Exact prediction of inflation and unemployment in Germany

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Abstract

Potential links between inflation, $\pi(t)$, and unemployment, $UE(t)$, in Germany have been examined. There exists a consistent (conventional) Phillips curve despite some changes in monetary policy. This Phillips curve is characterized by a negative relation between inflation and unemployment with the latter leading the former by one year: $UE(t-1) = -1.50\pi(t) + 0.116$. Effectively, growing unemployment has resulted in decreasing inflation since 1971, i.e. for the period where GDP deflator observations are available. The relation between inflation and unemployment is statistically reliable with $R^2 = 0.86$, where unemployment spans the range from 0.01 to 0.12 and inflation, as represented by GDP deflator, varies from -0.01 to 0.07.

A linear and lagged relationship between inflation, unemployment and labor force has been also obtained for Germany. Changes in labor force level are leading unemployment and inflation by five and six year, respectively. Therefore this generalized relationship provides a natural prediction of inflation at a six-year horizon, as based upon current estimates of labor force level. The goodness-of-fit for the relationship is 0.87 for the period between 1971 and 2006, i.e. including the periods of high inflation and disinflation.

Introduction

This paper is a continuation of a series devoted to the change rate of labor force level as the driving force behind inflation and unemployment (Kitov, 2006abc; Kitov, 2007ab; Kitov, Kitov, Dolinskaya, 2007ab). The principal finding of our previous studies conducted for the USA, Japan, France, Austria and Canada consists in the existence of a linear and lagged link between labor force, inflation and unemployment. In some countries, this generalized link can be separated into two independent linear links between inflation and labor force and between unemployment and labor force. These linear dependencies on one variable, obviously, result in the existence of reliable Phillips curves in these countries. These Phillips curves are not of conventional form, however, since they are represented by lagged dependences between inflation and unemployment. It is important that coefficients (tangents) in these linear dependencies can be positive and negative. In the former case (positive tangent), increasing inflation is associated with increasing (but lagged) unemployment, as is it observed in the USA (Kitov, 2006ab). In

the latter case, increasing inflation results in a decreasing unemployment rate, as observed in Germany (Kitov, 2007b).

Data on labor force, inflation, and unemployment were obtained from various sources. There are three principal statistical agencies providing these data: the OECD, the Eurostat, and the U.S. Bureau of Labor Statistics (BLS). The BLS provides two sets of data: one obtained according to national definition (NAC) and another obtained according to US definition of corresponding variable.

For any quantitative analysis, the most important issue is the quality of corresponding measurements. There are two main requirements to these data: they have to be as precise as possible according to any given definition, and the data must by comparable over time. The precision is related to methodology of measurements and implementation of corresponding procedures. The comparability is provided by the consistency of definitions and methodology. For example, the OECD (2005).provides the following information on the comparability of the labor force and unemployment time series for Germany

> **Series breaks:** *From 1999, the data have been calculated using an improved method of calculation and only refer to private households (Eurostat definition). Previously, persons living in collective and institutional accommodation, conscripts on compulsory community or military service are included (excluding those living in military barracks).*
>
> *Data from 1991, refer to Germany and prior to 1991 and the reunification, to western Germany (Federal Republic of Germany). Estimates of the total labor force have been revised from 1987 on, based on census results, and show a break between 1986 and 1987. Prior to 1984, annual data for the labor force are averages of monthly and annual estimates supplied by German authorities. Annual unemployment figures correspond to unemployed persons registered at the end of the month of September of each year. From 1984, annual average figures are consistent in terms of methodology and contents with the results of the annual European Labour Force Survey based on the national Microcensus conducted once a year in April.*

Therefore one might expect some breaks in linear relationships between the studied variables: labor force, inflation, and unemployment. However, as shown in Section 1, the Phillips curve for Germany demonstrates no breaks. The absence of any breaks evidences in favor of general comparability of the measurements over time.

This paper is primarily aimed at revealing the generalized relationship between the change rate of labor force level, inflation and unemployment in Germany. Also, individual relationships between the change rate and inflation, and the change rate and unemployment are investigated. These relationships allow answering fundamental questions addresses in numerous studies of inflation and unemployment. For example, Can central banks influence inflation and unemployment by implementing monetary policy?

Hayo and Hofmann (2005) studied reaction functions of the Taylor rule used by the Bundesbank and found that interest rate reaction function can be characterized by an inflation reaction coefficient of about 1.25 and an output gap reaction coefficient of about 0.3 before and after German reunification. They also reported that the handing-over of monetary policy from the Bundesbank to the ECB led to lower interest rates for Germany than they would have been under a hypothetical continuation of the former Bundesbank regime. However, since the long-term real interest rate is very imprecisely estimated under the ECB regime, this finding should be taken with considerable caution. Therefore, their paper states that monetary policy of the Bundesbank (and ECB) results in a measurable influence on inflation.

There exists a common opinion in the economics community that inflation is a monetary phenomenon. Nelson (2006) investigated this assumption as applied to Germany and Japan and argued that the experiences of these countries in the 1970s indicate that once inflation is accepted by policymakers as a monetary phenomenon, the main obstacle to price stability has been overcome. So, central banks are able to control inflation through monetary policy.

The feasibility of a proactive monetary policy is defined by the possibility to control driving force of inflation. The most popular explanation of inflation in economic models is related to inflation expectations. Doepke et al. (2005) reported the qualitative and quantitative applicability of the inflation expectations models and transmission

mechanisms, as obtained for the USA, to major European countries, including Germany. The authors claim that their findings are robust to a number of estimation methods (suited for data with various stochastic properties).

Currently, most popular inflation models are concentrated around the New Keynesian Phillips Curve (NKPC) approach. For Germany, Gottschalk and Fritsche (2006) found that such models do not explain the long-run negative correlations between inflation and unemployment. The authors suggested nonlinearity included in earlier Keynesian models might help for explaining the German inflation experience in the 1980s. We also found negative correlation between inflation and unemployment (lagged by one year), but for the whole period after 1971. This observation, however, is a natural part of our general approach.

The remainder of this paper consists of two sections and conclusion. Section 1 is devoted to the constriction of a quasi-conventional Phillips curve for Germany. Section 2 analyses the generalized link between three studied variables. In Conclusion, some principal findings are highlighted and some fundamental differences between our and conventional approach are discussed.

1. The Phillips curve

Inflation has not been a real problem in Germany since the mid-1990s. Figure 1 summarized three different measures of inflation in Germany: GDP deflator reported by the OECD and CPI inflation reported by the OECD and Eurostat. There is a general agreement between these three measures. The GDP deflator is available since 1971 and includes the period of the highest inflation between 1970 and 1985. The largest measured GDP deflator is 0.073 in 1974 and the lowermost one is -0.007 in 2000. This is a significant dynamic range, which should allow a reliable modeling. Moreover, all curves demonstrate several oscillations with amplitude from 0.04 to 0.07 and period from 7 to 11 years. If to extrapolate the periodicity associated with these oscillations, one can expect an increasing inflation in the next several years with the peak value of 0.04.

Before 1971, only two measures of CPI inflation are available, which are very close, except in 1962. Due to its obvious completeness for quasi-closed economies, GDP deflator is usually a better measure of overall inflation in developed counties and

provides more accurate results in quantitative modeling (Kitov, 2006ab, 2007a). Nevertheless, both principal measures of inflation should be modeled.

There are two different estimates of unemployment in Germany provided by national statistics and the OECD. They are close in shape, but undergo a significant divergence after 1974. One can explain this discrepancy by the introduction of different definitions in 1974. Due to the development of the EU, these two definitions almost coincide in 2004. True unemployment, as related to some perfect (but not available) definition of unemployment, might be between the curves and out of the curves as well. At the same time, both presented measures of unemployment are similar and it is likely that the true unemployment accurately repeats their shape. In this case, any of the measures can be used in quantitative modeling as representing the same portion of the true unemployment. The same is valid for inflation measures. Apparently, actual problems are associated not with the difference between measured and true variables but with sudden jumps in the definitions of measured variables.

According to conventional economic theory, there exists a (short-run or long-run) trade-off between inflation and unemployment (Mankiw, 2000). This link is called the Phillips curve. Since the first work of A.W. Phillips in 1958, economists have been looking for empirical evidences validating the existence of this relationship. No unifying empirical link covering all developed countries and all periods has been found so far. One can say that there is no reliable empirical proof in support to conventional quantitative theories of inflation. There is a simple explanation of this *status quo*. Phillips curves are different in developed countries. Only the same driving force behind inflation and unemployment unify them and build a Phillips-curve-type relation between them.

The links between inflation and unemployment actually demonstrate various and even opposite dependencies. In the USA, this dependence is characterized by a positive influence of inflation on unemployment (Kitov, 2006a). Effectively, low inflation in the USA leads low unemployment by three years because of a lag between these two variables. Germany provides a case with a negative coefficient, i.e. low unemployment results in high inflation. Figure 3 displays two curves - the OECD unemployment and GDP deflator. The GDP deflator curve is modified according to the linear relationship with coefficients of linear regression presented in Figure 4. This regression has been

calculated for several time shifts between the *UE* OECD and GDP deflator. The best fit (R^2=0.86) was obtained in the case when the unemployment curve led the inflation curve by one year. This situation is opposite to that in the USA, where inflation leads unemployment. This swap of the lead is likely the reason for the difference in the sign of the tangent in the Phillips curves for USA (positive) and Germany (negative).

Figure 3 demonstrates a very high agreement between the curves; in some sense the agreement is better than that between the two available measures of inflation or two measures of unemployment in Figure 1 and 2, respectively. Figure 4 actually provides the German Phillips curve:

$$UE(t-1) = -1.50[0.1]GDPdeflator(t) + 0.116[0.004] \qquad (1)$$

Standard deviation of the difference between the curves is *std*ev=0.012. Statistical estimates show a high reliability of the German Phillips curve. Therefore, one can expect an increasing inflation in the next few years accompanied by decreasing unemployment.

The existence of the Phillips curve in Germany raises a question about the consistency of monetary policy of the Bundesbank. Does the bank conduct a monetary policy, which balances inflation and unemployment? The last twenty five years show the unwillingness of the bank to reduce unemployment in exchange for higher inflation.

2. Modeling inflation and unemployment in Germany

There exists a generalized relationship linking inflation and unemployment to the change rate of labor force level. Therefore we analyze CPI and GDP deflator in Germany in relation to unemployment and labor force level according to standard procedure described in previous papers. In Germany, as in many developed countries, GDP deflator is less volatile than CPI inflation, but also spans a shorter period. It is common for a majority of European countries, that nominal and real GDP is determined (or reported) since 1971.

The standard procedure for the estimation of the link between the variables starts with a thorough inspection of general features of all involved time series. In Section 1, we discussed inflation and unemployment. Here we scrutinize (civilian) labor force

measurements in Germany. There are two series provided by the US BLS: according to its own definition and that reported by national statistics (NAC). The OECD also provides one time series. Accordingly, there are three curves representing the change rate of the labor force level displayed in Figure 5, with the readings corresponding to 1991 omitted due to the step change associated with the reunification. A step in level produces a spike in corresponding time derivative. Before 1983 (see Introduction for details), all three curves are almost identical. After 1992, the estimates made by the OECD and the BLS are close. Between 1984 and 1990 the curves are different, but actually very close, except for 1990. Apparently, each of these three time series can be used for explanation of various features of inflation and unemployment in Germany. In 1991, a structural break is possible with two different generalized relationships separated by this year.

First, we test the existence of a link between inflation and labor force. Because of the potential structural break in 1990, we have chosen the period before 1989 for linear regression analysis. Varying time lag between labor force and inflation time series one can obtain the best-fit coefficients for the prediction of CPI inflation according to the relationship:

$$CPI(t) = A + BdLF(t-t_0)/LF(t-t_0) \qquad (2)$$

where A and B are constants and t_0 is the time lag, which can be zero or some positive value. Figure 6 depicts the best-fit case with A= 0.041, B= -1.71, and t_0=6 years. Because of the short period of modeling, the estimate of coefficient B is not reliable. The time lag in Germany is very long, even longer than that in the USA, which is estimated as 5 years. The time lag estimate is also not too much reliable. It may have an uncertainty of one year. Coefficient A is a more reliable one because it defines the level of inflation in the absence of labor force change and does not depend much on details of the curves.

Figure 7 compares an observed CPI curve to that obtained from the change rate of labor force. Because of the low reliability of linear coefficients in Figure 6, we have tried to reach a general amplitude fit between the curves with the estimated time lag and obtained coefficient B=-2.5. Coefficient A is 0.04 and does not differ much from that in

Figure 6. The six-year time lag provides a good synchronization of the observed and predicted curves during the period between 1965 and 1988. For the period after 1991, our best guess is $A=0.017$ and $B=-1.0$, but with the same time lag. The latter coefficients are obviously not reliable due to the shortness of the studied period and small dynamic range of the CPI inflation changes. Since the 6-year lag is the same for both periods, the reaction of inflation on the structural break related to the labor force change in 1990 actually happened in 1996.

The predicted curve in Figure 7a is characterized by a relatively high volatility. As in other developed countries, this effect is induced by measurement uncertainty. As a rule, labor force is measured using small sample surveys, and then is projected to the whole population with some "population controls". The latter are also characterized by relatively low accuracy as estimated from up-to-date information on births, deaths, and net migration. A standard technique to suppress the noise associated with measurement errors consist in smoothing of original time series. Figure 7b demonstrates a significant reduction in the volatility of the (labor force based) predicted curve when such simple means as a two-year moving average, MA(2), is applied. Even the uncertainty of the time shifts between the observed and predicted curves became smaller.

It is difficult to precisely estimate the change in labor force level during one year. However, there are some benchmark years when all previous estimates are revised in order to match the measured level of labor force. Therefore one can expect an increasing precision of the net change of labor force level with increasing time baseline. In other words, the net change in the labor force during 10-year interval is measured much more accurate than that defined as a sum of 10 annual estimates of labor force change. The longer if the baseline the more accurate is the net change measured. If two macroeconomic variables are linked by a long-term equilibrium relation and are measured as levels or cumulative values, as labor force and consumer price index, and the levels are measured with a constant accuracy then one can expect a diminishing relative discrepancy between the variables with time. So, if these variables are actually linked by a robust mathematical relationship then the absolute difference between these cumulative values is constant, i.e. depends only on the accuracy of corresponding measurements, and the relative difference is inversely proportional to the attained level.

Second step consists in the modeling of unemployment as a function of labor force change. There is a general expectation of a good fit between these two variables for Germany. Figure 8 presents the results of a simple manual trail-and-error process for the period between 1965 and 1989. Since such procedure is based on visual fit only, no statistical estimates were made. The resulting relationship between unemployment and labor force in Germany is as follows:

$$UE(t) = 2.5*dLF(t-5)/LF(t-5) + 0.04 \qquad\qquad (3)$$

The observed and predicted curves demonstrate a general similarity of shape between 1980 and 1995. The curves are also similar after 1995 with *A*=0.08 instead of 0.04. This is a clear break induced by the reunification.

There are periods of large discrepancy between the curves, however. An important finding here is that unemployment in Germany increases with increasing rate of labor force growth. So, the remedy against high unemployment in Germany consists in reduction of labor force growth. Currently, a natural rate of unemployment in Germany, as related to zero labor force increase, reaches 8%.

The ultimate part of the modeling gathers all individual relationships in one generalized relation. Therefore we are trying to find the best-fit coefficients for the generalized (reduced) equation:

$$CPI(t) = A*dLF(t-6)/LF(t-6) + B*UE(t-1)+C \qquad\qquad (4)$$

There are several opportunities to estimate coefficient is (4). A standard way is to regress the CPI against shifted readings of the *UE(t-1)* and *dLF(t-6)/LF(t-6)*. As explained in (Kitov, Kitov, Dolinskaya, 2007ab), this is not the most reliable way in the case of variables measured as levels or cumulative values. The best way is to find the coefficients, which retain the lowermost RMS deviation between the cumulative curves. This method is applied to the time series of GDP deflator (GDPD), unemployment, and the labor force. Figure 9 depicts the case associated with the NAC definition of labor

force. The evolution of the cumulative curves of the observed and predicted CPI inflation is very close, except around 1990 and 2001 (as related to new definition).

Effectively, the difference between these two cumulative curves is small compared to the net change of CPI inflation and labor force between 1969 and 2004. However, the influence of strong deviations in the beginning and in the middle of the period is clear, as Figure 10 shows. One can easily find that the coefficients obtained by a linear regression of the GDPD on the LF and UE fails to provide the observed "closeness" between the cumulative curves as those coefficients, which are estimated by visual fit between the cumulative curves: $A = -0.3$, $B = 0.59$, and $C = 0.072$. Small absolute values of coefficients A and B are explained by the fact that they have effect of the same sign on inflation in Germany.

Finally, Figure 11 displays the originally measured GDP deflator and the predicted inflation obtained from the NAC labor force estimates. General fit between these two curves is relatively high $R^2=0.86$, as Figure 12 demonstrates. One can also consider the curve in Figure 12 as a modified Phillips curve. Really, relationship (4) involves unemployment, as the authentic Phillips curve contained, and also the change rate of labor force instead of "inflation expectations". Our approach has two advantages: the six-year lead of the predicted inflation and that the prediction is based on actually measured variables – unemployment rate and labor force level. The large lead allows more accurate estimates of labor force.

3. Conclusion

There exists a Phillips curve for Germany with a negative coefficient of the linear link between inflation and unemployment. The latter variable leads the former one by one year. The existence of the Phillips curve, i.e. a long-term equilibrium relationship between unemployment and inflation, put under doubts the relevance of the monetary policy conducted by the Bundesbank, which is aimed at a restricted money supply. Over the years, this policy results in somewhat elevated unemployment. The same effect has been observed in France since 1995, i.e. from the year when the Banque de France accepted the ECB monetary policy. In turn, the ECB monetary policy was in many details

borrowed from the Bundesbank. Therefore, some European countries suffer higher unemployment due to a thorough expansion of the Bundesnak's experience.

According to this revealed Phillips curve, unemployment in Germany leads inflation by one year. Apparently, the leading role of unemployment determines the negative linear functional dependence on inflation. This negative influence differs from that observed in the USA, where inflation leads unemployment by two years (Kitov, 2006a). This difference between Germany and the USA raises a question on the social organization and processes in developed countries.

The change rate of labor force has been found to be the driving force behind unemployment and inflation. This finding confirms the existence of a generalized linear and lagged relationship between labor force, unemployment, and inflation in developed countries. The same relationship holds in the USA, France, Japan, Austria, the UK and Canada.

The change in labor force in Germany leads inflation by 6 years and unemployment by 5 years. This observation contradicts the capability of central banks, including the Bundesbank, to influence the combined evolution of inflation and unemployment as driven by the labor force change. Central banks are able to restrict and actually restrict monetary supply in order to reduce inflation. In many cases, however the reduced inflation is accompanied by elevated unemployment, as defined by the generalized relationship. In that sense, inflation is a monetary phenomenon, but central banks actually conduct reactive rather than proactive policy. It is not clear whether some developed societies would welcome elevated levels of unemployment for the sake of lower inflation if they would be aware of this trade-off.

Since the change rate of labor force has been revealed as the driving force behind inflation and unemployment, the NKPC approach can not provide an accurate description. Thus, statistical results based on the NKPS approach, and other models of inflation developed in conventional economics, are occasional. The concept of inflation expectations should be reversed: households and firms do not actually expect any specific inflation level, but realize in their everyday practice the change in prices (and unemployment), which is predefined by the change rate of labor force.

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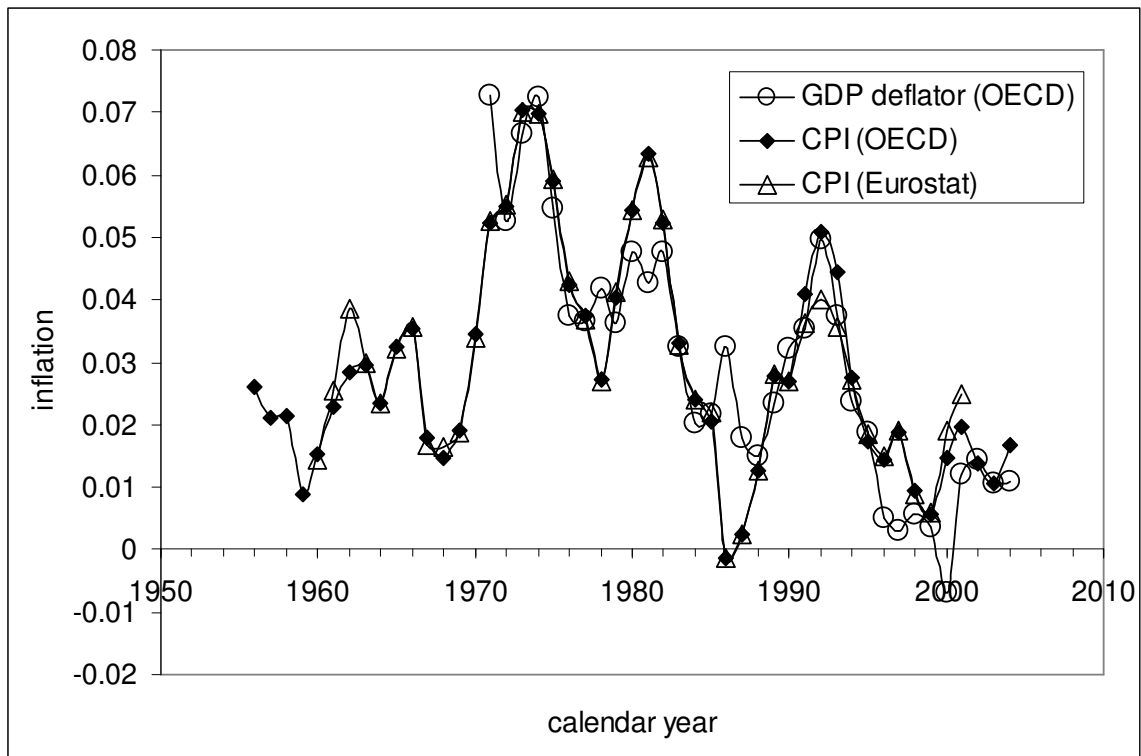
Figures

Figure 1. Various measures of inflation in Germany: GDP deflator reported by the OECD and CPI inflation reported by the OECD and Eurostat. There is a general agreement between these three measures. The GDP deflator is available since 1971.
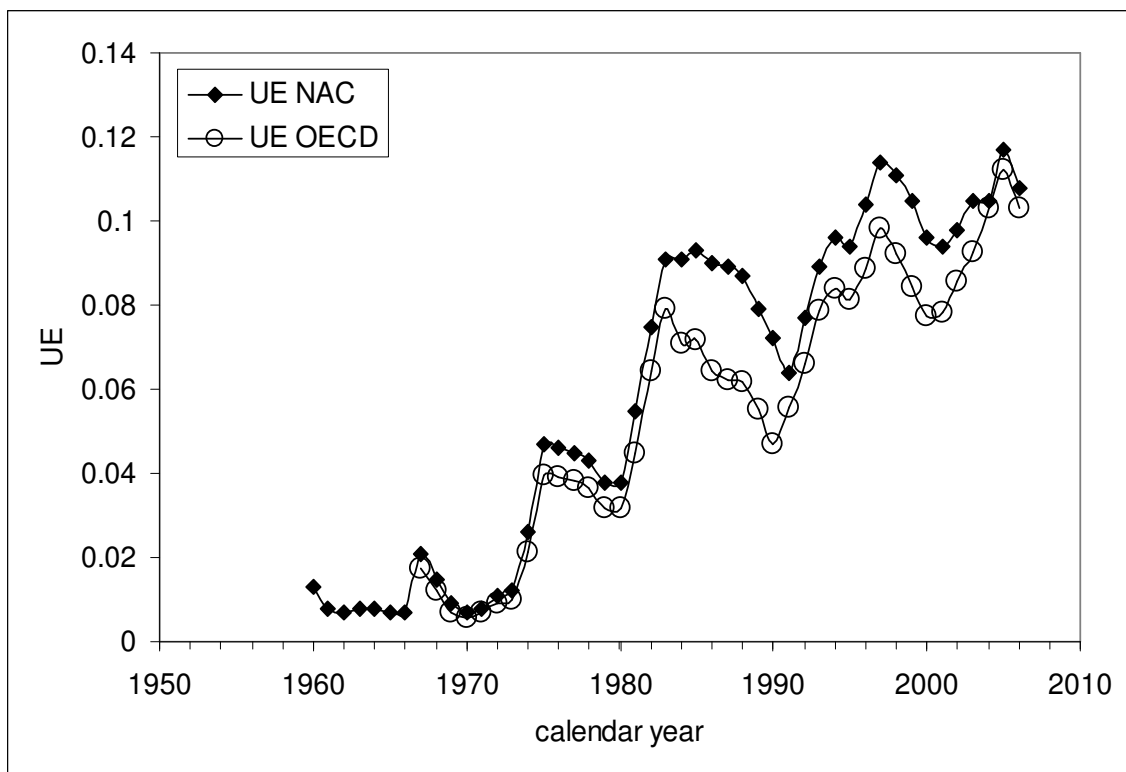
Figure 2. Comparison of two measures of unemployment provided by national statistics (NAC) and the OECD. Some changes in corresponding are obvious in 1974 and 2004.
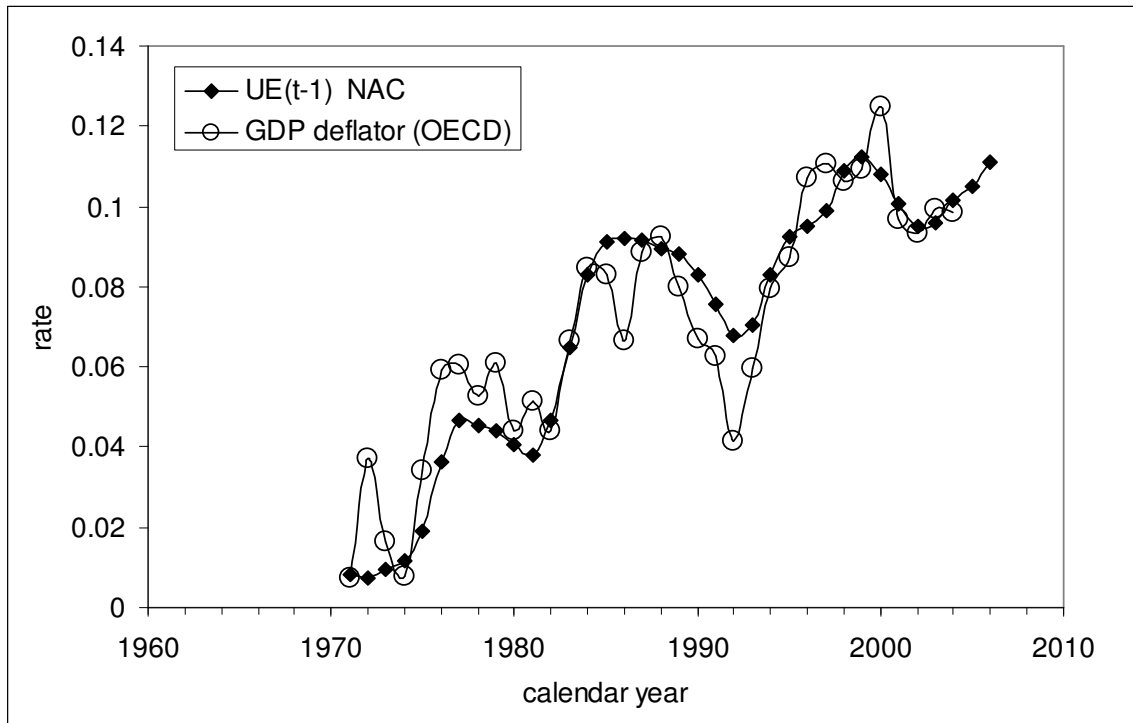
Figure 3. Unemployment and GDP deflator (both reported by the OECD) in Germany between 1971 and 2004. The GDP deflator readings are converted according to the Phillips curve relationship obtained in Figure 4.
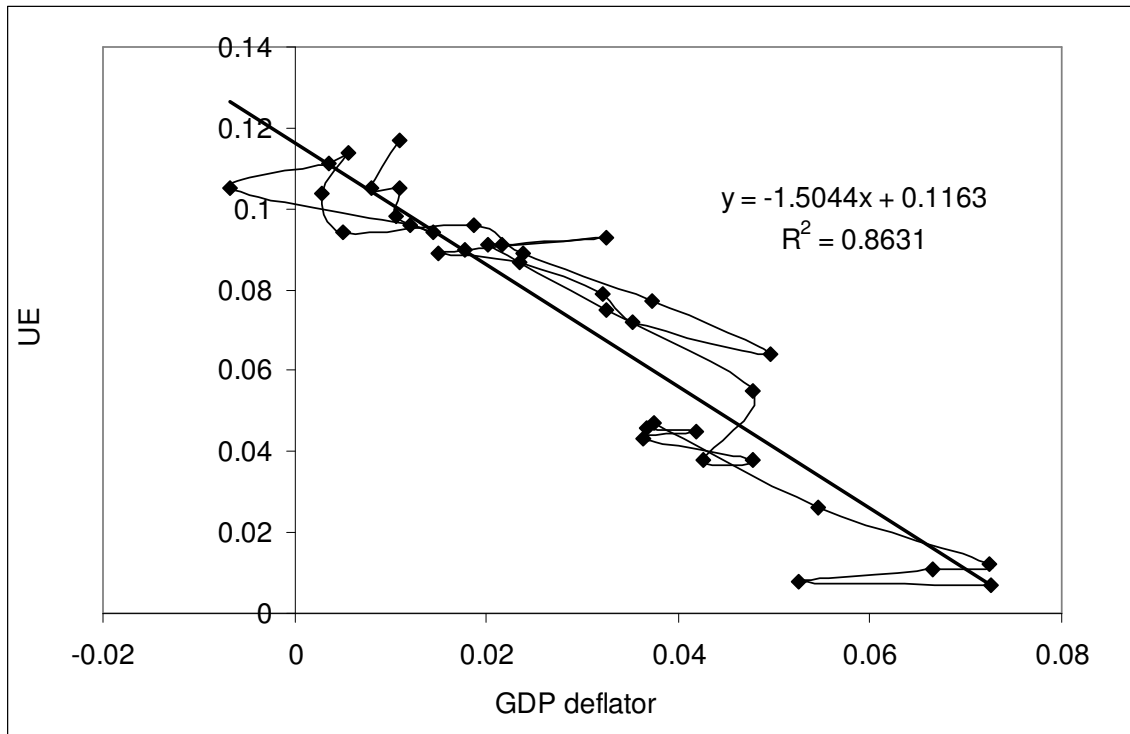
Figure 4. The Phillips curve for Germany. The unemployment readings are shifted by one year ahead to synchronize with the GDP deflator estimates. The goodness-of-fit is 0.86. There is a negative relationship between inflation and unemployment in Germany. Higher unemployment means lower inflation.
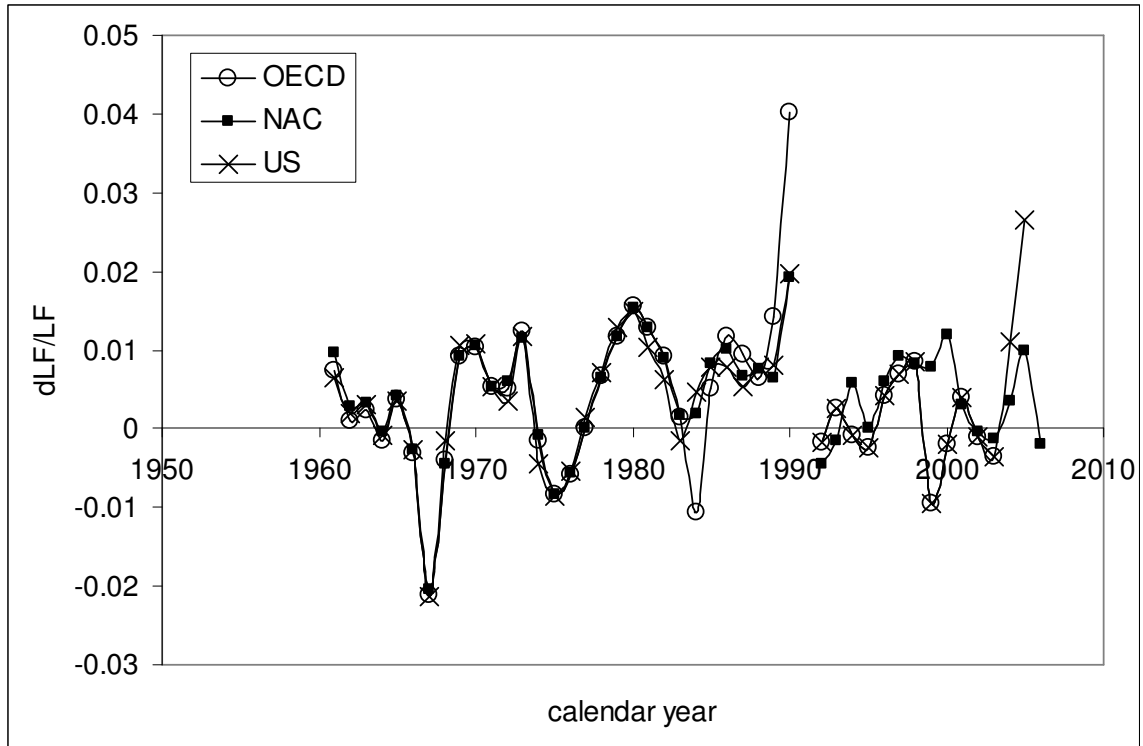
Figure 5. Comparison of the change rate of (civilian) labor force level measured by the OECD, national statistics (NAC), and according the definition of the US BLS. Due to a steep increase in labor force level in 1991 the readings of the change rate for this year are omitted.
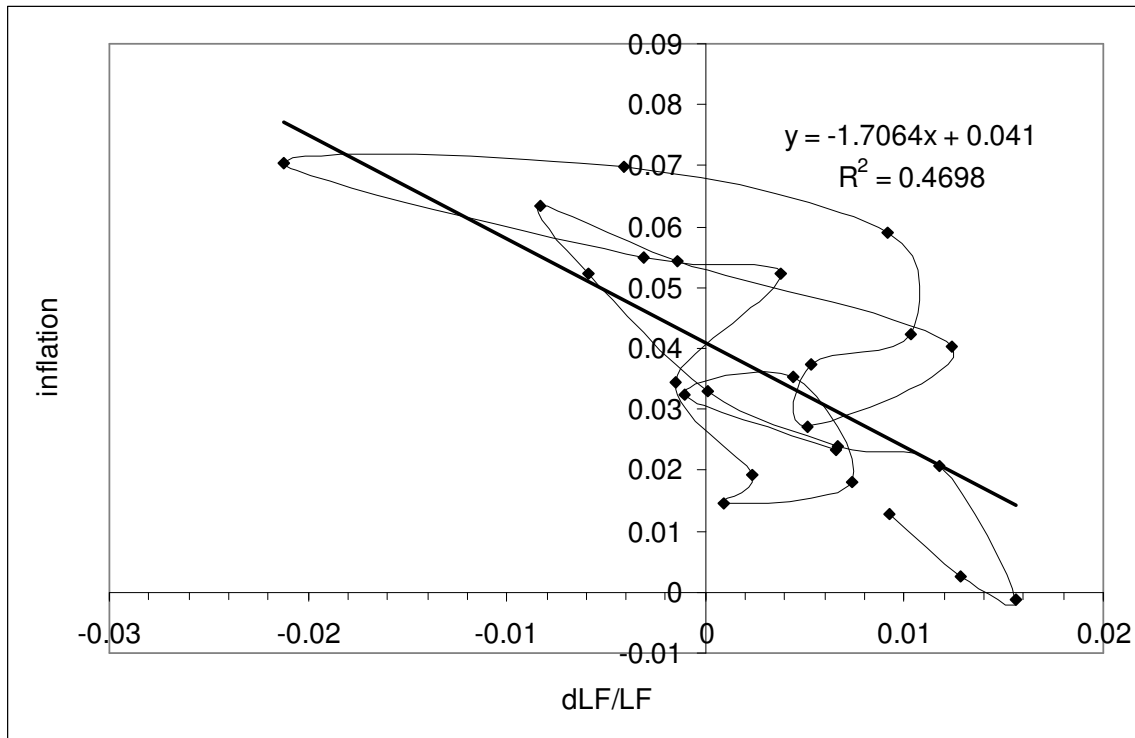
Figure 6. Linear regression of the CPI inflation (OECD) on the change rate of labor force level , dLF/LF, for the period between 1964 and 1988 for the CPI and 1958 to 1982 for the dLF/LF. The CPI time series lags by 6 years behind the change in labor force. Coefficients: tangent B= -1.71, free term A= 0.041, and the lag t_0=6 years provide the bets fit between these time series with R^2=0.47.

a)
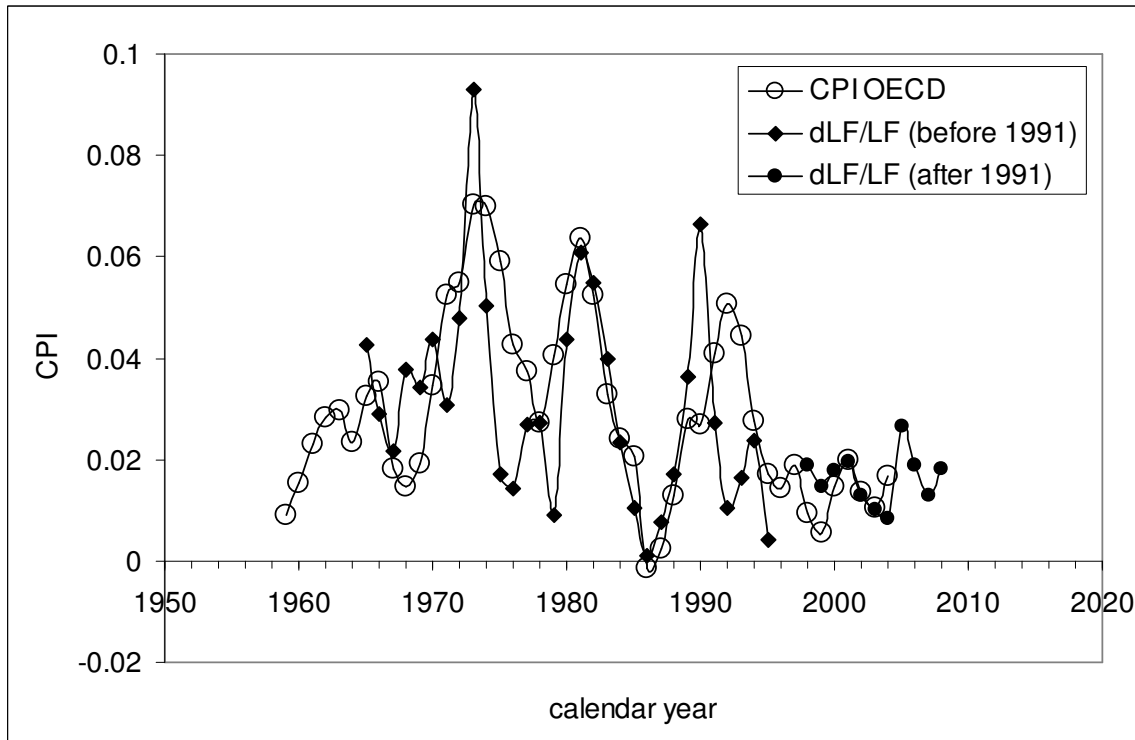
b)
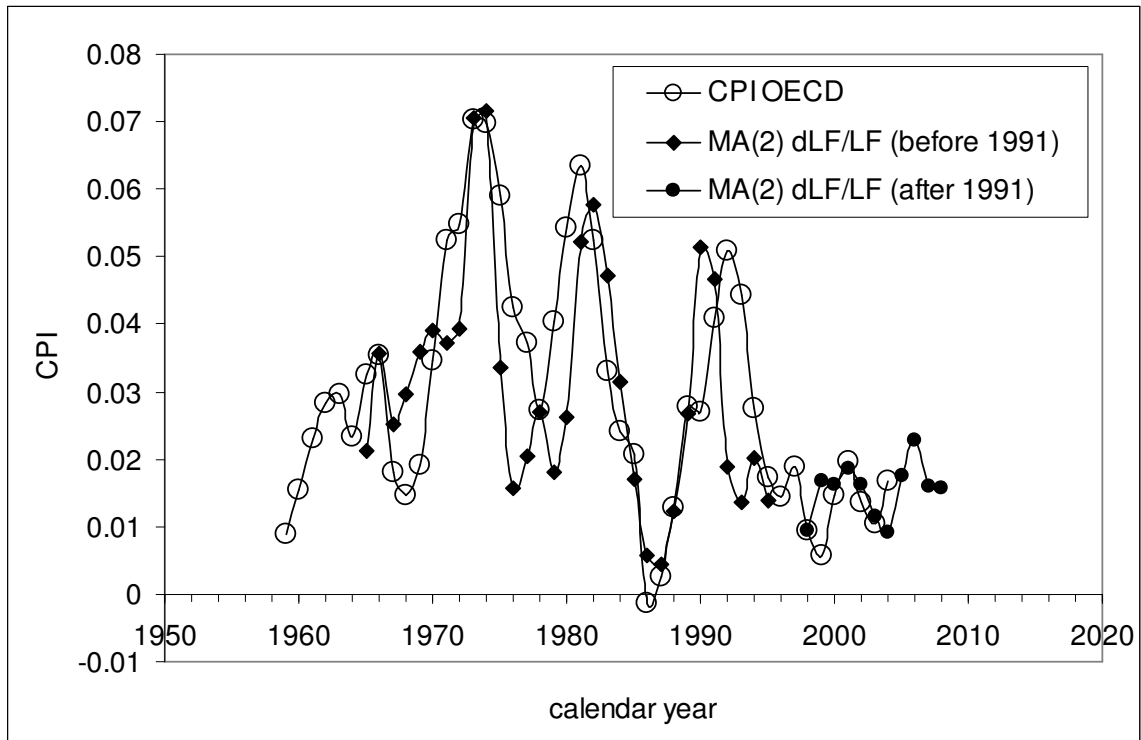
Figure 7. Comparison of the observed CPI inflation in Germany and that predicted using the change rate of labor force level as measured by national statistics: a) annual estimates of dLF/LF; b) MA(2) of dFL/LF.
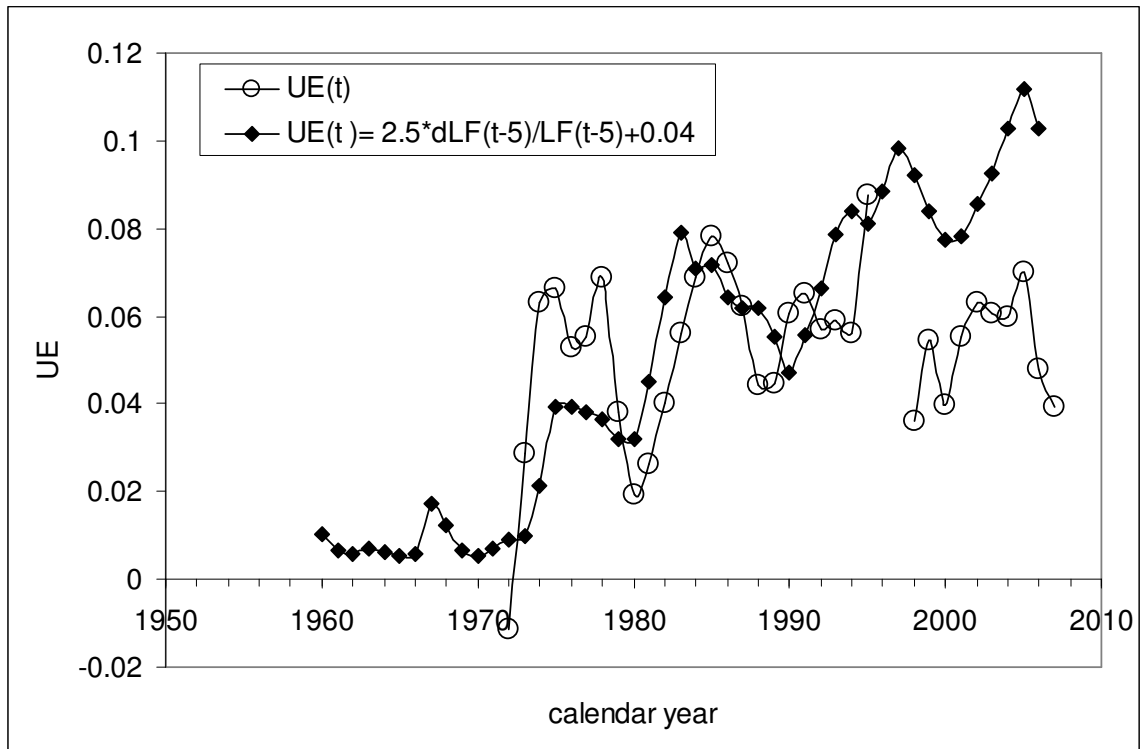
Figure 8. Comparison of measured unemployment and that predicted from the change rate of labor force level. In 1991, a structural break was observed.
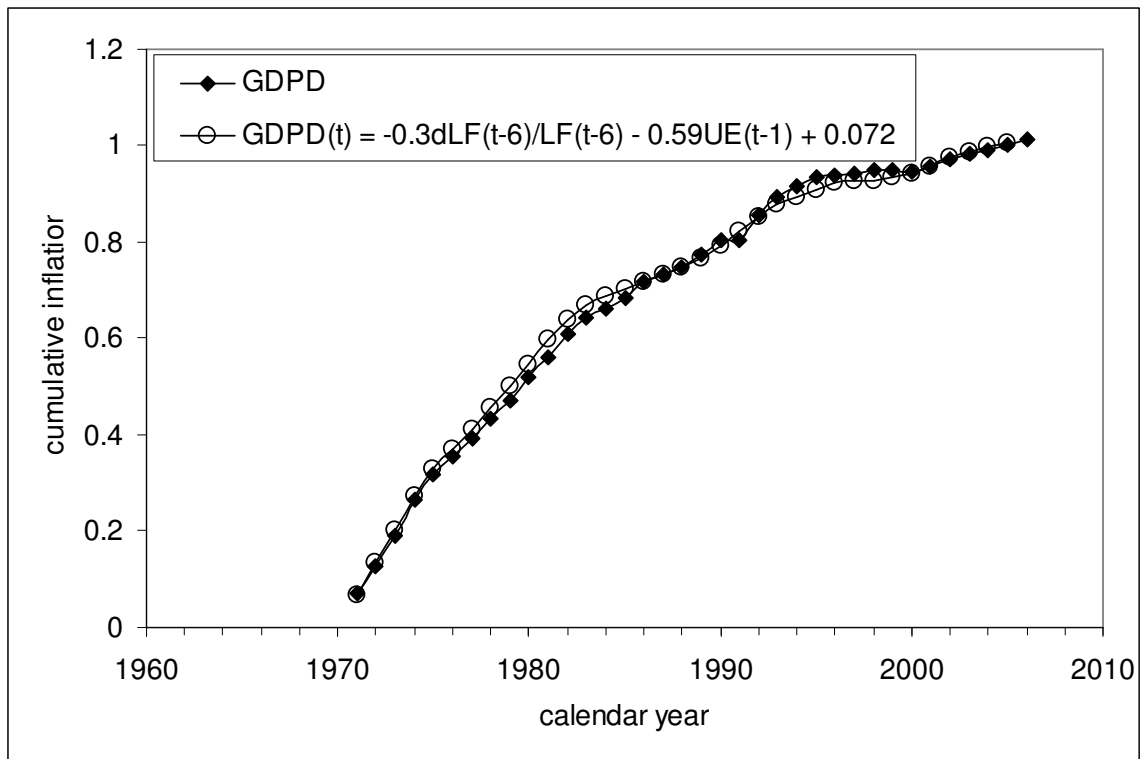
Figure 9. Comparison of cumulative curve for the measured GDP deflator and that predicted according to relationship (3) using the BLS definition of labor force.
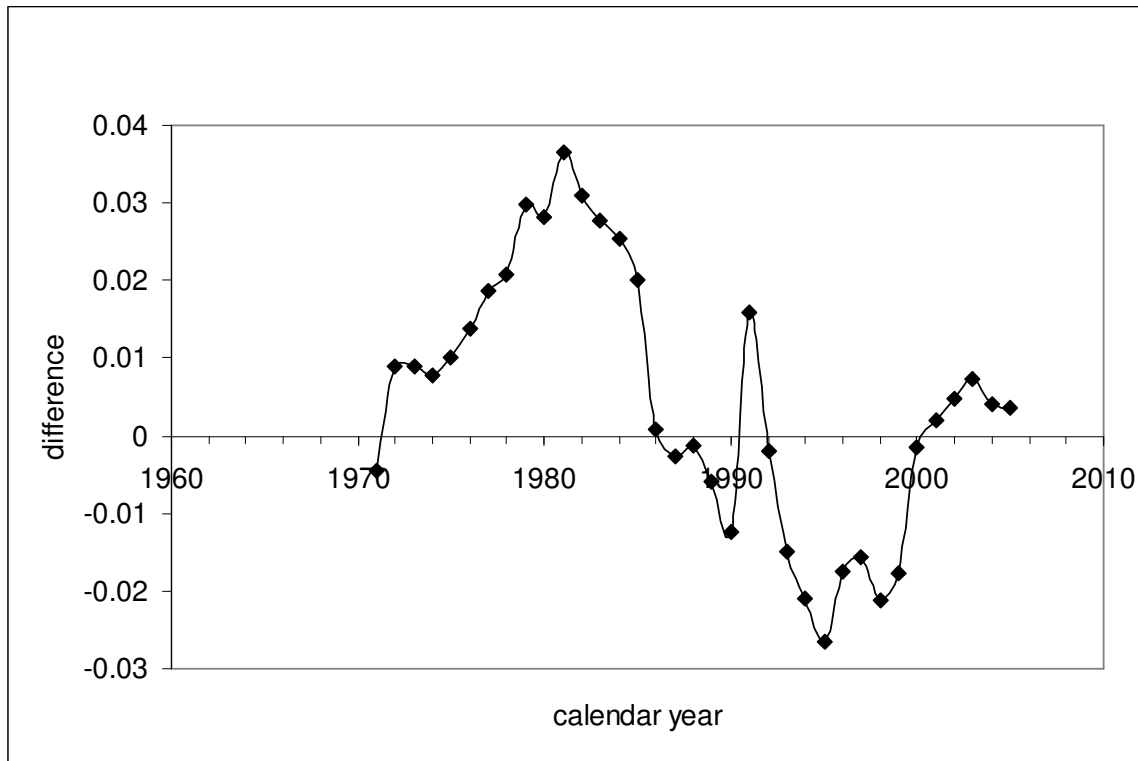
Figure 10. The difference between the cumulative curves in Figure 9.
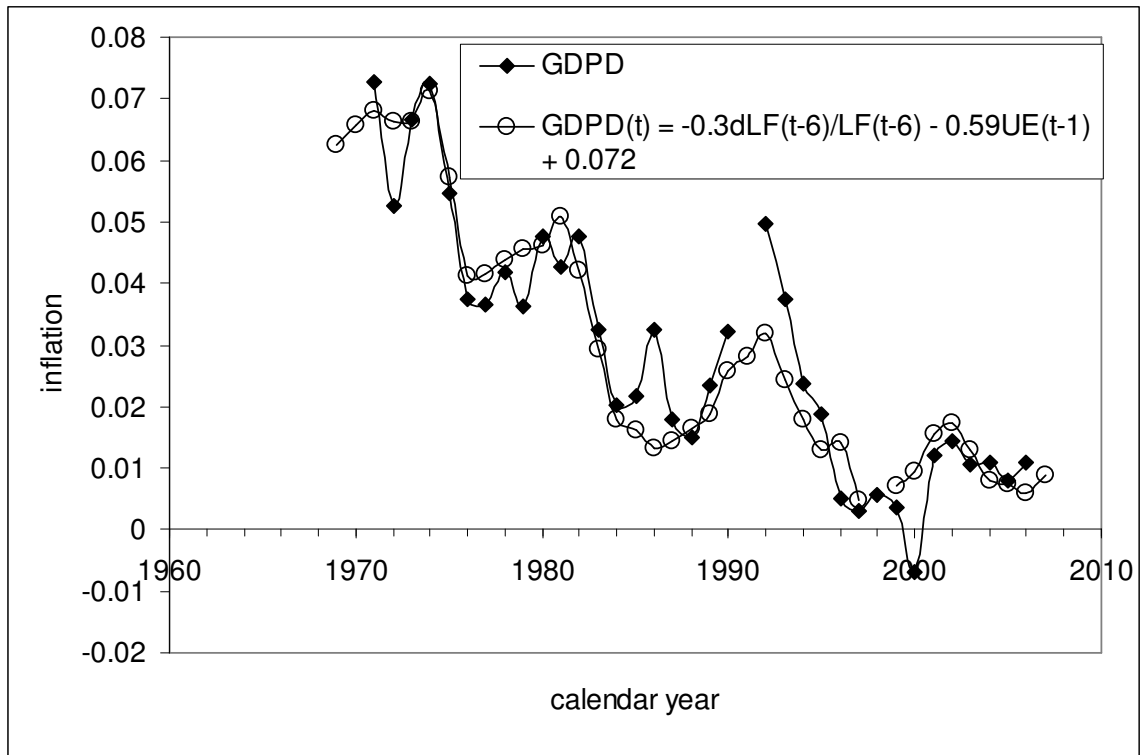
Figure 11. Comparison of the original measured GDP deflator (GDPD) curve and that predicted according to relationship (4).
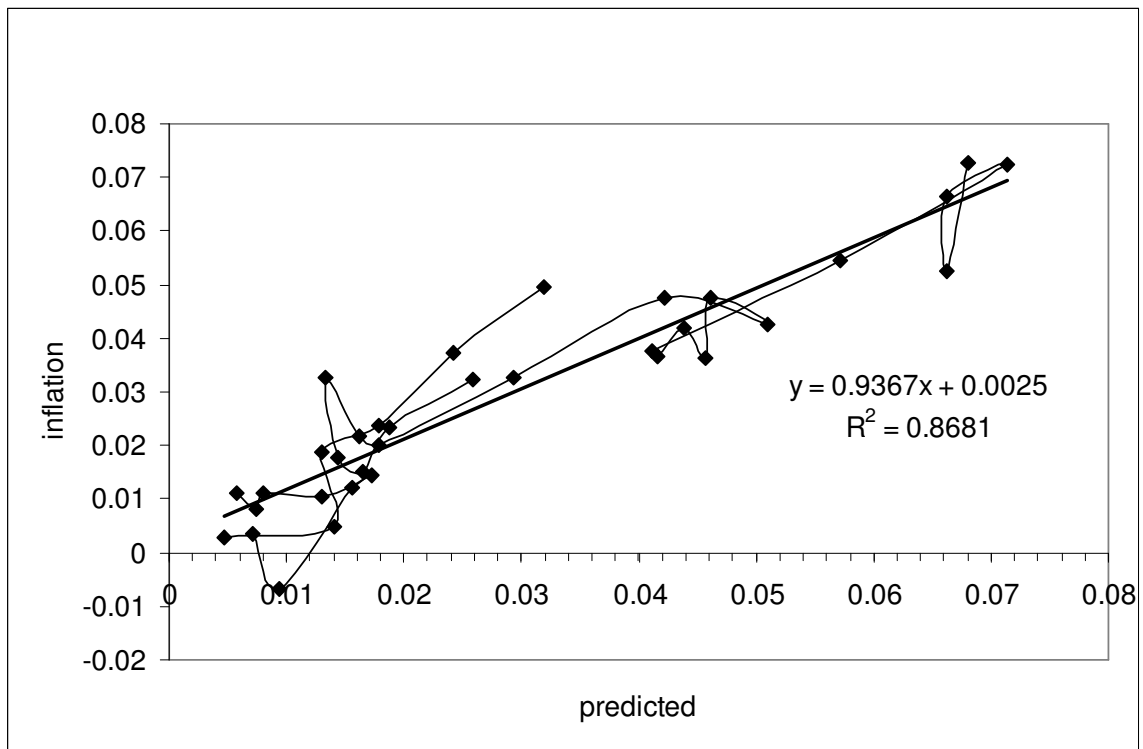
Figure 12. Linear regression of the observed GDP deflator against the predicted one for the period between 1971 and 2006.