# REAL WAGES AND UNEMPLOYMENT RATE RELATION – THE CASE OF THE CZECH REPUBLIC 1998-2010

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**Klíčová slova:**
Míra nezaměstnanosti, reálné mzdy, krátkodobá a dlouhodobá závislost.

**Keywords:**
Unemployment rate, real wages, short run and long run dependence.

**Abstrakt:**
Hlavním cílem článku je ukázat dlouhodobou a krátkodobou závislost mezi reálními mzdami a mírou nezaměstnanosti a odhadnout vliv zvýšené nabídky trhu práce na tyto proměnné pro případ České republiky v letech 1998-2010. Výsledky odhalují dlouhodobý negativní vzájemný vztah mezi proměnnými.

**Abstract:**
The main aim of this article is to reveal the short and long run relation between real wages and unemployment rates on data from the Czech Republic 1998-2010. Results support the existence of negative long-run relationship between the two variables.

## Introduction

The main inspiration for this analysis was the work of Jacobson, Vredin, and Warne (1998) [4], who investigated short-run and long run relation between real wages and unemployment rate in Sweden 1965-1990. They tried to find answers to three questions, earlier studied by other researchers: What is the relative importance of supply and demand factors behind the development of unemployment? How quickly do real wages and unemployment respond to different types of shocks? How strong are the long-run relations between real wages and unemployment rate?

The main aim of this article is to perform similar analysis on data from the Czech Republic 1998-2010 to reveal the short and long run relation between real wages and unemployment rate, as well as the impact of aggregate labor demand shock on wage variable. I would like to test if the Czech data shows mutual relationship between real wage and unemployment rate, and if this relation is negative, as observed on data from Sweden, or positive, as observed on historical data from the U.S. (Bernanke, 1989 [2]), or if this effect is negligible, as for the case of Italy (Papell, Murray, Ghiblawi, 2000 [12]).

Mutual relation between real wages and unemployment rate is a concept that has attracted attention of empirical economists for a long time. For example Bernanke, 1989 [2] described unemployment, inflation and wages during the Great Depression. He described 1930s as a period of robust real wage growth, accompanied with decline in average hours of work per week. He expects that shorter workweeks were due to “work sharing”, as firms were afraid of possible high unemployment compensations in the case of too many layoffs. Later on, the reduction in workweeks was pushed by legislation and higher union influence. Bernanke argues, that increase in real wages can be partially explained by the “transition to the efficiency wage” hypothesis. He wrote: “if the … hypothesis is true, part of the answer may be the higher wages to some extent ‘paid for themselves’ through increased productivity of labor.” Moreover, higher wages are increasing aggregate demand in economy that compensates increased costs of production. However, Malley and Moutos (1996) [7], has shown that the aggregate unemployment rate is the valuable measure of aggregate income uncertainty that partially contradicts to Bernanke argumentation.

Jacobson, Vredin, and Warne (1998) [4] proposed an alternative model for investigating mutual behavior of wage and unemployment rate. They have found that cointegration methods reveal the difference in Swedish data that reflects possible importance of different types of shocks. Common trends models support the idea of quicker unemployment response to an aggregate demand shock, comparing to wages response – this partially supports results that unemployment rate “Granger-causes” real wages. However, in the long run, these variables are unrelated. Particularly, the results for the Swedish data has revealed that a negative aggregate demand shock that increases unemployment by one percentage point after three quarters lowers real wages by five percentage points after nine quarters.

Papell, Murray and Ghiblawi (2000) [12] studied postwar unemployment rates in sixteen OECD countries. They tried to reveal possible structural changes during the period as a change in unit roots results of unemployment time series. Later, Nickell, Nunziata, and Ochel (2005) [10] studied unemployment patterns in OECD countries since 1960s. They have found that employment protections as well as employment taxes have a significant positive effect on unemployment rate. Moreover, the employment protection is raising unemployment persistence. Vokorokosova (2010) [14] discusses the influence of minimal wages to unemplyment rates.

Ljungquist and Sargent (2008) [6] tried to explain why the unemployment rate in Europe was different comparing to the U.S., and they found that the main difference is in reservation price of work. Van Dijk, Franses, and Paap (2002) [14] studied the influence of shocks on the U.S. unemployment time series and they found that “shocks to the series seem rather persistent and that it seems to rise faster during recessions than that it falls during expansions”. Their model covers the economic cycle influence.

The main aim of this article is to reveal basic long run and short-run dependence of unemployment rate and real wages in the Czech Republic for the period of 1998-2010. The first part covers overview over the theoretical models, data and econometric tools used in the analysis. The theoretical part is followed by a part covering estimation results and discussion. The conclusion followed by references ends the text.

## 1 Data, Model, and Econometric Tools

This analysis is based on quarterly data from the Czech Statistical Office - CZSO (www.czso.cz) for the years 1998-2010, namely data of harmonized unemployment rates (in per cent) – variable *Unempl*, and real hourly earnings (based on nominal hourly earnings and real wage index) – variable *Wage*. The quarterly data for the real wage indicators were not available for the period of 1993-1997.

For illustration, both data series are given in Figures 1 and 3. Unemployment rate series show an increasing trend in the period of 1/1998-1/2000 as the continuation of this trend since the start of economy transformation. The decreasing rate trend in 1/2000-2/2008 was interrupted by a short increase in unemployment rate in 2003/2004; however this trend indicates that the transformation of economy from the planned to free market was over. The deep increase in unemployment rate in the last 2/2008-2/2010 periods was caused by the global economic crisis that affected the Czech economy, as well. The evaluation of the global crises and its influence on the Czech Republic can be found in Mazurek (2010) [9].

The real wages index (Figure 2) has copied the trend in unemployment rate series. The index was steeply increasing in the period of 1/1998-3/2009 as the continuation of this trend since the start of transformation. The significant increase in the real wage index occurred in 2/2000-4/2002, 2/2005-1/2007, and 1/2009-4/2009 periods. The last data show decreasing trend in real wage index, which can be bound with decreasing unemployment rate.

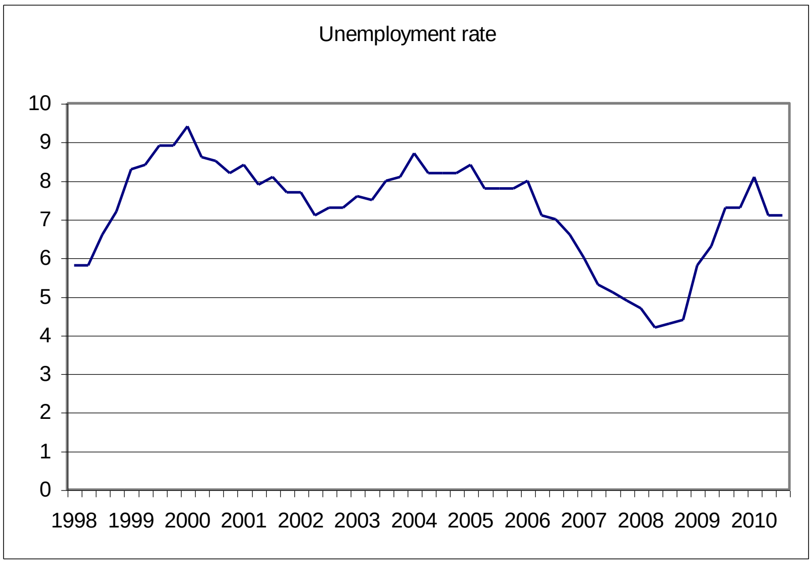


**Figure 1 Quarterly data series of unemployment rate for years 1998-2010. Source: CZSO data; calculations.**

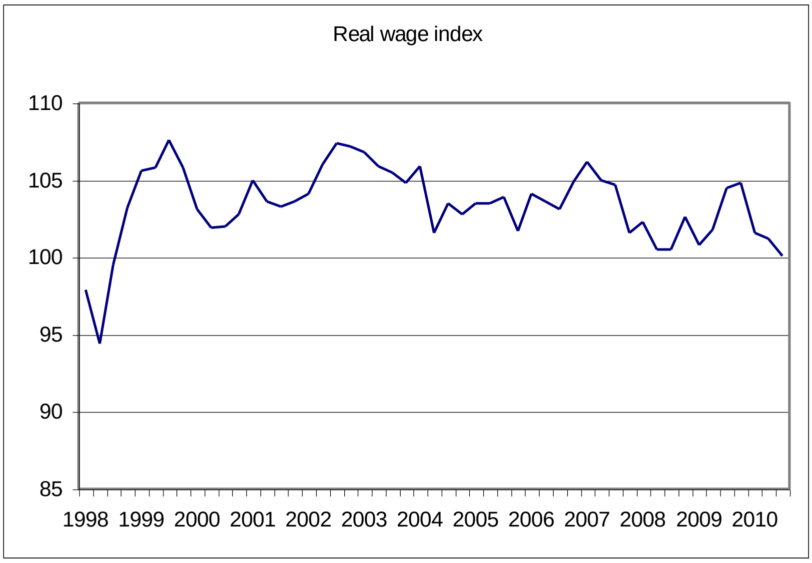


**Figure 2 Quarterly data series of real wage index for years 1998-2010. Source: CZSO data; calculations.**

The seasonally adjusted hourly real earnings series (Figure 3) were increasing the whole observed time period. The trend of this time series reflects the trend in nominal wages as well as in the real wages index.

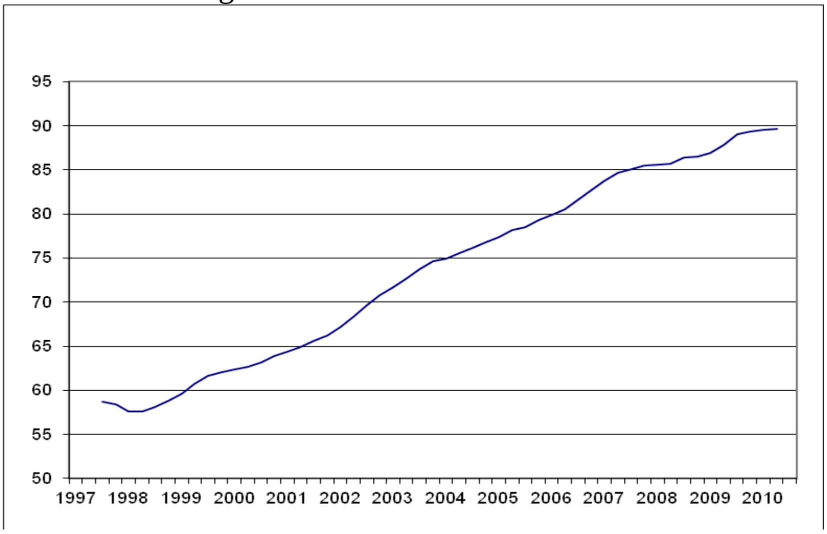


**Figure 3 The seasonally adjusted quarterly data series of real hourly earnings 1997-2010. Source: CZSO data; calculations.**

The labor market model described by Jacobson, Vredin, and Warne (1998) [4] consists of a production function and relations describing labor demand and supply, and wage setting. The production function is determined by employment variable and stochastic (exogenous) technology variable $\tau_{Y,t}$:

$$Y_t = y_t(E_t, \tau_{Y,t}) \qquad [1]$$

Labor demand ($E_t$) is a function of output and the real wage, while labor supply ($L_t$) is given as a function of the real wage and stochastic (exogenous) labor supply variable $\tau_{L,t}$:

$$E_t = e_t(Y_t, W_t) \qquad [2]$$

$$L_t = l_t(W_t, \tau_{L,t}) \qquad [3]$$

The wage-setting relation, according to Jacobson, Vredin, and Warne (1998) [4] gives the real wage as a function of unemployment and productivity:

$$W_t = w_t(L_t - E_t, Y_t - E_t) \qquad [4]$$

All equations are time-dependent.

Thus, the basic model expects that the real wage index (represented by variable *Wage*) is dependent on the level of unemployment rate (variable *Unempl*), taking productivity influence negligible:

$$Wage = f(Unempl) \qquad [5]$$

For the model, the expected linear dependence can be performed using ordinary least squares estimation. However, in the original research, the existence of serial correlation and spurious regression model has led to the error correction model (described for example in Hamilton, 1994 [5], Arlt, 1999 [1]).

## 2 Results and Discussion

The main hypothesis that has to be tested is the assumption, that the wage and unemployment rate variables exhibit a long-term equilibrium negative relationship. We could expect that there is a causal relationship from unemployment rate to wage variable; however, we studied both causal relationships (from unemployment rate to wage variable, as well as from wage to unemployment rate variable). Hence, the first step in this analysis is to estimate the linear dependence of variable *Wage* on the unemployment rate data – the variable *Unempl*; results of the regression estimation of $Wage = \beta_0 + \beta_1 Unempl + \varepsilon$ are given in Table 1:

| *Wage* | Coefficient | Std. error | t-ratio | p-value | |
|---|---|---|---|---|---|
| Const | 102.944 | 7.358 | 13.99 | 9.72e-019 | *** |
| Unempl | -3.872 | 1.001 | -3.868 | 0.0003 | *** |
| R-squared | 0.234 | Durbin-Watson | 0.058 | | |

**Table 1 Results of regression estimation** $Wage = \beta_0 + \beta_1 Unempl$ **; Source: gretl computations.**

The estimation results of the regression function $Wage = \beta_0 + \beta_1 Unempl + \varepsilon$ support the original assumption that the wage variable is negatively influenced by the unemployment rate. However, this model has quite poor fit ($R^2 = 0{,}234$**);** the Durbin-Watson value indicates problems with autocorrelation of disturbances.

Similarly, the results of the regression estimation $Unempl = \beta_0 + \beta_1 Wage + \varepsilon$ are given in Table 2:

| *Unempl* | Coefficient | Std. error | t-ratio | p-value | |
|---|---|---|---|---|---|
| Const | 11.762 | 1.182 | 19.955 | 2.34e-013 | *** |
| Wage | -0.060 | 0.016 | -3.868 | 0.0003 | *** |
| R-squared | 0.234 | Durbin-Watson | 0.199 | | |

**Table 2 Results of regression estimation** $Unempl = \beta_0 + \beta_1 Wage$ **; Source: gretl computations.**

The residuals of both models are non-stationary (see Figure 4); in order to eliminate the stochastic trend in data it is possible to use cointegration analysis [11].

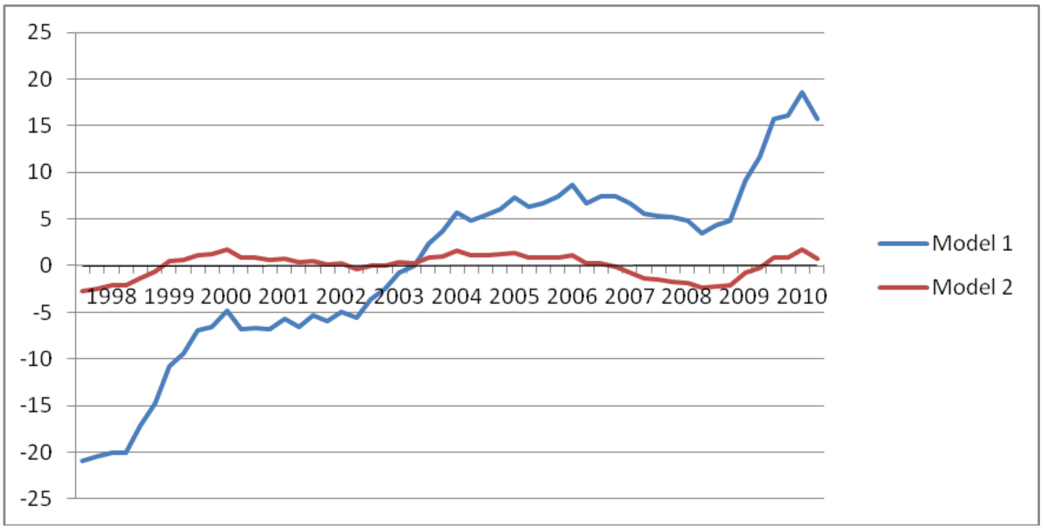


**Figure 4 The residuals of the regression models. Source: calculations.**

To perform the cointegration analysis, we have to check the stability of variables in the first differences – the unit root tests. Tests performed on the Czech quarterly data indicate, that the unit root using the Dickey-Fuller test cannot be rejected on the 5% level of significance for the variable *Wage* (p=0.2528), and cannot be rejected on the 5% level of significance for the variable *Unempl* (p=0.1169).

The possibility how to reveal the long-run dependence in multiple data series is to use the Johansen Maximum Likelihood procedure. For the used data, from the Akaike criterion the VAR(5) was chosen. The Johansen test reveals that there exist a cointegration relation between the two variables; values of trace tests and likelihood maximum test with the respective p-values in parentheses for expected rank r=0 are 19,427 (0,012) and 17,069 (0,0156). These values for r=1 are 2,358 (0.125), and 2.357 (0.125).

Another possibility how to reveal the cointegration relationship is to perform the Dickey-Fuller unit root test on residuals (variable *res*) from the original OLS estimation. The test on residuals of the model $Wage = \beta_0 + \beta_1 Unempl + \varepsilon$ indicates that the two variables have a long-run equilibrium relationship (Table 3).

| $\Delta res_t$ | | Coefficient | Std. error | t-ratio | p-value |
|---|---|---|---|---|---|
| | const | 0.735 | 0.287 | 2.562 | 0.0136 ** |
| | res_1 | -0.070 | 0.032 | -2.194 | 0.0331 ** |
| | R-squared | 0.091 | Durbin-Watson | | 1.798 |

**Table 3 Results of regression estimation** $\Delta res_t = \beta_0 + \beta_1 res_{t-1}$**; Source: gretl computations.**

Similarly, the Dickey-Fuller unit root test on residuals (variable *res*) from the original OLS estimation $Unempl = \beta_0 + \beta_1 Wage + \varepsilon$ indicates that the two variables have a long-run equilibrium relationship (Table 4).

| $\Delta res_t$ | | Coefficient | Std. error | t-ratio | p-value |
|---|---|---|---|---|---|
| | const | 0.063 | 0.069 | 0.914 | 0.3653 |
| | res_1 | -0.143 | 0.061 | -2.365 | 0.0221 ** |
| | R-squared | 0.104 | Durbin-Watson | 1.692 | |

**Table 4 Results of regression estimation** $\Delta res_t = \beta_0 + \beta_1 res_{t-1}$**; Source: gretl computations.**

The respective error correction models are (t-ratio statistics are given in parentheses):

$$\Delta Wage_t = 0.653 - 0.072.\Delta Unempl_t - 0.013.res_{t-1} + \varepsilon_t \qquad [6]$$
$$(-0.335) \qquad (-1.132)$$

$$\Delta Unempl_t = 0.0295 - 0.009.\Delta Wage_t - 0.143.res_{t-1} + \varepsilon_t \qquad [7]$$
$$(0.314) \quad (-0.090) \qquad (-2.336)**$$

While the original OLS estimation supported the hypothesis of mutual negative relation between the *Wage* and *Unempl* variables, under the assumption of long-term relationship the positive error term have to be counteracted by the statistically significant negative lagged residual. The results of both models (7,8) indicate, that the residuals' coefficients are negative, however, the statistically significant coefficient of lagged error term is the one of the model (7). From the respective model, the 1 percentage point increase in a real wage causes the decrease in an unemployment rate by 0.06. Approximately 14% of this negative shock is absorbed in the subsequent period ($\beta_2 = -0.143$ in estimation of equation 7) and the shock is totally absorbed after 7 quarters. The estimations of the VECM model for 5 lags in both variables indicate similar results; while the estimated coefficient value of the $res_{t-1}$ is 0.164 (p=0.2458) for the dependent variable $\Delta Wage$, the value of this coefficient is (-2,231), (p=0.0006) for the dependent variable $\Delta Unempl$.

The short-run dependency was studied by a Granger causality test (Engle, Granger, 1987 [3]). The optimal number of lags was set by the Schwartz-Bayesian criterion to be 1, and by the Akaike criterion, and by the Hannan-Quinn criterion to be 5. Results for the lag of 1 indicate that there is a Granger causality in the sense that "the Wage variable Granger causes Unemployment variable" on the 10% significance level (p=0.0608), the inverse statement does not held. The results for the lag of 5 indicate the same relation on the 10% significance level (p=0.0961).

The results do not correspond with the results of Bernanke (1989) [2] – the error correction model indicates that the increase in a real wage induces the decrease in an unemployment rate. These results contradict to the results of Jacobson, Vredin, and Warne (1998) [3], who have shown using the Swedish data, that an increase in unemployment rate is followed by the decrease in real wages, as a result of a demand shock. The results using the Czech data reveal an inverse relationship between the two variables.

## 3 Conclusion

The main aim of this article was to reveal the short and long run relation between real wages and unemployment rate, as well as the impact of an aggregate demand shock on both variables on data from the Czech Republic 1998-2010. The main result of this article is the fact, that there exist the long-run relationship between unemployment rate data series and the real wage data series, for the data from the Czech Republic 1998-2010. The relation between unemployment rate and the real wage time series is negative; that means that the increase in unemployment rate induces decrease in real wages. From the model, the one percentage point increase in unemployment rate causes the decrease of a real wage by 3.87 of percentage points. On the other hand, the one percentage point increase in a real wage is accompanied with the decrease in an unemployment rate time series by 0.06. These results are similar to the study of Jacobson, Vredin, and Warne (1998) [3]; however, they are different from the results of Bernanke (1989) [2] , who studied historical data from the Great Depression, and observed the positive relationship. The VECM, as well as the results of Granger-causality tests indicate that in the relationship of these two variables the changes in real wages precede the changes in unemployment rates time series. This result is different from the expected relationship. This relationship may be caused by the fact, that the increase in real wages indicate optimistic expectations of potential employers, and thus precede the decrease in an unemployment rate.

The further research concerning the topic of the mutual relationship between wage and unemployment rate time series should cover the additions of several exogenous variables to the model, as well as re-estimation of the model for the specific production and population segment. Another interesting point for the future research should be the use of different econometric tools, namely VARX model proposed by Jacobson, Vredin, and Warne (1998) [3].

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