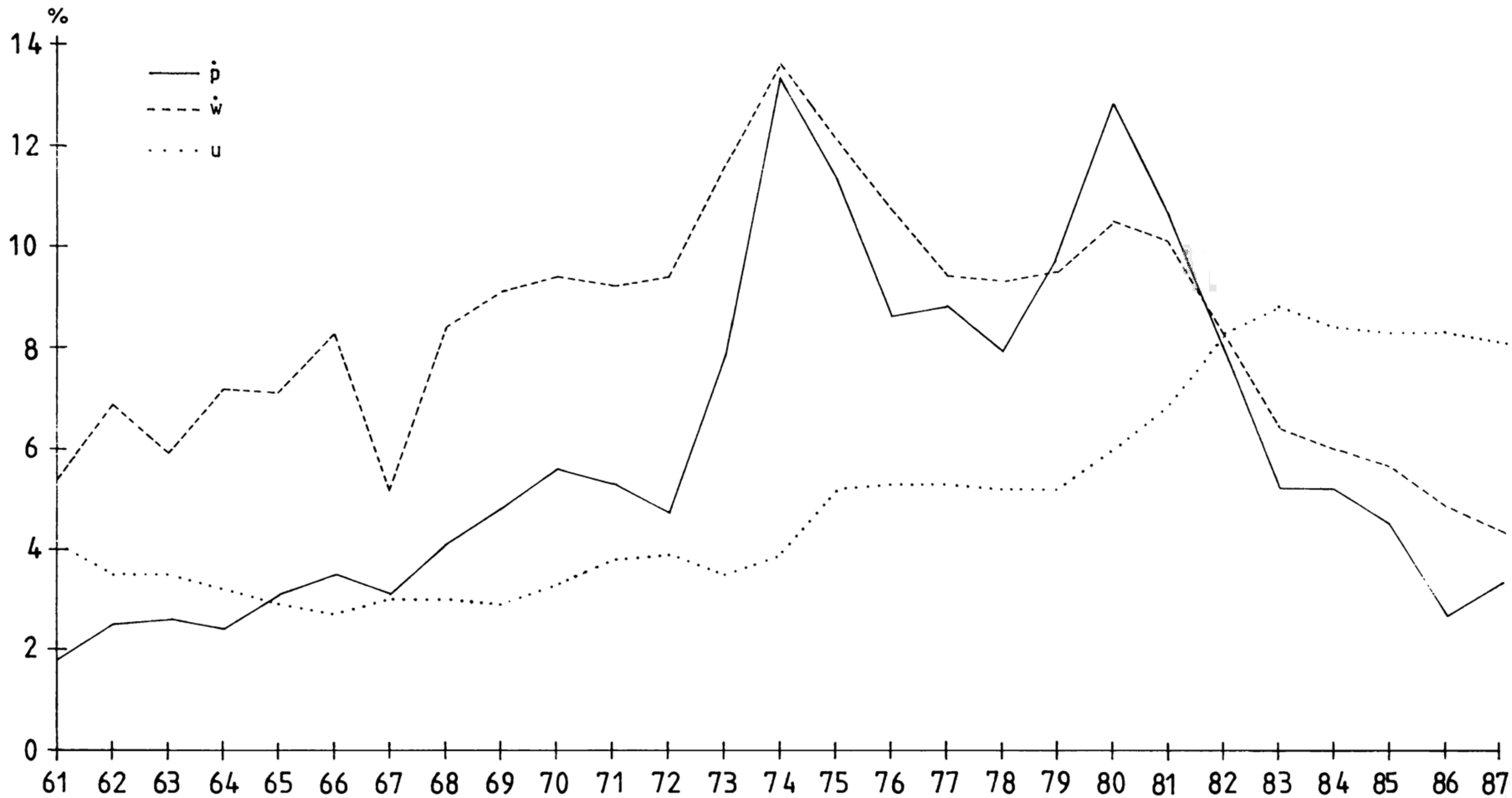
[7] See for example the analysis of the Hicks business cycle model by *Blatt* (1978).

[8] See *Moore* (1980), 78.

[9] E.g., see *Tobin* (1980).

[10] E.g., see *Lucas* (1981), 226. *Sachs* (1983), 265 stresses the necessity to differentiate between countries (in particular between the United States and Europe).

[11] The initial Phillips curve depicted a relation between unemployment (u) and money wage inflation ($\dot{w}$). To make the Phillips curve more useful to policymakers (who usually specify inflation targets in terms of rates of change of prices ($\dot{p}$) rather than wages), it was transformed from a wage-change relationship to a price-change relationship by assuming that prices are set by applying a constant mark-up to unit



$\dot{p}$ = price inflation (percentage change of CPI), $\dot{w}$ = money wage inflation (percentage change of compensation per employee), u = unemployment rate in percent.

Figure 1: Prices, Wages and Unemployment in the Business Cycle. (Total OECD)

"normal" (negatively sloped) Phillips curve. Looking at the actual data (Figure 1) one can detect that these "normal times" ended with the first oil price shock (1973/74). As *Lucas* (1981) 228 - 229 points out, such "shocks to supply which affect all, or many, sectors of the economy simultaneously" lead to " countercyclical wage / price movements". The succession and therefore permanency of supply shocks in the seventies (two oil price shocks) led to a phenomenon called "stagflation"[12]. In a „stagflation" inflation and unemployment move countercyclically which translates into a positively sloped Phillips curve[13]. Figure 2 illustrates that the first major shift from a (more or less) negatively sloped Phillips curve to a positively one occured in the wake of the first oil price shock in 1973/74, the second after the second oil price shock in 1979/80[14].

But as one can easily see from Figure 2, since 1974 (interrupted by the second oil price shock) a process of "disinflation" has taken place in the industrial countries[15]. I.e., the transition from high inflation to low inflation traces a short-run Phillips curve. This process is brought about by lowering inflationary expectations via creating slack capacity or excess supply in the economy. "Such slack raises unemployment above its natural level and thereby causes the actual rate of inflation to fall below the expected rate"[16].

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labour cost and so move in step with wages – or, more precisely, move at a rate equal to the differential between the percentage rates of growth of wages and productivity. The result of this transformation was the price-change Phillips relation (See *Humphrey* (1985), 5). For an empirical study about a wage-change Phillips curve for 19 OECD countries, see *Grubb* (1986).

[12] See *Brunner / Cukierman / Meltzer* (1980).

[13] The worsening of the trade-off in the seventies, i.e., the "stagflation" phenomenon, is now more frequently explained by the so-called "Friedman effect" (see *Friedman* (1977); at first proposed by *Lucas* (1973), 333, 334)). Empirical tests for the United Kingdom (see *Froyen / Waud* (1984)), for West Germany (see *Neumann /Hagen* (1985)), for Austria (see *Aiginger* (1986)). Accordingly, the increased variability of the inflation rate (induced by the oil price shocks) and hence the increase in uncertainty cause a reduction (increase) in the natural rate of real output (unemployment). Following Friedman's logical reasoning one could deduce that the dramatic oil price fall (the reserved oil price shock) in 1986 should have caused an increase in the allocative efficiency of the price system.

[14] If one looks at individual countries (for a four country comparison, see *Breuss* (1986)), one can observe different developments. Whereas the Phillips curve of the United States and of the Federal Republic of Germany exhibit rather the same pattern as those of "Total OECD", in the United Kingdom the Phillips curve was positively sloped from the beginning up to 1975. Austria is an exception. The rather stable long-run price-change Phillips curve in Austria is the result of a smoother adjustment to external price shocks which is attributed to the influence of the administered price-wage setting by the Austrian "Social Partnership" (see *Breuss* (1980); *Wörgötter* (1983); *Rosner / Tintner / Wörgötter / Wörgötter* (1984); *Neck* (1985); *Pollan* (1985/86)).

[15] For a broader discussion about "disinflation", see the proceedings of the conference on "Disinflation – West European Experiences" in (1985), Zeitschrift für Wirtschafts- und Sozialwissenschaften 2/3.

[16] See *Humphrey* (1985), 14.

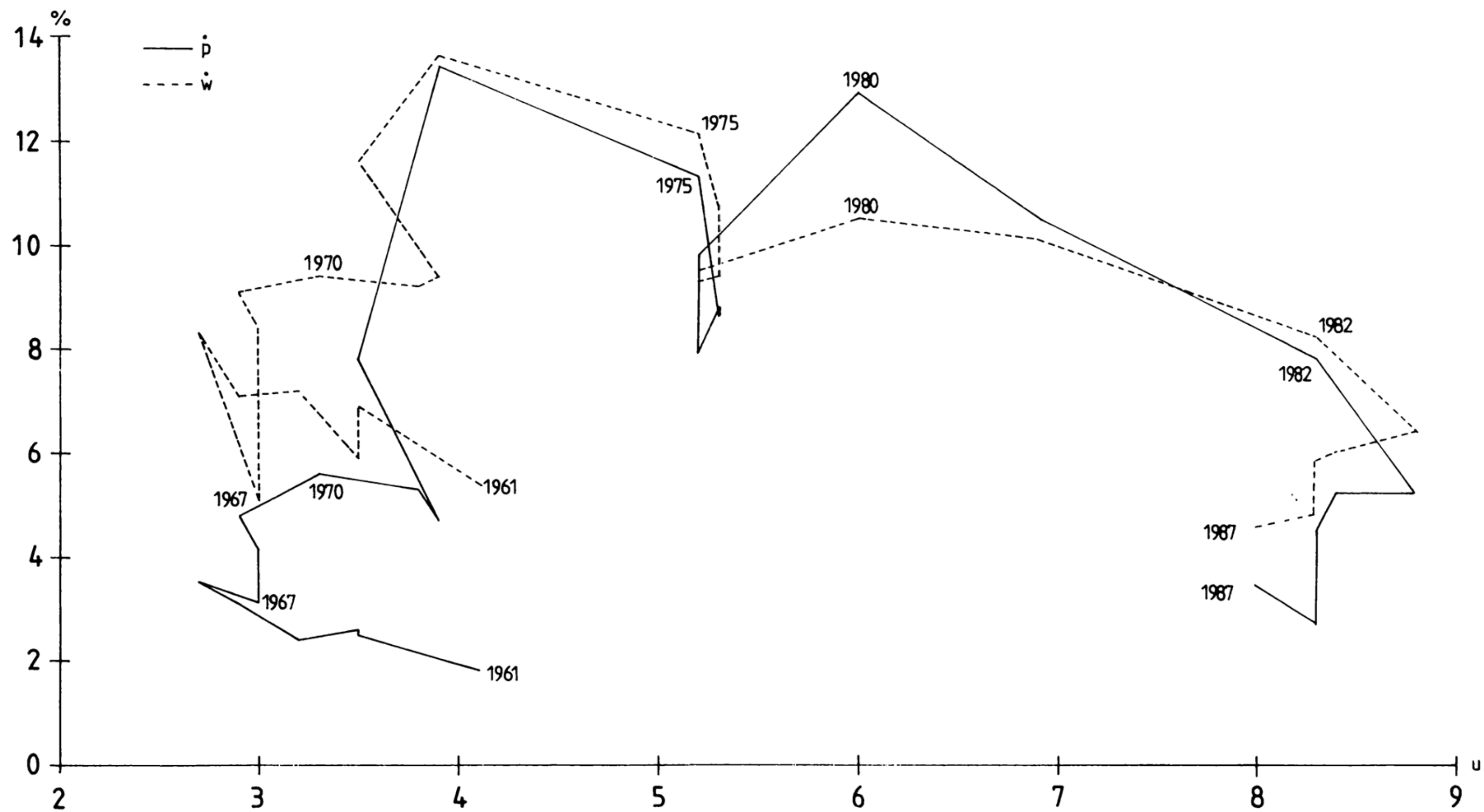


Figure 2: Phillips Curves of Total OECD

2. In addition to the cyclical behaviour of inflation and unemployment in the post World War II period, discussed so far, another feature is worth mentioning: The time series have also different trends (see Figure 1). Price and wage inflation rates follow an upward trend from the 1960s up to the mid-1970s (OPEC I). Since 1974 inflation rates fluctuate around a downward trend, amplified by the OPEC II price shock. Unemployment rate, on the other hand, decreased steadily up to the late 1960s and increased since then in several steps (after OPEC I and OPEC II).

If one abstracts from cycles and only looks at trends the following long-run Phillips curve constellations are possible: The combination of a secular increase of inflation and decrease of unemployment results in a negatively sloped Phillips curve (inflation process). The same holds for the combination of an inflation with a decreasing trend and an unemployment rate with an increasing trend (disinflation process). If, however, both series have an increasing trend, we get a positively sloped Phillips curve (stagflation). The rare combination of decreasing prices and decreasing unemployment would characterize a deflationary process along a positively sloped Phillips curve (e.g., after the oil price drop in 1986).

3. The Mathematical Model of the Generalized Phillips Curve

3.1 The Static Case or the Pure Cyclical Model

3.1.1 Periodic Cycles

When modelling the "stylized facts" story one must assume that, technically speaking, the Phillips curve is the statistical result of the superimposition of two harmonic sinoidal waves (oscillations)[17]. In a first approximation, business cycles can be represented by symmetric oscillations about a rising trend[18].

First, suppose there are two (exogenous)[19] cycles, one in excess demand for labour (for which the unemployment rate is a proxy) and one in inflation.

[17] A first step in this direction was made by *Hansen* (1970). Although he was mainly interested in the relationship between vacancies and unemployment he derived a Phillips relation with a stationary (long term) part and cycles around it. But he concentrated only on the explanation of Phillips' historical counterclockwise cycles. *Young / Barnett* (1978) also propose implicitly a wave-analytic approach to the Phillips curve. They deal with the dynamic properties of Phillips curves (interaction of the second differences of the inflation and the unemployment rates).

[18] *Bradford / Summers* (1984) found for six industrial countries that GNP growth rates and industrial production growth rates do not provide significant evidence of cyclical asymmetry, i.e., that contractions are shorter and sharper than expansions.

[19] In reality the cycles are not exogenous, but part of an interacting economic system.

Let the cycles (oscillations) in the unemployment rate ($u' = u - \bar{u}$) – where u' is detrended – be

$$u' = r_1 \sin \omega t \quad . \tag{3.1}$$

Or one can implicitly assume that u' oscillates around a constant trend or the "natural" value of u.

Similarly, the cycles (oscillations) in the (price)inflation ($\dot{p}' = \dot{p} - \bar{\dot{p}}$; $\dot{p}$ is percentage change in the CPI)[20] shall be given by

$$\dot{p}' = r_2 \sin(\omega t + \delta) \quad . \tag{3.2}$$

The equations (3.1) and (3.2) are general solutions of homogeneous second-order difference and/or differential equations for the special case of regular oscillations[21].

The parameters in the equations (3.1) and (3.2) have the following interpretations: r_1 and r_2 are the (constant) amplitudes (or radius); ω is the angular frequency (or angular velocity; $\omega = 2\Pi / T$; T is the length of the business cycle, measured e.g., in years); t is continous time; δ is the angle of the phase (or phase difference between the two waves for u' and $\dot{p}'$).

Through the transformation $u' = u - \bar{u}$ and $\dot{p}' = \dot{p} - \bar{\dot{p}}$ the position of both variables is given in the $\dot{p} - u$ diagram. In our example $\dot{p}'$ and u' are in the positive quadrant (see Figure 3). But any other constellation is possible. E.g., the case of negative values of $\dot{p}'$ which results in a positive intercept on the u axis.

Second, both single exogenous cycles are combined in order to generate a nonlinear inflation-unemployment relationship, known as the empirical construct "Phillips curve". This procedure is called the addition of two superimposed regular sinoidal waves. Rearranging equation (3.1) gives

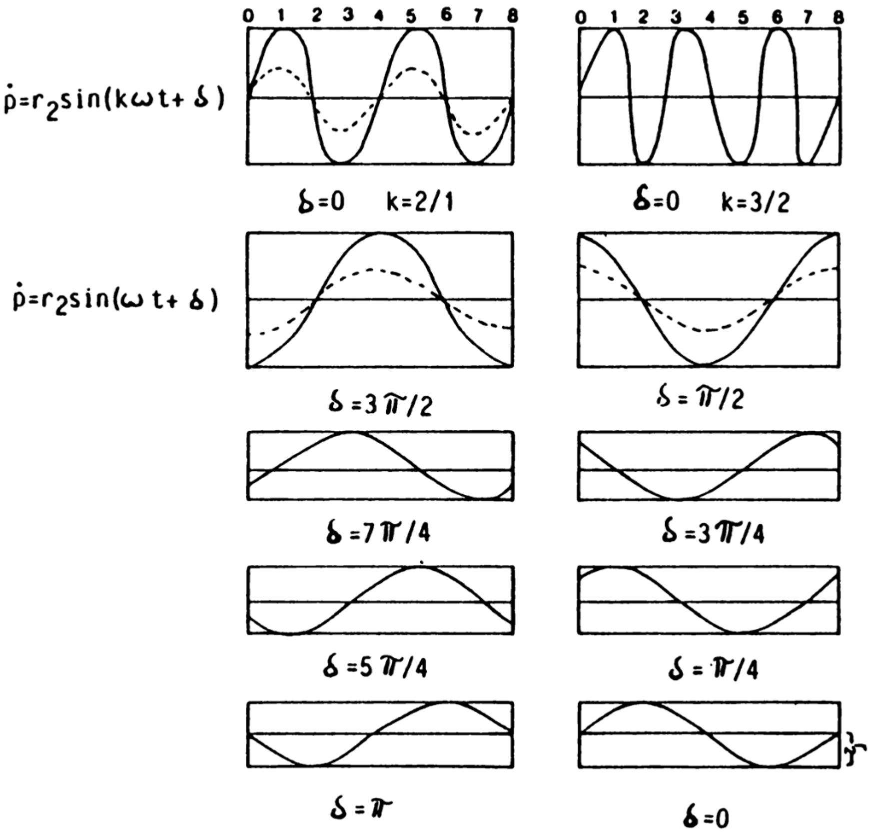
$$\sin \omega t = u'/r_1 \quad \text{and} \quad \cos \omega t = \sqrt{1 - \sin^2 \omega t} = \sqrt{1 - (u'/r_1)^2} \, .$$

From equation (3.2) and the above rearrangements one gets

$$\dot{p}'/r_2 = \sin \omega t \cos \delta + \cos \omega t \sin \delta = (u'/r_1) \cos \delta \pm \sqrt{1 - (u'/r_1)^2} \sin \delta \quad .$$

[20] As was mentioned in the preceding section, the terms "wages" and "prices" can be used interchangeably when analysing the Phillips curve.

[21] More precisely, the characteristic roots of the second-order difference and/or differential equations are conjugate complex. See *Chiang* (1974), 529 ff., 583. *Stöwe / Härtter* (1967), 256, 288, *Breuss* (1986), Appendix). A numerical example for the correspondence between a stochastic difference equation and a differential equation can be found in *Bracewell* (1978), 334, 335 and *Breuss* (1986), Appendix).



r_1, r_2 = amplitudes (radius) ω = frequency (angular velocity)
t = time δ = angle of the phase (phase difference)

Figure 3: Possible Shapes of Short-Run Phillips Curves

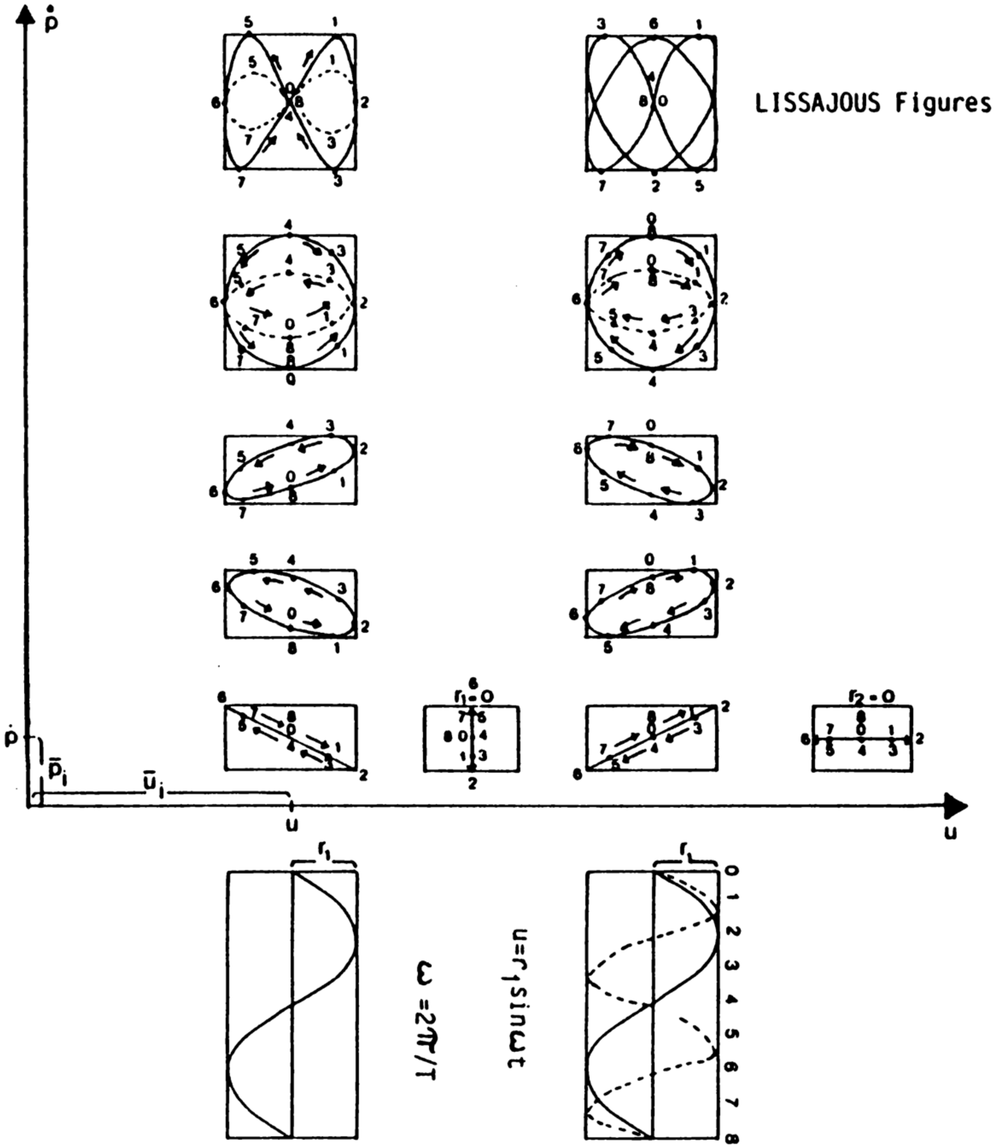


Figure 3 (Fortsetzung)

This can be rewritten such that

$$\left(\frac{\dot{p}'}{r_2} - \frac{u'}{r_1}\cos\delta\right)^2 = \left(1 - \frac{u'^2}{r_1^{\,2}}\right)\sin^2\delta\ .$$

or

$$\frac{u'^2}{r_1^{\,2}} + \frac{\dot{p}'^2}{r_2^{\,2}} - \frac{2\,u'\,\dot{p}'}{r_1\,r_2}\cos\delta = \sin^2\delta\ .$$

From this implicit elliptic function one gets the formula (model) for the generalized static Phillips curve, which turns out to be an ellipsis, namely

$$\dot{p}' = r_2\left[\frac{u'}{r_1}\cos\delta \pm \sqrt{1-\left(\frac{u'}{r_1}\right)^2}\sin\delta\right] \tag{3.3}$$

The static Phillips ellipsis (curve) is the result of repeated regular (business) cycles and equation (3.3), hence, characterizes a stationary state because in the absence of time-trends the repitition of regular sinoidal waves over the given length of a cycle is the only dynamic element[22]. To indicate the absence of "historical" time the variables have no time subscipt. Equation (3.3) depicts the short-run aspects of the Phillips curve.

Equation (3.3) can be interpreted as the *"Phillips possibility curve"*[23] because it allows us to generate different variants of Phillips curves. Varying the values of the parameters r_1, r_2 (amplitudes of the cycles) and δ (phase difference between the inflation and the unemployment cycles) one gets all possible shapes of short-run Phillips curves (see Figure 3):

1. We are now able to verify the heuristic propositions of the "stylized facts" story. In the case of "normal" business cycles one gets a "normal" or standard Phillips curve (a negative, linear[24] relationship between inflation and the unemployment rate). In the "normal" cycle inflation moves procyclically and unemployment countercyclically with respect to a common "reference cycle". If the cycle of the unemployment rate is taken as "reference cycle" the inflation rate oscillates exactly countercyclically. Technically, this is the case if the phase difference parameter $\delta = \Pi$. Then (because $\delta = \Pi$ implies $\sin\delta = 0$ and $\cos\delta = -1$) equation (3.3) yields

$$\dot{p}' = -\,\alpha\,u'$$

[22] The continuous time (t) involved here represents only the measure of an interval $[T', T'']$ between "historical" time (T), defined as the length of a cycle. For these distinctions, see *Georgescu-Roegen* (1971), 135, 136.

[23] This expression is borrowed from *Young / Barnett* (1978), 33.

[24] Because of the static nature of the present analysis only a linear relationship results in this special case. In the dynamic case (next section) the Phillips curve for the "normal" cycle also becomes nonlinear.

where $\alpha = (r_2/r_1)$. α is the relationship between the amplitude for the inflation cycle (r_2) and those for the unemployment cycle (r_1). The steepness of the Phillips curve is determined by the relationship of the amplitudes of both variables, namely by α. The greater (smaller) α the steeper (flatter) the Phillips curve. If there is no inflation cycle ($r_2 = 0$), then $\dot{p}'$ is zero or the Phillips curve becomes horizontal. If, in the other extreme, there is no unemployment cycle ($r_1 = 0$), then $\dot{p}'$ is not defined, i.e., the Phillips curve becomes vertical[25]. The proposition that there is no systematic Phillips curve relationship belongs to the folklore of the "New Classical" macroeconomics. If there are no cycles in both variables ($r_1 = r_2 = 0$), then the Phillips curve, according to the static model of equation (3.3) would shrink to a single point.

2. In a period of "stagflation" inflation and unemployment move countercyclically in relation to a common "reference cycle". I.e., there is a comovement of both variables. Translated in the general model of equation (3.3) this means that the phase difference is zero ($\delta = 0$). Then (because $\delta = 0$ implies $\sin \delta = 0$ and $\cos \delta = +1$) equation (3.3) yields

$$\dot{p}' = + \alpha u'$$

where $\delta = (r_2/r_1)$ as before. Thus the phenomenon of a "stagflation" results in a positively sloped Phillips curve (see Figure 3). Within this static framework, we deal with the "pure" stagflation case, i.e., a situation where the "natural" rate of unemployment is constant.

3. A further aspect of the Phillips curve analysis concerns the *loops*. A. W. Phillips noted that the raw data points were distributed around his long run fitted curve in a systematic way: before World War II, the data described counterclockwise loops and thus tended to lie above the fitted curve when unemployment was falling (and inflation rising); after World War II, the loops became clockwise. A look at the empirical Phillips curve in Figure 2 reveals that in our "aggregate OECD Phillips curve" there was one counterclockwise loop in the wage-change Phillips curve (in the 1960s) and clockwise loops in both Phillips curves after OPEC I (in the individual countries there were several – mostly clockwise – loops after World War II).

A great variety of interpretations[26] has been offered to explain both phenomena. According to *Barro / Grossmann* (1976), 199 - 210[27] both var-

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[25] Extending this short-term model over many periods, this extreme case can also be interpreted as a situation in which the average value for excess demand for labour (the proxy is u) is equal to zero over successive cycles. This implies an average value of unemployment given by u^* (constant "natural" rate). Thus, in the long run, the level of unemployment becomes independent of the rate of inflation (see *Barro / Grossmann* (1976), 207, 208). Hence, on average over all business cycles the long-run Phillips curve becomes vertical.

[26] For an overview, see *Santomero / Seater* (1978), 503, 504.

iants of loops have different theoretical explanations: Clockwise cycles are explained by a price expectations approach (expectation cycles),while counterclockwise cycles are produced by an adaptation mechanism for unemployment (adaptation cycles).

The generalized Phillips curve according to equation (3.3) is able to generate every possible looping pattern. The direction of the loops depends only on the value of the phase difference parameter δ. Clockwise cycles appear when the phase difference (δ) is for instance $\Pi/4$, $3\,\Pi/4$ or $\Pi/2$. Counterclockwise cycles occur when δ is bigger, namely $5\,\Pi/4$, $7\,\Pi/4$ and $3\,\Pi/2$ (in our example in Figure 3). Thus, a slight shift, say from $3\,\Pi/4$ to $5\,\Pi/4$ induces a change from a clockwise to a counterclockwise loop.

In addition, also the exact shape of the loops (cycles), whether they are circles, ellipses or whether they collapse to a straight line, as well as the position of the loops (vertical; horizontal; inclined to the right or to the left) can be determined by varying the parameters r_1, r_2 and δ.

3.1.2 From Order to Chaos

Up to now we have dealt with deterministic order and stability. We assumed that inflation and unemployment follow regular cycles, i.e., the frequencies (ω) of the two superimposed sinoidal waves stand in a one-to-one relation to each other. The most complicated geometrical shape of the Phillips curve was an ellipsis. It can, hover, be demonstrated that the "Phillips possibility curve", created by the superimposition of two harmonic sinodial waves, can take on even more complicated geometrical loop forms than ellipses and circles. Moreover, a simple change in the initial constellation of parameters can lead to "chaos".

Only recently a scientific discovery keeps the scientific community in suspense. Since human records began, human beeings were trained to discover order in nature. Although in some fields (e.g., in astrophysics and in the quantum theory in physics) irregularities are well known, only recently one discovered in ordinary natural processes the "deterministic chaos"[28]. The conclusion is that in contrast to the traditional belief in science, not order is the rule in natural processes, but chaos[29].

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[27] For an application of this traditional approach to explain the loops of the Austrian Phillips curve, see *Stiassny* (1985).

[28] See *Deker / Thomas* (1983); *Breuer* (1985); *Dewdney* (1985).

[29] Recent mathematical theories have been constructed by using the notion of the "bifurcation" of a dynamical system in order to explain the emergence of cycles and the transition to turbulent ("chaotic") behaviour in physical, biological, or ecological systems. Catastrophe Theory (CT) is one such theory. It is a branch of differential topology founded by *Thom* (1972, 1975). It deals with the problems of structural instability of dynamical systems. Simply spoken: It deals with the question under which

In order to demonstrate that the Phillips curve can also end in chaos, we use the concept of the so-called "Lissajous" figures, which are well known in physics. One gets such Lissajous figures when the frequencies ω_1 and ω_2 of the sinoidal oscillations of the equations (3.1) and (3.2) stand in a specific proportion to each other. In Figure 3 only two examples of much more complicated Lissajous figures are generated. In the first case, the relation of $k = \omega_1 / \omega_2$ is 2 : 1 and in the second example k is 3 : 2. For the simplest case ($k = 2/1$; $\delta = 0$) the Phillips curve has the general formula

$$\dot{p}' = 2\,u' \pm \sqrt{1 - \left(\frac{u'}{r_1}\right)^2} \tag{3.4}$$

The Phillips loop has a so-called "point attractor" in the middle of the picture, i.e., the graphs of the trajectory intersect always in the middle. *Deker / Thomas* (1983) speak in this context of "strong causality" (i.e.: similar causes have similar effects)[30]. Translated in our example: Finite repetions of the experiment always result in the same picture. In principle the same is true for the case of $k = 3/2$, except that one cannot derive the explicit formula for this already more complicated Phillips loop.

Now, the initial conditions of our simple nonlinear system are slightly changed. I.e., it is assumed that the frequency proportions k do not consist of integers but of decimals. As a consequence, the parameter changes result in a "deterministic chaos" in so far as the trajectory fo the Lissajous figures does not coincide in a common attractor but diverges from former orbits in an unpredictable way[31]. In this case one speaks of "chaotic attractors"[32] or "crazy attractors"[33]. Such "chaotic" patterns can be found in actual empirical real wage-change Phillips curve (e.g., for the United States[34])[35].

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conditions small changes in the system parameters can lead to qualitative changes (jumps) in the original system behaviour. In economics CT is applied in several special fields (for a mathematical and critical overview, see *Ursprung* (1982); for a more applied overview, see *Fischer* (1985)). Recently, not only qualitative models are built but one concentrates more and more on empirical parameter estimations. One example in our context is the parameter estimation of a cusp catastrophe of the Phillips curve for the United States (see *Fischer / Jammernegg* (1986)). They specify the CT stagflation model by *Woodcock / Davis* (1978), 130 - 132. Formally, this is a nonlinear specification of the traditional expectations augmented Phillips curve.

[30] "Strong causality" implies "weak causality" (i.e., equal causes have equal effects). Traditional scientific measurement (with measurement errors included) is based on the "strong causality" principle.

[31] For an explicit demonstration, see *Breuss* (1986).

[32] See *Haken* (1983), 42 ff.

[33] See *Deker / Thomas* (1983), 74, 75.

[34] See *Breuss* (1986).

[35] *Rothschild* (1982), 191 points to the fact that the inflation-unemployment trade-off is not symmetric. I.e., both, a negatively sloped and a positively sloped (stagflation) Phillips curve is possible. Assuming, that the possible combinations of inflation and unemployment rates are randomly distributed over the p-u diagram, he demon-

3.2 The Dynamic Case or the Complete Model

Until now we have only dealt with the cyclical component of the variables inflation and unemployment. Having worked out the various consequences of the cyclical behaviour of the respective variables for the short-run Phillips curve "Gestalt" we are now ready to complete the model. For this purpose the model is dynamized, i.e., in addition to the cycles also the trends of the time series are taken into consideration.

In reality, the cycles are no longer static and selfrepeating, but their pattern changes over time. A look at Figure 1 reveals that there are trends (increasing and decreasing) in the "natural" rate of unemployment and also in the inflation rate. Hence, in order to model a realistic picture of a changing Phillips curve "Gestalt" over time, we assume that both series consist of a trend component and a cyclical term in the following way.

Let the development of the actual unemployment rate (u_t) be characterized by

$$u_t = u_o e^{g_u t} + e^{g_{r_1} t} r_1 \sin \omega_u t \tag{3.5}$$

where ($u_o e^{g_u t}$) is the trend component[36] and ($e^{g_{r_1} t} r_1 \sin \omega_u t$) is the business cycle term. g_u is the trend growth rate for the unemployment rate. u_o is the starting value of the unemployment rate. g_{r_1} is the growth rate of the amplitude r_1. The cycle in "u" can be damped, if $g_{r_1} < 0$, uniform, if $g_{r_1} = 1$ and explosive, if $g_{r_1} > 0$.

Similarly, let the development of the actual inflation rate ($\dot{p}_t$) be modelled by

$$\dot{p}_t = \dot{p}_o e^{g_p t} + e^{g_{r_2} t} r_2 \sin(\omega_p t + D\,\delta) \tag{3.6}$$

The parameters have the same interpetation as those of equation (3.5). g_u and g_p as well as g_{r_1} and g_{r_2} need not, of course, be identical. ω_u (ω_p) are the special angular frequencies for u_t and $\dot{p}_t$ respectively. Attached to the phase difference shift parameter is a Dummy variable D which may be used to distinguish different time periods with different phase differences.

The same derivation as in the static case yields the formula for the generalized dynamic Phillips curve, which is an exploding or imploding

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strates that a weak negatively sloped Phillips curve emerges. Low unemployment rates are "on average" combined with higher inflation rates. He concludes that uncertain (not sharp) Phillips curves are not the rule, but they are nevertheless the more frequent case in "normal" times.

[36] The trends are not constant over time, but adjustable in the medium term.

ellipsis, depending on positive or negative growth rates for the amplitude parameters (r_1, r_2):

$$\dot{p}_t = e^{g_{r_2}t} r_2 \left[\left(\frac{u_t - u_o e^{g_u t}}{e^{g_{r_1}t} r_1} \right) \cos D\,\delta \pm \pm \sqrt{1 - \left(\frac{u_t - u_o e^{g_u t}}{e^{g_{r_1}t} r_1} \right)^2} \sin D\,\delta \right] + \dot{p}_o e^{g_p t} \tag{3.7}$$

or

$$\dot{p}_t - \dot{p}_o e^{g_p t} = e^{g_{r_2}t} r_2 \left[\left(\frac{u_t - u_o e^{g_u t}}{e^{g_{r_1}t} r_1} \right) \cos D\,\delta \pm \pm \sqrt{1 - \left(\frac{u_t - u_o e^{g_u t}}{e^{g_{r_1}t} r_1} \right)^2} \sin D\,\delta \right] \tag{3.7'}$$

This curve exists under the conditions that $r_1 > u_t - u_o$ and

$$\left(\frac{u_t - u_o e^{g_u t}}{e^{g_{r_1}t} r_1} \right) \leq 1 \ .$$

As one can easily recognize, the generalized Phillips curve of equation (3.7) is identical with the expectations-augmented standard version of the Phillips curve, except for the fact that our formula explicitly specifies the loopings, the shape and the shifts of the curve. In so far as it includes all possible shapes of Phillips curves, it is a true "Phillips possibility curve"[37].

The similarity with the expectations-augmented version of the Phillips curve becomes clear, if one identifies $\dot{p}_o e^{g_p t}$ as the price expectations term $(\dot{p}^e_t)$, the "shift variable", and if one interpretes ${u_o}^{g_u t}$ as the "natural" rate of unemployment (u^*_t), which in our case is not constant, but variable over time.

Equation (3.7') corresponds directly to the "natural rate hypothesis" interpretation of the Phillips curve, namely

$$\dot{p}_t - \dot{p}^e_t = f(u_t - u^*_t)$$

where "f" is an unspecified function. Hence, the trade-off is between unexpected inflation (the difference between actual and expected inflation

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[37] It would be interesting to estimate the parameters of the generalized Phillips curve. Such a test could help to decide, whether this generalized Phillips curve is superior to other specifications in explaining the wage/price dynamics in special subperiods. One has to note, however, that the generalized Phillips curve is highly nonlinear. The most important coefficient in the estimation procedure is δ.

$\dot{p}_t - \dot{p}^e_t$) and unemployment. That is, only "surprise" price increases could induce deviations of unemployment from its natural rate (u^*_t)[38].

In order to capture the main characteristics of the morphogenesis of the actual p-u relationship in most industrial countries after World War II (a fairly stable Phillips curve in the sixties; the phenomenon of stagflation with a positive p-u relationship after the oil shocks; and then a period of disinflation and hence, the return to a normal Phillips curve) a "stylized" generalized Phillips curve is designed in Figure 4 (p. 36/37) and interpreted by the help of the generalized Phillips curve model of equation (3.7).

For this purpose three phases are distinguished:

Phase I is characterized by "normal" business cycles. In addition, due to a secular growth rate of GDP in the range of 4% to 5% the trends in unemployment (downward) and in inflation (upward) point into the opposite direction. A stable international framework on the one hand concerning international trade (increasing liberalization under the OEEC and GATT), on the other hand with respect to international finance (Bretton-Woods fixed exchange rate system; liberalization of international capital transactions under the IMF), as well as more or less constant raw material prices dampen the business cycles. Mild fluctuations around an increasing trend in GDP provoke no drastic policy interventions. This scenario is not fictitious, but a historical sketch of the already glorified period of post World War II up to 1973, the "golden age" of growth in the industrialized world. This period coincides with the "golden years" of a strong belief in the stability of a negatively sloped Phillips curve: first, the general properties of a "normal" business cycle, which imply – due to the equality between $\delta = \Pi$ – also a "normal" Phillips curve; second, the opposite trends in prices and unemployment. These combinations yield a nonlinear downward-sloping Phillips curve.

In Figure 4 this scenario is depicted by 6 cycles of equal length ($T = 4$ years). During the first three cycles we have modelled a "normal" business cycle, i.e., $\delta = \Pi$. The unemployment rate has a downward trend, inflation rate follows a slight upward trend. Furthermore, the business cycle has mildly expanding amplitudes. This results in a nonlinear negatively sloped Phillips curve in the years $t = 0$ to 6. Then, according to the mechanism of the "natural rate" interpretation of the expectations-augmented version of the Phillips curve the short-run Phillips curve shifts to the right (in the years 6 to 11). The transition to Phase II follows.

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[38] For the special case of $\delta = \Pi$ (i.e., $\sin \delta = 0$ and $\cos \delta = -1$) one can derive the explicit form of an "expectations-augmented Phillips curve" from equation (3.7′)

$$\dot{p}_t - \dot{p}^e_t = -\varepsilon(u_t - u^*_t)$$

where the expression $\varepsilon = (e^{g_{r_2} t}\, r_2 \,/\, e^{g_{r_1} t}\, r_1)$ determines the steepness of the curve.

Phase II is characterized by "stagflation". Two oil price shocks (1973/74 and 1979/80) lead – via a deterioration of the terms of trade in the industrialized countries – to an upsurge in inflation (to countercyclical wage / price movements), to a decline in productivity and GDP growth rates, to wider swings in the business cycle, and to a secular increase in unemployment. The period sees radical changes in the policy stance: from a generally accepted Keynesian fiscal policy stance to a more monetarist oriented policy in the largest countries; from a system of fixed exchange rates to more or less flexible exchange rates. Summing up, one could speak of a "policy regime change" in a more broadly defined sense than *Lucas* (1976) had in mind. Lucas warned us, that the coefficients of econometric models might change in the face of policy changes. This is probable true for the most important coefficient in our model, namely δ. The oil price shocks led to a comovement of prices and unemployment, technically, to $\delta = \Pi/4$. Furthermore the "natural" rate of unemployment increased in trend, a phenomenon which can be explained either by the so-called "Friedman effect" (increase in price uncertainty), mentioned erlier or by the persistence of supply shocks[39].

Looking at Figure 4 we see that the "stagflation" period starts with the "oil price shocks" (to simplify the analysis the actual two shocks were concentrated in one "hypothetical" shock) in $t = 12$. The Phillips curve becomes positive and exhibits a clockwise cycle, a phenomenon which corresponds to the actual evolution of Phillips curves in the industrial countries around the oil price shock years 1973/74 and 1979/80 (in the "OECD Phillips curve" there is only one loop after OPEC I; see Figure 2).

Phase III is characterized by the adjustment process of the industrial economies to the oil price shocks. The combination of technological change (structural change into a high-tech society, also in order to regain competitiveness against the NICs on the world market), the substitution of oil intensive techniques as well as energy conservation (a development which led to an oil glut and a near breakdown of the OPEC cartel, and last but not least to the dramatic oil price fall in 1986), the real wage adjustment[40] as well as the policy regime changes (from Keynes to Friedman) induced a process of "disinflation". In this context one can speak of a second "policy regime change" in the Lucasian sense[41]. As a result, in nearly all industrialized

[39] See *Brunner / Cukierman / Meltzer* (1980).

[40] *Bruno / Sachs* (1985), in particular stress the importance of "wage moderation" in fighting stagflation.

[41] Empirical studies which concentrated on the US-Phillips curve found only little change in the coefficients of the standard Phillips curve (no major shift) according to the DRI model (see *Blanchard* (1984)) and time-series techniques (see *Taylor* (1984)) after the monetary policy regime change in the United States in October 1979 (shift from interest rate to money stock targeting). But the policy change was probably only minor and the period (1980 - 83) to short for a serious test of the "policy regime change" hypothesis.

$$\dot{p}_t = \underbrace{\dot{p}_0 e^{g_p t}}_{\text{trend}} + \underbrace{e^{g_{r_2} t} r_2 \sin(\omega_p t + D\delta)}_{\text{business cycle}}$$

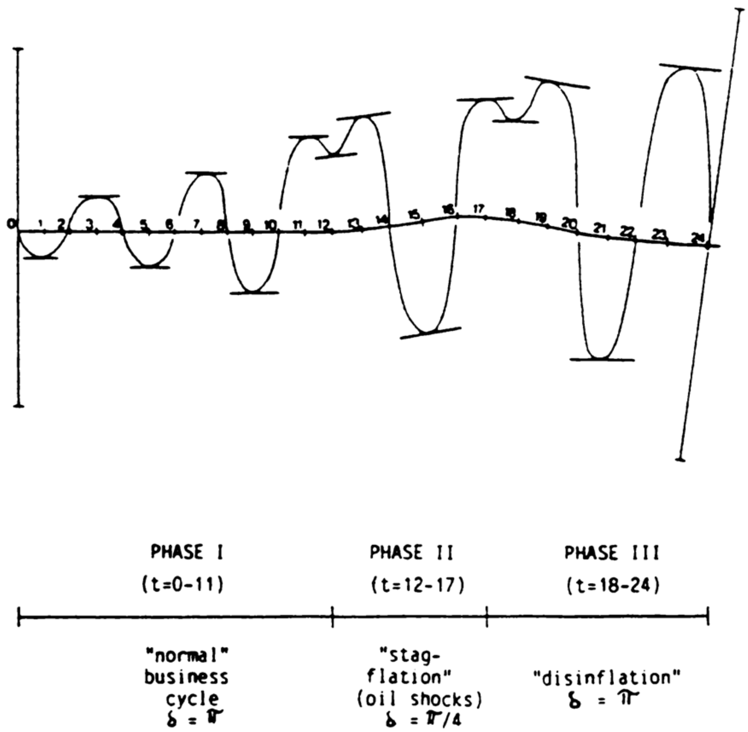

Figure 4: "Stylized" Generalized Phillips Curve

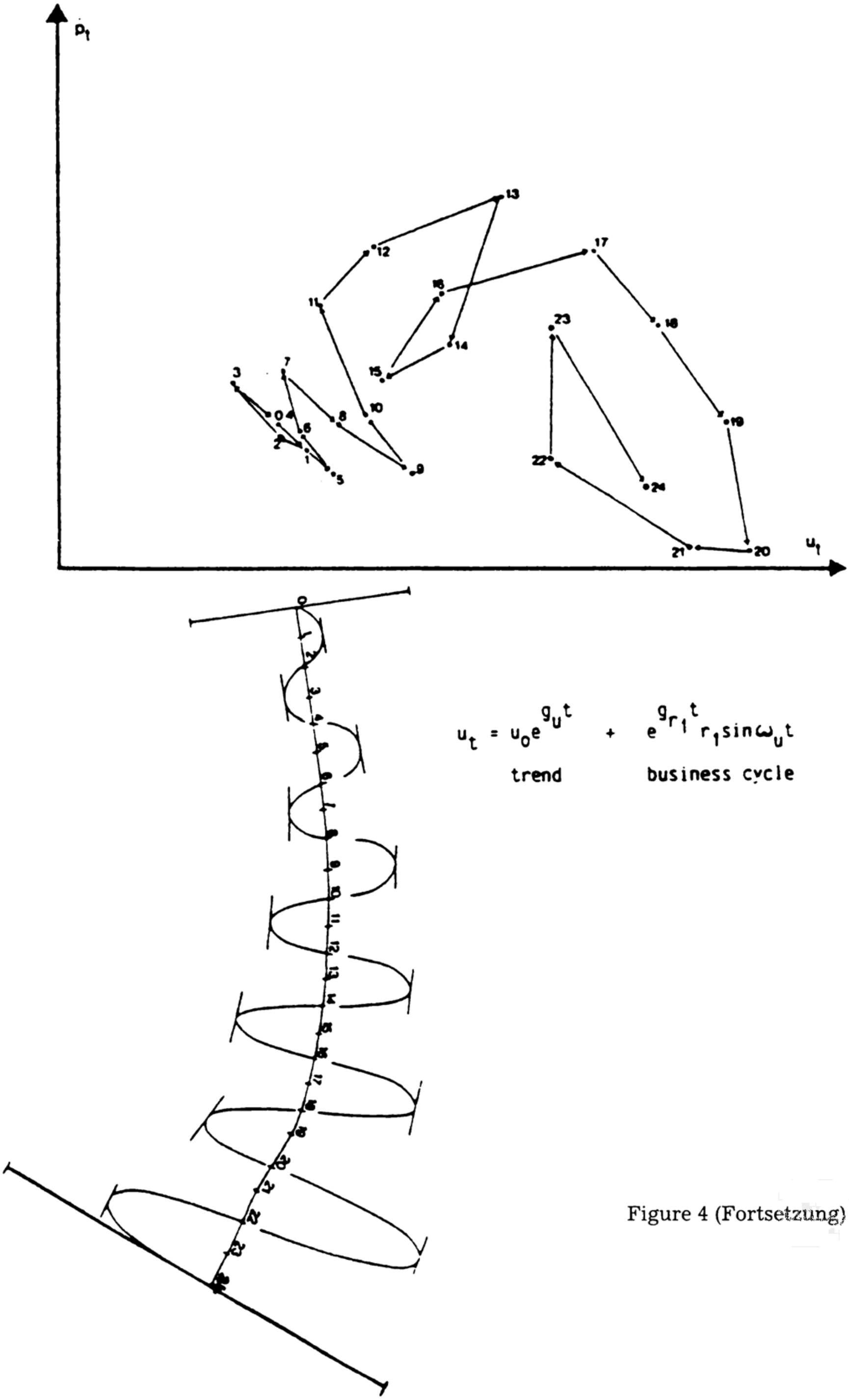

Figure 4 (Fortsetzung)

countries the inflation rate fell to levels comparable to those of the mid-sixties (see Figure 2). This transition from high to low inflation rates ("disinflation" process) is also captured in Figure 4. We assumed that during Phase III (form $t = 18$ to 24), the business cycle becomes gradually "normal" again, i.e., $\delta = \Pi$.

In summing up the results of our generalized Phillips curve, one can draw the following tentative conclusions: The Phillips curve concept is in some version or another the core of modern macroeconomics. But the hope of the sixties that with the Phillips curve the economics profession finally found the long expected "economic constant" like the natural constants in physics, which could it make easier to understand and govern the "chaotic" business life[42], faded as time passed by.

4. The Lucas Supply Function – A Special Case of the Generalized Phillips Curve

In this section it will be demonstrated that the so-called "Lucas supply function"[43] is a special case of our generalized Phillips curve. Furthermore it is shown that it is possible to derive the "invariance proposition" with our generalized Phillips curve, a proposition which belongs to the folklore of the "New Classical" macroeconomics.

4.1 Macro Model

In order to show this, the dynamic version of the generalized Phillips curve, developed in section 3 (equation 3.7), is embedded in an exceedingly simple macro model[44], such that one can find a rational expectation solution. Fiscal policy will be assumed to be held constant, and monetary policy will be the only policy variable affecting the demand for output. The velocity of money will also be constant (implicitly assuming that the demand for money is not responsive to the interest rate). Furthermore it is assumed that wages are indexed with price inflation.

With these assumptions, the aggregate demand for output can be written, in logs, as

[42] See *Rothschild* (1982), 184.

[43] See *Lucas* (1973). For a survey of the Lucas supply function, see *Hof* (1983).

[44] Similar to those of *Begg* (1983), *Sheffrin* (1983), 40 ff. and *Minford / Peel* (1983), 15 ff.

Aggregate demand

$$m_t + \bar{v}_t = q_t + y_t \tag{4.1}$$

where m_t = log of the money supply; $\bar{v}_t$ = log of the (constant) velocity of money; q_t = log of the (GDP) price level; y_t = log of real output (GDP).

In equation (4.1) it is assumed that the appropriate deflator (q_t) is the price of domestic output (GDP). In the Phillips curve, however, the usual variable is a deflator that is a weighted average of domestic and import prices, namely the private consumption deflator or the CPI. In such a formulation the definition of the "price level", p_t in logs, could be written as

Definition of CPI

$$p_t = \alpha\, q_t + (1 - \alpha)\,(\overline{p\,w}_t + x_t) \tag{4.2}$$

or alternatively for q_t

Definition of GDP deflator

$$q_t = (1/\alpha)\, p_t - ((1 - \alpha) / \alpha)\,(\overline{p\,w}_t + x_t) \tag{4.2'}$$

where α and $(1 - \alpha)$ are the expenditure shares of domestic goods and imports; $\overline{p\,w}_t$ = log of the (constant) world price level.

Following *Dornbusch's* (1976), 1163, overshooting model "x_t" is the expected rate of depreciation of the domestic currency, or the expected rate of increase of the domestic currency price of foreign exchange. Denoting the logarithms of the current and long-run rate by "e_t" and "$\bar{e}_t$" respectively, Dornbusch assumes that

Exchange rate expectation formation

$$x_t = \theta\,(\bar{e}_t - e_t) \tag{4.3}$$

This equation states that the expected rate of depreciation of the spot rate is proportional to the discrepancy between the long-run rate and the current spot rate. θ is the coefficient of adjustment.

After the transformation from percentage changes in the price level ($\dot{p}_t$) to the CPI price level ($\dot{p}_t = p_t - p_{t-1}$; p_t in logs) the generalized (dynamic) Phillips curve of equation (3.7) is used here to determine the price level.

Generalized Phillips curve

(4.4)

$$p_t - p_{t-1} = p_t^* - p_{t-1}^* + b\left[\left(\frac{u_t - u_t^*}{a}\right)\cos\delta \pm \sqrt{1 - \left(\frac{u_t - u_t^*}{a}\right)^2}\sin\delta\right]$$

where u_t = unemployment rate (in %, not in logs); u_t^* = "natural" rate of unemployment (in %; $u_t^* = u_o e^{g_u t}$); p_t = log of the price level (CPI); p_t^* can be interpreted as price expectations. Then: $p_t^* = {}_{t-1}p_t^e$ = log of the price level (CPI) that the public expects will prevail in time t viewed from period $t-1$; $p_t^* - p_{t-1}^* = \dot{p}_t^* = p_o e^{g_p t}$ = "expected" rate of change of the price level; $p_{t-1} \approx p_{t-1}^*$; $b = e^{g_{r_2} t} r_2$ = fluctuations of the amplitude for p_t; $a = e^{g_{r_1} t} r_1$ = fluctuations of the amplitude for u_t; D = shift dummy for δ (in equation 3.7), set equal to one.

In the standard rational expectation models one uses explicitly the "Lucas supply function" in order to determine aggregate supply. In the approach chosen here, the "Lucas supply function" is implied by the generalized Phillips curve[45].

The labour market and the goods market are connected here by a special version of Okun's law in the following way

Okun's law

(4.5) $$u_t - u_t^* = \varrho\,(y_t - y_t^*)$$

where y_t^* = log of full employment (or potential output); ϱ = coefficient of adjustment ($\varrho < 0$).

[45] If one assumes that $\delta = \Pi$ (= "normal" business cycle), then $\sin\delta = 0$ and $\cos\delta = -1$ (for $\delta = 0$, the case of "stagflation", $\sin\delta = 0$ and $\cos\delta = +1$).

In the special case of ($\delta = \Pi$) the generalized Phillips curve (equation 4.4) results in a

"Lucas supply equation" for the labour market

(4.4′) $$u_t = u_t^* + \beta_1\,(p_t - p_t^e)$$

where $\beta_1 = -(a/b)$.

And one gets a

"Lucas supply equation" for output by substituting equation (4.5) in (4.4)

(4.5′) $$y_t = y_t^* + \beta_2\,(p_t - p_t^e)$$

where $\beta_2 = +(\beta_1/\varrho)$.

It is interesting to note that the Lucas supply function can be derived as a special case from our generalized Phillips curve and, hence, is the same statistical construct as the Phillips curve. *Grandmont* (1985), 1033, criticizes the "Lucas supply function" more fundamentally by pointing out that the relationship between output and price surprises involves equilibrium magnitudes and therefore cannot be interpreted as supply or demand functions.

In rational expectations models, price expectations are not fixed or predetermined but respond to anticipated movements in the money supply. It is assumed here that the policy authorities utilize the following

Money supply rule

$$m_t = \bar{m}_t + \epsilon_t \tag{4.6}$$

where $E(\epsilon_t / I_{t-1}) = 0$; $\bar{m}_t$ = log of monetary target (known constant).

With rational expectations, the price expectations are determined within the model in light of future developments of the money supply. This is expressed as

Rational expectations

$${}_{t-1}p_t^e = E(p_t / I_{t-1}) \tag{4.7}$$

Equation (4.7) asserts that people's expectations of the price level (${}_{t-1}p_t^e$) equal the mathematical expectations of the price level, given both the structure of the model and the information (I_{t-1}) available.

4.2 Rational Expectations Solution

Given the expectation hypothesis of equation (4.7) one can solve the macro model by substitution. Substituting (4.5) in (4.4) and (4.4) in (4.2′) as well as (4.2′) and (4.6) in (4.1) gives

$$\begin{aligned} \bar{m}_t + \epsilon_t + \bar{v}_t = {} & y_t + (1/\alpha)\, p_t^* + \\ & + (1/\alpha)\, b \left[\left\{ \varrho \left(\frac{y_t - y_t^*}{a} \right) \right\} \cos\delta \pm \sqrt{1 - \left\{ \varrho \left(\frac{y_t - y_t^*}{a} \right) \right\}^2} \sin\delta \right] \\ & - ((1-\alpha)/\alpha) \left[\overline{p\, w}_t + \theta(\bar{e}_t - e_t) \right] \end{aligned} \tag{4.8}$$

Taking the mathematical expectation on both sides of the equation as of time $t-1$ (and assuming: $p_{t-1} = p_{t-1}^*$; $p_t^* = p_t^e$; $y^*{}_t = y_t^e$; $e_t = e_t^e$) gives

$$\bar{m}_t + \bar{v}_t = y_t^e + (1/\alpha)\, p_t^e - ((1/\alpha)/\alpha)\, \overline{p\, w}_t \tag{4.9}$$

or, solved for p_t^e

$$p_t^e = -\alpha\, y_t^e + (1-\alpha)\, \overline{p\, w}_t + \alpha\, \bar{m}_t + \alpha\, \bar{v}_t \tag{4.9′}$$

Now one can solve for output, y_t, by substituting equation (4.9′) into equation (4.8). Simplifying (e.g., assuming that the expression $\left\{\varrho\left(\frac{y_t - y_t^*}{a}\right)\right\}^2$ is approximately zero) gives the solution

$$(4.10)\quad y_t - y_t^* = \frac{\pm(1/\alpha)\,\mathrm{b}\sin\delta}{\left[1 + \frac{(1/\alpha)\,\mathrm{b}}{a}\varrho\cos\delta\right]} + \frac{((1-\alpha)/\alpha)\,\theta\,(\bar{e}_t - e_t)}{\left[1 + \frac{(1/\alpha)\,\mathrm{b}}{a}\varrho\cos\delta\right]} + \frac{\in_t}{\left[1 + \frac{(1/\alpha)\,\mathrm{b}}{a}\varrho\cos\delta\right]}$$

or

$$(4.10')\quad y_t = y_t^* + \left[(4.10)\right]$$

A simplification of (4.10) is possible for the special case of $\delta = \Pi$. Then $\sin\delta = 0$ and $\cos\delta = -1$, (4.10) yields

$$(4.10'')\quad y_t - y_t^* = \frac{((1-\alpha)/\alpha)\,\theta\,(\bar{e}_t - e_t)}{\left[1 - \frac{(1/\alpha)\,\mathrm{b}}{a}\varrho\right]} + \frac{\in_t}{\left[1 - \frac{(1/\alpha)\,\mathrm{b}}{a}\varrho\right]}$$

If one assumes that "b" is approximately equal to "a", the first term in equation (4.10) is a constant. Expectations of the exchange rate ($x_t = \theta\,(\bar{e}_t - e_t)$), in the second term of equation (4.10), also influence actual output only because of the special Dornbusch assumption for exchange rate changes[46].

In general, however, equations (4.10) and (4.10′), respectively, reflect the "invariance proposition" of the "New Classical" macroeconomics. Output fluctuates randomly around the full employment level, with the fluctuations due to unanticipated movements in the money stock ($\in_t$)[47].

[46] With the use of only one deflator (e.g., p_t) in the equations (4.1) and (4.2) this term would vanish. Furthermore, the definitions of the price levels (equations 4.2 and 4.2′) would be made superfluous by this simplification. If instead of (4.3) a "hard currency" exchange rate rule would have been formulated (e.g. like: $x_t = \bar{e}_t + \omega_t$); with $\bar{e}_t$ the exchange rate target and ω_t a stochastic term) equation (4.10) would include a second stochastic element (ω_t) in the second term. Such a formulation would for instance be adequate for Austria's "hard-currency policy".

[47] In contrast to the proposition of the "New Classical" macroeconomics that only unanticipated inflation matters, *Grandmont* (1985), 1031ff., demonstrated with an endogenous competitive business cycle model that there is a systematic relationship between equilibrium levels of output and the real rate of interest (or inflation).

Substituting equation (4.10) into (4.5) and (4.4) respectively, one can solve for the price level, p_t

$$p_t = -\alpha y_t^e + (1-\alpha)\,\overline{p\,w}_t + \alpha\,\bar{m}_t + \alpha\,\bar{v}_t + \tag{4.11}$$

$$+ b\left[\left\{\frac{\varrho}{a}\,[4.10]\right\}\cos\delta \pm \sqrt{1 - \left\{\frac{\varrho}{a}\,[4.10]\right\}^2}\,\sin\delta\right]$$

Hence, the behaviour of prices reflects the choice of the money supply (feedback) rule.

The gap between the actual price and the expected price is[48] ($p_t^* = p_t^e$)

$$p_t - p_t^e = + b\left[\left\{\frac{\varrho}{a}\,[4.10]\right\}\cos\delta \pm \sqrt{1 - \left\{\frac{\varrho}{a}\,[4.10]\right\}^2}\,\sin\delta\right] \tag{4.12}$$

This rather messy expression shows that – as postulated by the rational expectations hypothesis – there is no trade-off between inflation and unemployment (i.e., no Phillips curve). The rational expectations hypothesis implies that deviations in the unemployment rate from its natural rate can still occur when mistakes are made in predicting inflation, but these errors must be of a random nature.

Finally, a simplification of (4.12) is possible. If, for instance, $\delta = \Pi$, then $\sin \delta = 0$ and $\cos \delta = -1$. In this special case, equation (4.12) yields

$$p_t - p_t^e = -\frac{b}{a}\,\delta\left[\frac{((1-\alpha)/\alpha)\,\theta\,(\bar{e}_t - e_t)}{\left[1 - \dfrac{(1/\alpha)}{a}\,b\,\varrho\right]} + \frac{\epsilon_t}{\left[1 - \dfrac{(1/\alpha)}{a}\,b\,\varrho\right]}\right] \tag{4.12'}$$

Conclusions

The Phillips curve is a widely used concept in theoretical and empirical macroeconomics. Depending on the theoretical point of view, the Phillips curve offers either a stable enduring trade-off or it offers no trade-off at all. Thus, the big variety of interpretation of one and the same phenomenon (the Phillips curve) sheds a significant light on economics as a science.

In order to overcome this shortcoming we try to formulate a generalized version of the Phillips curve. For this purpose we start with the idea that the Phillips curve is basically the construct of the interaction of two separate

[48] The solution for q_t would follow if (4.12) were substituted into the definition of q_t (equation 4.2′). The expression of (4.12) would be a little bit more messy but non of the qualitative results would be affected by this exercise.

variables, inflation and unemployment. The "stylized facts" of modern business cycle analysis claim that in "normal" business cycles inflation moves procyclically and unemployment countercyclically. When putting both variables together in a "wave-analytic" approach, this results in a "normal" negatively sloped short-run Phillips curve. In a period of "stagflation", when prices and unemployment – due to external shocks – move countercyclically, one gets a positively sloped Phillips curve. But in general, the generalized short-run Phillips curve is an ellipsis. In reality, however, the variables inflation and unemployment are not only characterized by a cycle but also by trends. Putting trends and cycles together and making again use of the "wave-analytic" approach, one gets a generalized Phillips curve, which is able to map all possible changes of the pattern of the empirical Phillips curve and, hence, is also open to all theoretical interpretation known so far. Therefore, our generalized curve is a true "Phillips possibility curve". Thus, the generalized Phillips curve can either be interpreted by reference to the traditional "expectations-augmented" approach or the „rational expectations" approach. In both cases one can reproduce the postulated results. As an interesting side-result, it could be demonstrated that the so-called "Lucas supply function" can be derived as a special case of our generalized Phillips curve and, hence is the same statistical artifact as the Phillips curve itself.

Summary

The Phillips curve has many interpretations. Either it offers a stable enduring inflation unemployment trade-off (this was the belief of the earlier proponents) or it offers no trade-off at all (this is the folklore of the "New Classical" macroeconomics). The "stylized facts" approach to modern business cycle analysis is used to generalize the Phillips curve. This model is able to map all possible patterns of the empirical curve and, hence, is also open to all theoretical interpretation ("Phillips possibility curve"). The so-called Lucas supply function is derived as a special case of the generalized Phillips curve.

Zusammenfassung

Die Phillips Kurve hat viele Interpretationen. Einige frühe Verfechter glaubten an einen anhaltend stabilen Inflations-Arbeitslosigkeits trade-off, für andere (Vertreter der Neuen Klassischen Makroökonomik) gibt es gar keinen trade-off. Der „stylized facts" Ansatz der modernen Konjunkturanalyse wird zur Verallgemeinerung der Phillips-Kurve herangezogen. Dieses Modell kann alle möglichen Formen von empirischen Kurven abbilden und ist auch offen für alle bisher bekannten theoretischen Interpretationen („Phillips-Möglichkeiten-Kurve"). Die sogenannte Lucas-Angebotsfunktion wird als Spezialfall der verallgemeinerten Phillips-Kurve abgeleitet.

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