CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

Department of Economics

CZECH
UNIVERSITY
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DIPLOMA THESIS

Econometric Evaluation of Phillips Curve Theory and its Predictive Abilities

Author: Bc. Václav Procházka

Supervisor: Ing. Lenka Šobrová, Ph.D.

Declaration

I hereby declare I have worked on my bachelor thesis "Econometric Evaluation of Phillips Curve Theory and its Predictive Abilities" on my own and I have used only the sources mentioned in the bibliography.

Prague, the 8th April 2009 ....

Václav Procházka

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Econometric Evaluation of Phillips Curve Theory and its Predictive Abilities

Ekonometrické zhodnocení teorie Phillipsovy křivky a jejího využití pro prognózy

Summary

This work analyses the relationship between inflation and unemployment with regard to the Phillips curve theory. It briefly explains the main terms and how the theory about the theory about this relationship was developing over time. It is focused on an analysis of the empirical data of inflation and unemployment in Taiwan and the Czech Republic. It uses a classical linear regression model and ordinary least square method of parameter estimation. In this work there are created and tested linear and hyperbolic models and later on also models augmented by inclusion of the adaptive expectations. It empirically shows based on the analytical results that the relationship between inflation and unemployment has, in accord with the theory, an inverse character and the hyperbolic shape of the curve gives a better fit than simple linear. It also shows that including adaptive expectations in the model improves its properties. However, an econometric model trying to explain inflation only by unemployment and adaptive expectations that would be suitable for reliable inflation forecasting was not found.

Keywords: econometric model, inflation, linear regression, Phillips curve, prediction, unemployment

Souhrn

Tato práce analyzuje vztah mezi inflací a nezaměstnaností s ohledem na Phillipsovu křivku. Stručně vysvětluje hlavní pojmy a jak se teorie o tomto vztahu během doby vyvíjela. Soustředí se na analýzu empirických dat inflace a nezaměstnanosti na Taiwanu a v České republice. Používá klasický model lineární regrese a metodu nejmenších čtverců na odhad parametrů. V této práci jsou vytvořeny a testovány lineární a hyperbolické modely a později také modely vylepšené přidáním adaptivního očekávání. Empiricky, na základě výsledků analýzy, ukazuje, že vztah mezi inflací a nezaměstnaností má v souladu s teorií inverzní charakter a že hyperbolický tvar křivky je lepším proložením dat než jednoduchý lineární. Také ukazuje, že zahrnutí adaptivního očekávání do modelu zlepšuje jeho vlastnosti. Nicméně, ekonometrický model, snažící se vysvětlit inflaci pouze pomocí nezaměstnanosti a adaptivního o čekávání, který by byl vhodný ke spolehlivému předpovídání inflace nebyl nalezen.

Klíčová slova: ekonometrický model, inflace, lineární regrese, Phillipsova křivka Předpověď, nezaměstnanost

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1 Introduction

The four main objectives of the economic policy makers are usually to keep high economic growth, low unemployment, low inflation and long-term balance of payments. However, the historical experience suggests that to fulfil all these tasks simultaneously is impossible. Some of them might be even in contradiction. The topic of this diploma thesis is an analysis of the possible relationship between unemployment and inflation with regard to the theory of the Phillips curve. It is intended to look critically at this theory and attempt to quantify the suggested relationship between the inflation and unemployment by employing a suitable econometric model.

This relationship was examined since 1920s. It was believed that the answer was the Phillips curve as constructed in 1950s. However, the whole idea seemed dead after the occurrence of stagflation in 1970 which was in complete contradiction with this theory. There have been written various works focusing on this issue since then. Some were in favour and tried to improve the theory by adding other factors such as the expectations and supply shocks, which can shift the Phillips curve, and others were strongly opposing the idea of any possible trade-off between inflation and unemployment regarding the whole relationship only as a statistical exercise. Yet, until today, there has not been given the final answer.

The currently prevailing opinion generally accepted by the majority of economists is that there is a short term relationship between the inflation and unemployment as it is suggested by the theory of the Phillips curve in its original form. However, in the long term the Phillips curve becomes a vertical line when the economy is operating at its production possibility level and the unemployment is at its natural rate or NAIRU.

2 Objectives of the thesis and methodology

2.1 Objectives and hypotheses

The topic of this diploma thesis is an analysis of the possible relationship between unemployment and inflation with regard to the theory of the Phillips curve. It means, whether there is a trade-off between the unemployment and inflation.

The main hypothesis is: **“There is an inverse relationship between inflation and unemployment as it is suggested by the theory of the Phillips curve.”**

The first aim of this diploma thesis is to prove or disprove the main hypothesis on the basis of the empirical data analysis. We will start with the original theory of the Phillips curve with unemployment and inflation as the only variables. However, we will also look at the later research that included another variable into the model.

A supplementary hypothesis is: **“An econometric model based on the theory of the Phillips curve can be used to forecast future inflation.”**

The second aim is to determine whether it is possible to use a model based on this theory for reliable predictions of future inflation if the explanatory variables were known. The qualitative character of the relationship will be examined in certain limits as specified in the methodology part and it will also be attempted to quantify the relationship in order to prove or disprove the theses.

2.2 Methodology

The data used throughout this work were obtained from the respective statistical offices as they were published online, that is from the Czech statistical office, Ministry of labour of the

Czech Republic and Directorate General of Budget, Accounting and Statistics (Taiwan). There were used the monthly time series. It was decided to use a change consumer price index (CPI) as a measure of inflation in the models instead of wage rates used originally by Phillips. In order to avoid the seasonal influence the inflation rate was measured as the change of the CPI with regard to its value in the corresponding month previous year. It was recognised there has been a change in the methodology of reporting the unemployment rate in the Czech Republic since June 2004 and this issue was resolved by including a dummy variable representing this change into the model.

For the statistical calculations there were used programs Gretl 1.8.5 and an analysis Tool Pack that is an add-in program of the Microsoft Excel 2010.

2.2.1 Main steps of the approach

The main methodological tool used in this work is the analysis of the empirical data. In order to do so there are employed the tools of econometrics, particularly the linear regression model. It is done in eight steps:

a) Formation of an economic model

Here, the hypothesis or hypotheses based on the economic theory are formed.

b) Construction of a mathematical model

In this part the hypotheses are translated into the mathematical language. The main thing here is to decide about the right functional form of the model.

c) Specification of an econometric model

The stochastic variable or the error term is introduced into the model because a pure mathematical dependency among the economic variables is very unlikely to occur.

d) Collection of the data

In this work there are used the time series of the unemployment rate and inflation rate (represented by Consumer Price Index – CPI) for chosen countries obtained mainly from the appropriate statistical offices.

e) Parameter estimation of the model

The linear regression and the Ordinary Least Square method – OLSM are used to estimate parameters of the models.

f) Economic verification

Economic verification means that the properties of the estimated model are compared with the assumptions that we made while forming the economic model in step **a)**.

g) Statistical verification

In the statistical verification there are tested the statistical properties of the model such as the fit of the model, significance of the estimated parameters and the assumptions behind the used classical linear regression model.

h) Making a prediction based on the model

In the last step the endogenous variable is calculated based on the known values of the exogenous variable or variables.

2.2.2 Assumptions of the model

For the purposes of this work it was decided to use the classical linear regression model (**CLRM**). In order to do so we always need to be aware that there are five basic assumptions behind this model that need to be fulfilled to get best linear unbiased estimators (**BLUE**) by the ordinary least square method (**OLSM**). According to (Gujarati, 1992) these assumptions are:

- **a)** The explanatory variables are nonstochastic; that is, their values are fixed numbers.
- **b)** The expected, or mean, value of the disturbance term is zero.
- **c)** The variance of each disturbance term is constant, or homoscedastic.
- **d)** There is no correlation between any two error terms. (No autocorrelation)
- **e)** There is no exact linear relationship among the explanatory variables. (No multicollinearity)

If any of these assumptions does not hold, there is a danger of getting estimators that are not BLUE or getting unreliable results of the statistical properties of the model. Therefore, as a part of the evaluation of estimated models' properties it is necessary to check whether these assumptions hold. In case there is an indication that some of the assumptions were broken in the model, then it is necessary either to change the model in order to eliminate this problem or it has to be kept on mind when making any conclusions based on such a model.

3 Literature overview

3.1 Economic theoretical background

3.1.1 Inflation and its measurement

The general definition of inflation states: "***Inflation is an increase in the average level of prices.***" (Maitah, 2009) In other words it can be also seen as a weakening of the real purchasing power of a given currency. In case of a negative value, decrease of prices, there is used the term deflation. It can be measured by various price indexes. Probably the most widely used index is the consumer price index (**CPI**). However, there are many more indexes such as GDP deflator or Producer price index. There are two main reasons why the CPI was chosen rather than some of the other indexes. Firstly, it is probably the most important measurement of inflation for employees. It is based on the consumer basket of goods they usually need to buy. Therefore it should reflect the changes in the real purchasing power of their wages better than in the case of other indexes. Second reason was the availability of the monthly data.

The only small complication of the CPI is the fact that it is an index with a fixed base. Its value shows how the price of a given consumption basket in the current period differs from the price of the same basket of goods in the base period by taking the price in the base period as 100. However, it is easy to calculate the inflation rate and the statistical offices often publish both the index and the inflation rate.

There are different ways how the inflation is reported:

a) Inflation rate measured as an increase in average annual CPI.

b) Inflation rate measured as an increase in CPI compared with the corresponding month of preceding year.

c) Inflation rate measured as an increase in CPI compared with preceding month.

d) Basic indices - Inflation rate as an increase in CPI compared with the base period.

3.1.2 Expectations influence on inflation

Expectations are one of the most important factors influencing the development of many macroeconomic variables. It is well known that if the policy makers can influence the expectations about the future development of certain indexes to the desired direction, they can achieve similar effects as if they used some monetary or fiscal policy. On the other hand, it can also have an undesired effect offsetting the potential impacts of the economic policy. For example if there is the situation of the economy slowing down. One of the often used measures in such case is an expansionary monetary policy carried out by the central bank. It can happen that the central bank for example decreases the basic interest rate in order to support the economic growth in such situation. However, the effect will be none or even opposite. This can be explained if we consider the existence of expectations. The economic actors have learnt over time that the central bank acts this way in a situation like this. Therefore they expect the central bank to decrease the interest rate even before it happened and adjust their decisions to this expectation. If the central bank than decreases the interest rate by some amount, the effect is much weaker than expected and it can even seem to have the opposite effect if the expected measures were higher.

Inflation is one of the economic variables that are strongly affected by expectations. It is well known even by the general public. Therefore, it is logical that for example in case of the collective bargaining the employees will tend to ask for higher nominal contracts if they expect a higher inflation in the future. On the other hand, they will not be so demanding if they expect a low inflation rate. We can categorize the expectations according to its formation as adaptive and rational.

Adaptively expected inflation

The assumption behind the adaptive formed inflation is that the economic subjects base their decision on the inflation in the previous period or periods. The expectations, however, will probably not be formed only on the basis of the previous real values of inflation. The economic subjects can learn from experience so they will probably also take the previous mistakes into account. Therefore it can be expected that they will form their expected inflation with regard to the inflation in the previous period and also with regard to the difference between the inflation in the previous period and their expectations in that period. This approach will be used in the **chapter 4** of this paper when a model based on the expectations augmented Phillips curve will be formed.

Rationally expected inflation

According to this theory the economic subjects do not form their expectations only on the basis of the past experience (adaptively explained in the previous paragraph). They are more likely to use all available information regarding both the past and the future development. (Muth,1961) Their information is not exactly correct but it should be correct on average. This allows avoiding the systematic errors. At the beginning of this subchapter there was used the example of the central bank using the expansionary monetary policy (decrease interest rates) in order to boost the economy. It was argued that the economic subjects might anticipate such move and adjust their expectations accordingly. That is exactly the example of rational expectations. Of course they would still probably take the past development into account but they would also consider this assumption about the monetary policy. The same can be expected about the potential measures of the fiscal policy as well.

3.1.3 Money wage rate vs. Inflation

The original Phillips' research was focused on the money wage rate, particularly the production workers. It represented the total costs per employee including not only the remuneration of the employee but also the benefits and income tax. It was believed that these costs were crucial for the pricing decision of firms. The original Keynesian models of macroeconomic fluctuations were usually based on the assumption of rigid wages. It was later on, in 1970 when this idea was gradually abandoned and the new models began to be built on the premise of rigid prices rather than wages. There is a strong linkage between the money wage rates and inflation. We can see that increase in inflation causes a strong pressure on the increase of money wage rates, which increases the production costs and can lead to even higher inflation.

It also needs to be mentioned here that Phillips in his original work did not distinguish between the real and nominal wages. That is possible in the world of rigid prices or a stable price changes rate over time; however, it is not very suitable if there is no a stable average rate of changes of prices. As Friedman (1968) argues, "For periods or countries for which the rate of change of prices varies considerably, the Phillips curve will not be well defined." This can be resolved either by using the rate of change of real wages or it should be better said the anticipated real wages because the employees cannot be sure at the time of negotiation about wages what the inflation would be exactly. Friedman (1968) further suggests that in the empirical analysis of the Phillips curve there can be used the rate of change of the price level, in other words inflation, as an independent variable.

3.1.4 Unemployment

"The unemployment rate measures the percentage of those people wanting to work who do not have jobs." (Maitah, 2009) If we add those who are employed, we will get the total labour force. People who do not belong to any of the above categories (working or seeking to work) are not included in the labour force. It is important to understand the definition of the labour force in order to understand the data on the unemployment rate because the definition of who is included in the labour force and who is not may differ from country to country. Then we can get different and sometimes unexpected quantitative results of our analysis that can be caused by these differences.

Types of unemployment:

Frictional unemployment usually means short term unemployment caused by incomplete information in the labour market. It represents relatively short periods of time after employees quit the previous job and before they begin new ones.

Structural unemployment refers to the people spending long time out of job. It is usually caused by a structural change in the economy and resulting obsolesces of certain skills. It includes people with an inadequate or very limited set of skills.

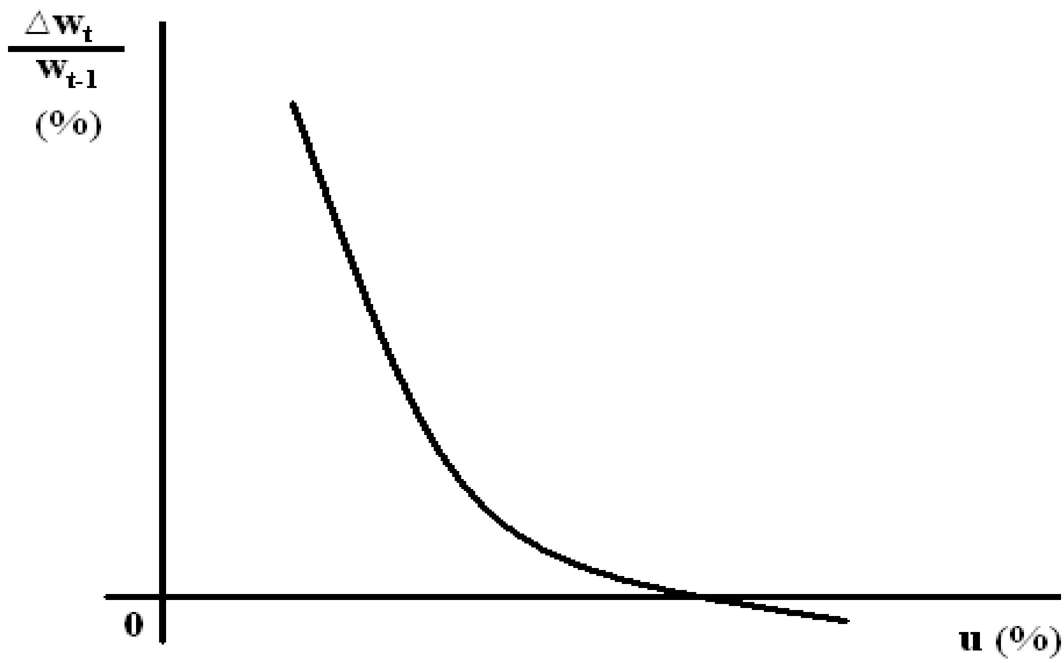
Cyclical unemployment is related to the economic cycle. “It is the difference between the actual unemployment rate at a given time and the natural rate.”(Maitah, 2009)

Seasonal unemployment is connected with the seasonal character of certain jobs such as building industry, life guard at the beach or ski instructors.

Natural rate of unemployment is defined as the sum of the frictional and structural unemployment by (Maitah, 2009). It is defined as the point where the original Phillips curve crosses the x axes and later on was replaced by the so called no accelerating inflation rate of unemployment (**NAIRU**) that is supposed to be, according to Phelps and Friedman, a level of unemployment that generates stable inflation. It should be found where the slope of the Phillips curve is zero or in the intercept of the long term Phillips curve and the x axis.

3.1.5 History of the Phillips curve theory

Figure No. 1: The Phillips Curve



Source: author

Attempts to analyse a possible relationship between inflation and unemployment can be traced back to 1920s to the American neoclassical economist Irving Fisher. He published his finding in the article: A statistical relation between unemployment and price changes that was published in the International labour review in June 1926. (Mach, 2001) However, the discovery of the inverse relationship between inflation and unemployment is usually attributed to A. W. Phillips; a New Zealand's economist, who analysed the collected data on unemployment and the wage rate changes in the UK from 1861 to 1957. Based on this research, he concluded that there was an inverse relationship between those two variables. These results were published in his most famous article: The Relation between

Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957. The general form of the Phillips curve is depicted in the **Figure No. 1**, where unemployment (**u**) is plotted on the horizontal axis the rate of change of money wage rates **(**$\Delta \mathbf{w_t}/\mathbf{w_{t-1}}$) on the vertical axis.

From that we can draw three main characteristics of the Phillips curve:

a) It is downward sloping.

b) It has a hyperbolic shape

c) It intersects the x axis.

The intuitive logic behind this inverse relationship is that when the unemployment rate is very low it is difficult for the employers to find employees. They are forced to attract them by offering higher wages. Higher wages than result in more spending at it creates a pressure on prices to increase therefore it can be associated with higher inflation.

On the other hand, when the unemployment rate is high, it is easy for the employers to find employees and there is not this pressure on the wages to increase, therefore there is not this upward pressure on prices so we expect lower inflation.

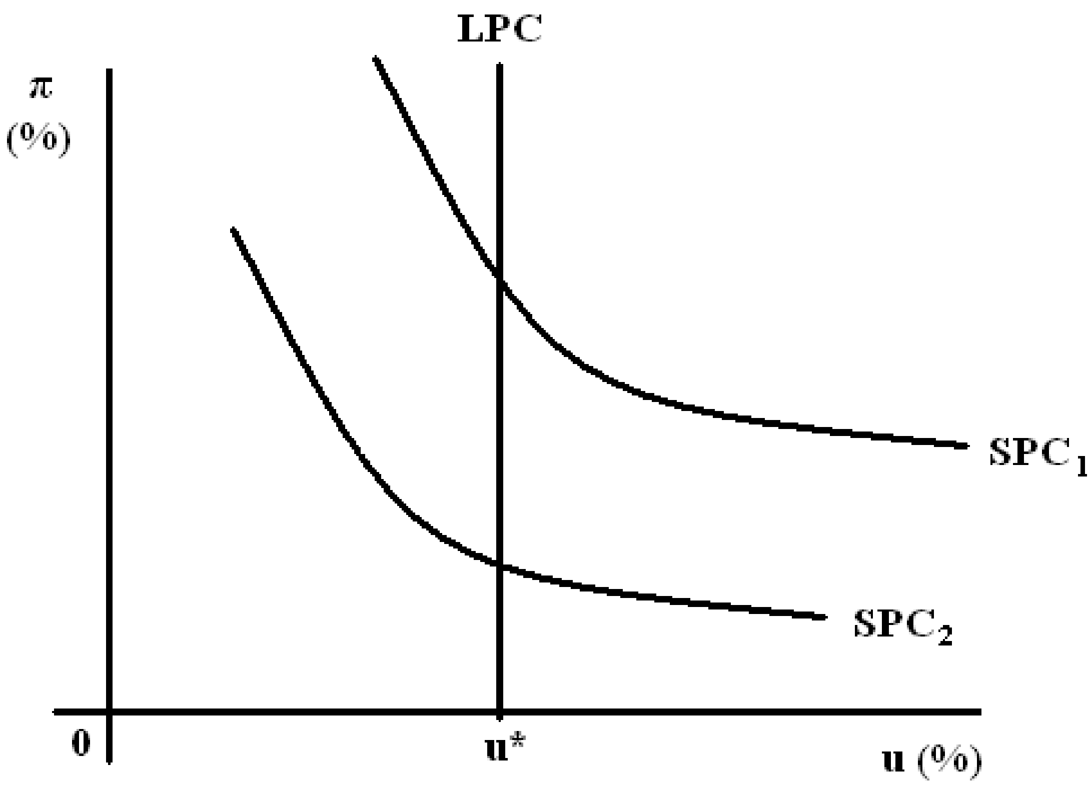
An important question about the practical use of the theory of the Phillips curve is whether we can use monetary tools to influence the unemployment rate. When Phillips stated his theory it was praised and it was believed that it provides to the policy makers a powerful tool to adjust the unemployment rate to their will by simply changing the inflation rate. Monetary policy makers can easily influence the inflation rate by changing the base interest rates or changing the quantity of money in the market. Phillips's work suggested that this relationship holds over almost 100 years (at least for the UK) and the problem of changes in real versus nominal wages was addressed P. A. Samuelson and R. M. Solow in 1960s. They simply substituted the rate of change of the nominal wages by the rate of inflation (change of the price level). Phillips curve was then defined as the inverse relationship between the rate of inflation and the rate of unemployment. This relationship was surprisingly stable for relatively long periods of time in many countries. Therefore, it was a useful tool of macroeconomic policy as it allowed to the policy makers to decide between differentiated combinations of unemployment and inflation rates.

In 1970s there occurred a problem of stagflation. ***"Stagflation is undesirable rates of both unemployment and inflation together."*** (Maitah, 2009) This raised a criticism of the Phillips curve theory because it is with direct contradiction with the assumption of a trade-off between the inflation and unemployment rates and stagflation cannot be explained by this theory. American economists Edmund S. Phelps and M. Friedman analysed the problem of unemployment-inflation relationship more deeply, taking into consideration also the problem of information in the economy. The economic subjects never actually have the full information about the actions of others and to a great extent act on the basis of their expectations. Based on this assumption, they formulated the expectations-augmented Phillips curve. (In 2006 was Phelps awarded the Nobel Prize in economics for his analysis of inter-temporal trade-offs in macroeconomic policy and this research was one of his main contributions.) According to this theory, inflation depends not only on unemployment but also on the expected inflation. Then we can explain the occurrence of stagflation. Simply put, the higher the expected inflation, the higher the real inflation and it can happen that even if the unemployment is rising, the effect of high expected inflation can be stronger and cause the real inflation to rise as well. As we will see in **chapter 4**, the quantification of these expectations is actually one of the biggest problems if we want to create an econometric model based on this expectation augmented Phillips curve.

Phelps and Friedman also used the term natural rate of unemployment, which we can identify on the original Phillips curve in the intersect of the curve with the x axis and which occurs if the economy operates in the long run on its full potential.

That can be explained if we realize that real wages should adjust to the equilibrium in the labour market. That is the point where the supply and demand for the labour are in equilibrium. In such case if the government tries to reduce unemployment by expansionary fiscal policy, it will cause an increase of inflation and consequently an increase of expected inflation. The expected inflation will always eventually adjust to any level of the real inflation and the rate of unemployment will also return to its natural rate. Therefore, we should distinguish between the short-term Phillips curve and the long-term Phillips curve. Because the wages and consequently unemployment tend to get to the natural rate in equilibrium, the long run Phillips curve must be actually vertical as depicted in **Figure No. 2**. Where π is inflation, u means unemployment, **u*** is the natural rate of unemployment, **LPC** stands for the long run Phillips curve and $\mathbf{SPC_{1,2}}$ are the short run Phillips curves.

Figure No. 2: Long run Phillips curve



Source: author

We can explain the mechanism of upward shifting short-term Phillips curve when we imagine that the government wants to decrease the unemployment below its natural level by using monetary tools. They can do it in the short-term and the economy can get above its production possibility curve. It will be result in higher inflation, which will result in higher expected inflation. The expected inflation will then shift the Phillips curve upwards so that the rate of unemployment rises back to its natural level but the inflation remains higher. We can imagine it as a move from $\mathbf{SPC_2}$ to $\mathbf{SPC_1}$ in the **figure No. 2**.

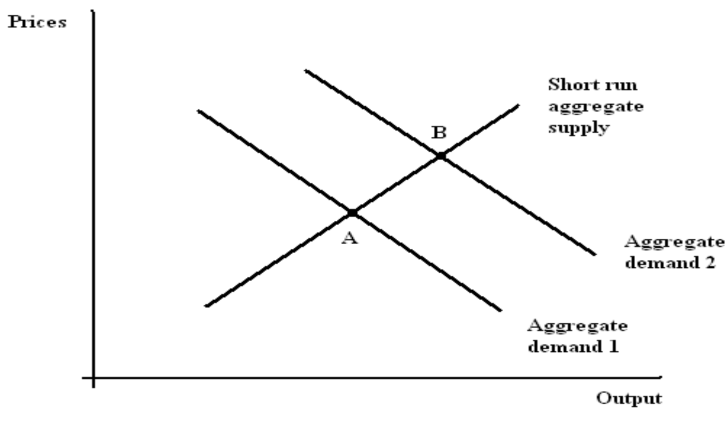
3.1.6 Supply shocks

In 1973 after the Jomkipur war between Israel and a coalition of Arab countries, Organization of Petroleum Exporting Countries (**OPEC**) deliberately decreased the oil production and stopped exporting crude oil into the countries that supported Israel. It caused the biggest oil shock in history with the prices almost quadrupling in a short time. They lowered the production for a long time in order to secure higher income. This is an example of a shock to aggregate supply. (Mankiw, 2003) It had direct impact on firms and shifted the aggregate supply to the left because such a large increase of costs of a major input reduces the amount of production at every price level. In other words we had a situation with an increase of prices accompanied by a decrease of output (**stagflation**). A left shift of the aggregate supply is consequently followed by a right shift of the short term Phillips curve. When the output of the economy decreases, firms need less workers and the unemployment rises. At the same time we have higher prices so the inflation rate is higher. How long will last the effect of such is supply shock is not exactly sure. ***"It depends on how people adjust their expectations of inflation."*** (Mankiw, 2003) If the economic actors use the rational expectations approach and see the inflation caused by the supply shock only as a temporary situation, the expected inflation will not change. However, if they see it as a more permanent situation or if they use just the adaptive expectations approach, the effect on the expected inflation can last for longer time.

3.1.7 The Phillips curve and the aggregate demand and supply

The model of aggregate supply and aggregate demand are strongly connected with the Phillips curve and they allow an explanation of the possible outcomes depicted by the Phillips curve. ***"The Phillips curve simply shows the combinations of inflation and unemployment that arise in the short run as shifts in the aggregate-demand curve move the economy along the short-run aggregate-supply curve."*** (Mankiw, 2003) Let's assume a short run aggregate supply and aggregate demand model in an economy working bellow its potential. We can imagine such a situation if we look at the **figure No. 3** and consider the equilibrium in the point **A**. If the aggregate demand shifts to the right, the new equilibrium is in the point **B**. It is clear that both the output and the prices have risen. We can then see the link between the Phillips curve and aggregate supply and demand. As the economy worked in B, the prices were lower and the output as well, therefore fewer workers were needed. When the situation changed from A to B, There is higher level of prices which means higher inflation and also the output is higher, therefore there are more workers needed so the unemployment should decrease. This shows clearly how the policy makers could influence the shifts along the Phillips curve because there are many tools how to shift the aggregate demand.

Figure No. 3: Short run aggregate supply and aggregate demand



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3.2 Detection and solution of the practical problem of the regression analysis

3.2.1 Heteroscedasticity of the error term variance

If the error term in the model is heteroscedastic, the estimators obtained by the **OLSM** are not **BLUE** anymore because the estimate variances of the **OLSM** estimators are biased. (Gujarati, 1992)

For the detection of this problem, there is a simple qualitative graphical way to get some idea whether it should be suspected it or not. The residuals or their squares can be plotted against the variables of the model and checked whether there appears to be a certain pattern. This approach is formalized in the **Park test**. The idea of this test is to run simple regressions of the model's residuals against each variable of the model as in the **equation 1**, where **ε** stands for the error term of the examined model and **X** stands for the variable.

$$\mathbf{\ln(\varepsilon_t)^2 = B_1 + B_2 \ln(X_t) + u_t} \qquad \textbf{(Equation 1)}$$

Then there would be tested the hypothesis that $\mathbf{B_2 = 0}$, which would mean there is no heteroscedasticity. This method is not very good for the models used in this work because the variables such as inflation or expected inflation can have a negative value in some periods, therefore it would be impossible to use the logarithmic form of the function. It is necessary to change the **equation 1** in a way that there could be used negative values of the variable. Therefore, it was chosen to use the method suggested by (Glejser, 1969). That is to use the absolute value of the error term instead of squares and other functional forms of variables such as linear or rational, which are possible also for the negative values. Heteroscedasticity is not expected to occur in the models used throughout this paper as it is usually a problem of the cross-sectional series rather than time series.

3.2.2 Autocorrelation of the residual

According to (Gujarati, 1992), if there is the autocorrelation problem in the model, the consequences can be similar as in the case of heteroscedasticity. Again the **OLSM** estimators are not **BLUE** and their variances are biased. The usual **t** and **F** values are consequently unreliable. There could appear high values of the adjusted coefficient of determination suggesting the model is a good fit and the parameters can seem significant as a result of this issue even if the model is actually bad.

In order to detect this problem, there can be used a similar graphical method as in the case of heteroscedasticity. The values of the residual can be simply plotted against time and then if there appears to be a certain pattern, it is likely there is the autocorrelation of the residual. However, there will be employed some more formalised statistical methods to detect the autocorrelation problem in this work. Probably the most widely used method is the **Durbin-Watson d statistics** calculated as in the **equation 2**.

$$\boldsymbol{d = \frac{\sum_{t=2}^{n}(\varepsilon_t-\varepsilon_{t-1})^2}{\sum_{t=1}^{n}\varepsilon_t^2}} \qquad \textbf{(Equation 2)}$$

$\boldsymbol{\varepsilon_t}$.........the error term in the period **t**

n.........the sample size

The computed value of **d** is always between 0 and 4. Values of **d** close to 0 (resp. 4) suggest there is a positive (resp. negative) autocorrelation. In case the value is around 2, it is an evidence of no autocorrelation. In order to be more precise about the decision whether or not there is the autocorrelation, there can be found tabulated values of the upper bound $\mathbf{d_U}$ and the lower bound $\mathbf{d_L}$, which depend on the chosen level of significance, number of observations and the number of explanatory variables in the model. Then it can be said that there is no autocorrelation in case the condition in the **equation 3** holds.

$$\boldsymbol{d} \in (\boldsymbol{d_U}; \boldsymbol{4} - \boldsymbol{d_U}) \qquad \textbf{(Equation 3)}$$

However, there are certain limits when using the **d** statistics because it cannot be used in case of autoregressive models; that are models where a lagged endogenous variable is included among the explanatory variables. In such a case it is more appropriate to use the **Durbin h statistics**, which is expressed in the **equation 4**.

$$\boldsymbol{h} \approx \hat{\boldsymbol{\rho}} \sqrt{\frac{\boldsymbol{n}}{\boldsymbol{1} - \boldsymbol{n} \cdot \boldsymbol{var}(\boldsymbol{b})}} \qquad \textbf{(Equation 4)}$$

$\hat{\boldsymbol{\rho}}$........................the estimator of the autocorrelation coefficient

n........................the sample size

var(b) ....the variance of the coefficient of the lagged explained variable

var(b) can be obtained from the results given by the excel statistical package as the square of the standard error of the appropriate parameter and the estimator of the autocorrelation coefficient $\hat{\boldsymbol{\rho}}$ can be estimated from the **d** statistics according to the **equation 5**. (Gujarati, 1992)

$$\hat{\boldsymbol{\rho}} = \boldsymbol{1} - \frac{\boldsymbol{d}}{\boldsymbol{2}} \qquad \textbf{(Equation 5)}$$

Durbin showed that for a large enough sample and given the null hypothesis that **$\rho = 0$**, the **h** statistics follows the normal distribution. It leads to a simple rule that the null hypothesis is rejected in case **h > critical value** of the normal distribution at the given significance level. (e.g. 1.96 for $\alpha = 0.05$)

An occurrence of the autocorrelation problem in some of the following models is expected because it happens relatively often in case of the models based on the time series. If that happens, it will be resolved by transforming the model equation into a different form where the error term would not be auto correlated.

3.2.3 Multicollinearity

In case of a perfect multicollinearity, that means that a vector of any explanatory variable would be an exact linear combination of the vectors of the other explanatory variables, it would not be possible to estimate the parameters of the model by using the **OLSM** because there would simply be more unknowns than equations. The model would be under identified. However, even the imperfect multicollinearity can cause a problem in the model. Although the estimators in such a case would still be **BLUE**, it might not be possible to specify the exact influence of particular explanatory variables on the explained variable and some variables might even seem to be insignificant, when using the standard **t** statistics, in spite of having a strong influence according to the theory. For example the statistical outcome of the model can display a high value of the adjusted coefficient of determination together with insignificant partial parameters but a significant simultaneous effect of the explanatory variables. Simply put there could appear rather contradictory statistical properties of a model containing the multicollinearity issue.

When examining the model on the presence of multicollinearity among the explanatory variables, it is not a question whether there is or is not the multicollinearity in the model but a question of its degree. (Gujarati, 1992) There are various signs on its presence in the model that should cause an alarm if they occur. For example if the model exhibits some of the confusing results as mentioned in the previous paragraph, it should be a warning that it might be caused by multicollinearity. Another possibility to detect this issue is to check the pairwise correlation between each two explanatory variables. In this work, if the value of the coefficient of correlation is higher than **0.8,** it is considered to be a sign of high probability of the presence of multicoullinearity in the model. This issue can be resolved by many methods ranging from exclusion of one or more explanatory variables from the model to different mathematical operations exercised on the variables. The choice depends on the particular situation.

3.2.4 Functional forms

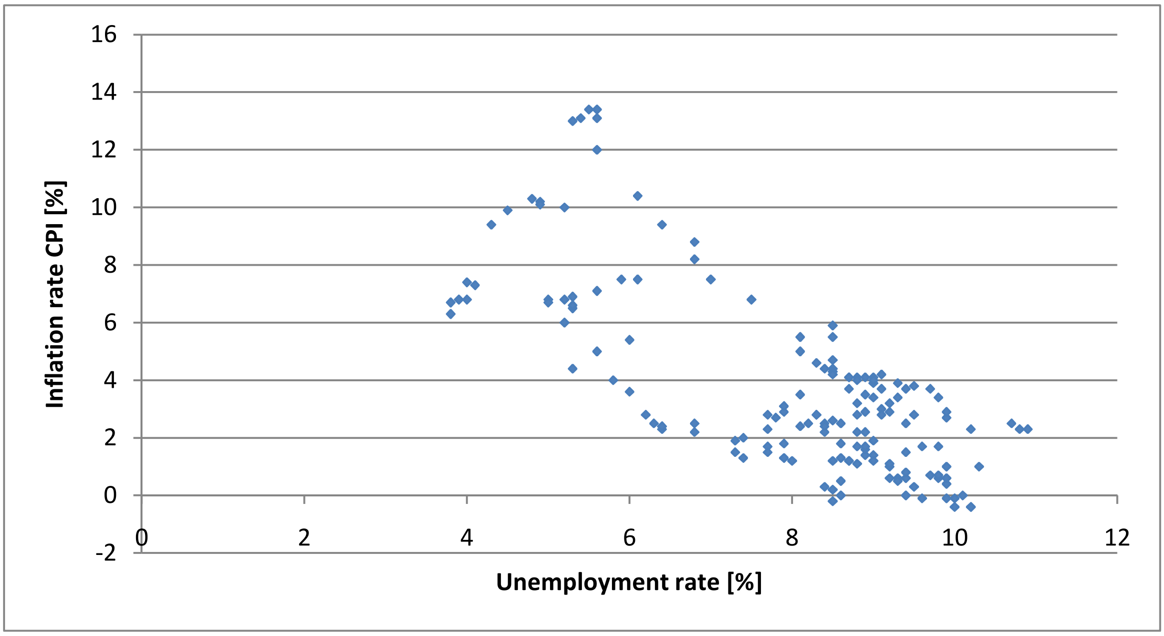
Because the method chosen for the modelling in this paper was the **CLRM**, the functions on which it is applied must be linear in the parameters. That means that ***"the conditional mean of the dependent variable will be a linear function of the parameters."*** (Gujarati, 1992) It was considered to use some other function such as the semi-logarithmic function, logarithmic function or the power function, however, in order to use the **OLSM** for the parameter estimation such functional forms would have to be linearized. For the linearization process it is usually necessary to use the logarithm of one or more variables instead of the original variable and that would be a problem because values of inflation or expected inflation can have negative values and the logarithm function is defined only for positive values. Therefore it was decided not to use other than linear functions in the parameters. As for the functional form with regard to the variables, there are no limits by the used model. There are only limitations by the negative values of some of the variables. In this work there were compared models based on the expected linear relationship and hyperbolic relationship between the inflation and unemployment rates.

4 Analysis and discussion of the empirical data

4.1 The Czech Republic

All calculations in this part are based on the real monthly data on inflation (**CPI**) and unemployment in the Czech Republic from January 1998 to June 2010. We can see these data plotted in the **Figure No. 4**.

Figure No. 4: Inflation vs. Unemployment in the Czech Republic (1998 - 2010)



Source: Ministry of Labour and Social Affairs of the Czech Republic and the Czech Statistical Office

4.1.1 Linear model

The first model is based on the original Phillips curve theory; it means there is expected to be the relationship only between unemployment and inflation without any other influence. We formed the **equation 6**, where $\boldsymbol{\pi}$ stands for inflation and **U** for unemployment, **ε** expresses the stochastic variable.

$$\pi_t = \gamma_1 + \gamma_2 U_t + \varepsilon_t; \qquad \gamma_1 > 0, \gamma_2 < 0 \qquad \textbf{(Equation 6)}$$

Based on the theory, we expect the coefficient $\boldsymbol{\gamma_1}$ to be positive and the coefficient $\boldsymbol{\gamma_2}$ to be negative because we assume the negative relationship between inflation and unemployment and also that the curve should cross the x (unemployment) axis and unemployment can never have a negative value.

The estimated curve obtained by application of the linear regression on the data is then:

$$\hat{\pi}_t = 14.538 - 1.363 U_t; \qquad \textbf{(Equation 7)}$$

The economic verification is positive because the curve is downward sloping as it was expected (– 1.363 < 0). However, when we look at the statistical verification, the results are not satisfactory. In the **table No. 1**, we can see, that the adjusted coefficient of determination is rather low (only 0.462) despite a sufficient number of observations.

Table No. 1: Regression statistics of the linear model

Multiple R	0.683
R Square	0.466
Adjusted R Square	0.462
Standard Error	2.135
Observations	150

Source: own calculations

Table No. 2: ANOVA statistics of the linear model

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	589.191	589.191	129.204	6.47E-22
Residual	148	674.905	4.560		
Total	149	1264.096			
	Coefficients	*Standard Error*	*t Stat*	*Lower 95%*	*Upper 95%*
Intercept	14.538	1.003	14.488	12.555	16.521
γ_2	-1.363	0.120	-11.367	-1.600	-1.126

Source: own calculations

When we look at the **table No. 2**, we can see the analysis of the variance. It shows that both parameters are significant at our chosen level of significance ($\alpha = 0.05$). However, we have omitted one important fact in our model. The methodology of the unemployment calculation in the Czech Republic has been different since July 2004. We have decided to include this influence into our model by introducing a dummy variable D. This variable has the value of 0 during the whole period before July 2004 and it is 1 afterwards. The econometric form of our model will then be:

$$\pi_t = \gamma_1 + \gamma_2 U_t + \gamma_3 D_t + \gamma_4 D_t U_t + \varepsilon_t; \qquad \gamma_1 > 0, \gamma_2 < 0 \qquad \textbf{(Equation 8)}$$

Our expectations regarding the coefficients γ_1 and γ_2 are as before but we do not have any expectations regarding the coefficients γ_3 and γ_4 because they represent only a technical variable introduced in order to include unspecified effects of the methodological change in the unemployment rate computation. Coefficient γ_3 expresses the change of the intercept term and γ_4 stands for the change of slope.

The estimated curve will then be:

$$\hat{\pi}_t = 24.737 - 2.404U_t - 14.138D_t + 1.393D_tU_t; \qquad \textbf{(Equation 9)}$$

The results in the **equation 9** are again in accord with our expectations as it shows the negative relationship between inflation and unemployment rates. We can also see how the methodological change for the unemployment calculation influenced our model. After the change occurred, the intercept goes down by 14.138 and the slope gets more gradual (less steep) by 1.393.

Table No. 3: Regression statistics of the linear model with a dummy variable

Multiple R	0.871
R Square	0.759
Adjusted R Square	0.754
Standard Error	1.446
Observations	150

Source: own calculations

As we can see in the **table No. 3**, the adjusted coefficient of determination increased significantly after including the dummy variable D. More than **75%** of the variance of the inflation rate is explained by the variance of our exogenous variables. In the table No. 4, we can see that all parameters of the model are significant at the chosen level of significance (**α = 0.05**). This shows, together with an increased adjusted coefficient of determination, that including the influence of the changed unemployment calculation methodology was the move in the right direction.

Table No. 4: ANOVA statistics of the linear model with a dummy variable

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	958.980	319.660	152.960	7.3E-45
Residual	146	305.115	2.090		
Total	149	1264.096			
	Coefficients	*Standard Error*	*t Stat*	*Lower 95%*	*Upper 95%*
Intercept	24.737	1.104	22.411	22.555	26.918
γ_2	-2.404	0.125	-19.188	-2.652	-2.157
γ_3	-14.138	1.447	-9.774	-16.997	-11.279
γ_4	1.393	0.173	8.059	1.051	1.734

Source: own calculations

4.1.2 Hyperbolic model

In our second model we suppose a hyperbolic shape of the Phillips curve and change the function accordingly. We can see the new form in **equation 5**.

$$\pi_t = \gamma_1 + \gamma_2 U_t^{-1} + \gamma_3 D_t + \gamma_4 D_t U_t^{-1} + \varepsilon_t; \qquad \gamma_1 < 0, \gamma_2 > 0 \qquad \textbf{(Equation 10)}$$

The estimated curve based on the same dataset is then in the **equation 11**.

$$\hat{\pi}_t = -13.119 + 143.169 U_t^{-1} + 8.603 D_t - 88.982 D_t U_t^{-1} \qquad \textbf{(Equation 11)}$$

The change of the functional form from linear to hyperbolic seems to be the right thing to do because as we can see from the **table No. 5**, the adjusted coefficient of determination increased again. Almost **81%** of the inflation variance is now explained by the exogenous variables' variances.

Table No. 5: Regression statistics of the hyperbolic model with a dummy variable

Multiple R	0.902
R Square	0.813
Adjusted R Square	0.809
Standard Error	1.272
Observations	150

Source: own calculations

In the **table No. 6** we can see that all parameters of the model are significant at the chosen level of significance ($\alpha = 0.05$). That again supports our choice to change the model. We should also notice that the signs and sizes of the estimated parameters in **table No. 6** comply with our theoretical assumption formed in the **equation 5**.

Table No. 6: ANOVA statistics of the hyperbolic model

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	3	1027.936	342.645	211.832	5.70E-53
Residual	146	236.160	1.618		
Total	149	1264.096			
	Coefficients	*Standard Error*	*t Stat*	*Lower 95%*	*Upper 95%*
Intercept	-13.119	0.766	-17.125	-14.633	-11.605
γ_2	143.169	6.370	22.474	130.579	155.760
γ_3	8.603	1.053	8.173	6.523	10.683
γ_4	-88.982	8.252	-10.783	-105.291	-72.673

Source: own calculations

4.1.3 Expectations augmented model

In the next step we decided to introduce another exogenous variable into the model. That is the expected inflation π_e. By including the expected inflation into the model we will get the expectation augmented hyperbolic Phillips curve in the form of **equation 12**.

$$\boldsymbol{\pi_t = \gamma_1 + \gamma_2 U_t^{-1} + \gamma_3 D_t + \gamma_4 D_t U_t^{-1} + \gamma_5 \pi_t^e + \varepsilon_t; \qquad \gamma_1 < 0, \gamma_2 > 0, \gamma_5 > 0} \quad \textbf{(Equation 12)}$$

The apparent problem of this approach is how to determine values of the expected inflation. We decided to use the method of adaptive expectation formation. Under this method, expected inflation is estimated as a weighted average of the real and expected inflation rates in the previous period. [Mach, 2001] We can see it expressed in the **equation 13**.

$$\boldsymbol{\pi^e_t = \pi^e_{t-1} + j(\pi_{t-1} - \pi^e_{t-1})} \qquad \textbf{(Equation 13)}$$

The constant **j** in the **equation 13** is a coefficient of adaptation. It expresses how quickly the expected inflation converges to the real inflation. [Mach, 2001] We decided to run a series of model calculations for various values of **j∈ <0.1; 0.9>.** Then they were compared on the basis of their properties. Our target was to get an improved model that would represent a better fit; therefore our aspiration was to get a model with a higher value of the adjusted coefficient of multiple determination.

Obviously we also had to take into account some theoretical assumptions about the coefficient of adaptation. In the **equation 8** it can be seen that the coefficient of adaptation expresses how strongly the expected inflation depends on the expected (resp. real) inflation in the previous period. The higher (resp. lower) the value of **j**, the stronger the influence of the real (resp. expected) inflation in the previous period on the expected inflation in the current period.

After the series of tests with different value of j, we decided to choose the model with **j = 0.8** for two reasons. Firstly the model has a higher value of the adjusted multiple coefficient of determination than the previous model and secondly we think that the real inflation in the previous period has much higher influence on the expected inflation in the current period than the previous expectations.

We can see the result with estimated parameters in the **equation 14**.

$$\hat{\pi}_t = -0.229 + 3.538U_t^{-1} + 0.226D_t + 1.543D_tU_t^{-1} + 0.908\pi^e_t \qquad \textbf{(Equation 14)}$$

We can see that the results are in accord with our theory. From **table No.7** we can see that it seems that **95%** of the variance of the inflation is now explained by the model. However, we need to look more carefully on the statistical property of the model before deciding whether it is really such a good fit.

Table No. 7: Regression statistics of the expectations augmented hyperbolic model

Multiple R	0.975
R Square	0.951
Adjusted R Square	0.950
Standard Error	0.630
Observations	149

Source: own calculations

When we look at the **table No. 8**, the model still seems to have all the desirable characteristics. All coefficients apart of $\boldsymbol{\gamma_4}$ are significant at ($\boldsymbol{\alpha} = \mathbf{0.05}$). It is not a big problem, because $\boldsymbol{\gamma_4}$ represents only a technical dummy variable. Also the F = 699, suggests a high significance of all parameters together.

Table No. 8: ANOVA statistics of the expectations augmented hyperbolic model

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	1110.335	277.584	699.038	3.321E-93
Residual	144	57.181	0.397		
Total	148	1167.516			
	Coefficients	*Standard Error*	*t Stat*	*Lower 95%*	*Upper 95%*
Intercept	-0.229	0.720	-0.317	-1.653	1.195
γ_2	3.538	7.326	0.483	-10.943	18.018
γ_3	-0.226	0.673	-0.335	-1.556	1.105
γ_4	1.543	5.960	0.259	-10.238	13.323
γ_5	0.908	0.043	21.202	0.823	0.993

Source: own calculations

Here we have to look whether the assumptions of the linear model as stated in the **chapter 2.2.2** hold. When we tried to test the autocorrelation of the residual, we first calculated the value of **d** from the Durbin-Watson test (see **equation 2**). We computed $\mathbf{d = 0.903}$. It would suggest a strong positive autocorrelation of the residual as the appropriate indecisive interval is (**1.679; 1.788**). However, we have to be careful here because by introducing an expected inflation into the model we actually included certain influence of the lagged inflation on itself. It means that our model is to some extend autoregressive and therefore the simple Durbin-Watson test might not be appropriate in such a case. Therefore we tried to use the more suitable Durbin h test where we considered the expected inflation to be a lagged explained variable. We estimated the coefficient of autocorrelation based on the **equation 5** and then calculated h value $\mathbf{h = 7.85}$ from the **equation 4**. It is much larger than **1.96**, which is the critical value for our 5% significance level, so we have a clear indication of a first order autocorrelation of the residual.

In order to resolve this problem, we have decided to transform the **equation 12** into a different form. We can assume that the error term **ε** can be expressed by **equation 15**.

$$\boldsymbol{\varepsilon_t = \rho\varepsilon_{t-1} + u_t} \qquad \textbf{(Equation 15)}$$

Where **ρ** is the autocorrelation coefficient and **u** is a stochastic variable. We have already estimated **ρ** when computing the Durbin **h** statistics. We transform **equation 12** by rewriting it in the period **t – 1** and multiplying by **ρ**.

$$\boldsymbol{\rho\pi_{t-1} = \gamma_1\rho + \gamma_2\rho U_{t-1}^{-1} + \gamma_3\rho D_{t-1} + \gamma_4\rho D_{t-1}U_{t-1}^{-1} + \gamma_5\rho\pi_{t-1}^{e} + \rho\varepsilon_{t-1};} \qquad \textbf{(Equation 16)}$$

Then if we subtract the **equation 12** from the **equation 16**, we will get:

$$\boldsymbol{\pi_t - \rho\pi_{t-1} = \gamma_1(1-\rho) + \gamma_2(U_t^{-1} - \rho U_{t-1}^{-1}) + \gamma_3(D_t - \rho D_{t-1}) + \gamma_4(D_tU_t^{-1} - \rho D_{t-1}U_{t-1}^{-1}) + \gamma_5(\pi_t^{e} - \rho\pi_{t-1}^{e}) + \varepsilon_t - \rho\varepsilon_{t-1};} \qquad \textbf{(Equation 17)}$$

If we use **equation 15** and use symbol Δ to express a weighted change from the brackets, we can rewrite the **equation 17** as:

$$\boldsymbol{\Delta\pi_t = \gamma_1^{*} + \gamma_2\Delta U_t^{-1} + \gamma_3\Delta Dt + \gamma_4\Delta D_tU_t^{-1} + \gamma_5\Delta\pi_t^{e} + u_t;} \qquad \textbf{(Equation 18)}$$

By using this transformation, we will lose the oldest set of observations but we should get rid of the autocorrelation problem. When we compare the equations 12 and 18, we can see that the parameters are the same only with exception of γ_1 but we can easily get the original γ_1 back because:

$$\gamma_1 = \frac{\gamma^*}{1-\rho} \qquad \textbf{(Equation 19)}$$

After running the **OLSM** on the same data to estimate the parameters of **equation 18**, we get:

$$\Delta\hat{\pi}_t = -1.039 + 26.592\Delta U_t^{-1} + 1.279\Delta Dt - 13.602\Delta D_t U_t^{-1} + 0.732\Delta\pi_t^{e}; \qquad \textbf{(Equation 20)}$$

We have succeeded in resolving the autocorrelation problem because the Durbin-Watson d statics gives the value of **1.93**, which is well within the interval (**1.788; 2.212**) and the Durbin **h** statistics of **0.62** also does not suggest there should be the autocorrelation present in our model.

Table No. 9: Regression statistics of the expectations augmented hyperbolic model without autocorrelation

Multiple R	0.912
R Square	0.832
Adjusted R Square	0.827
Standard Error	0.510
Observations	148

Source: own calculations

From the **table No. 9** we can see that the adjusted coefficient of determination is now lower than in the model biased by autocorrelation of the residual; however it is still higher than in the model without the expected inflation. We should also notice in the **table No. 10** that all the parameters are now significant at **α = 0.05**. We were also unable to detect the heteroscedasticity in the model by both plotting the residuals and their squares against the variables and also by the Gejsler test as described in the **chapter 3.1.1**. We also checked for the multicollinearity and found only a high partial correlation between the variables **D** and **DU^{-1}**. That is understandable because of the nature of the dummy variable and it does not require any further measures especially when we can see that there are not the other signs of the multicollinearity problem such as insignificant parameters.

Table No. 10: ANOVA statistics of the expectations augmented hyperbolic model without autocorrelation

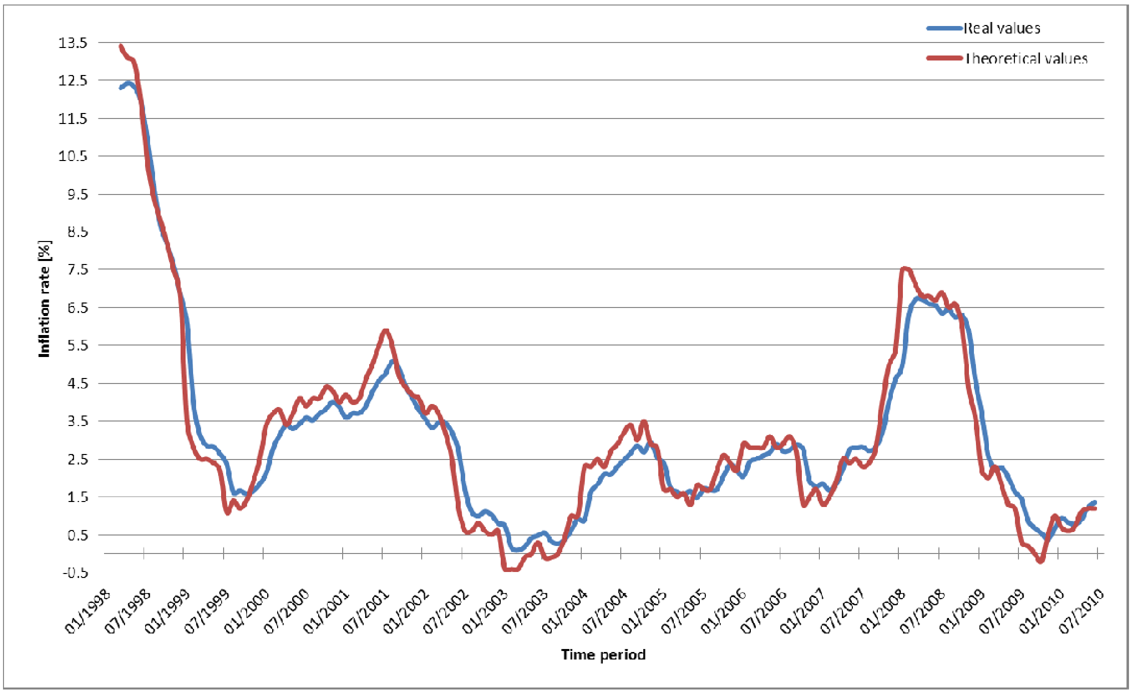
	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	183.406	45.852	176.592	2.868E-54
Residual	143	37.129	0.260		
Total	147	220.536			
	Coefficients	*Standard Error*	*t Stat*	*Lower 95%*	*Upper 95%*
Intercept	-1.039	0.480	-2.164	-1.989	-0.090
γ_2	26.592	10.567	2.517	5.704	47.479
γ_3	1.279	1.068	1.198	-0.831	3.390
γ_4	-13.602	9.316	-1.460	-32.018	4.814
γ_5	0.732	0.060	12.214	0.613	0.850

Source: own calculations

4.1.4 Discussion of the best fit

Based on the analysis of the results, the model represented by the **equation 20** is considered to be the best fit for the data so it was decided to use the parameters estimated from this model for calculation of the theoretical values of inflation. In the **figure No. 5** you can see the theoretical inflation plotted together with the real inflation in the Czech Republic during the period on which the model was constructed. That is from January 1998 to June 2010. It is clear that the curves representing the theoretical and the real values are relatively close, which was expected because the model's adjusted coefficient of determination was **0.83** so the **figure No. 4** only confirms that the model is a good fit.

Figure No. 5: Real vs. Estimated Inflation in the Czech Republic (1998 - 2010)



Source: own calculations and the Czech Statistical Office

The estimated parameters (see **table No. 10**) are in accord with the theory. It was expected that the influence of the inversely taken unemployment on the inflation would be positive. That is certainly true because the parameter γ_2 representing the influence of the inverse unemployment on the slope of inflation before June 2004 is positive and the sum of parameters γ_2 and γ_4, which represents this influence afterwards, is positive as well. Positive value of the parameter $\boldsymbol{\gamma_3}$ is also as expected because a higher expected inflation should drive the real inflation upwards as stated in the theory of the expectations augmented Phillips curve.

Table No. 11: Forecast of the inflation in the Czech Republic based on the equation 20

	Inflation rate [%]		**Difference**		**Standardized**
Period	Real	Predicted	Absolute	Relative	**deviation**
2010 - July	1.9	1.3	0.6	29.3%	0.21
2010 - August	1.9	1.8	0.1	6.6%	0.05
2010 - September	2.0	1.9	0.1	6.2%	0.05
2010 - October	2.0	2.0	0.0	2.4%	0.02
2010 - November	2.0	1.9	0.1	2.6%	0.02
2010 - December	2.3	1.8	0.5	22.0%	0.19
2011 - January	1.7	2.0	-0.3	15.1%	-0.10
2011 - February	1.8	1.7	0.1	8.1%	0.06

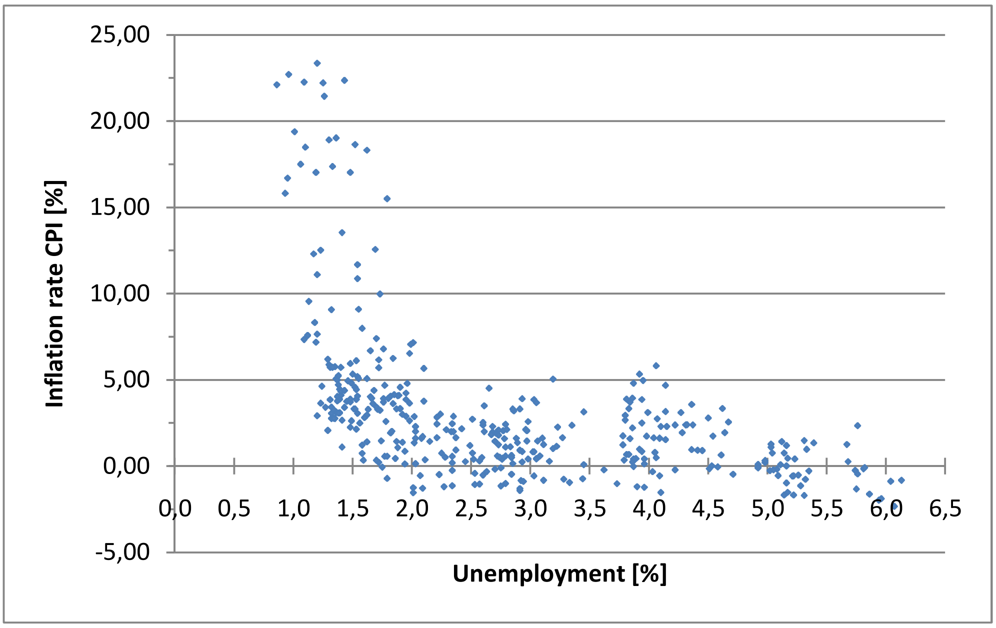
Source: own calculations

It is clear that the model is relatively close to the reality during the period on which it was constructed. However, an important question is, whether it is also close to the reality during the following period. In order to show how the model works for the future data, it was applied the data on inflation and unemployment in the Czech Republic from July 2010 to February 2011. In the **table No. 11** there is a comparison between the real data on inflation and its theoretical values during that period. It seems that the results of the theoretical inflation based on the model are very close to the real data during the eight months period after the model was constructed. The average difference between the predicted and real value is only 0.23% which is 11.5% of the value. This is supported by the fact that the standardized **deviation** $\ll$ **1**. However, it is necessary to be careful here. The standardized deviation was based on the period over which the model was constructed and the inflation variance over that time was much higher than during the last eight months. The average inflation over the whole period was around 3% spanning from over 13% even to a slight deflation. The inflation over the last eight months, on the other hand, was very stable around 2%. Therefore it is possible to say that the model gives very good results for the stable situation as it has been since July 2011, however, it is not quite sure, that it would give such a good predictions for some more unstable situation. It can suggest that the other effects which have influence on inflation and which were not included in the model were relatively constant over that time. For example it seems there has not been any supply shock in the Czech Republic so the model works.

4.2 The Republic of China (Taiwan)

All calculations in this part are based on the real monthly data on inflation (**CPI**) and unemployment in the Republic of China (Taiwan) from January 1978 to June 2010. We can see these data plotted in the **Figure No. 6**.

Figure No. 6: Inflation vs. Unemployment in the Republic of Taiwan (1978 - 2010)



Source: National Statistics of the Republic of China

4.2.1 Linear model

The first model is based on the original Phillips curve theory; it means there is expected to be the relationship only between unemployment and inflation without any other influence. The form is the same as for the Czech Republic (see **equation No. 6**) and the expectations about the parameters are the same as well.

The estimated curve obtained by application of the linear regression on the data is then:

$$\hat{\pi}_t = 8.037 - 1.759\ U_t \qquad \textbf{(Equation 21)}$$

The economic verification is positive because the curve is downward sloping as we expected (**– 1.759 < 0**). However, when we look at the statistical verification, the results are not satisfactory. In the **table No. 12**, we can see, that the coefficient of determination is extremely low (only **0.267**) despite a high number of observation.

Table No. 12: Regression statistics of the linear model

Multiple R	0.517
R Square	0.267
Adjusted R Square	0.266
Standard Error	3.939
Observations	390

Source: own calculations

When we look at the **table No. 13**, we can see the analysis of the variance. It shows that both parameters are significant at our chosen level of significance ($\alpha = 0.05$). However, we have to refuse this model because In this model, less than **27%** of the variance of inflation is explained by the variance of unemployment, which can be caused either by an omission of an important variable (resp. variables) or by a wrong functional form. We supposed the latter possibility and formed another model with changed functional form.

Table No. 13: ANOVA statistics of the linear model

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2197.913	2197.913	141.635	4.704E-28
Residual	388	6021.030	15.518		
Total	389	8218.943			
	Coefficients	*Standard Error*	*t Stat*	*Lower 95%*	*Upper 95%*
Intercept	8.037	0.459	17.518	7.135	8.939
γ_2	-1.759	0.148	-11.901	-2.050	-1.469

Source: own calculations

4.2.2 Hyperbolic model

In our second model we suppose a hyperbolic shape of the Phillips curve and change the function accordingly.

$$\pi_t = \gamma_1 + \gamma_2 U_t^{-1} + \varepsilon_t; \qquad \gamma_1 < 0, \gamma_2 > 0 \qquad \textbf{(Equation 22)}$$

The estimated curve based on the same dataset is then in the **equation 23**

$$\hat{\pi}_t = -3.430 + 14.551 U_t^{-1} \qquad \textbf{(Equation 23)}$$

Again we can see that the estimated parameters comply with our initial assumptions as stated in the **equation 22**. Nevertheless, the properties of the model are not satisfactory when we look at the statistical verification. Although the coefficient of determination is higher than in the linear model (see **table No. 14**), it is still too low because it suggests that less than **50%** of the variance of the inflation can be explained by the variance of the unemployment rate.

Table No. 14: Regression statistics of the hyperbolic model

Multiple R	0.670
R Square	0.448
Adjusted R Square	0.447
Standard Error	3.419
Observations	390

Source: Own calculations

In the **table No. 15**, we can see that both estimated parameters are again significant at our chosen level of significance (**α = 0.05**). Though, we still cannot say that this model would prove to us that there is a trade-off between inflation and unemployment as suggested by our theory. We can at least conclude that it was the right move to change the functional form of the model from linear to hyperbolic because it definitely improved its fit.

Table No. 15: ANOVA statistics of the hyperbolic model

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	3684.498	3684.498	315.272	4.693E-52
Residual	388	4534.445	11.687		
Total	389	8218.943			
	Coefficients	*Standard Error*	*t Stat*	*Lower 95%*	*Upper 95%*
Intercept	-3.431	0.408	-8.418	-4.232	-2.629
γ_2	14.552	0.820	17.756	12.940	16.163

Source: Own calculations

4.2.3 Expectations augmented model

In the next move we decided, as in the case of the Czech Republic, to introduce another exogenous variable into the model. That is the expected inflation $\boldsymbol{\pi}^{\mathbf{e}}$. By including the expected inflation into the model we will get the expectation augmented Phillips curve in the form of equation 24.

$$\boldsymbol{\pi_t = \gamma_1 + \gamma_2 U_t^{-1} + \gamma_3 \pi_t^e + \varepsilon_t;} \qquad \gamma_2 > \mathbf{0},\ \gamma_3 > \mathbf{0} \qquad \textbf{(Equation 24)}$$

The expected inflation is calculated again from the **equation 13**. As before, we decided to run a series of model calculations for various values of **j** $\in <0.1; 0.9>$**.**

As in the case of the Czech Republic we chose a model with **j = 0.8** as we believe that the lagged real inflation has much stronger influence on the expected inflation than the lagged expected inflation. The estimated curve then follows:

$$\boldsymbol{\hat{\pi}_t = -0.323 + 1.131U_t^{-1} + 0.934\pi_t^e} \qquad \textbf{(Equation 25)}$$

Table No. 16: Regression statistics of the expectations augmented hyperbolic model

Multiple R	0.964
R Square	0.929
Adjusted R Square	0.929
Standard Error	1.227
Observations	389

Source: Own calculations

Here we can see that the estimated parameters are again in accord with our expectations. When we look at the **table No. 16** we can say that the adjusted coefficient of determination increased dramatically after we have included the expected inflation into our model. It seems now that almost **93%** of the inflation variance is explained by the inverse unemployment rate and expected inflation. It is almost as high as it was in case of a similar model for the Czech Republic but there was a problem with the autocorrelation of residual so we have to check for it here as well before coming to any conclusion.

Table No. 17: ANOVA statistics of the expectations augmented hyperbolic model

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	7622	3811	2533	1.124E-222
Residual	386	581	2		
Total	388	8203			
	Coefficients	*Standard Error*	*t Stat*	*Lower 95%*	*Upper 95%*
Intercept	-0.323	0.158	-2.043	-0.635	-0.012
γ_2	1.131	0.394	2.872	0.357	1.905
γ_3	0.934	0.018	51.192	0.899	0.970

Source: Own calculations

The **table No. 17** shows that all the estimated parameters of the **equation 25** are significant at $\boldsymbol{\alpha}$ **= 0.05**. Durbin-Watson **d** statistics computed according to the **equation 2** was **1.71** and the appropriate limits to reject the autocorrelation here are (**1.84; 2.16**). This result suggests there is a negative autocorrelation of the residual. Again we think it might not be appropriate to rely only on this and we also run the Durbin **h** statistics because it is more appropriate for the models which contain the lagged explained variable among the explanatory variables. The result of h calculated from the **equation 4** with $\boldsymbol{\rho}$ estimated from the **equation 5** is $\boldsymbol{h \approx 3}$. That is higher than the critical value **1.96** so the h test also indicates the autocorrelation of the residual.

We decided to resolve this problem by employing a similar transformation method as in the case of the Czech Republic. We rewrote the **equation 24** in the lagged form and multiplied by the estimated coefficient of autocorrelation to get:

$$\rho\pi_{t-1} = \rho\gamma_1 + \gamma_2\rho U_{t-1}^{-1} + \gamma_3\rho\pi_{t-1}^{e} + \rho\varepsilon_{t-1}; \qquad \textbf{(Equation 26)}$$

Then we construct our model as the difference between **equations 24** and **26** and get:

$$\pi_t - \rho\pi_{t-1} = \gamma_1(1-\rho) + \gamma_2(U_t^{-1} - \rho U_{t-1}^{-1}) + \gamma_3(\pi_t^{e} - \rho\pi_{t-1}^{e}) + \varepsilon_t - \rho\varepsilon_{t-1}; \qquad \textbf{(Equation 27)}$$

If we assume the **equation 15** holds and we use Δ to express the operator of the weighted difference, we can write:

$$\Delta\pi_t = \gamma_1^{*} + \gamma_2\Delta U_t^{-1} + \gamma_3\Delta\pi_t^{e} + u_t; \qquad \textbf{(Equation 28)}$$

If we compare **equations 24** and **28**, we can see that the parameters γ_2 and γ_2 are the same in both equations and the parameter could be constructed back if we used the **equation 19**; therefore we still have the same expectations about them as stated in the **equation 19**. The estimated equation is then:

$$\Delta\hat{\pi}_t = -0.321 + 1.364\Delta Ut\text{-}1 + 0.918\Delta\pi t^{e}; \qquad \textbf{(Equation 29)}$$

We can see that the differences between the parameters of **equations 24** and **29** are very small.

We have succeeded in resolving the autocorrelation problem because the Durbin-Watson **d** statics gives the value of **1.94**, which is well within the interval (**1.84; 2.16**) and the Durbin **h** statistics of **0.62** also does not suggest there should be the autocorrelation present in our model.

Table No. 18: Regression statistics of the expectations augmented hyperbolic model without autocorrelation

Multiple R	0.952
R Square	0.907
Adjusted R Square	0.906
Standard Error	1.214
Observations	388

Source: own calculations

Table No. 19: ANOVA statistics of the expectations augmented hyperbolic model without autocorrelation

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	5515.1	2757.5	1871.548	4.7E-199
Residual	385	567.3	1.473		
Total	387	6082.3			
	Coefficients	*Standard Error*	*t Stat*	*Lower 95%*	*Upper 95%*
Intercept	-0.321	0.155	-2.074	-0.625	-0.017
γ_2	1.364	0.447	3.050	0.485	2.244
γ_3	0.918	0.021	44.068	0.877	0.959

Source: own calculations

From the **table No. 18** we can see that the adjusted coefficient of determination is now slightly than in the model biased by autocorrelation of the residual; however it is still much higher than in the model without the expected inflation. We should also notice in the table No.

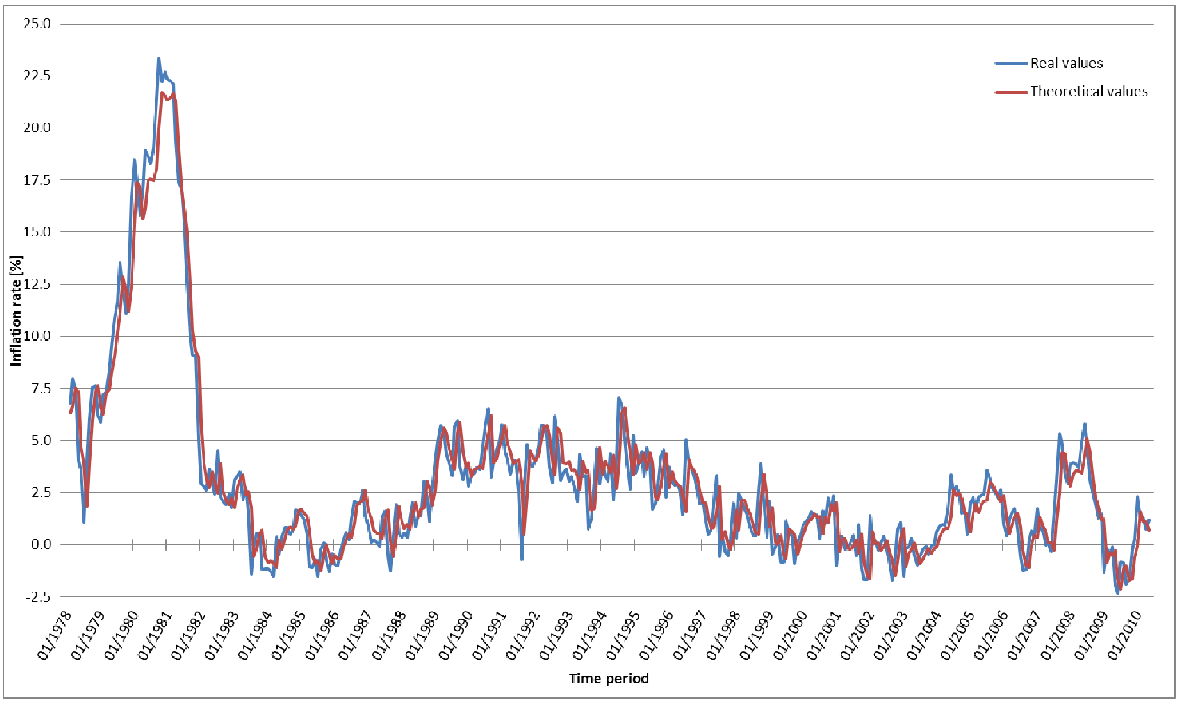
19 that all the parameters are now significant at **$\alpha = 0.05$**. We were also unable to detect the heteroscedasticity in the model by both plotting the residuals and their squares against the variables and also by the Gejsler test as described in the chapter 2.2.2. We also checked for the multicollinearity and did not find anything suggesting its presence in our model.

4.2.4 Discussion of the best fit

Based on the analysis of the results, the model represented by the **equation 29** is considered to be the best fit for the data so it was decided to use the parameters estimated from this model for calculation of the theoretical values of inflation. In the **figure No. 6** you can see the theoretical inflation plotted together with the real inflation in Taiwan during the period on which the model was constructed. That is from January 1978 to June 2010. It is clear that the curves representing the theoretical and the real values are relatively close, which was expected because the model's coefficient of determination was **0.91** so the **figure No. 4** only confirms that the model is a good fit on the data.

The estimated parameters (see **table No. 19**) are in accord with the theory. It was expected that the influence of the inversely taken unemployment on the inflation would be positive. That is certainly true because the parameter **γ_2** representing the influence of the inverse unemployment on the slope of inflation is positive. Positive value of the parameter **γ_3** is also as expected because a higher expected inflation should drive the real inflation upwards as stated in the theory of the expectations augmented Phillips curve.

Figure No. 7: Real vs. Estimated Inflation in Taiwan (1978 - 2010)



Source: own calculations and National Statistics of the Republic of China

It is clear that the model is relatively close to the reality during the period on which it was constructed. Its adjusted coefficient of determination is even higher than in the case of the Czech Republic model and it is also possible to see it in the **figure No. 7**. However, an important question is, whether it is also close to the reality during the following period. In order to show how the model works for the future data, it was applied the data on inflation and unemployment in the Taiwan from July 2010 to January 2011. In the **table No. 20** there is a comparison between the real data on inflation and the theoretical values during that period. It seems that the results of the theoretical inflation based on the model are much further from the real data during the seven months period after the model was constructed than it was in the case of the Czech Republic. The average difference between the predicted and real value is 0.6% which is 100% of the value! There are extremely big deviations from the model in August and September, while in December and January the model seems to give results very close to the reality. At the same time the standardized **deviation** . However, it is necessary to be careful here. The standardized deviation is influenced by a big variance of inflation in Taiwan over the examined period. The average inflation over the whole period was again around 3% but it was spanning from over 23% to an almost 2% deflation. The inflation over the last seven months was, in contrast with the Czech Republic, relatively volatile. Therefore, it is much clearer than in the case of the Czech Republic that this model is not very reliable in case of predicting inflation.

Table No. 20: Forecast of the inflation in Taiwan based on the equation 20

	Inflation rate [%]		**Difference**		**Standardized**
Period	**Real**	**Predicted**	**Absolute**	**Relative**	**deviation**
2010 - July	1.31	0.9	0.4	29.6%	0.08
2010 - August	-0.47	1.1	-1.5	325.1%	-0.33
2010 - September	0.29	-0.2	0.5	174.6%	0.11
2010 - October	0.56	0.1	0.5	83.4%	0.10
2010 - November	1.52	0.4	1.2	76.1%	0.25
2010 - December	1.24	1.1	0.1	9.4%	0.03
2011 - January	1.10	1.1	0.0	2.6%	0.01

Source: own calculations

5 Conclusions

The main hypothesis of this work was that: **There is an inverse relationship between inflation and unemployment as it is suggested by the theory of the Phillips curve.** Most economists accept that at least for the short term there is a trade-off between these two indexes but it is not exactly specified what is the short term and what is the long term. Phillips showed that this relationship was stable for almost 100 years in England. But it was before the policy makers were not aware of that and when the inflation was relatively stable over a long time. Later on, after this relationship was discovered and the policy makers started using it in practice is stopped working. The theory was criticised and condemned by some economists and there were attempts to improve the theory by adding some other influences such as the expectations and supply shocks and differencing between the short term and long term situation.

The analysis carried out in this work on the data from the Czech Republic and Taiwan convincingly indicates that if there is simply examined the relationship between the inflation and the unemployment, its character is invers. Firstly, all the models constructed in this work showed always the expected sign of the respective parameter. Secondly, the respective parameters were always significant at (**α = 0.05**). When there was added the influence of the expectations in the form of the adaptive expected inflation, the unemployment was still significant and with the expected direction of the influence. This was true for both countries. It was clear that the inclusion of adaptive expected inflation improves the models because in both cases it increased the adjusted coefficient of determination. That supports the idea that the original theory is a good base and rather than abandoning it, it is better to improve it by adding other influences. When it is used by the policy makers it is very important that they do not forget to take into account also those other factors because if they focus only on the trade-off between the rate of unemployment and inflation and try to intervene, when the results are not as they expected. For example, they need to understand that it is not possible to use this trade-off to keep the unemployment rate below its natural rate for a long time. They also need to understand that the Phillips curve can shift over time, which can change the corresponding values of inflation and unemployment significantly. They should also know that the economic actors also behave rationally so if there is certain government policy, they can take it into account in the form of expected inflation and the resulting outcome can be again very different from what was expected. The conceivable strong influence of possible supply shocks were also discussed in this paper. All those other factors, however, do not change the fact that there is a statistically significant inverse relationship between the inflation and unemployment of the character as suggested by the theory of the Phillips curve.

Therefore, this work concludes, that on the basis of the analysis of the empirical data of The Czech Republic and Taiwan, the main hypothesis cannot be rejected.

As for second hypothesis, the results are unconvincing. Although, the trade-off between the rate of inflation and unemployment seem to be qualitatively correct, its quantification in this paper is not very reliable for predicting of the future inflation. It gives better results than if we used a simple average but the particular deviations of the theoretical values from the real values can be relatively high especially of the inflation is relatively volatile over the examined period. Therefore, it has to be concluded that the econometric models based on the theory of the Phillips curve are not a reliable tool for forecasting of future inflation. In order to improve the models it would be probably necessary to improve the way how the expected inflation was expressed. I would probably need to be some combination of the adaptive and rational expectations and the coefficient of adaptation is probably dynamic and changes over time so it cannot be in reality represented by a constant as was done in this work.

Simply put, the results of the analysis done in this work suggest that the qualitative character of the Phillips curve theory is correct but the models as they were constructed are not suitable for those who desire reliable quantification of this relationship.

6 Bibliography

1) Czech Statistical Office. Inflation rate [online], 2011 [quot. 2011-3-15]. Available from WWW: < http://www.czso.cz/csu/redakce.nsf/i/mira_inflace>.

2) FRIEDMAN, M. The Role of Monetary Policy. The American Economic Review. 1968, Vol. 58, No. 1, p. 1-17

3) GLEJSER, H. A New Test for Heteroskedasticity. Journal of the American Statistical Association. 1969, 64, 325, p. 316-323.

4) GUJARATI, Damodar. Essentials of Econometrics. 1st edition. New York : McGraw-Hill, 1992. 466 s. ISBN 0-07-025194-0.

5) Integrated Portal of the Ministry of Labour and Social Affairs of the Czech Republic. Employment [online], 2011 [quot. 2011-3-15]. Available from WWW: < http://portal.mpsv.cz/sz/stat/nz>.

6) MACH, Miloš. Makroekonomie IWe : pro magisterské (inženýrské) studium. 1. a 2. část. 3. vyd. Slaný : Melandrium, 2001. 367 s. ISBN 80-86175-18-9

7) MAITAH, M.: Macroeconomics. 1st edition. Praha, Česká zemědělská univerzita v Praze 2009. ISBN 978-80-213-1904-2.

8) MANKIW, N. G. Principles of Economics. 3rd edition. [s.l.] : South-Western College , 2003. 848 p. ISBN ISBN-10: 0324168624, ISBN-13: 978-0324168624.

9) MANKIW, N. G. The inexorable and Mysterious Tradeoff between Inflation and Unemployment [online]. NBER Working Paper. 2000 [quote. 2011-01-17]. Available at WWW: < http://ces.univ-paris1.fr/membre/schubert/mankiw2.pdf >

10) MUTH, J.F. Rational Expectations and the Theory of Price Movements. Econometrica, 1961, vol. 29, No. 3.

11) National Statistics of the Republic of China (Taiwan) [online]. Taipei City: Directorate General of Budget, Accounting and Statistics, 2011 [quot. 2011-3-10]. Available from WWW: < http://eng.stat.gov.tw/mp.asp?mp=5>.

12) PHELPS, E. Phillips Curves, Expectations of Inflation and Optimal Unemployment over Time. Economica New Series, 1967, Vol. 34, No. 135, p. 254-281.

13) PHILLIPS, A. W. The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957 [online] Available from WWW: < http://paper.blog.eonet.jp/Phillips_1958.pdf >

7 Supplements

7.1 Supplement No. 1: The inflation rate in the Czech Republic [%] (original data)

	Month											
Year	1	2	3	4	5	6	7	8	9	10	11	12
1998	13.1	13.4	13.4	13.1	13.0	12.0	10.4	9.4	8.8	8.2	7.5	6.8
1999	3.5	2.8	2.5	2.5	2.4	2.2	1.1	1.4	1.2	1.4	1.9	2.5
2000	3.4	3.7	3.8	3.4	3.7	4.1	3.9	4.1	4.1	4.4	4.3	4.0
2001	4.2	4.0	4.1	4.6	5.0	5.5	5.9	5.5	4.7	4.4	4.2	4.1
2002	3.7	3.9	3.7	3.2	2.5	1.2	0.6	0.6	0.8	0.6	0.5	0.6
2003	-0.4	-0.4	-0.4	-0.1	0.0	0.3	-0.1	-0.1	0.0	0.4	1.0	1.0
2004	2.3	2.3	2.5	2.3	2.7	2.9	3.2	3.4	3.0	3.5	2.9	2.8
2005	1.7	1.7	1.5	1.6	1.3	1.8	1.7	1.7	2.2	2.6	2.4	2.2
2006	2.9	2.8	2.8	2.8	3.1	2.8	2.9	3.1	2.7	1.3	1.5	1.7
2007	1.3	1.5	1.9	2.5	2.4	2.5	2.3	2.4	2.8	4.0	5.0	5.4
2008	7.5	7.5	7.1	6.8	6.8	6.7	6.9	6.5	6.6	6.0	4.4	3.6
2009	2.2	2.0	2.3	1.8	1.3	1.2	0.3	0.2	0.0	-0.2	0.5	1.0
2010	0.7	0.6	0.7	1.1	1.2	1.2	1.9	1.9	2.0	2.0	2.0	2.3
2011	1.7	1.8										

Source: Czech Statistical Office

7.2 Supplement No. 2: The unemployment rate in the Czech Republic [%] (original data)

	Month											
Year	1	2	3	4	5	6	7	8	9	10	11	12
1998	**5.6**	**5.6**	**5.5**	**5.4**	**5.3**	**5.6**	**6.1**	**6.4**	**6.8**	**6.8**	**7.0**	**7.5**
1999	**8.1**	**8.3**	**8.4**	**8.2**	**8.1**	**8.4**	**8.8**	**9.0**	**9.0**	**8.9**	**9.0**	**9.4**
2000	**9.8**	**9.7**	**9.5**	**9.0**	**8.7**	**8.7**	**9.0**	**9.0**	**8.8**	**8.5**	**8.5**	**8.8**
2001	**9.1**	**9.0**	**8.7**	**8.3**	**8.1**	**8.1**	**8.5**	**8.5**	**8.5**	**8.4**	**8.5**	**8.9**
2002	**9.4**	**9.3**	**9.1**	**8.8**	**8.6**	**8.7**	**9.2**	**9.4**	**9.4**	**9.3**	**9.3**	**9.8**
2003	**10.2**	**10.2**	**10**	**9.6**	**9.4**	**9.5**	**9.9**	**10**	**10.1**	**9.9**	**9.9**	**10.3**
2004	**10.8**	**10.9**	**10.7**	**10.2**	**9.9**	**9.9**	9.2	9.3	9.1	8.9	8.9	9.5
2005	9.8	9.6	9.4	8.9	8.6	8.6	8.8	8.9	8.8	8.5	8.4	8.9
2006	9.2	9.1	8.8	8.3	7.9	7.7	7.9	7.9	7.8	7.4	7.3	7.7
2007	7.9	7.7	7.3	6.8	6.4	6.3	6.4	6.4	6.2	5.8	5.6	6.0
2008	6.1	5.9	5.6	5.2	5.0	5.0	5.3	5.3	5.3	5.2	5.3	6.0
2009	6.8	7.4	7.7	7.9	7.9	8.0	8.4	8.5	8.6	8.5	8.6	9.2
2010	9.8	9.9	9.7	9.2	8.7	8.5	8.7	8.6	8.5	8.5	8.6	9.6
2011	9.7	9.6										

Source: Ministry of Labour and Social Affairs of the Czech Republic

7.3 Supplement No. 3: Inflation and unemployment rates [%] (original data)

Date	1978M01	1978M02	1978M03	1978M04	1978M05	1978M06	1978M07	1978M08	1978M09	1978M10	1978M11	1978M12
Unemployment Rate	2.01	1.84	1.76	1.58	1.70	1.65	1.84	1.88	1.89	1.53	1.12	1.20
CPI growth rate	7.16	6.25	6.79	7.98	7.40	4.02	3.62	1.07	4.10	6.11	7.58	7.65
Date	1979M01	1979M02	1979M03	1979M04	1979M05	1979M06	1979M07	1979M08	1979M09	1979M10	1979M11	1979M12
Unemployment Rate	1.29	1.30	1.19	1.09	1.18	1.13	1.54	1.54	1.41	1.17	1.20	1.23
CPI growth rate	6.19	5.88	7.18	7.34	8.32	9.55	10.87	11.68	13.54	12.30	11.10	12.52
Date	1980M01	1980M02	1980M03	1980M04	1980M05	1980M06	1980M07	1980M08	1980M09	1980M10	1980M11	1980M12
Unemployment Rate	0.95	1.10	1.06	0.93	1.19	1.30	1.52	1.62	1.36	1.26	1.20	1.25
CPI growth rate	16.69	18.48	17.50	15.81	17.02	18.91	18.64	18.31	19.02	21.44	23.35	22.21
Date	1981M01	1981M02	1981M03	1981M04	1981M05	1981M06	1981M07	1981M08	1981M09	1981M10	1981M11	1981M12
Unemployment Rate	0.96	1.43	1.09	0.86	1.01	1.33	1.48	1.79	1.69	1.73	1.55	1.32
CPI growth rate	22.70	22.36	22.26	22.11	19.38	17.37	17.02	15.50	12.56	9.98	9.09	9.07
Date	1982M01	1982M02	1982M03	1982M04	1982M05	1982M06	1982M07	1982M08	1982M09	1982M10	1982M11	1982M12
Unemployment Rate	1.36	1.62	1.32	1.49	1.98	1.95	2.21	2.65	2.68	2.77	2.71	2.79
CPI growth rate	5.06	2.96	2.76	2.62	3.64	2.89	2.44	4.51	2.30	2.05	1.91	2.42
Date	1983M01	1983M02	1983M03	1983M04	1983M05	1983M06	1983M07	1983M08	1983M09	1983M10	1983M11	1983M12
Unemployment Rate	2.73	3.45	2.91	2.61	2.42	2.51	2.88	2.91	2.70	2.79	2.34	2.27
CPI growth rate	1.79	3.14	3.31	3.50	2.16	2.72	1.61	-1.41	-0.18	0.58	0.56	-1.19
Date	1984M01	1984M02	1984M03	1984M04	1984M05	1984M06	1984M07	1984M08	1984M09	1984M10	1984M11	1984M12
Unemployment Rate	2.34	2.75	2.09	2.01	2.11	2.23	2.52	3.02	3.03	2.77	2.25	2.21
CPI growth rate	-1.14	-1.15	-1.28	-1.54	0.37	-0.49	0.40	0.82	0.83	0.48	0.75	1.65
Date	1985M01	1985M02	1985M03	1985M04	1985M05	1985M06	1985M07	1985M08	1985M09	1985M10	1985M11	1985M12
Unemployment Rate	2.03	2.15	2.49	2.28	2.57	2.53	3.44	4.10	3.62	3.45	3.28	2.91
CPI growth rate	1.61	1.43	1.19	0.51	-1.04	-1.07	-0.73	-1.53	-0.22	0.09	-0.76	-1.30

Date	1986M01	1986M02	1986M03	1986M04	1986M05	1986M06	1986M07	1986M08	1986M09	1986M10	1986M11	1986M12
Unemployment Rate	2.53	3.33	2.79	2.34	2.34	2.72	2.93	3.11	2.96	2.61	2.33	1.98
CPI growth rate	-0.42	-0.95	-1.01	-0.25	0.19	0.59	0.24	1.25	2.12	2.00	2.00	2.63
Date	1987M01	1987M02	1987M03	1987M04	1987M05	1987M06	1987M07	1987M08	1987M09	1987M10	1987M11	1987M12
Unemployment Rate	1.92	2.37	2.03	1.72	1.94	1.75	2.02	2.08	2.07	2.01	1.86	1.82
CPI growth rate	1.38	0.93	0.14	0.22	0.12	-0.06	1.35	1.61	-0.55	-1.25	0.44	1.92
Date	1988M01	1988M02	1988M03	1988M04	1988M05	1988M06	1988M07	1988M08	1988M09	1988M10	1988M11	1988M12
Unemployment Rate	1.77	1.70	1.79	1.59	1.74	1.83	1.94	1.87	1.62	1.54	1.48	1.41
CPI growth rate	0.56	0.34	0.57	0.34	1.46	2.02	0.86	1.43	1.40	3.06	2.25	1.10
Date	1989M01	1989M02	1989M03	1989M04	1989M05	1989M06	1989M07	1989M08	1989M09	1989M10	1989M11	1989M12
Unemployment Rate	1.35	1.88	1.46	1.31	1.50	1.68	1.76	1.87	1.72	1.48	1.45	1.36
CPI growth rate	2.76	4.08	4.94	5.73	5.33	4.39	3.91	3.32	5.70	5.94	3.75	3.13
Date	1990M01	1990M02	1990M03	1990M04	1990M05	1990M06	1990M07	1990M08	1990M09	1990M10	1990M11	1990M12
Unemployment Rate	1.31	1.60	1.51	1.32	1.48	1.67	1.96	2.10	1.98	1.73	1.80	1.52
CPI growth rate	3.85	2.81	3.32	3.42	3.72	3.62	4.79	5.66	6.53	3.24	3.93	4.57
Date	1991M01	1991M02	1991M03	1991M04	1991M05	1991M06	1991M07	1991M08	1991M09	1991M10	1991M11	1991M12
Unemployment Rate	1.37	1.35	1.39	1.40	1.43	1.37	1.82	1.78	1.79	1.56	1.49	1.39
CPI growth rate	4.99	5.76	4.46	4.11	3.40	4.03	4.06	2.59	-0.72	2.49	4.81	3.88
Date	1992M01	1992M02	1992M03	1992M04	1992M05	1992M06	1992M07	1992M08	1992M09	1992M10	1992M11	1992M12
Unemployment Rate	1.37	1.54	1.38	1.33	1.40	1.54	1.76	1.92	1.72	1.55	1.36	1.27
CPI growth rate	3.77	4.06	4.71	5.72	5.72	5.19	3.71	2.99	6.16	5.08	3.10	3.41
Date	1993M01	1993M02	1993M03	1993M04	1993M05	1993M06	1993M07	1993M08	1993M09	1993M10	1993M11	1993M12
Unemployment Rate	1.23	1.32	1.34	1.34	1.29	1.40	1.71	1.90	1.58	1.58	1.39	1.24
CPI growth rate	3.64	3.06	3.26	2.77	2.07	4.33	3.29	3.33	0.74	1.22	3.09	4.63
Date	1994M01	1994M02	1994M03	1994M04	1994M05	1994M06	1994M07	1994M08	1994M09	1994M10	1994M11	1994M12
Unemployment Rate	1.20	1.66	1.52	1.38	1.43	1.53	1.85	1.99	1.65	1.62	1.48	1.41
CPI growth rate	2.92	3.93	3.31	3.07	4.38	2.14	4.14	7.06	6.69	5.07	3.88	2.66

Date	1995M01	1995M02	1995M03	1995M04	1995M05	1995M06	1995M07	1995M08	1995M09	1995M10	1995M11	1995M12
Unemployment Rate	1.38	1.70	1.53	1.53	1.63	1.77	1.95	2.09	2.03	2.02	1.95	1.90
CPI growth rate	5.24	3.43	3.87	4.44	3.29	4.68	3.86	1.71	2.01	2.87	4.23	4.57
Date	1996M01	1996M02	1996M03	1996M04	1996M05	1996M06	1996M07	1996M08	1996M09	1996M10	1996M11	1996M12
Unemployment Rate	2.03	2.10	2.24	2.21	2.35	2.60	2.97	3.19	3.03	3.05	2.86	2.60
CPI growth rate	2.29	3.76	3.01	2.83	2.88	2.38	1.45	5.04	3.85	3.68	3.20	2.53
Date	1997M01	1997M02	1997M03	1997M04	1997M05	1997M06	1997M07	1997M08	1997M09	1997M10	1997M11	1997M12
Unemployment Rate	2.68	2.97	2.79	2.59	2.51	2.67	2.85	3.03	2.84	2.63	2.60	2.45
CPI growth rate	1.97	2.05	1.10	0.50	0.76	1.83	3.31	-0.57	0.62	-0.32	-0.52	0.26
Date	1998M01	1998M02	1998M03	1998M04	1998M05	1998M06	1998M07	1998M08	1998M09	1998M10	1998M11	1998M12
Unemployment Rate	2.35	2.57	2.34	2.29	2.37	2.70	2.93	3.05	2.98	2.98	2.93	2.80
CPI growth rate	2.00	0.30	2.46	2.11	1.65	1.44	0.84	0.44	0.41	2.58	3.90	2.12
Date	1999M01	1999M02	1999M03	1999M04	1999M05	1999M06	1999M07	1999M08	1999M09	1999M10	1999M11	1999M12
Unemployment Rate	2.76	2.73	2.84	2.75	2.84	2.92	3.11	3.22	3.08	3.05	2.94	2.85
CPI growth rate	0.40	2.09	-0.47	-0.10	0.50	-0.84	-0.82	1.14	0.59	0.41	-0.89	0.15
Date	2000M01	2000M02	2000M03	2000M04	2000M05	2000M06	2000M07	2000M08	2000M09	2000M10	2000M11	2000M12
Unemployment Rate	2.74	2.91	2.83	2.73	2.78	2.89	3.06	3.16	3.10	3.19	3.23	3.27
CPI growth rate	0.51	0.92	1.12	1.24	1.59	1.36	1.45	0.28	1.62	1.02	2.26	1.65
Date	2001M01	2001M02	2001M03	2001M04	2001M05	2001M06	2001M07	2001M08	2001M09	2001M10	2001M11	2001M12
Unemployment Rate	3.35	3.73	3.89	3.96	4.22	4.51	4.92	5.17	5.26	5.33	5.28	5.22
CPI growth rate	2.36	-1.02	0.43	0.42	-0.22	-0.15	0.10	0.45	-0.52	0.97	-1.14	-1.68
Date	2002M01	2002M02	2002M03	2002M04	2002M05	2002M06	2002M07	2002M08	2002M09	2002M10	2002M11	2002M12
Unemployment Rate	5.14	5.12	5.16	4.98	5.02	5.11	5.23	5.35	5.32	5.31	5.22	5.04
CPI growth rate	-1.68	1.42	0.01	0.21	-0.26	0.09	0.41	-0.28	-0.77	-1.70	-0.56	0.76
Date	2003M01	2003M02	2003M03	2003M04	2003M05	2003M06	2003M07	2003M08	2003M09	2003M10	2003M11	2003M12
Unemployment Rate	5.03	5.17	5.08	4.92	4.98	5.09	5.16	5.21	5.05	4.92	4.71	4.58
CPI growth rate	1.09	-1.52	-0.18	-0.10	0.32	-0.55	-0.98	-0.58	-0.22	-0.05	-0.47	-0.05

Date	2004M01	2004M02	2004M03	2004M04	2004M05	2004M06	2004M07	2004M08	2004M09	2004M10	2004M11	2004M12
Unemployment Rate	4.53	4.61	4.45	4.36	4.41	4.54	4.62	4.67	4.50	4.31	4.14	4.09
CPI growth rate	0.01	0.64	0.90	0.95	0.92	1.74	3.34	2.55	2.79	2.39	1.53	1.62
Date	2005M01	2005M02	2005M03	2005M04	2005M05	2005M06	2005M07	2005M08	2005M09	2005M10	2005M11	2005M12
Unemployment Rate	4.06	4.28	4.15	4.04	4.10	4.22	4.32	4.36	4.14	4.07	3.94	3.86
CPI growth rate	0.49	1.94	2.30	1.64	2.30	2.38	2.40	3.57	3.16	2.74	2.50	2.21
Date	2006M01	2006M02	2006M03	2006M04	2006M05	2006M06	2006M07	2006M08	2006M09	2006M10	2006M11	2006M12
Unemployment Rate	3.80	3.92	3.87	3.78	3.84	3.98	4.05	4.09	3.96	3.90	3.86	3.81
CPI growth rate	2.67	0.98	0.41	1.23	1.59	1.73	0.79	-0.56	-1.23	-1.19	0.24	0.67
Date	2007M01	2007M02	2007M03	2007M04	2007M05	2007M06	2007M07	2007M08	2007M09	2007M10	2007M11	2007M12
Unemployment Rate	3.79	3.78	3.94	3.83	3.87	3.96	4.03	4.09	3.99	3.92	3.87	3.83
CPI growth rate	0.35	1.75	0.85	0.68	-0.02	0.13	-0.33	1.61	3.11	5.33	4.80	3.33
Date	2008M01	2008M02	2008M03	2008M04	2008M05	2008M06	2008M07	2008M08	2008M09	2008M10	2008M11	2008M12
Unemployment Rate	3.80	3.94	3.86	3.81	3.84	3.95	4.06	4.14	4.27	4.37	4.64	5.03
CPI growth rate	2.94	3.86	3.94	3.88	3.71	4.97	5.81	4.68	3.10	2.39	1.94	1.27
Date	2009M01	2009M02	2009M03	2009M04	2009M05	2009M06	2009M07	2009M08	2009M09	2009M10	2009M11	2009M12
Unemployment Rate	5.31	5.75	5.81	5.76	5.82	5.94	6.07	6.13	6.04	5.96	5.86	5.74
CPI growth rate	1.48	-1.33	-0.15	-0.46	-0.09	-1.98	-2.33	-0.82	-0.88	-1.89	-1.62	-0.25
Date	2010M01	2010M02	2010M03	2010M04	2010M05	2010M06	2010M07	2010M08	2010M09	2010M10	2010M11	2010M12
Unemployment Rate	5.68	5.76	5.67	5.39	5.14	5.16	5.20	5.17	5.05	4.92	4.73	4.67
CPI growth rate	0.26	2.34	1.26	1.34	0.76	1.19	1.31	-0.47	0.29	0.56	1.52	1.24
Date	2011M01											
Unemployment Rate	4.64											
CPI growth rate	1.10											

Source: Directorate General of Budget, Accounting and Statistics- The Republic of China (Taiwan)