# Models of the Minimum Wage Impact upon Employment, Wages and Prices: The Romanian Case

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*Abstract:* - This paper focuses on modeling the impact of the national minimum wage upon the average gross wage, employment rate and prices in Romania, during the period q1 1999 - q4 2009. The tools and models that were used consist of a system equation model and a VAR model. Based on the results we are confident that both models can be reliable when modeling the minimum wage impact for the case of Romania.

*Key-Words:* - minimum wage, employment, wage, prices, econometric model, VAR, forecast

## 1 Introduction

The aim of this paper consists in modeling the impact of the national minimum wage upon the average gross wage, employment rate and prices in Romania, during the period q1 1999 - q4 2009. Estimating both a system equation model and a Vector Autoregressive model we were able to quantify this impact and to predict the evolution of wages, employment and prices for the year 2010.

Since the economists have always been preoccupied by the consequences of minimum wage upon the labor market, the international literature provides quite a large variety of studies, in which special attention was mostly paid in modeling the minimum wage impact upon wages and employment. One of the first results in the field, based on USA sector data, was presented in 1992 by the economists Neumark and Wascher [8], who stated that a 10% increase in minimum wage generates 1% to 2% decrease in young employment, without an immediate effect. This can be eventually explained through better educational and training opportunities for young people, outside the labor market. In another approach, Schaafsma and Walsh [9] formulated some general equilibrium models based on linear-logarithmic simultaneous equations, using Canadian regional data between 1975 and 1979 and reached that the minimum wage has a significant negative effect on employment and labor force for most age groups, as well as a significant positive impact on all unemployment age-group rates.

A different approach was formulated in Sara Lemos's [6,7] study in Brazil in 2005, in which the novelty consisted in modeling the impact of the minimum wage variation simultaneously upon the following three main elements of the labor market: prices, employment and wages. The results indicated that a 10% increase of minimum wage during 1982-2000 generates only 0.2% decrease of employment, but a 0.8% prices increase after a 5 month adjustment period.

Several other empirical studies on the economic consequences of the minimum wage variation upon employment [3,10] identified that young employees, young adults, and unqualified workers or underpaid employees in sectors such as hotels and food, retail, agriculture, forest and fishing, health and social assistance are most affected by the minimum wage variation.

Although the international literature in the field is quite vast, one can notice that little has been written about the impact of minimum wage upon the European developing countries. That is why our aim consists in extending the research of the minimum wage impact on the European developing countries, by choosing the case of Romania.

The paper is organized as follows: Section 2 describes the data, Section 3 presents the econometric framework used for this study, while Section 4 presents and compares the estimated results of the tested methods. Section 5 concludes.

## 2 Data description

For this study, we made use of the following main variables: the national nominal minimum wage, the average gross nominal wage, the rates of employment, unemployment, activity and inflation, the consumer price index, the producer price index and the productivity index. Quarterly data were used, starting with first quarter of 1999 and ending with the fourth

quarter of 2009. The reason for choosing this period was based on data availability, since there were no available data for the producer price index before 1999. The consumer price index, the producer price index and the productivity index were calculated as chain indices. The rates are in percentage and the minimum wage and the average wage were used in nominal form and are expressed in RON. The main data sources were the Romanian National Institute of Statistics, the Ministry of Labor, Family and Social Protection and the National Bank of Romania.

## 3 Models and Methodologies

In order to quantify the impact of the minimum wage on the Romanian labor market, we made use of several econometric tools, which will be further on presented in this section.

### 3.1 Regression models

The simplest econometric method for describing certain relationships based on economic theory among our variables of interest consists of estimating a multivariate regression model. However, in order to be able to make use of the econometric results, the residuals have to pass the following important conditions: the residuals should not be correlated or heteroskedastic and should have a normal distribution.

In case the residuals are serially correlated or do not pass all of the above tests, the estimated coefficients will be biased and inconsistent and the equation should be re-specified before using any econometric results.

In our case, we estimated a three equation system to describe the impact of minimum wage upon prices, wages and employment.

### 3.2 VAR model

One further step consisted in proposing a new approach in modeling the minimum wage impact by estimating a VAR (p) model, based on the assumption that all three dependent variables might be interrelated. That means, that the variables might influence each other through several $p$ lag periods, and therefore each variable should be described by a separate equation. The mathematical representation for a VAR (2) with just two variables is:

$$Y_t = a_{11}Y_{t-1} + a_{12}X_{t-1} + b_{11}Y_{t-2} + b_{12}X_{t-2} + c_1 + \varepsilon_{1t}$$
$$X_t = a_{21}Y_{t-1} + a_{22}X_{t-1} + b_{21}Y_{t-2} + b_{22}X_{t-2} + c_2 + \varepsilon_{2t} \quad (1)$$

where $\varepsilon_{1t}$ and $\varepsilon_{2t}$ are the innovations that may be contemporaneously correlated but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables.

In order to choose the right lag length, there are several criteria that suggest the order of the VAR model that should be used, such as:

- FPE (Final prediction error)

$$FPE(p) = \left[ \frac{T + kp + 1}{T - kp - 1} \right]^k \left| \sum_{\hat{u}\hat{u}}(p) \right| \quad (2)$$

- AIC (Akaike information criterion)

$$AIC(p) = \ln \left| \sum_{\hat{u}\hat{u}}(p) \right| + (k + pk^2)\frac{2}{T} \quad (3)$$

- SC (Schwarz information criterion)

$$SC(p) = \ln \left| \sum_{\hat{u}\hat{u}}(p) \right| + (k + pk^2)\frac{\ln(T)}{T} \quad (4)$$

- HQ (Hannan-Quinn information criterion)

$$HQ(p) = \ln \left| \sum_{\hat{u}\hat{u}}(p) \right| + (k + pk^2)\frac{2\ln(\ln(T))}{T} \quad (5)$$

where k is the number of variables, T is the number of observations, p is the lag length and the matrix $\left| \sum_{\hat{u}\hat{u}}(p) \right|$ is the determinant of the variance-covariance matrix of the estimated residuals.

The last two criteria (SC and HQ) are better than the first two (AIC and FPE), because the latter tend to overestimate the true lag length. In addition, the next relations are true:

$$\hat{p}(SC) \leq \hat{p}(HQ)$$
$$\hat{p}(SC) \leq \hat{p}(AIC) \qquad for \qquad T \geq 8 \quad (6)$$
$$\hat{p}(HQ) \leq \hat{p}(AIC) \qquad for \qquad T \geq 16$$

In order to check the validity of a VAR model, we need to test for Granger causality, normality, serial correlation and heteroskedasticity. The stability of the VAR model is also required, implying the roots of the characteristic polynomial to lie inside the unit circle [4,5].

Additional insights into the impact of minimum wage shocks on the average wages, prices and employment are obtained from the impulse response functions and from variance decomposition. Although impulse response functions provide information on the size and speed of the impact, they give no information on the importance of the respective shocks for the variance of the other variables, for which variance decomposition does. The variance decomposition actually specifies the percentage contribution of the different shocks to the variance of the k-step ahead forecast errors of the variables.

## 4 Experimental Results

In order to obtain stationary variables, most of the series had to be transformed. Thus, we used the first difference of the natural logarithm of the average wage (*dlnw*), the national minimum wage (*dlnmw*), the consumer price

index (*dlnCPI*) and the producer price index (*dlnPPI*). We also used the first difference of the employment rate (*dn)*, the unemployment rate (*du)*, the activity rate (*dx)* and the natural logarithm of the productivity index (*lnWI)*. The inflation rate was stationary in level and was therefore used in level (*i*).

In section 4.1 the econometric models are described, while the forecast results are presented in section 4.2.

## 4.1    The econometric results

Using stationary series, we first estimated three equations in order to quantify the impact of minimum wage upon average wage, employment and prices in the Romanian labor market. Secondly, a VAR model with the following four variables: the minimum wage, the consumer price index, the average wage, and the employment rate, was estimated.

The results are presented in the next subchapters.

### 4.1.1  System model

The three equations were estimated as a system, but the tests for normality, autocorrelation and heteroskedasticity were performed individually. For this reason, the equations will be discussed individually.

The wage equation has the following form:

$$dlnw(t) = 0.037 - 0.144*dlnmw(t-4) + 0.0085*i(t-1) + 0.0056*i(t-4) - 0.0135*du(t-2) + 0.0047*dx(t-3) - 0.42*dlnw(t-1) \quad (7)$$

The model was then validated. The residuals passed the normality Jarque-Bera test with a probability of 13.98% and the White Heteroskedasticity Test with 43.85%, while the LM Test indicated the absence of any autocorrelation for the first 4 lags with a probability of 30.3%.

The average gross wage is highly inertial, with an oscillating dynamic [2], while the coefficient of -0.42 of its first lag indicates a significant quarterly correction of it. The growth of the average gross wage is slightly hindered by the minimum wage dynamics through the annual adjustments of the latter, since the coefficient is only -0.144.

An interesting fact is that inflation does not affect the average gross wage dynamics, which shows that wages are not adjusted in terms of inflation. Moreover, the unemployment rate influence is insignificant; the only important element is the negative sign of the estimated coefficient, in accordance with a Phillips curve.

A similar situation occurs with the activity rate among young people (aged 15-24 years), which is positive, but insignificant in terms of influence.

The employment equation is the following:

$$dn(t) = 0.17 + 6.217*dlnmw(t-1) - 10.37*dlnmw(t-3) - 5.73*dlnmw(t-4) - 0.298*i(t) + 0.367*i(t-2) - 0.21*dx(t-2) \quad (8)$$

The residuals passed the Jarque-Bera test with a probability of 30 % and the White Heteroskedasticity Test with 37.3%, while the LM Test indicated the absence of any autocorrelation for the first 4 lags with a high probability of 75.7%.

Employment rate has an oscillating dynamic being slightly influenced by the minimum wage increment. It is also worth mentioning that the annual minimum wage increases hamper the employment growth by two corrections: an annual one and another one with a delay of three quarters (with a double impact force - coefficient -10.37, as opposed to -5.73 in the case of the first shock). This means that employers gradually adjust the employment level according to the frame of the planned wage funds. The two negative corrections of the employment rate are followed by a positive correction after one quarter, with a significant coefficient located, as an absolute level, between the previous coefficients values. This could indicate a positive correction that compensates for the past negative corrections caused by the annual and nine months shocks of the minimum wage. It is very important that the employment rate does not have a self-recessive component, since the econometric tests of its various lags were insignificant.

Inflation also affects employment rate fluctuations, in a negative way for the time being and in a positive way through the quarterly shock (lag 2). Given the deflationary process registered in Romania during the analyzed period, it results that the inflation dynamics influence the employment dynamics as follows:

- the current level of inflation stimulates the employment rate due to the signals of quality improvement of the business environment;

- the quarterly shocks, with a slightly larger influence (estimated coefficient of +0.367 as opposed to - 0.298) reveal a Phillips curve correlation, highlighting the National Bank of Romania's focus on the inflation target (ignoring the employment level). In fact, the graphs of the inflation gross series and employment rate show decreasing dynamics for both indicators.

Regarding the activity rate among young people, there can be seen the lowest degree of influence (coefficient of -0.207), of a negative sign, which could be interpreted either by an immolation of the employment rate through programs for inserting young people on the labor market (which is unlikely), or by a higher labor productivity for young people (a marginal rate of sub-unitary substitution compared with other age groups). Furthermore, young people might be the compensation

element of the annual shock corrections of the minimum wage in terms of wage funds due to the low wage level they are paid.

The last equation that was estimated is the price equation:

$$dlnCPI(t) = 0.22 - 0.03*dlnmw(t-1) - 0.05*dlnmw(t-5) - 0.17*dlnPPI(t-1) - 0.22*dlnPPI(t-2) - 0.15*dlnPPI(t-4) - 0.05*lnWI - 0.65*dlnCPI(t-1) \quad (9)$$

The residuals passed the Jarque-Bera test with a probability of 38.5%, the White Heteroskedasticity Test with 62.6% and the LM Test indicated the absence of any autocorrelation for the first 4 lags with a probability of 68.6%.

There can be noticed that the price dynamics is highly inertial and oscillatory. The interpretation of the influence of the factors upon consumer prices should take into account the deflationary context of our country [1]. Thus, the dynamics of consumer prices is supported by producer prices variations (PPI) with different lags, indicating the existence of production cycles of different sizes (annual – 0.15 coefficient, biannual – 0.22 coefficient and quarterly – 0.17 coefficient). As for the rest, the other factors (the minimum wage and labor productivity) have a low influence on consumer prices.

### 4.1.2  VAR model

The novelty of the analysis consists in modeling the impact of the minimum wage upon average wage, employment and prices based on a Vector Autoregression (VAR) approach, by considering that all variables are interrelated. The VAR model is well suited to capture both the size and the speed of the impact of minimum wage upon wages, prices and employment.

In order to determine the lag order of the VAR model several order selection criteria were examined. Although the AIC and FPE suggested a 4 lag model, we decided to rely on the SC and HQ information criterion, which indicated a 2 lag model, since AIC and FPE criteria tend to overestimate the lag order.

After deciding upon estimating a VAR (2) model, we then checked the stability condition, implying that all the roots of the characteristic polynomial should lie inside the unit circle.

Once we concluded that the VAR (2) model is stable, we further analyzed the estimation results. Although we were not particularly interested in the coefficients values, we did perform the Granger causality test in order to make sure that each variable does Granger cause each other. The results of the test confirmed that the VAR model was properly specified in which all the variables do influence each other.

Several other tests were performed in order to check for the normality and the homoskedasticity of the residuals, as well as for the absence of residual autocorrelation.

The hypothesis of normality of the residuals was accepted with a low probability of 14.3%. The residuals are not serial correlated up to order 12 as obtained with the VAR Residual Serial Correlation LM Test, and the hypothesis of homoskedasticity was accepted with a probability of 15.5%.

The estimated coefficients of the VAR model are presented in the following table.

Table 1 The estimated coefficients of the VAR model

|  | DLNMW | DLNCPI | DLNW | DN |
|---|---|---|---|---|
| DLNMW(-1) | 0.078888 | -0.005006 | 0.189045 | 2.146025 |
|  | [ 0.45002] | [-0.17983] | [ 2.09520] | [ 0.63543] |
| DLNMW(-2) | -0.010692 | 0.002739 | 0.030767 | 3.246684 |
|  | [-0.06524] | [ 0.10525] | [ 0.36476] | [ 1.02831] |
| DLNCPI(-1) | 0.635884 | -0.656598 | 0.517933 | -1.167733 |
|  | [ 0.81745] | [-5.31496] | [ 1.29360] | [-0.07792] |
| DLNCPI(-2) | -1.073539 | -0.155673 | 0.623288 | 20.11261 |
|  | [-1.35763] | [-1.23963] | [ 1.53142] | [ 1.32022] |
| DLNW(-1) | 0.727690 | -0.072021 | -0.124962 | -7.676201 |
|  | [ 2.49863] | [-1.55716] | [-0.83364] | [-1.36810] |
| DLNW(-2) | 0.240439 | -0.017392 | 0.478999 | -3.190851 |
|  | [ 0.79404] | [-0.36167] | [ 3.07336] | [-0.54696] |
| DN(-1) | -0.026406 | 0.000596 | 0.000317 | -0.083546 |
|  | [-4.08310] | [ 0.58056] | [ 0.09532] | [-0.67055] |
| DN(-2) | 0.006164 | 0.002029 | 0.010394 | -0.752313 |
|  | [ 1.07130] | [ 2.22012] | [ 3.50985] | [-6.78714] |
| C | -0.000380 | 0.001459 | 0.022902 | 0.077321 |
|  | [-0.01661] | [ 0.40202] | [ 1.94681] | [ 0.17559] |

The study was followed by the analysis of the impulse response functions and variance decomposition. Impulse response functions were constructed in order to provide information on the size and the speed of the impact of minimum wage shocks, while variance decomposition was computed to point out the relative importance of external shocks in explaining fluctuations on the labor market.
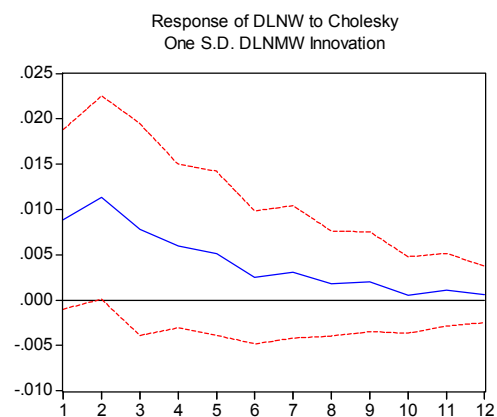


Fig.1 Impulse-response of average wages
to the minimum wage shocks

In the case of average wage, the minimum wage shocks have a positive impact during all 12 periods analyzed.

The variance decomposition of average wage due to minimum wage shocks in the first period represents 7.6%, while its own innovations represent 92%.

Response of DN to Cholesky
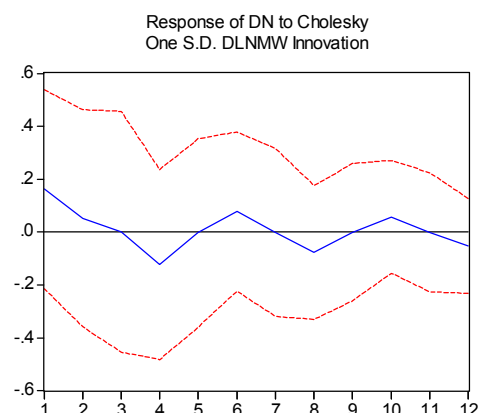One S.D. DLNMW Innovation

Fig.2 Impulse-response of employment
to the minimum wage shocks

Regarding the response of employment to the minimum wage shocks, we noticed that the impact alternates, starting at a 0.162 point. The variance decomposition however, indicates that in the first period the variance of the employment is 96% explained by its own innovations and only 1.8% due to shocks in minimum wage.

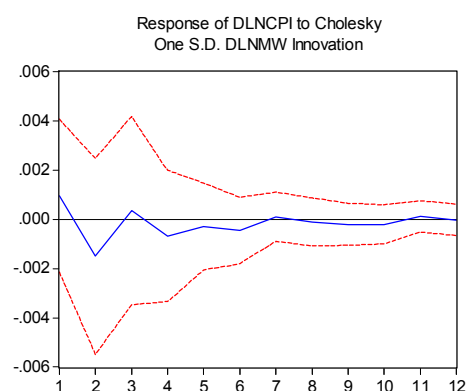Response of DLNCPI to Cholesky
One S.D. DLNMW Innovation

Fig.3 Impulse-response of prices
to the minimum wage shocks

As for the response of prices to the minimum wage shocks, on a 12 period horizon as shown in fig. 3, we first notice that the impact is quite low, having alternative signs. The variance decomposition indicates that in the first period the variance of the prices is 99% explained by its own innovations and only 1% due to shocks in minimum wage, as presented in fig. 4.
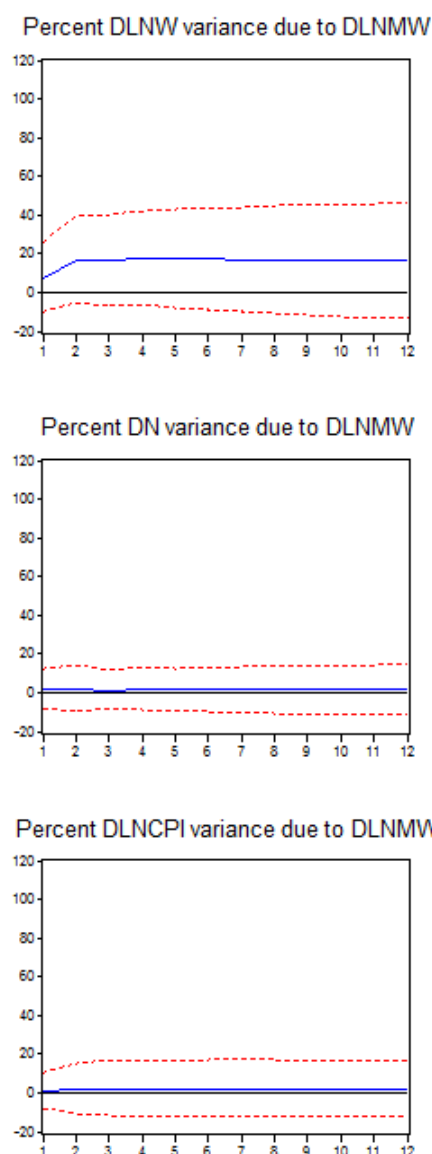The variance decomposition of average wage, employment and prices due to minimum wage shocks is described in fig.4.

Percent DLNW variance due to DLNMW

Percent DN variance due to DLNMW

Percent DLNCPI variance due to DLNMW

Fig.4 Variance decomposition of prices, wages and
employment to the minimum wage shocks

## 4.2 Forecasting results

Lastly we used both the system equation model and the VAR model in order to forecast average wages, employment and prices for a 4 quarter period. The forecasted values of the three dependent variables obtained from the two models for the period q1 2010 – q4 2010, as long as with their evolutions starting with the first quarter of 2008, are presented in the following graphs.

We notice that the predictions of both the regression model and the VAR model are quite similar in all three cases, indicating that both models are very appropriate to describe the labor market fluctuations.
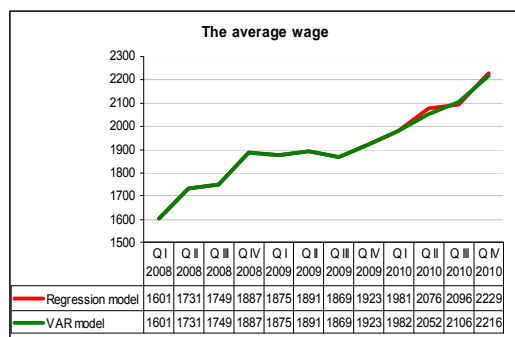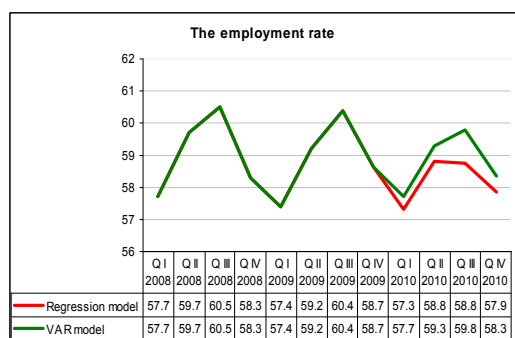
**The average wage**

| | Q I 2008 | Q II 2008 | Q III 2008 | Q IV 2008 | Q I 2009 | Q II 2009 | Q III 2009 | Q IV 2009 | Q I 2010 | Q II 2010 | Q III 2010 | Q IV 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Regression model | 1601 | 1731 | 1749 | 1887 | 1875 | 1891 | 1869 | 1923 | 1981 | 2076 | 2096 | 2229 |
| VAR model | 1601 | 1731 | 1749 | 1887 | 1875 | 1891 | 1869 | 1923 | 1982 | 2052 | 2106 | 2216 |

Fig.5 The average wage evolution



**The employment rate**

| | Q I 2008 | Q II 2008 | Q III 2008 | Q IV 2008 | Q I 2009 | Q II 2009 | Q III 2009 | Q IV 2009 | Q I 2010 | Q II 2010 | Q III 2010 | Q IV 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Regression model | 57.7 | 59.7 | 60.5 | 58.3 | 57.4 | 59.2 | 60.4 | 58.7 | 57.3 | 58.8 | 58.8 | 57.9 |
| VAR model | 57.7 | 59.7 | 60.5 | 58.3 | 57.4 | 59.2 | 60.4 | 58.7 | 57.7 | 59.3 | 59.8 | 58.3 |

Fig.6 The employment rate evolution



**The consumer price index**

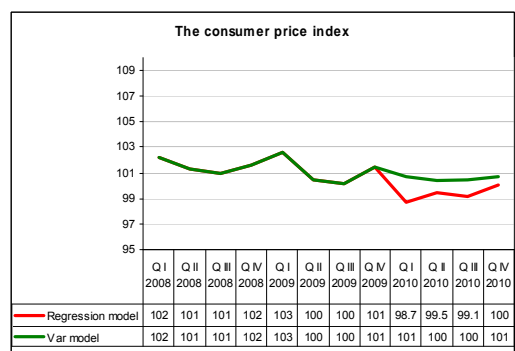| | Q I 2008 | Q II 2008 | Q III 2008 | Q IV 2008 | Q I 2009 | Q II 2009 | Q III 2009 | Q IV 2009 | Q I 2010 | Q II 2010 | Q III 2010 | Q IV 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Regression model | 102 | 101 | 101 | 102 | 103 | 100 | 100 | 101 | 98.7 | 99.5 | 99.1 | 100 |
| Var model | 102 | 101 | 101 | 102 | 103 | 100 | 100 | 101 | 100 | 100 | 100 | 101 |

Fig.7 The consumer price index evolution

In addition to it, it can be seen that the predicted values are following the same trends as those of the initial series, making the results more plausible.

## 5 Conclusions

In this paper we present the results of a study whose purpose was to identify the impact of the national minimum wage upon the average gross wage, employment rate and prices in Romania, during the period q1 1999-q4 2009. In order to do that, we first estimated a system of three equations using as dependent variables the average gross wage, employment rate and the consumer price index. The results indicate that a 10% increase of the growth rate of the minimum wage generates a 1.44% decrease of the growth rate of the average wage, with one year lag. It also hampers the employment growth by a cumulated 0.9% from the 1st, 3rd and the 4th quarter lag, which means that employers gradually adjust the employment level according to the frame of the planned wage funds. In the case of prices, the same 10% increase of the growth rate of the minimum wage leads to a cumulated 0.8% decrease in the growth of prices, delayed with one year and a quarter.

As a novelty, we then tried modeling the impact of the minimum wage upon wages, employment and prices on a different approach, based on the idea that all variables are interrelated. Thus, a VAR (2) model was estimated and the impulse response functions, as well as the variance decomposition, indicated that the shocks in minimum wage do have a low impact.

Based on the conclusions drawn from the two estimated models and from their forecasts, which follow the same trends as those of the initial series, we are confident that both models can be reliable when modeling the minimum wage impact for the case of Romania.

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