Clusters and Loops of the German Phillips Curve

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The Phillips Curve is one of the greatest findings in economics. This widely shared assessment may well be the reason for its presence in almost any textbook on macroeconomics. A short description of what the statistician and economist Alban William Housego Phillips (* New Zeeland 1914; † Australia 1975) has discovered is often followed by an elaborated account of the modifications, critiques and extensions which arose in the course of the cognitive process that was triggered by Phillips (1958). In this way, his achievement appears belittled if not obsolete. For instance, Blanchard and Illing (2009, p. 255) write with a reference to the data of the German economy:

„Nach 1970 bricht der stabile Zusammenhang zwischen Inflation und Arbeitslosigkeit weitgehend zusammen.“[1]

For the time after this “break-down” Dieckheuer (2003, p. 355) states:

„Und auch in empirischen Untersuchungen kam man jetzt immer häufiger zu dem Schluss, dass der mit der (einfachen) Phillipskurve beschriebene stabile Zusammenhang zwischen Inflationsrate und Arbeitslosenquote für viele Industriestaaten nicht bestand.“[2]

Similar assessments which often sound like a falsification (refutation) of Phillips’ discovery can be found easily. A modified Phillips Curve is said to have replaced the original relationship:

„Die alte Phillips-Kurve wurde gerettet, indem sie durch zwei Kurven ersetzt wurde: (1) eine kurzfristige, um Erwartungen erweiterte Phillips-Kurve, die der alten ähnlich ist, sich aber bewegen kann, und (2) eine langfristige Phillips-Kurve, die immer senkrecht verläuft“[3] (Burda and Wyplosz, 2009, p. 386).

From the point of view of critical rationalism one ought to speak of totally different relationships with each of these modifications. However, considering the extensive literature we shall follow the tradition and use the term modifications.

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[1] English translation by the authors: “After 1970 the stable relationship between inflation and unemployment widely broke down.”

[2] English translation by the authors: “And also in empirical studies one came more and more to the conclusion that in most industrialized countries the stable relationship between inflation rate and unemployment rate, which could be described with the (simple) Phillips Curve, did not exist.”

[3] English translation by the authors: “The old Phillips Curve was recovered by replacing it with two curves: (1) one short-term curve including expectations which is similar to the old one but can shift and (2) a long-term Phillips Curve that always runs vertical.”

1. Definition of three different versions

1.1. The original Phillips Curve

Phillips discovered – not without preliminary theoretical considerations – a statistical interrelation, more precisely: a negative, nonlinear relationship between the annual rate of change of money wage rates (y) and the annual unemployment rate (x). The empirical basis of his study consisted of data of the United Kingdom from 1861 to 1957. Based on the period 1861-1913 and verified with the periods 1913-1948 and 1948-1957, he set up an equation which generalizes his finding (Phillips, 1958, p. 290):

$$y + 0.9 = 9.638x^{-1.394}. \quad (1)$$

In this formula, it is not the parameter values that are the main issue of the discovery – they were revised soon – but rather this "significant and very interesting relation" (Lipsey, 1960, p. 30) between the change of the average wage rate and unemployment, which can be characterized as statistical, nonlinear and negative. Stressing the *statistical* nature of Phillips' finding implies that equation (1) is thought to explain the central tendency of the data only. Other factors like the changes of the unemployment rate, of the consumption and of the import price index should be drawn on to explain the deviations from the central tendency (Phillips, 1958, p. 298; Lipsey, 1960).

Two years later Samuelson and Solow replicated Phillips' finding for the United States of America. They came to the conclusion that the same generalized relation could be observed for the US-American economy too. Due to the availability of data, they did not utilize the annual rate of change of the nominal wage rates, but instead utilized the average hourly wages in the manufacturing industry (Samuelson and Solow, 1960, pp. 187-194).

1.2. First modification of the Phillips Curve

Samuelson and Solow went another step further and replaced the rate of change of wages by the inflation rate. [4] One reason for this modification was probably that they considered the wage-price spiral not empirically analyzable. Based on their post-war experiences with the American economy, they postulated a negative relationship between inflation and unemployment and called it:

"our price-level modification of the Phillips Curve" (ibid., p. 192).

Both authors expected that their "Phillips Curve" would be shifted by fiscal or monetary policy arrangements. Furthermore, they drew the consequence that in the short-term there should be a "menu of choice" between the macroeconomic variables "inflation" and "unemployment" (ibid., p. 193). However, they warn of doing explicit forecasts or even "guesses" for the long-term based on the Phillips Curve. In the cited article one cannot find any evidence for the thesis that those authors deduced a long-term "menu" as a guideline for policy makers, which enabled them to choose between the two evils of inflation and unemployment (Hoover, 2010). Moreover, for Samuelson and Solow exists a one-way dependency whereupon unemployment

[4] For a theoretical derivation of this transformation see Steinmann (1973, p. 106). Its basic assumptions are a constant relation between prices and unit labour costs and a constant development of productivity.

affects the inflation in the short-term (Samuelson and Solow, 1960, p. 192) and not the other way around. For the conclusion that the modified Phillips Curve can be utilized in the contrary causality too (a high inflation rate that leads to a low unemployment rate), no evidence can be found in the last mentioned article. The postulated trade-off between inflation and unemployment means the following: If any economic measure produces lower unemployment, higher inflation has to be accepted.

1.3. Second modification of the Phillips Curve

At the end of the 1960s the modified Phillips Curve increasingly faced criticism. The main critique consisted in the thesis that there could not be a long-term trade-off between a nominal variable (inflation) and a real variable (unemployment) (Phelps, 1967; Friedman, 1968; Phelps, 1968). Higher inflation leads to a higher inflation expectation, which again positively affects inflation. According to this view, the real wage and not the nominal wage represents the relevant price for the labour supply and labour demand, which are illustrated in the unemployment rate (Kösters and Hofmann, 1998, p. 160). The conclusion was that in the long-run the Phillips Curve has to be a vertical line (Abel and Bernanke, 2001, p. 445 or Mankiw, 2004, p. 786). Only at times in which the average of the actual inflation and along with it the expected inflation would develop relatively steady, the relation postulated by Samuelson and Solow should be applied (Friedman, 1968, p. 9). Therefore, the second modification consisted in the addition of inflation expectations to the relation between inflation and unemployment.

1.4. Other developments

Further modifications could be seen in the alternative modeling of the formation of expectations. If, for example, the expected inflation is equal to the inflation of the previous period, it can easily be shown that unemployment does not affect the inflation but the change of the inflation rate.[5] According to Blanchard and Illing (2009, p. 257), „…diese Argumentation ist der Schlüssel zu den Geschehnissen seit den 70er Jahren“[6]. If this holds true for the German economy is now to be examined.

2. A pretest

Table 1 shows the estimated results for linear regression equations with which the above described versions of the Phillips Curve can be formulated in a simplified form and statistically tested in an easy manner. The simplification consists in a linear approximation. It is legitimized as far as “there was only seldom strong evidence that unemployment exhibited a nonlinear influence” (Heilemann and Samarov 1990, p. 449). The parameters of the original Phillips Curve (PC0), its first (PC1) and second modification (PC2) as well as an alternative modeling of the expectation formation (PC3) are estimated by the method of ordinary least-squares (OLS). We utilize official annual data of the German Statistical Office (Statistisches Bundesamt) from 1952 to 2004 of the German Economy. The wage rates (w) are operationalized by gross wages and earnings in the numerator and the employees (native concept) in the denominator. In our view, effective wage rates are closer to the real situation on the labour market compared to negotiated wage rates. The “Δ” stands here for the annual

[5] For the theoretically derivation see Blanchard and Illing (2009, p. 251-258).
[6] English translation by the authors: “…this argument is the clue that leads to an understanding of events since the 1970s.”

rate of change and the symbol “t” for the time. As an indicator for the inflation (π) we use the annual change of the consumer price index.

		Parameter value for the exogenous variables…			
Version	Endogenous variable	Unemployment rate	Lagged inflation rate	Adjusted R^2	D-W-statistic
PC0	Δw_t	-0.94*** (-8.35)	- -	0.57	1.74
PC1	π_t	-0.30*** (-3.95)	- -	0.22	0.52
PC2	π_t	-0.20** (-3.28)	0.56*** (6.21)	0.55	1.05
PC3	$\Delta\pi_t$	-0.12 (-1.66)	- -	0.03	1.26

Table 1: Estimated values for different versions of the Phillips Curve.
*Own computations according to data from the German Statistical Office (Statistisches Bundesamt). The t statistics are reported in parentheses below each parameter. One star * means significant on the 5%-level, **significant on the 1%-level, and ***significant on the 1/10%-level.*

The structure of the table is now shortly illustrated by means of two examples. For the second modification of the Phillips Curve (PC2) the inflation rate π is determined by the unemployment rate and the lagged inflation rate (equates the inflation rate of the previous year) modeling inflation expectations. Of course, all estimated equations include a constant, which is not reported here. For an alternative modeling of the process of expectation formation (PC3) the change of the inflation rate ($\Delta\pi_t$ – the difference to the previous year) is explained mainly by the unemployment rate. In the equation PC3 the coefficient of the lagged inflation rate (see equation PC2) is fixed a priori at the value of one. As it is generally known, this relation is utilized to determine the NAIRU[7] (Blanchard and Illing, 2009, p. 258.).

The results: The signs of all parameters are theoretically plausible. The unemployment rate imposes a negative influence on the dependent variable while the lagged inflation rate has a positive impact.

The original Phillips Curve offers a relatively high adjusted R^2 particularly with regard to the fact that the annual rate of change of money wage rates is explained by only one variable, namely the unemployment rate. According to this result, a one percentage increase of the unemployment rate would lead to a decrease of the change of the wage rates of 0.94 percentage points.

The first modification of the Phillips Curve according to the Samuelson and Solow approach shows a considerable lower adjusted R^2 compared to the original Phillips Curve.

An improvement compared to the latter version of the Phillips Curve yields the second modification on the basis of the Friedman and Phelps considerations. However, even this modification supplies worse results when compared to the original Phillips Curve.

The regression of the alternative modeling of the expectation formation comes up with serious problems. The only explanatory variable (the unemployment rate) has no

[7] Non-acceleration inflation rate of unemployment.

significant impact on the change of the inflation rate. The adjusted R^2 is by far the lowest of all reviewed versions. Furthermore, with regard to the estimation of the second modification of the Phillips Curve, it must be stated that fixing the coefficient of the lagged inflation rate to the value 1 is not a realistic choice.

To this finding we have to add that from the beginning of the theoretical discussion of the "natural unemployment rate" their long-run variability was assumed. Therefore, it was not to expect to get a "good" estimation of the NAIRU for a period of 53 years. Had we chosen shorter periods and let the estimations move over all dates we would have gotten better results. But the periods should not be too short. Considering that the concept of natural unemployment was proposed to measure the relationship of short-run changes of inflation as a function of deviations of the observed unemployment rate from the natural unemployment rate, it makes little sense to estimate the NAIRU based on periods with the length of one year or – even worse – a quarter of a year, although mathematical modeling may enable us to carry out this procedure (Borchert and Fröhling, 2001).

The comparatively best fit to the data has the original or unmodified Phillips Curve, and this was the reason to focus our research on the original finding which is to explain the rate of change of money wage rates by the help of the unemployment rate. We extended our analysis to quarterly data which are available from 1970Q1 to 2009Q4 and explored the visible deviations from the central tendency, especially such special phenomena like clusters and loops, which were already observed by Phillips.

3. OLS or ML? A short remark to the estimation method

There is no doubt that wages and prices are jointly dependent variables that affect each other. A comprising analysis of the circle "prices → wages → prices" requires a complete econometric model endowed with several equations, one of them addressing wages (Eckstein and Girola, 1978, p. 330, Lipsey and Parkin, 1970 or Parkin, 1970). Because wages depend (among other variables) on prices, and prices depend on wages, neither of them should be treated as an independent variable in an ordinary least squares regression. An estimation of the whole system of equations with, at best, the maximum-likelihood (ML) method would be appropriate. However, single equation estimates with OLS are widely used in econometric and forecasting literature, probably because of the technical difficulties inherent in the ML-estimation of models with, say more than, 15 equations. We have chosen OLS as the estimation method in the hope to give some advice for model building too. The main point is not OLS or ML, but that the focus of our analysis is laid to an analysis of single equations. It is well known that OLS and ML estimators of a one equation system are the same in value.

4. The Phillips Curve in Germany

Due to computational restrictions, the Phillips Curve can be displayed from the first quarter of 1972 to the last available date only. Thereby the values for the changes of nominal wages are based on the quarterly average of the monthly labour costs per employee and the unemployment rate is a moving average of four quarters of the number of unemployed per working force. As can be seen in Figure 1, there are two

salient features of Germany's Phillips Curve: Periods in which the data cluster together alter with periods of moving data points from one cluster to another.

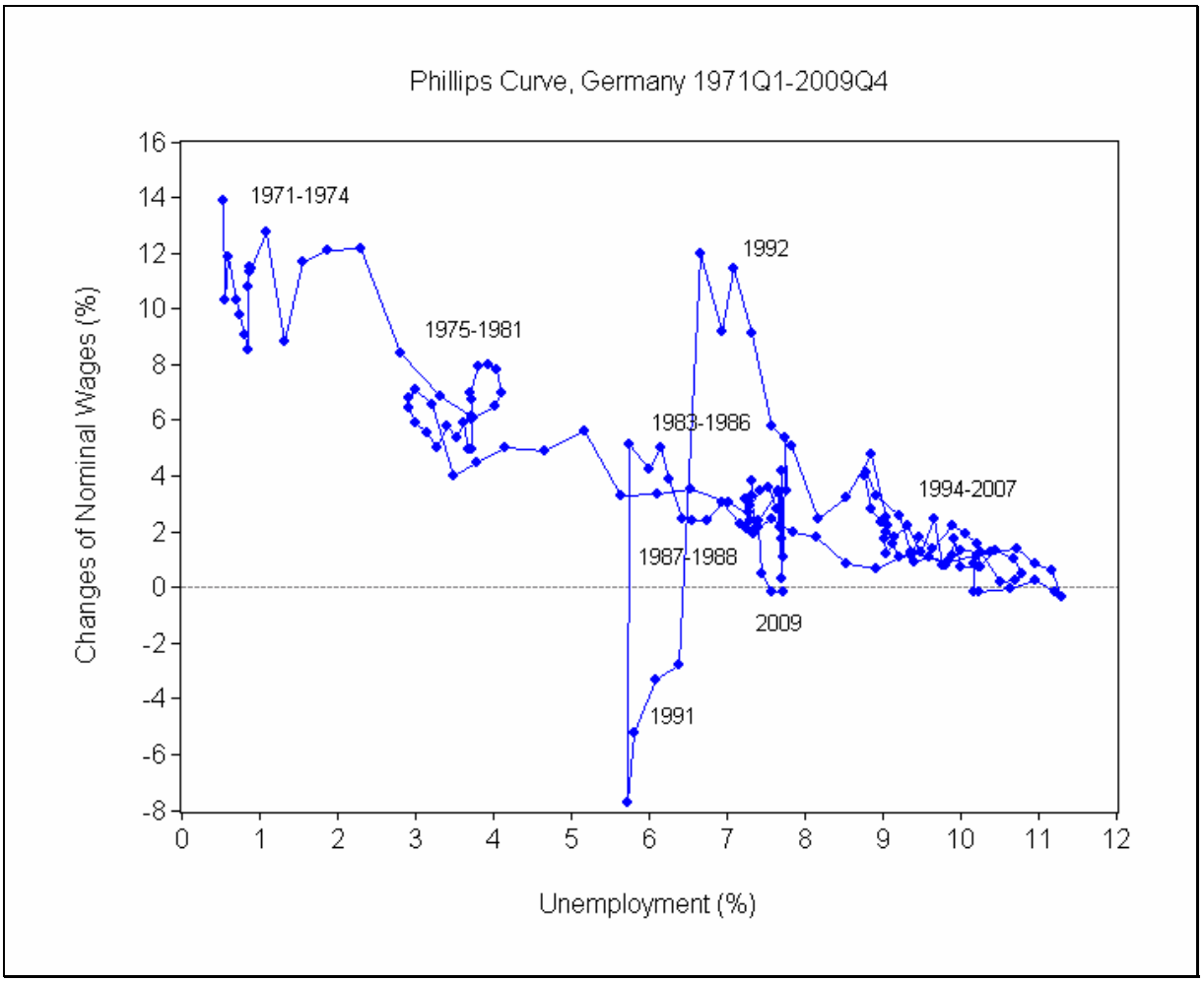

Figure 1: Phillips Curve with its clusters, quarterly data.

From a simple inspection of the data, some crucial questions arise. First, what can be considered as a short-term movement of data points contrary to a long-term movement? Of course, there is no other choice than to assess the whole period of 38 years as a long-term period. Taken this for granted, the observations conflict with the theoretical assumption of a vertical curve which should govern the spread of data in the long run. The vertical curve seems to be a theoretical construction only. As a matter of fact, Figure 1 shows by and large the same non-linear and negative relationship as central tendency of the data, which was discovered by Phillips. Second, taking into account the flexible definitions of "short-term," which can be found in textbooks, at least one thing can be said with certainty: a short-term period must be timely smaller than a long-term period. To avoid the slippery slope of skepticism, we decided to recognize the shortest observed period – the quarter – as the basic element of a short-term movement. Once again, on the rationale of these definitions, the observations conflict with the ruling dogma: The short-term movements, especially in the clusters, are often not like the one we have to expect according to the modern theory that the Phillips Curve as a whole is shifting. Third, the movements between the clusters, comprising often many quarters, have a negative slope of the same kind that Phillips found. Therefore, the next questions are

as follows: Where are the famous shifts located, which are claimed by modern theory allegedly to move the whole Phillips Curve up and down? Do the shifts happen between or in the clusters? How can it be that the shifts between the clusters often have a negative slope like the one in the clusters and like the whole Phillips Curve? When we assume that the shifts are located in the clusters, why does Figure 1 show the same old loops and movements that were already part of Phillips' discovery?

A closer look at the clusters discloses 12 loops (including double loops and one emerging loop at the end of the observation period, see Table 2), some of them with a left and others with a right turn around, among them the 4 examples depicted in Figure 2. The loops are mostly interrupted by periods of simple movements of different lengths.

Period	Correlation coefficient	Type	Turn
1971Q1 – 1975Q2	-0.43	Movement	- -
1975Q2 – 1978Q1	0.30	Loop	Left
1978Q1 – 1979Q1	-0.68	Movement	- -
1979Q1 – 1981Q1	-0.79*	Loop	Right
1981Q1 – 1983Q3	-0.70*	Movement	- -
1983Q3 – 1984Q2	0.28	Loop	Left
1984Q2 – 1986Q1	-0.37	Double Loop	Left
1986Q1 – 1986Q4	-0.05	Movement	- -
1986Q4 – 1987Q4	0.55	Loop	Right
1987Q3 – 1988Q2	0.14	Loop	Left
1988Q2 – 1989Q3	-0.36	Movement	- -
1989Q3 – 1992Q1	0.54	Loop	Left
1992Q1 – 1994Q1	-0.87**	Movement	- -
1994Q1 – 1996Q1	-0.74*	Loop	Right
1996Q1 – 1996Q4	-0.81	Movement	- -
1996Q4 – 1999Q2	-0.50	Double Loop	Left/right
1999Q2 – 2000Q2	-0.10	Movement	- -
2000Q2 – 2002Q3	-0.13	Loop	Left
2002Q3 – 2003Q3	0.09	Movement	- -
2003Q3 – 2007Q1	-0.40	Loop	Left
2007Q1 – 2009Q4	-0.02	Emerging Loop	Left

Table 2: Periods with Loops, Double Loops and simple Movements.
*One star * means significant on the 5%-level and **significant on the 1%-level.*

The correlation coefficients indicate periods in which data could be explained by the simple Phillips Curve (negative sign) or periods in which a shift of the Phillips Curve could have happened (positive sign).

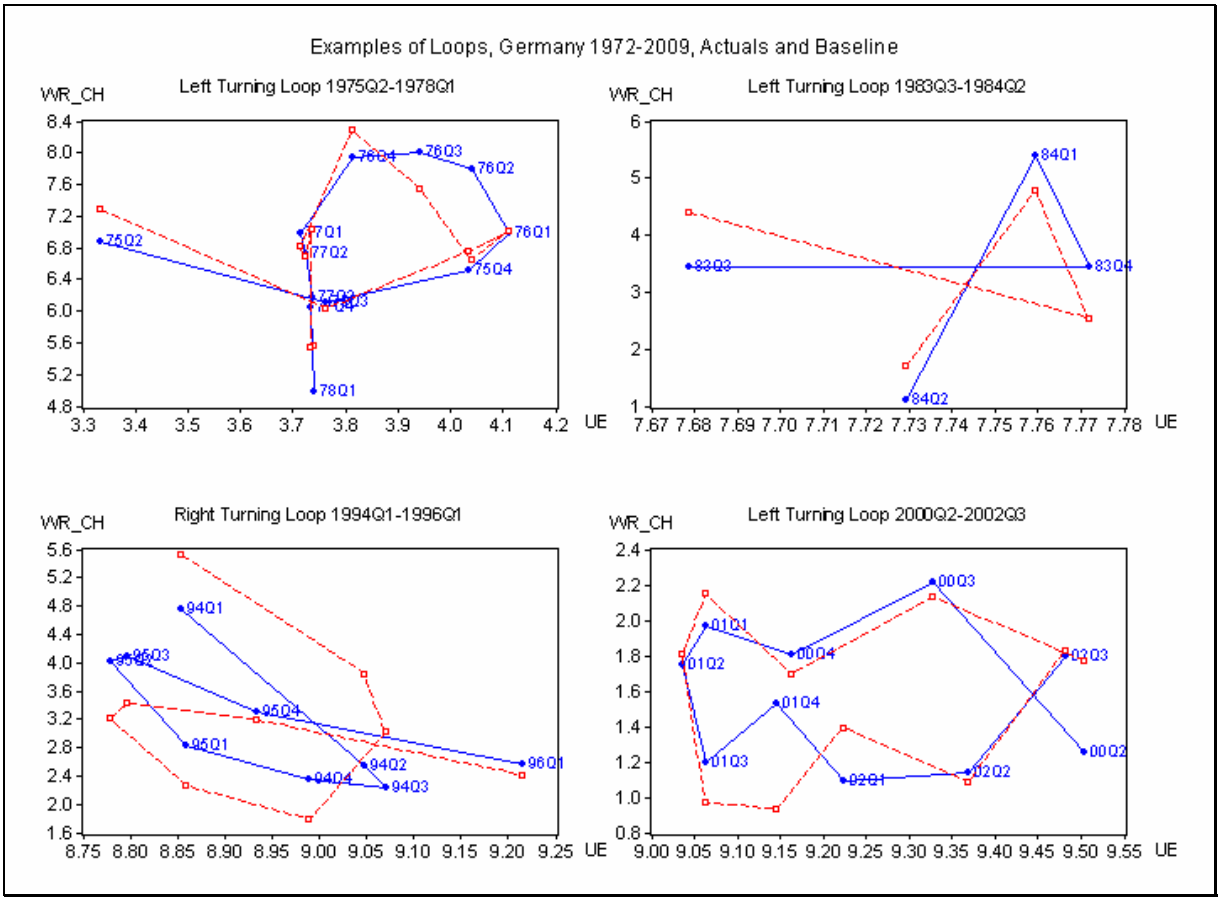

Figure 2: Examples of loops. UE: Unemployment Rate; WR_CH: Change of Nominal Wage Rate; Actuals: solid line; Baseline: broken line.

Phillips suggested that these loops were a phenomenon which occurs more or less in every business cycle. In the phase of a cyclical upturn the actual rate of change of money wage rates were systematically higher and in a cyclical downturn systematically lower than the central tendency of the original Phillips Curve predicted (Phillips 1958, p. 290; Lipsey, 1960, p. 20). This fact was interpreted as the cyclical instability of the Phillips Curve (see Maneval, 1973, p. 91). Phillips also assumed that the possibility "of a time lag in the response of wage changes to changes in the level of unemployment" (Phillips, 1958, p. 293) could be a reason for the formation of the loops. If such a time lag exists the wage change in the actual period will be related to the lagged unemployment rate and not to the unemployment rate of the same period (ibid., p. 292). In his judgment such a time lag would lead to the loops in the diagrams showing the relationship between wage changes and unemployment. For Lipsey (1960, p. 23), structural differences in and dependencies between several product and labour markets of an economy produced the loops.

Other authors interpreted the emergence of the loops as the break-down of the original Phillips curve (Streit, 1972) – if it ever had existed.

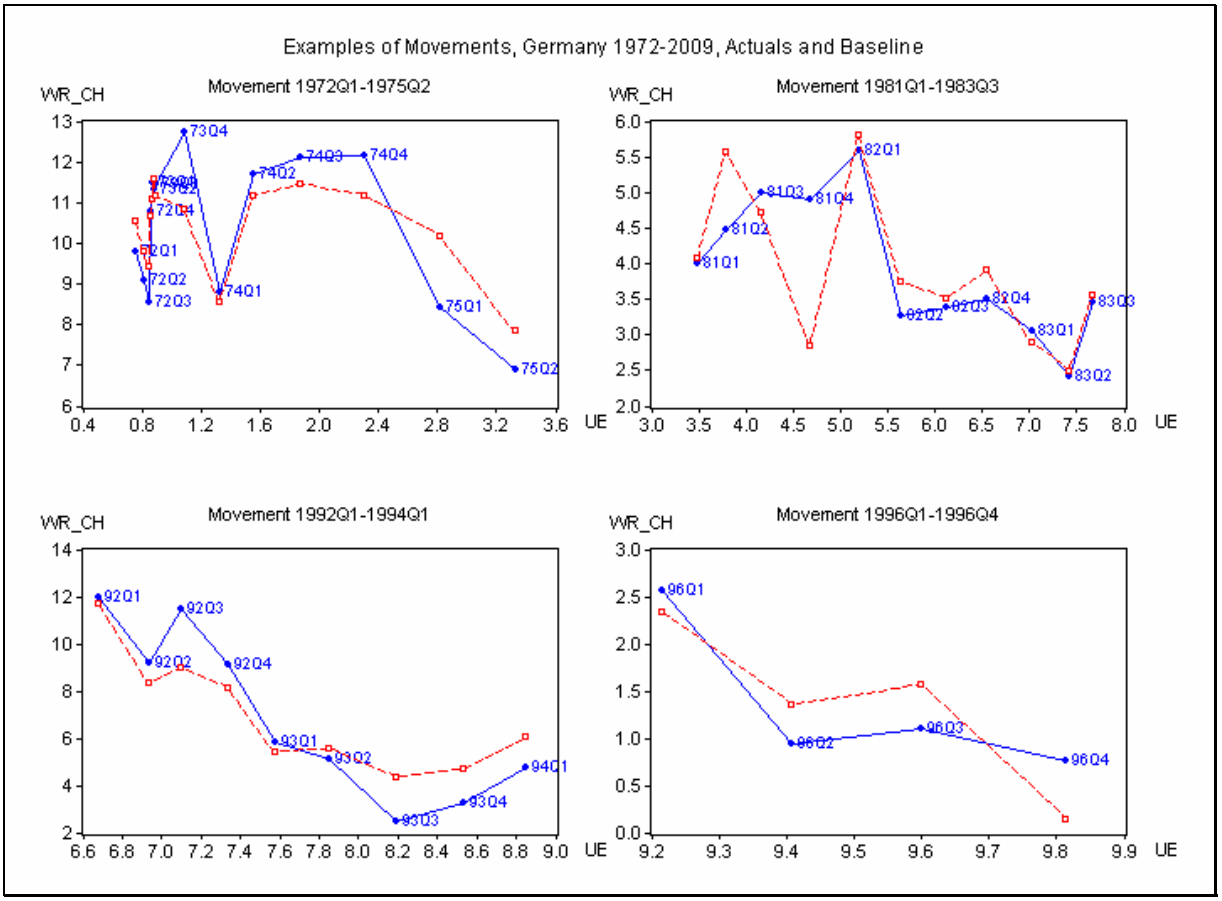

Figure 3: Examples of simple Movements. UE: Unemployment Rate; WR_CH: Change of Nominal Wage Rate; Actuals: solid line; Baseline: broken line.

The German data show that both, the number of loops and the changing direction of their turn around, allow the conclusion that they have nothing to do with the few cyclical upswings and downswings the German economy has experienced (the first hypothesis made by Phillips).

In the search of a new explanation of the loops and the movements between the clusters (loops) we followed the standard method of (i) regressing the long-term movement and (ii) trying to explain the short-term deviations from the long-term tendency by special assumptions and regressions. It turns out that there is no essential difference between the explanation of the loops and the explanation of the movements between the clusters (loops). In the next part we will show that both can be explained by the same regression with about the same accuracy.

5. The estimation of different wage equations

In the years after Phillips' findings, several studies with the focus on additional exogenous variables for the explanation of the rate of change of wage rates were published.[8]

Table 3 shows the estimation results for six different approaches of the determinants of the rate of change of money wage rates. The first five approaches were elaborated by Phillips (1958), Lipsey (1960), Eckstein and Wilson (1962), Perry (1964), and Kuh

[8] A summary of the results of different studies is delivered by Dicks-Mireaux and Dow (1959, pp. 169-172), Eckstein and Wilson (1962, pp. 402-405) or Liebling and Cluff (1969).

(1967). The last estimation equation is an eclectic approach based on the ideas and findings of these and other authors. Also two variables which attracted (by now) in the listed literature only little interest namely the import prices and the export prices are implemented.[9] All equations were fitted by the method of ordinary least-squares to German data for 1972Q1-2009Q4.[10] The constants of the estimated equations are not reported.

The German unification was a shock that is mirrored in our regressor variables only partly: The process of integration of a population governed by a different wage regime into the West German economy needed several years, but the average wage rate was affected immediately. Therefore, we tested the influence of a dummy variable for the German reunification for all equations. This dummy equals the value one for 1991Q1-1991Q4 and zero for the rest of the observation period. In all fitted equation it has a significant negative impact on wages which varies from -9.19 to -11.50. The dummy is part of all equations, but also not reported in the table.

For the nominal wage rates (WR) we use the reported quarterly average of the monthly labour costs per employee. The unemployment rate (U) is a moving average of four quarters of the number of unemployed per working force. As indicator for the inflation we utilise the percentage change of the consumer price index (P); the import prices and the export prices are treated accordingly and denoted by (P_{im}) and (P_{ex}) respectively. The values for the productivity (H) equal the labour productivity per employee and the profit rates (R) are operationalized by property income related to the income of employees. A "Δ" stands for the annual rate of change.

	Parameter values for the exogenous variables…											**RMSPE (%)**	
Author	U	ΔU	ΔP	ΔP_{im}	ΔP_{ex}	H	ΔH	R	ΔR	Adj. R^2	D-W	Loops	Movements
Phillips	-0.93*** (-18.79)	- -	- -	- -	- -	- -	- -	- -	- -	0.75	0.55	87	35
Lipsey	-0.69*** (-9.54)	0.01* (2.17)	0.32* (3.14)	- -	- -	- -	- -	- -	- -	0.78	0.63	108	34
Eckstein, Wilson	-0.90*** (-16.72)	- -	- -	- -	- -	- -	- -	-0.04 (-1.50)	- -	0.75	0.59	86	36
Perry	-0.76*** (-11.99)	- -	0.21[a] (2.85)	- -	- -	- -	- -	- 0.03[b] (-0.82)	-0.05*[c] (-2.61)	0.77	0.65	98	34
Kuh	-0.59** (-4.85)	- -	0.42*** (4.35)	- -	- -	-0.02 (-1.08)	- -	- -	- -	0.77	0.62	111	34
Best Fit	-0.29*** (-6.48)	- -	0.54*** (7.62)	-0.25*** (-9.37)	0.41*** (7.67)	- -	0.80*** (16.72)	- -	-0.14*** (-14.38)	0.94	1.13	53	27

*Table 3: Estimated values for different approaches of the determinants of the rate of change of money wage rates. Own computations according to data from the German Statistical Office (Statistisches Bundesamt). The t-statistics are reported in parentheses below each parameter. One star * means significant on the 5%-level, **significant on the 1%-level and ***significant on the 1/10%-level. U: Unemployment rate; ΔU: Annual rate of change of the unemployment rate; ΔP: Annual rate of change of the consumer price index; ΔP_{im}: Annual rate of change of the import prices; ΔP_{ex}: Annual rate of change of the export prices; H: Labour productivity; ΔH: Annual rate of change of the labour productivity; R: Profit rate; ΔR: Annual rate of change of the profit rate; RMSPE: Root Mean Squared Percentage Error. "a": one period lagged sum of the one-quarter per cent changes in the consumer price index for periods t-1, t-2, t-3, t-4. "b": one period lagged average annual profit rate over the last four quarters. "c": annual rate of change of the average annual profit rate over the last four quarters.*

[9] For instance Phillips (1958, p. 284) assumed that import prices affect the rate of change of money wage rates.

[10] For detailed information about the data, which were used in the estimation equations, see www.forschungsseminar.de/phillips.htm.

In all equations the unemployment rate (U) has a highly significant negative influence on the rate of change of money wage rates. In four of the six estimation equations the consumer price index (ΔP) is an exogenous variable and in three of this it shows a significant positive impact. In Lipsey's equation the influence of the annual rate of change of the unemployment rate (ΔU) is significant and positive. The profit rate (R) has in the Eckstein and Wilson equation and also in the Perry equation no significant impact on wages, but the annual rate of change of the profit rate (ΔR) shows a significant influence in the Perry equation. For the Kuh approach, the level of labour productivity (H) has no significant impact on wages. The adjusted R^2 of the first five estimation equations varies from 0.75 to 0.78. Furthermore, the Durbin-Watson statistic (D-W) signalizes that for all these "historical" approaches there is a problem with autocorrelations.

Also, Table 3 shows the Root Mean Squared Percentage Error (RMSPE) that is based on the differences between actuals and baseline solutions, taken over the (centre of the) loops and over the movements separately, and this for all estimated approaches. Compared to the forecast accuracy of a comprehensive econometric model, the error values are high. The reader may take into account that we try to simulate short-term loops and movements by the help of average parameters estimated over 38 years. In general, we can observe that the errors for the movements are smaller than those inside the loops. But there are not only differences between the explanation of loops and of movements, but also between the explanation of different loops and explanation of different movements. Of course, the Phillips Curve approach with one variable only provides no explanation of any loop at all, because it provides a flat simulation curve. The simulation of a loop can be better or worse compared to a flat one depending on the extent of deviation from the observed data. Therefore, RMSPE has a limited scope for assessing the fit of the simulations. The astonishing fact is that all the different loops and movements can be simulated and in this sense explained by one equation model only.

In the equation of our eclectic approach the rate of change of money wage rates is explained by the unemployment rate (U), the annual rates of changes of the consumer price index (ΔP), of the import prices (ΔP_{im}), of the export prices (ΔP_{ex}), of the labour productivity (ΔH), and of the profit rate (ΔR). For all these variables a highly significant influence can be observed. Ninety-four percent of the total variance is explained. The results signalize the possibility of a first-order autocorrelation. On the other side, the values of the t-statistics are high enough for being taken seriously.[11]

The single variable with the highest influence is productivity. Getting a share in productivity gains seems to play a more important role in the bargaining strategy of unions than getting a compensation for inflation – as far as it does play an important role. The productivity determination theory was ushered by Kuh (1967) as a proxy for profit. It turns out that the rate of change of productivity represents an important determinant, indeed, but it cannot replace profit as part of the single equation model.

There is a broad consensus that money wages are affected by prices reflecting living cost. On average, a change in consumer prices of one unit causes an increase of wages of about 0.54, suggesting that even though money wage bargains are made with a special attention to inflation, compensation is not complete (for similar results

[11] We have to note that between the varibales in the equation of the eclectic approach the problem of multicollinearity exists and therefore instability of the parameter could occur.

see for example Dicks-Mireaux and Dow, 1959, Hines, 1964 or Perry, 1964). This can be interpreted as a partial money illusion or, once again, as a limited effect of bargaining processes.

Surprisingly, the third place in importance is taken by the change of export prices. It reflects the special conditions of an export oriented economy (the “openness” index of Germany is more than 60 percent). Our interpretation of the positive sign of the parameter is simple and sounds plausible: A short-term change in export prices does not reduce immediately the quantity of exports, but enhances the revenue. This seems to be also profitable for employees.

The other side of the coin (of an open economy) are import prices. Because the influence of import prices on living costs is already included in our inflation index, we interpret this channel as follows: Higher import prices mean higher production cost for firms and this reduces the leverage for higher wages.

Changes of export and import prices are taken in this study as production-oriented prices; both are replacing GDP-deflator in this role.

Slightly more important for the explanation of changes of the wage rate in the eclectic approach is the standard variable of unemployment. Even though we introduced five other variables the unemployment rate has kept its significant influence. After several supply shocks and even during and after the German unification, the unemployment rate yields a reliable explanation of wage adjustments not only in the short, but also in the long-run.

The smallest parameter, albeit still significant, mirrors the negative influence of profit changes on wages. On the one hand this seems plausible because an increase of profits leads to the situation that less income can be distributed among the employees. On the other hand the negative impact of profits stands in opposition to some theoretically considerations (Kaldor, 1959, p. 293). The complex relationship can be described as follows: (i) profits and wages are exclusive shares of national income; (ii) growing national income results statistically in both, higher profits and higher wages; (iii) the higher the growths of profits the lower the enhancements of wages. The last point is what we found.

Lagged variables, especially for inflation, did not enhance the explained variance of our best fit regression equation. This seems to contradict the rules and experiences of wage bargaining in which inflation is one of the arguments that is made by union leaders for higher wages. Bargaining is a time consuming process and therefore a time lag should play a role in modelling the influence of the inflation rate. Speaking more exactly, it should be the expected inflation formed in one of the previous periods that plays a role in wage negotiations. Our finding could be interpreted as an indicator of the high ability of unionists in predicting inflation rates. If this were the case, it would be no outstanding skill: With a simple regression equation more than 90% of the next quarter’s inflation rate can be predicted. On the other side, inflation rate defined by the change of the price level, more exactly: of the index of the price development, includes as one factor the Paasche price index of the previous year, which can be interpreted as a crucial factor forming price and inflation expectations (for more on this point see next footnote).

Figure 2 and Figure 3 illustrate that the eclectic estimation equation can explain both the loops and the movements of the German Phillips Curve satisfactorily.[12] Table 3 shows that the RMSPE of the "best fit" approach is by far the lowest of all fitted equations inside the sum of all loops as well as for the sum of all movements. These results suggest the conclusion that the found estimation equation that determines the rate of change of money wage rates in the long-term can trace short-term deviations from the central tendency of these long-term movements too. In other words the curve in the long-run can be explained by the same variables as in the short-run.

6. Stability of the parameter estimates

The reported estimations are based on the comparatively long period of 38 years. The parameter values are averages with a high statistical significance due to the high number of 152 observations. We carried out simple stability tests under the leading question whether or not the same dependencies could be detected by the help of a regression analysis by OLS based on periods with a length of 10 years only. Figure 4 shows the estimates of all parameters of our best fit regression reflecting the most recent last 40 observations (10 years) for every quarter since 1981Q4 (so called "moving window").

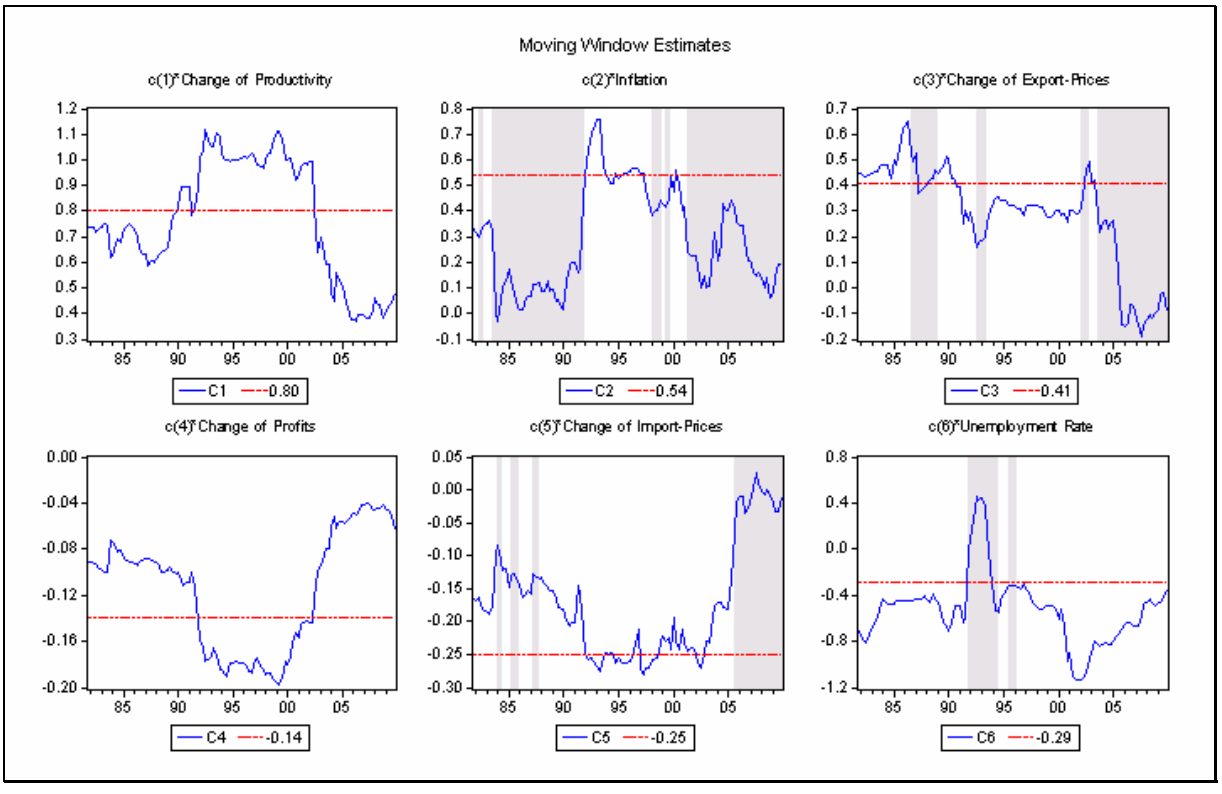

Figure 4: Moving Window (10 Years) Parameter Estimations of the best fit approach; total average: broken line; not significant estimates on the 5 percentage level: shaded area.

[12] For lack of space only four examples of loops and movements are presented in this study. A summarisation of all loops and movements with the estimated values of the eclectic approach can be found on the following website: www.forschungsseminar.de/phillips.htm. The exact definitions of indicators applied in this study can also be found.

The positive influence of productivity changes on changes of the wage rate could be observed all the time, even after 2002 when it fell down considerably. The widely shared opinion of inflation as the central argument in wage setting bargaining shows up in parameter estimation only partially: more than half of the time the parameter was not statistically significant. The parameter of the inflation rate is below one all the time indicating a non-accelerating wage-price mechanism. With the exceptions of the crisis at the end of the 1980s, in the 1990s, and during the sluggish development in the first decade of this century, a change in export prices had fruitful consequences for wage earners. Apparently, difficult to detect for many researchers in the past, we found that higher changes of profits reduce the leverage of wage enhancements – of course, this is no big surprise. Import prices are interpreted here as wage reducing cost – the periods with deviant parameter values nearby zero or even with a positive sign show no statistical significance. The standard explanation of wage rate changes by unemployment holds for almost all the time; only during a short period after the German unification this relationship could not be detected by regression estimations using a ten-year moving window.

To econometricians of the past who had had the same best fit regression and data available as we did, periods in which one of the parameter values turned out to not be significant would have appeared as structural breaks because with one parameter in an equation less all parameter estimates would have changed. In general, the presence of changes in the parameter estimates is an indicator of an incomplete specification: there are changes in the determinants of wage rate changes that still cannot be explained. It reminds us that someone's best fit equation cannot pass as the last word about the Phillips Curve. Consequently, we did not intend to present a new theory of macroeconomic wage determination, but went as far as possible with the old one and picked up the post signs to new approaches.

7. Conclusion

The assumption that Phillips' original finding might still be of empirical relevance turns out to be true. Switching from a yearly to a quarterly data set of the German economy makes a more sophisticated analysis of the central tendency of the data and of its deviations possible. The three phenomena visible by a closer look at the data are (i) the negative, possibly non-linear central tendency of the data points in the long-run, (ii) a dozen loops that are the most salient deviation from the central tendency and (iii) movements between the loops. The hypothetical explanation of the loops by the cyclical up- and downturns of the economic development can be rejected as insufficient. Several versions of the Phillips Curve proposed in the literature proof the stable influence of the unemployment rate on the change of nominal wage rates, but are incapable to explain the loops. After completing a selection of historically recommended variables that turned out to be statistically significant in the regression analysis by the two indices of export and import prices the determination coefficient reaches 94 percent, the Durbin-Watson statistics improves and the corresponding

model solution follows the loops. In spite of the striking differences between the described phenomena, one regression equation model is sufficient to explain the loops, the movements between the loops and the long-term tendency of the German Phillips Curve.

References

Abel, A. B. and B. S. Bernanke (2001), *Macroeconomics*, 4th edn, Addison Wesley Longman.

Blanchard, O. and G. Illing (2009), *Makroökonomie*, 5th edn, Pearson, München.

Borchert, M. and A. Fröhling (2001), 'NAIRU, fiskalische Abgabenlast und Arbeitsproduktivität in Deutschland', *WiSt – Wirtschaftswissenschaftliches Studium* 30, 454-462.

Burda, M. C. and C. Wyplosz (2009), *Makroökonomie: Eine europäische Perspektive*, 3th edn, Franz Vahlen, München.

Dicks-Mireaux, L. A. and J. C. Dow (1959), 'The Determinants of Wage Inflation: United Kingdom, 1946-1956', *Journal of the Royal Statistical Society* 122, 145-184.

Dieckheuer, G. (2003), *Makroökonomik,* 5th edn, Springer, Berlin.

Friedman, M. (1968), 'The Role of Monetary Policy'*, The American Economic Review* 58, 1-17.

Eckstein, O. and T. A. Wilson (1962), 'The Determination of Money Wages in American Industry', *The Quarterly Journal of Economics* 76, 379-414.

Eckstein, O. and J. A. Girola (1978), 'Long-Term Properties of the Price-Wage Mechanism in the United States, 1891 to 1977', *The Review of Economics and Statistics* 60, 323-333.

Heilemann, U. and A. Samarov (1990), 'Changes in the Determinants of the Rate of Change of Wage Rates in the FRG: A Recursive Analysis 1952 to 1985', *Jahrbücher für Nationalökonomie und Statistik* 207, 448-463.

Hines, A. G. (1964), 'Trade Unions and Wage Inflation in the United Kingdom 1893-1961', *The Review of Economic Studies* 31, 221-252.

Hoover, K. D. (2010), 'Phillips Curve, The Concise Encyclopedia of Economics', URL: *www.econlib.org/library/Enc/PhillipsCurve.html*, download Jan. 2010.

Kaldor, N. (1959), ‘Economic Growth and the Problem of Inflation‘, *Economica* 26, 287-298.

Kösters, W. and B. Hofmann (1998), ‘40 Jahre Phillipskurve: Ein kurzer aktueller Überblick über eine lange Diskussion‘, in: R. Hüpen and T. Werbeck (eds.), *Wirtschaftslehre zwischen Modell und Realität – Theoretische Analyse als Fundament anwendungsbezogener Aussagen*, Lucius & Lucius, Stuttgart.

Kuh, E. (1967), ‘A Productivity Theory of Wage Levels – An Alternative to the Phillips Curve’, *The Review of Economic Studies* 34, 333-360.

Liebling, H. I. and A. T. Cluff (1969), ‘U.S. Postwar Inflation and Phillips Curves’, *Kyklos* 22, 232-250.

Lipsey, R. G. (1960), ‘The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1862-1957: A Further Analysis’, *Economica* 27, 1-31.

Lipsey, R. G. and J. M. Parkin (1970), ‘Income Policy: A Re-Appraisal’, *Economica* 37, 115-138.

Maneval, H. (1973), *Die Phillips-Kurve. Empirische, theoretische und wirtschaftspolitische Aspekte,* Paul Siebeck, Tübingen.

Mankiw, G. N. (2004), *Principles of Economics*, 3th edn, Thomson South-Western, Ohio.

Parkin, J. M. (1970), ‘Income Policy: Some Further Results on the Determination of the Rate of Change of Money Wages’, *Economica* 37, 386-401.

Perry, G. L. (1964), ‘The Determinants of Wage Rate Changes and the Inflation-Unemployment Trade-off for the United States’, *The Review of Economic Studies* 31, 287-308.

Phelps, E. S. (1967), ‘Expectations of Inflation and Optimal Unemployment over Time’, *Economica* 34, 254-281.

Phelps, E. S. (1968), ‘Money-Wage Dynamics and Labor-Market Equilibrium’, *The Journal of Political Economy* 76, 678-711.

Phillips, A. W. (1958), ‘The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957’, *Economica* 25, 283-299.

Samuelson, P. A. and R. M. Solow (1960), ‘Analytical Aspects of Anti-Inflation Policy’, *The American Economic Review* 50, 177-194.

Steinmann, G. (1973), 'Lohnentwicklung und Beschäftigungsgrad: Die Neuauflage der Kontroverse zwischen der Keynesschen und der neoklassischen Theorie bei der Diskussion um die Phillips-Kurve', *Kyklos* 109, 105-120.

Streit, M. E. (1972), 'The Phillips curve: Fact or fancy? — The example of West Germany', *Review of World Economics* 108, 607-633.

Data Sources

Statistisches Bundesamt (StBA), Lange Reihen für das frühere Bundesgebiet nach ESVG, 2. Auflage, Jahresdaten 1950-1969, March 1994.

StBA, Volkswirtschaftliche Gesamtrechnung, Fachserie 18, Reihe S.21, Revidierte Ergebnisse 1970-2004, March 2005.

StBA, Volkswirtschaftliche Gesamtrechnungen, Fachserie 18, Reihe 1.5, Inlandsproduktsberechnung, Lange Reihen ab 1970, September 2007 / Februar 2010.

StBA, Volkswirtschaftliche Gesamtrechnungen, Fachserie 18, Reihe S.27, Inlandsproduktsberechnung, Revidierte Vierteljahresergebnisse, September 2006 / November 2006.

StBA, Volkswirtschaftliche Gesamtrechnungen, Fachserie 18, Reihe 1.2, Inlandsproduktsberechnung, Vierteljahresergebnisse, Zusatztabellen, Tabelle Unverketteten Volumenangaben, Februar 2010.

Agentur für Arbeit, Aktuelle Daten - Arbeitslose nach Rechtskreisen. http://www.pub.arbeitsamt.de/hst/services/statistik/detail/a.html

Agentur für Arbeit, Zeitreihen – Arbeitslosigkeit in Deutschland seit 1950. http://www.pub.arbeitsamt.de/hst/services/statistik/detail/z.html

Definitions, Indicators, and Data
www.forschungsseminar.de/phillips.htm