SOME ASPECTS OF AVERAGE WAGE EVOLUTION IN THE CZECH REPUBLIC

Luboš Marek

Abstract

We analyze the development of average wages in the Czech Republic in the last 18 years in our article. We build the appropriate model for the average wage and its characteristics (mean and standard deviation). There are two possible ways to build this model. We can construct the probability model for the wage distribution using empirical data by using general probabilistic approach. The second possibility is to use time series analysis for the model building. Both methods are then combined to estimate the future values of characteristics with the aid of trend analysis.

The average wage for each year is compared with the minimum wage. We consider inflation when creating the model. We compute the Gini index for each year as a measure of inequality of wages in the CR. For comparison purposes, we use quantile measures such as median, lower and upper quartiles, and 10% and 90% percentiles.

Key words: wage, average, percentiles, standard deviation, Gini index

JEL Code: C40, F470

Introduction

In this article we analyze the time evolution of wages in the Czech Republic in the years from 1995 to 2012, using data from the second quarter of each calendar year. The second quarter was chosen due to the fact that the working hours are most stable in this quarter on a long-term basis. Our data source is the Trexima Company. The data represents employees' wages, that is, numbers derived from average per-hour wages for labor-law purposes in the second quarter of each calendar year. The scope of the data set on which the analyses were carried out was gradually increased from more than 300,000 observations in 1995 to approx. two million in 2012. The Czech Statistical Office's official website states the average number of registered employees in the Czech Republic in the first quarter of 2012 as 3733.2 thousand (headcount), or 3867.4 thousand (full-time equivalent). In either case the size of the data set is larger than 50% of the parent population. There is a question of whether or not it is worth discussing the size of the sample: the results obtained more or less represent the condition of

the employees' parent population. The data is structured in a very detailed way, in which the salary values are divided into intervals whose widths are 500 CZK. Such a detailed structure enables us to achieve quite accurate results.

Several analyses were carried out on the data set. First of all, we were interested in the evolution of the wage absolute values represented by the average wage. However, the time evolution was also viewed with the aid of quantiles. Wage variability and its time evolution were also of interest. Growing variability indicates the differentiation of the wages over a period of time. We further considered the effects of inflation and cleaning such effects from the data. The evolution of the average wage was compared with that of the minimum wage. We also calculated the Gini index for the average wages by region and evaluated the time evolution of this index. This comparison enables us to assess wage distribution in the Czech Republic. We also based our considerations on our previous articles (Marek, 2010), (Marek, 2011), (Marek & Vrabec, 2010), (Marek &Vrabec, 2011). A detailed treatise of the topic can also be found in (Bartošová, 2011), (Bartošová & Želinský, 2013), (Malá, 2011), (Malá, 2012), (Tartaľová, 2012) or (Löster & Langhamrová, 2012) .

1   Evolution of the average wage in the Czech Republic

Let us first have a look at the evolution of the average wage in the Czech Republic. The data is displayed in a chart and then tabled.

Fig. 1: Average wage in the Czech Republic
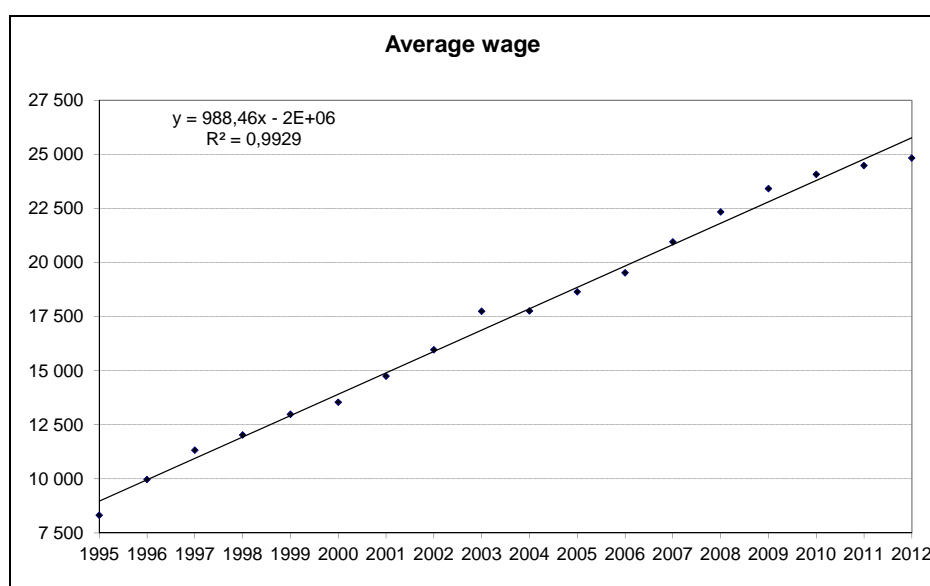
Source: Our own calculations

Trend analysis was used for the description of the average wage evolution (Marek, 2010). A linear trend was applied. The equation of the trend line and the value of the correlation coefficient are shown in the chart. Since the correlation coefficient nearly equals one, we can see that the average wage's evolution is strictly linear. Let us recall that our sample represents more than 50% of the parent population and it would therefore be useless to analyze residua or test the trend line parameters. The data is also shown in Table 1, which contains inflation parameters as well. The latter will be used in the subsequent analysis.

Table 1 Average wage and inflation in the Czech Republic

Year	Average wage	Inflation rate	Adjusted inflation rate rate	Average wage - prices in 2012	Average wage - prices in 1995
1995	8311	1.091	1.091	17,450	8311
1996	9962	1.088	1.089	19,172	9131
1997	11,322	1.085	1.086	19,999	9525
1998	12,026	1.107	1.096	19,552	9312
1999	12,982	1.021	1.063	19,258	9172
2000	13,541	1.039	1.030	18,894	8999
2001	14,743	1.047	1.043	19,973	9513
2002	15,964	1.018	1.032	20,736	9876
2003	17,748	1.001	1.009	22,330	10,635
2004	17,759	1.028	1.014	22,134	10,542
2005	18,640	1.019	1.023	22,902	10,908
2006	19,526	1.025	1.022	23,440	11,164
2007	20,953	1.028	1.026	24,612	11,722
2008	22,338	1.063	1.045	25,562	12,174
2009	23,418	1.010	1.036	25,635	12,209
2010	24,077	1.015	1.012	25,436	12,115
2011	24,484	1.019	1.017	25,546	12,167
2012	24,829	1.033	1.026	24,829	12,133

Source: Trexima, www.czso .cz (Czech Statistical Office) and own calculations

1.1　Effects of inflation

The inflation rate values are taken from the Czech Statistical Office's website. The average wages in our data set are taken from the second quarter of each year, while the inflation rate is annual (even though its monthly values are also stated on the Czech Statistical Office's website, but not before 2000). Hence we cannot avoid a certain type of inaccuracy, of which we are aware. We use the following approximation for the inflation index in the respective years

$$I_{Adj\_Year\,t} = \left(I_{Year(t-1)} \cdot I_{Year\,t}\right)^{1/2} \tag{1}$$

where $I_{Adj\_Year\,t}$ is the index of inflation used for the calculation. This value is based on taking, for year t, the index of inflation from the preceding half-year (the second half of year t-1) and the first half-year of t. The re-calculated values are shown in the fourth column of Table 1. Let us view the average wage data cleaned from the effects of inflation. Figure 2 is obviously less optimistic than Figure 1. It is seen that the actual wages have been going down in the last four years, even though the nominal wages have been growing.

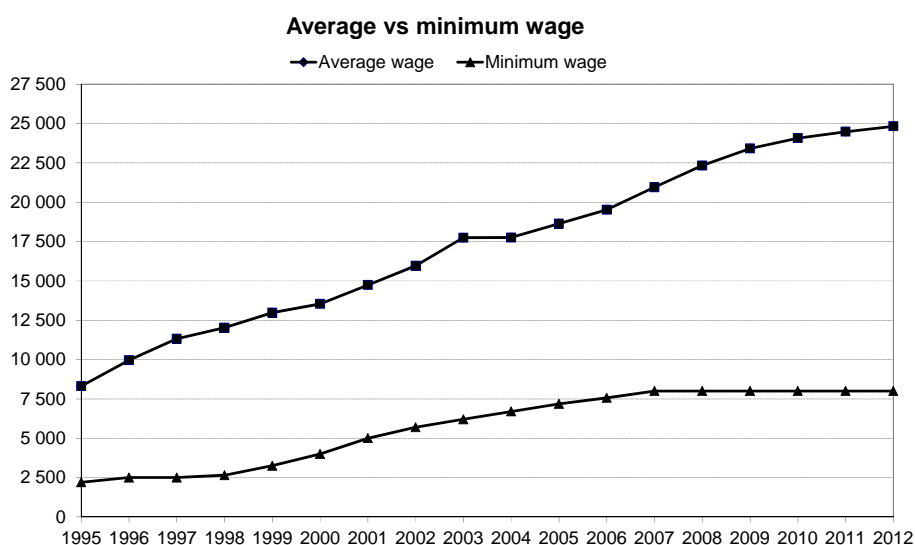**Fig. 2: Average wage in the Czech Republic – impact of inflation**
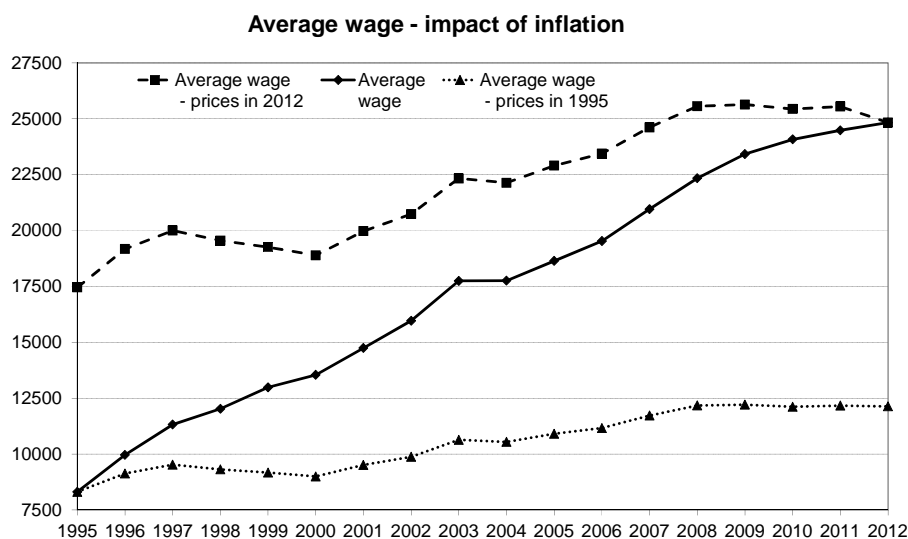
Source: Our own calculations

1.2   Average and minimum wages

The minimum wage was first introduced in the Czech Republic in 1991. It has been changed 15 times since then. However, we will only be interested in its values in the period beginning in 1995. Unfortunately, not all modifications of the minimum wage were applied in January of the respective year. The value of the minimum wage was changed twice within certain years, but it has not been changed at all since 2007. For purposes of comparison, we will always use the value of the minimum wage valid in the second quarter of each year. The Figure clearly indicates that the minimum wage has been stagnating for seven years while the average wage is (at least nominally) growing. Exact data is shown in Table 2.

Fig. 3: Average wage in the Czech Republic – impact of inflation

Source: Trexima, www.czso.cz (Czech Statistical Office) and our own calculations

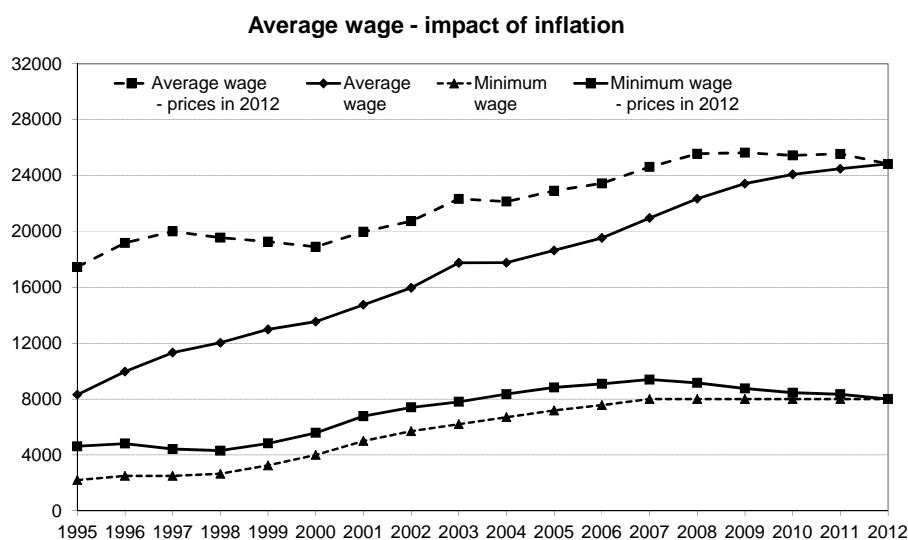**Table 2 Average wage and inflation in the Czech Republic**

Date of change	Minimum wage
1991 February	2000
1992 January	2200
1996 January	2500
1998 January	2650
1999 January	3250
1999 July	3600
2000 January	4000
2000 July	4500
2001 January	5000
2002 January	5700
2003 January	6200
2004 January	6700
2005 January	7185
2006 January	7570
2006 July	7955
2007 January	8000

Year	Minimum wage for comparison	Minimum wage - prices in 2012
1995	2200	4619
1996	2500	4811
1997	2500	4416
1998	2650	4308
1999	3250	4821
2000	4000	5581
2001	5000	6774
2002	5700	7404
2003	6200	7801
2004	6700	8351
2005	7185	8828
2006	7570	9088
2007	8000	9397
2008	8000	9154
2009	8000	8757
2010	8000	8452
2011	8000	8347
2012	8000	8000

Source: Ministry of Labor and Social Affairs

Let us have a look at the minimum wage evolution cleaned from inflation. We will base the calculations on the modified index of inflation given in Table 2. Let us re-calculate the

average and minimum wage values using the prices of 2012. The comparison indicates that the minimum wage in 2012 is the smallest value in the last nine years.

Fig. 3: Average wage in the Czech Republic – impact of inflation

Source: Our own calculations

2 Wage quantiles

We will use quantiles for comparison with the average wage (Marek, 2012).

Table 3 Average wage and inflation in Czech Republic

D1	Q1	Median	Q3	D9	Average wage
4879	5963	7500	9691	12,314	8311
5645	7047	8956	11,505	14,748	9962
6178	7910	10,171	13,083	16,774	11,322
6287	8114	10,563	13,801	17,911	12,026
6894	8859	11,506	14,911	19,499	12,982
6981	9077	11,860	15,570	20,435	13,541
7693	9870	12,901	16,794	22,234	14,743
8181	10,564	13,857	18,058	24,003	15,964
9143	11,829	15,519	20,070	26,271	17,748
9185	12,073	15,789	20,168	26,143	17,759
9371	12,403	16,432	21,376	27,754	18,640
9710	12,882	17,143	22,192	28,828	19,526
10,381	13,659	18,185	23,602	31,257	20,953
11,060	14,583	19,267	25,094	33,306	22,338
11,681	15,339	20,138	26,241	35,093	23,418
12,084	15,778	20,753	27,009	36,143	24,077
12,199	15,996	21,020	27,225	36,677	24,484
12,255	16,281	21,319	27,583	37,328	24,829

Source: Trexima

The respective values of the quantiles are given in Table 3. We are using the following quantiles: 10% quantile (D1), lower quartile (Q1), median, upper quartile (Q3), and 90% quantile (Q9).

Let us see the charts of quantiles.

Fig. 4: Average wage and percentiles of wage
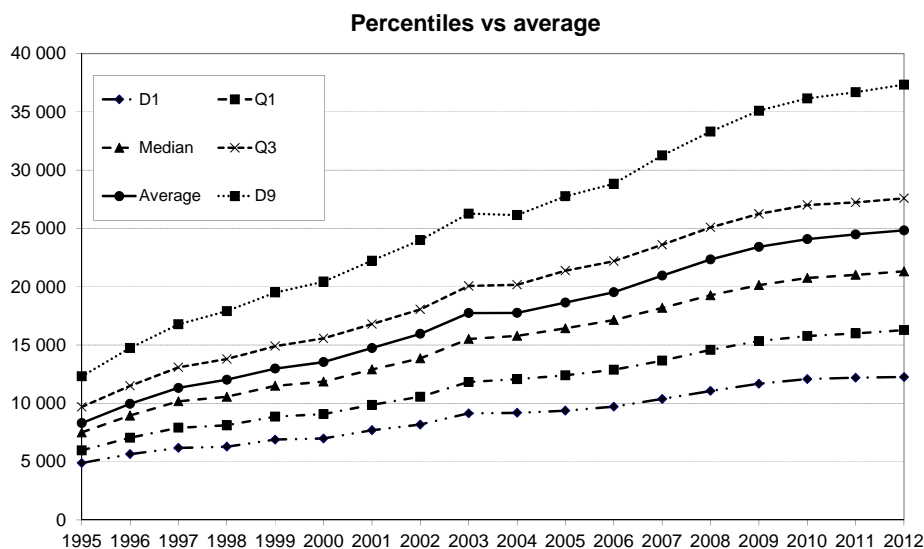
Source: Our own graph

It is useful to realize what the quantiles tell us. A simple overview is shown in Table 4.

Table 4 Selected percentiles of wages in the Czech Republic, 2012

Wage interval		Frequency*100%	Absolute Frequency*100%
under	12,255	10%	10%
12,255	16,281	15%	25%
16,281	21,319	25%	50%
21,319	24,829	14%	64%
24,829	27,583	11%	75%
27,583	37,328	15%	90%
over	37,328	10%	100%

Source: Trexima and our own calculations

The highest 10% of the wages poses a small problem. This interval contains wages above 100,000 CZK, for which we cannot say whether they are closer to 200,000 or 1,000,000 CZK (in the data set, all such wages are aggregated in the interval above 100,000 CZK; there were 16,994 of them in 2012).

It is not surprising that the median is considerably smaller than the average value. Considering years 2011 and 2012, and supposing that logarithmic-normal distribution represents a suitable probability model for the average wage (Marek &Vrabec 2011), (Malá, 2011) we easily calculate:

- for 2011 $\bar{x} = x_{0,663}$ holds, meaning that the arithmetic mean is a 66.3% quantile,

- while for 2012 $\bar{x} = x_{0,639}$, holds, that is, the arithmetic mean is a 63.9% quantile.

The values are different – we work with empiric data and models. Nonetheless the average is, on a long term basis, around a 65% to 66% quantile. This fact confirms the generally accepted feeling that about 2/3 of wages are lower than the arithmetic mean. In this context a question naturally arises, whether the arithmetic mean is a good characteristic of wages. The wage median in 2012 equals 21,319 CZK – that is, 50% of wages are lower than or equal to this value. And the average wage is 24,829, i.e., larger by 3,510 CZK!
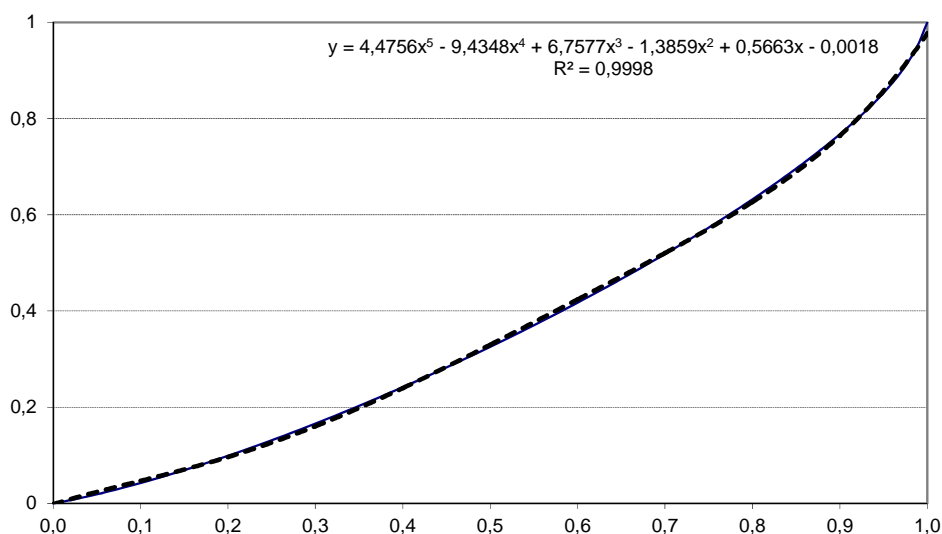
3   Gini index

The Gini index is commonly used as a measure of inequality in wages. It is a well-known numeric characteristic of diversification with values between 0 and 1. If it were equal to 0, the wages would be equal (with the total amount of the wages uniformly divided among all employees), while 1 would mean absolute non-equality (one person would be receiving all the wages). Let us view the situation in the Czech Republic.

Fig. 5: Theoretical Lorenz Curve
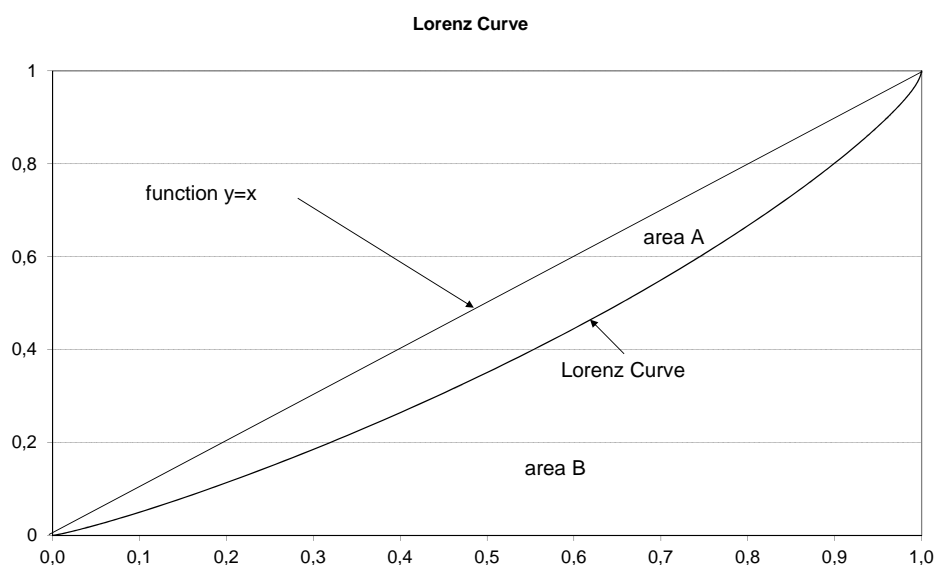
Source: Our own calculations

Fig. 6: Lorenz Curve of wages

Source: Our own calculations

We based our calculations of the Gini index (G_{index}) on the classical Lorenz curve; its value

was then calculated in the usual way as the ratio of the respective areas $G_{index} = \dfrac{A}{A+B}$. Since

we worked with empiric data and not a mathematical function, we had to estimate the shape

of the Lorenz curve. This estimate made use of a regression model: a 5th-degree polynomial

was used to smooth the data. The fit of the regression curve (model) to the data was perfect,

as can also be seen from the index of determination, which was close to 1 (both curves look

identical in the chart). The area under the curve was then easily calculated from the

polynomial by integration (Marek, 2011).

Repeating the same procedure for each year we obtained its Gini index value. The results are

shown in the following Table 5 and Fig. 7.

Table 5 The Gini index for wages in the Czech Republic

Year	Gini index	Year	Gini index
1995	0.220	2004	0.248
1996	0.231	2005	0.255
1997	0.220	2006	0.258
1998	0.258	2007	0.260
1999	0.250	2008	0.261
2000	0.238	2009	0.263
2001	0.265	2010	0.262
2002	0.262	2011	0.264
2003	0.257	2012	0.263

Source: Our own calculations

Fig. 7: Lorenz Curve of wages
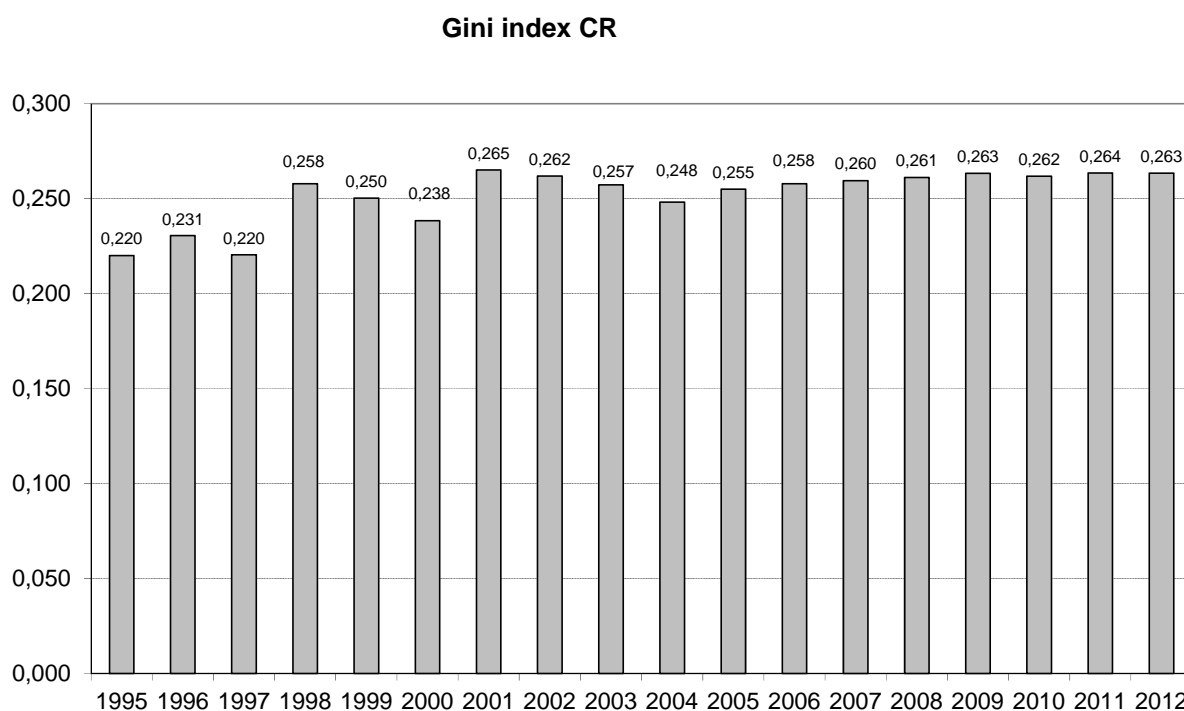
Gini index CR

Source: Our own calculations

As we can see from both the Table and the Figure, the Gini index value is relatively stable, around 0.263. This value is rather low; most European countries (including those in Northern Europe) state their Gini index of **income** (while we only consider wages here) between 0.30 and 0.40, the USA between 0.45 and 0.49. However, the situation is unclear: different sources state different values of this index and in different years, and the comparison is thus problematic. The value of 0.263 in the Czech Republic indicates rather egalitarian wages in comparison with other countries in the world.

Conclusions

The goal of the present article is to evaluate different aspects of the time evolution of the average wages in the Czech Republic. On the basis of the published data and our own analyses we can say:

- the average wage nominally grows in time (regardless of the economic crisis);
- real wages stagnate or go down due to the inflation of recent years;
- the "scissors of inequality" between the average and minimum wages are getting wider;

- the minimum wage has been stagnating for seven years now, and its real value is significantly lower due to inflation;

- quantiles, and in particular the median, provide better information about the wages than the arithmetic mean;

- the gap between the average and median wages is getting wider in time;

- the arithmetic mean is, on a long-term basis, at about a 65% to 66% quantile (i.e., 2/3 of wages are below the average);

- the Gini index for the Czech Republic has stabilized at around 0.263 in recent years, which is a value lower than in most countries world-wide.

Acknowledgment

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Contact

Luboš Marek

University of Economics, Prague

W. Churchill sq. 4, 130 67 Prague 3, Czech Republic

marek@vse.cz