DEVELOPMENT OF WAGE DISTRIBUTION OF MEN AND WOMEN IN THE CZECH REPUBLIC AT BEGINNING OF THE THIRD MILLENIUM AND THE IMPACT OF THE GLOBAL ECONOMIC CRISIS ON THE DEVELOPMENT OF SUCH DISTRIBUTION

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Abstract

This paper deals with the development of the wage distribution in the Czech Republic since 2003, according to gender. It is a development of descriptive characteristics of location, differentiation and shape of wage distribution, but also the development of concentration characteristic of wage distribution. Gross monthly wage of Czech employees represents the variable under research. Emphasis is placed on changes in the development of wage distribution since 2009 in connection with the onset of economic recession. The economic crisis has greatly influenced the development of the wage distribution in the Czech Republic, wage growth virtually stopped at this time. Differences in the development of wage distribution between men and women in the Czech Republic are also under this research. Development of wage distribution has been studied by modelling the distribution. Three-parametric lognormal curves are served as a theoretical probability distribution whose parameters were estimated using the L-moment method of point estimate of parameters. Dependence of gross monthly wage on gender has been the subject of research as well. This dependence was researched using one-way analysis of variance. Forecast of wage distribution of men and women in the Czech Republic for the years 2012 and 2013 is included in this research.

Key words: Wage distribution of men and women in the Czech Republic; impact of global economic crisis on wage; characteristics of location, differentiation, shape and concentration of wage distribution; dependence of wage on gender; development of wage distribution in time

JEL Code: C13, C16

Introduction

Wage development of Czech emploees in the last two decades requires that we pay greater attention to issues of their differentiation in research. Wage structure changes during this period and group of employees with distinctively high wage arises here (Marek, 2010). The purchasing power of Czech households changes (Bartošová, 2009) or (Bartošová, 2013) and strong differences between regions arise from this point of view in the Czech Republic (Löster, 2012). Disparities between regions of the Czech Republic in terms of opportunities in the labour market are gradually forming (Löster & Langhamrová, 2012). The phenomenon of unemployment appears (Miskolczi, Langhamrová & Fiala, 2011) or (Miskolczi, Langhamrová & Langhamrová, 2011), which then gradually develops (Jarošová & Malá, 2005) or (Löster & Langhamrová, 2011). Wages of Czech employees and incomes of Czech households are under appreciable changes. A number of authors was engaged in research on wage and income distribution in the past (Čabla, 2011), (Marek, 2010) or (Malá, 2011).

Gross monthly wage in CZK is the researched variable in this research. Data come from the webside of the Czech Statistical Office[1] and they are categorized by the gender. Descriptive characteristics of the wage distribution were calculated. The wage distribution was modelled using three-parametric lognormal curve (Kleiber & Kotz, 2003). The parameters of these curves were estimated by the method of L-moments of parametric estimation (Hosking, 1990) or (Kyselý & Picek, 2007). Dependence of gross monthly wage on gender was researched, too. Wee therefore researched the dependence of the numerical variable on categorical variable (Řezanková, Löster & Húsek, 2011) or (Řezanková & Löster, 2013). Test one-way analysis of variance was used for this purpose.

The necessary calculations were performed using Microsoft Excel spreadsheet and using SAS and Statgraphics statistical program packages.

1   Development of descriptive characteristics of wage distribution

Known characteristics of location and differentiation were used to descriptive the development of wage distribution of men and women in the years 2003-2011. Gini coefficient was used to characterize the development of concentration of wage distribution of men and women in the period.

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[1] www.czso.cz

Fig. 1: Lorenz curve
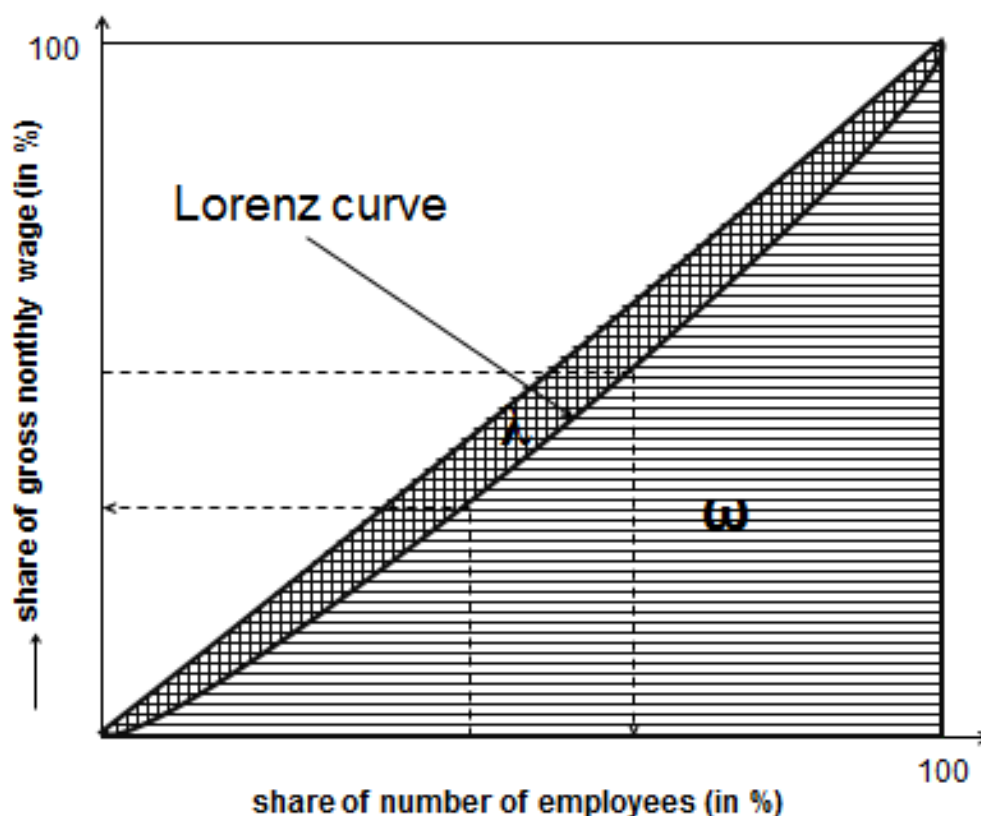
Source: Own research

Gini coefficient is related to the famous Lorenz curve, see Figure 1, Lorenz curve is a bold here (including two extreme possibilities of shape for the case of zero concentration and for the case of maximum possible concentration). Lorenz curve is plotted in a rectangular chart with two scales from 0 percent to 100 percent. The cumulative relative frequencies (percentage) of the units representing the wearers of studied variable are the abscissa. Employees are carriers of gross monthly wage in this case. Cumulative totals of concentrated variable (percentage) are located on the axis of ordinates. Gross monthly wage is concentrated variable in this case. Cumulative relative frequencies of units (in %), which represent the wearers of studied variable, and their corresponding cumulative totals of concentrated variable (in %), thus represent the coordinates of points on the Lorenz curve. Lorenz curve merges with a diagonal of the graph in the case of zero concentration, when the same proportion of the total sum of values of the researched variable falls on each unit. In this case, this situation would be if every employee had the same gross monthly wage. Lorenz curve bends more the concentration of researched variable is greater, when the concentration

of considerably large part of the total sum of values of the variable grows into a small number of units. The highest concentration occurs when the total sum of values of variable is only concentrated into a single unit.

Gini concentration coefficient is the ratio of the area content that define the diagonal of the graph and the Lorenz curve, which is indicated ▦ (λ) in Figure 1, and the content of the total area of the triangle below the diagonal of the graph, which is indicated by an area of ▦ + ▤ ($\lambda + \omega$) in Figure 1

$$G = \frac{\lambda}{\lambda + \omega}. \tag{1}$$

The value of Gini coefficient is thus ranges from zero at extreme levelling (zero concentration), where all employees have the same wage, to one with extreme diferentiation (maximum possible concentration), where all wage belongs to one employee.

Table 1 shows the annual growth rate and the average annual growth rate (in %) of middle and average wage of men and women in the Czech Republic in 2003-2011. Figures 2 and 3 represent the development of middle and average gross monthly wage of men and women in the Czech Republic between the years 2003-2010. Because the wage distribution is characterized by positive skewness, most employees do not reach the average wage. For this reason, the wage median is prefeable characteristic of wage level than their arithmetic mean.

Tab. 1: (Average) growth rate (in %) of middle and average gross monthly wage

| Year	Men						Women					
	Middle wage			Average wage			Middle wage			Average wage		
	Growth rates	Average growth rate	Average growth rate	Growth rates	Average growth rate	Average growth rate	Growth rates	Average growth rate	Average growth rate	Growth rates	Average growth rate	Average growth rate
2003	–			–			–			–		
2004	6.05			5.44			5.47			4.19		
2005	4.84			5.09			5.19			5.63		
2006	4.53	6.03		4.65	6.54		5.21	5.50		6.07	5.83	
2007	7.81			10.45			5.87			7.03		
2008	6.98			7.18			5.78			6.25		
2009	-1.17		-1.37	-0.11		-1.61	2.05		0.74	2.16		0.67
2010	2.20			1.62			1.51			1.27		
2011	-5.00			-6.17			-1.32			-1.40		

Source: Own research

Fig. 2: Development of middle gross monthly wage (in CZK) of men and women in the Czech Republic between the years 2003-2011
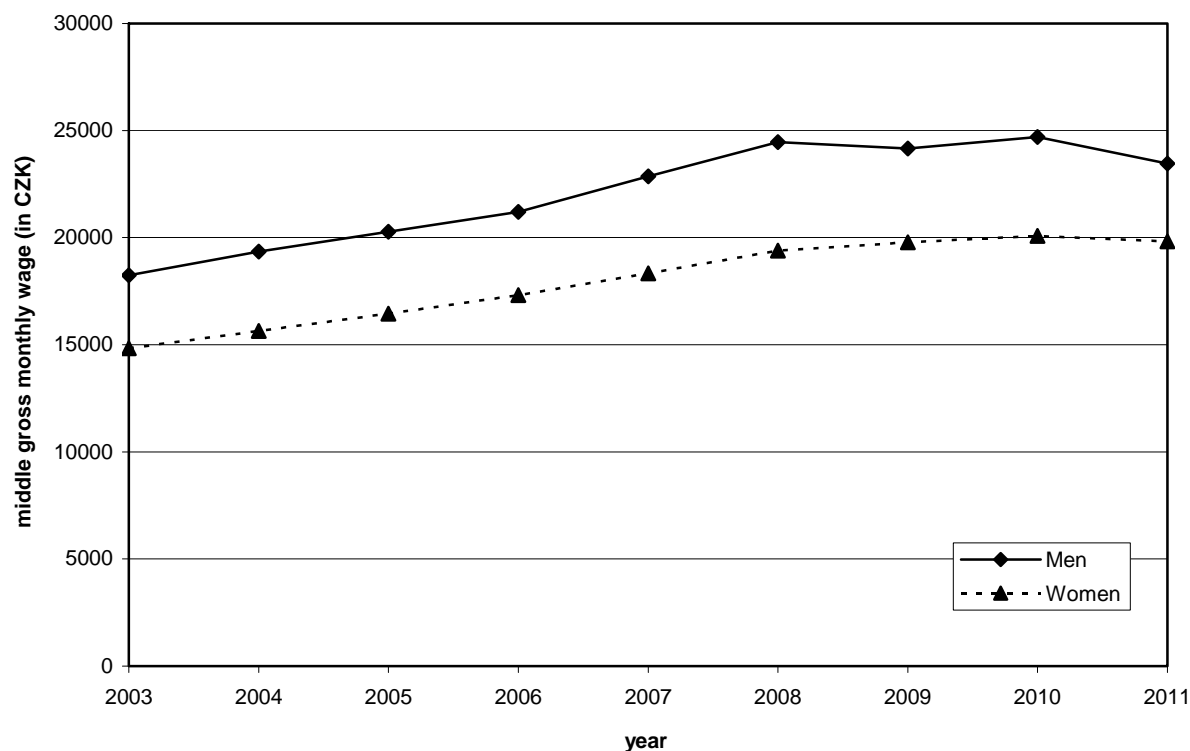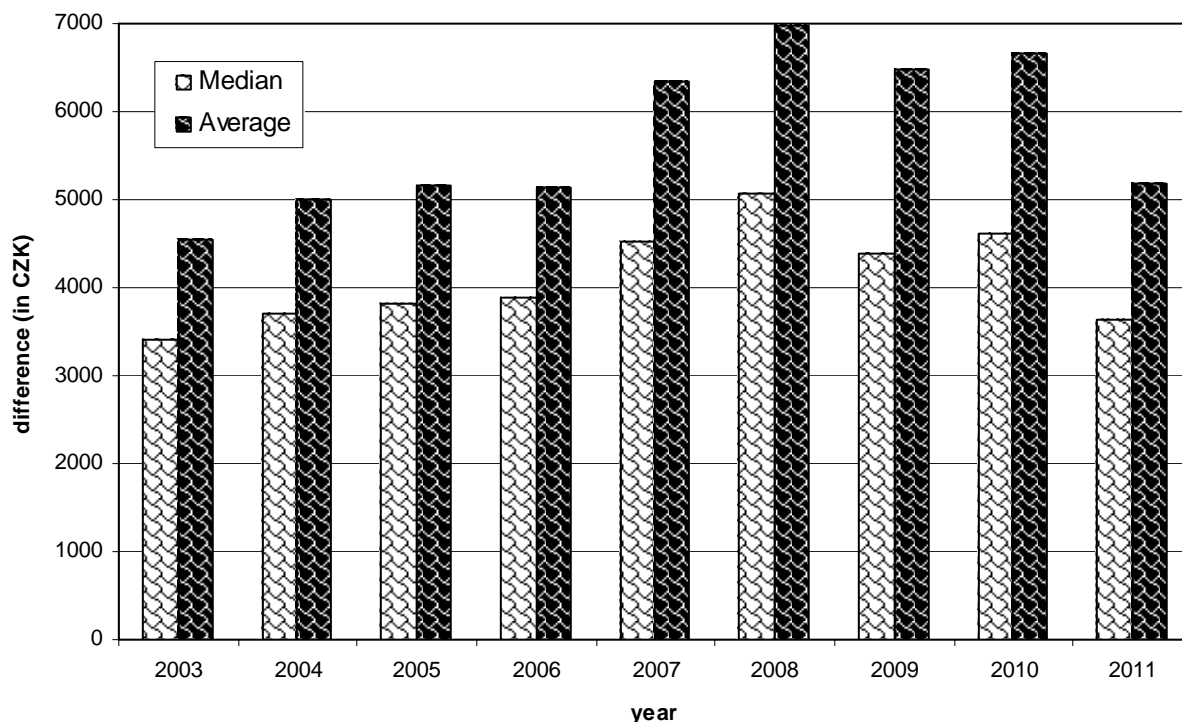

Source: Own research

Fig. 3: Development of average gross monthly wage (in CZK) of men and women in the Czech Republic between the years 2003-2011
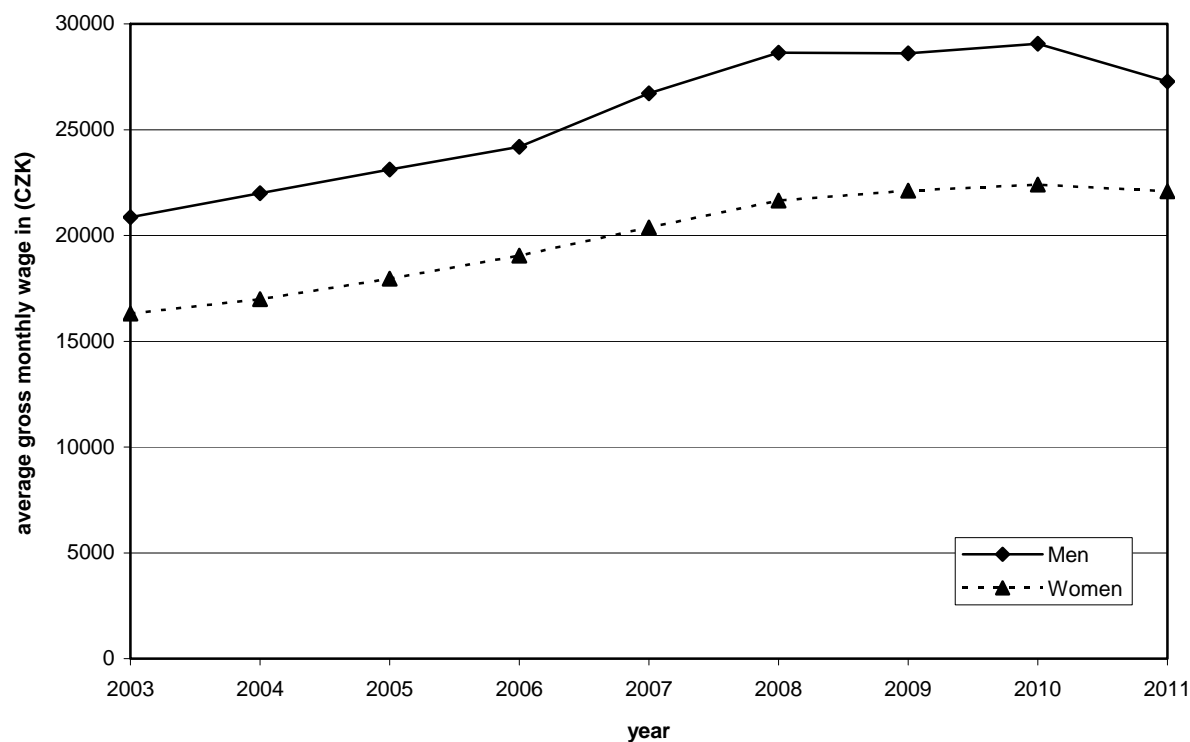
Source: Own research

Fig. 4: Differences between the wage level of men and women (in CZK)

Source: Own research

From Table 1 it is evident that the middle gross monthly wage of men increased by an average of 6.03 % per annum in the period before the economic crisis, while it decreased on average by 1.37 % per year during the economic crisis. The average gross monthly wage of men increased by an average of 6.54 % per annum in the period before the economic crisis, while it decreased on average by 1.61 % per year during the economic crisis. We can also see from this table that the middle gross monthly wage of women increased by an average of 5.50 % annually in the period prior to global economic resession, while it increased by an average of 0.74 % per annum during the period of the crisis. Average gross monthly wage of women increased by an average of 5.83 % annually in the period prior to global economic resession, while it increased by an average of 0.67 % per annum during the period of the crisis. We can thus observe from Table 1 and Figures 2 and 3 that the level of gross monthly wage of men even declined during the economic recession (years 2009 and 2011). The middle gross monthly wage of men increased by an average of 3.20 % per year, and the average gross monthly wage of men increased by an average of 3.41 % per annum for the entire period 2003-2011. The middle gross monthly wage of women increased by an average of 3.69 % per year, and the average gross monthly wage of women increased by an average of 3.86 % per

annum for the entire period 2003-2011. Wage of women thus roses slightly faster than wage of men.

We can see form Figures 2−4 strong differences between middle gross monthly wage of men and women and the differences between average gross monthly wage of men and women. We can observe from these figures that the difference between the wage level of men and women has increased gradually in the period before the onset of the global economic crisis. The wage level of men grew faster than the wage level of women in this period, see Table 1. Differences between wage level of men and women have downward trend during the economic crisis, it is even decline in the wage level of men since 2008, while wage of women still rising slightly (with the exception of 2011).

Table 2 represents the development of characteristics of differentiation and concentration of the wage distribution of men and women, indicating an increase in the characteristic of absolute variability (standard deviation) in time. Therefore, the data cannot be considered homoscedastic within the meaning of the same variability in the same distribution. The characteristic of relative variability (the coefficient of variation) oscillates in time with increasing tendency.
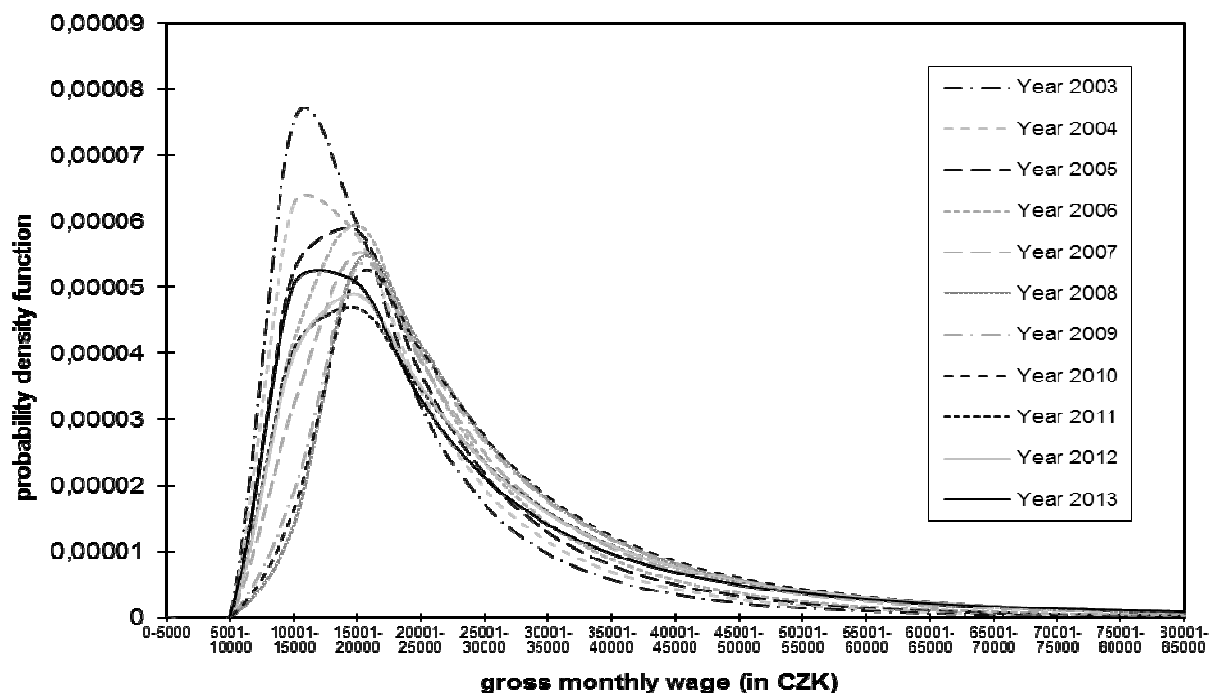
Figures 5 and 6 show the development of model distribution of gross monthly wage of men and women in the period 2003-2011 including forecasts for 2012 and 2013.

Tab. 2: Standard deviation (in CZK), coefficient of variation (in %) and Gini coefficient (in %) of the distribution of gross monthly wage of men and women in the Czech Republic since 2003

Year	Men			Women		
	Standard deviation	Coefficient of variation	Gini coefficient	Standard deviation	Coefficient of variation	Gini coefficient
2003	9,987	47.88	24.06	7,752	47.52	23.78
2004	11,068	50.33	25.07	8,442	49.67	24.81
2005	11,465	49.61	25.11	8,866	49.38	24.84
2006	11,849	48.99	25.04	9,202	48.32	24.25
2007	15,879	59.44	27.51	11,463	56.25	26.39
2008	16,736	58.45	27.42	12,076	55.77	26.18
2009	17,108	59.81	28.06	12,328	55.72	26.51
2010	17,172	59.08	27.96	12,391	55.30	26.27
2011	17,133	62.82	30.23	12,557	56.84	27.75

Source: Own research

Fig. 5: Development of probability density function of three-parametric lognormal curves of the distribution of gross monthly wage of men including forecasts for 2012 and 2013
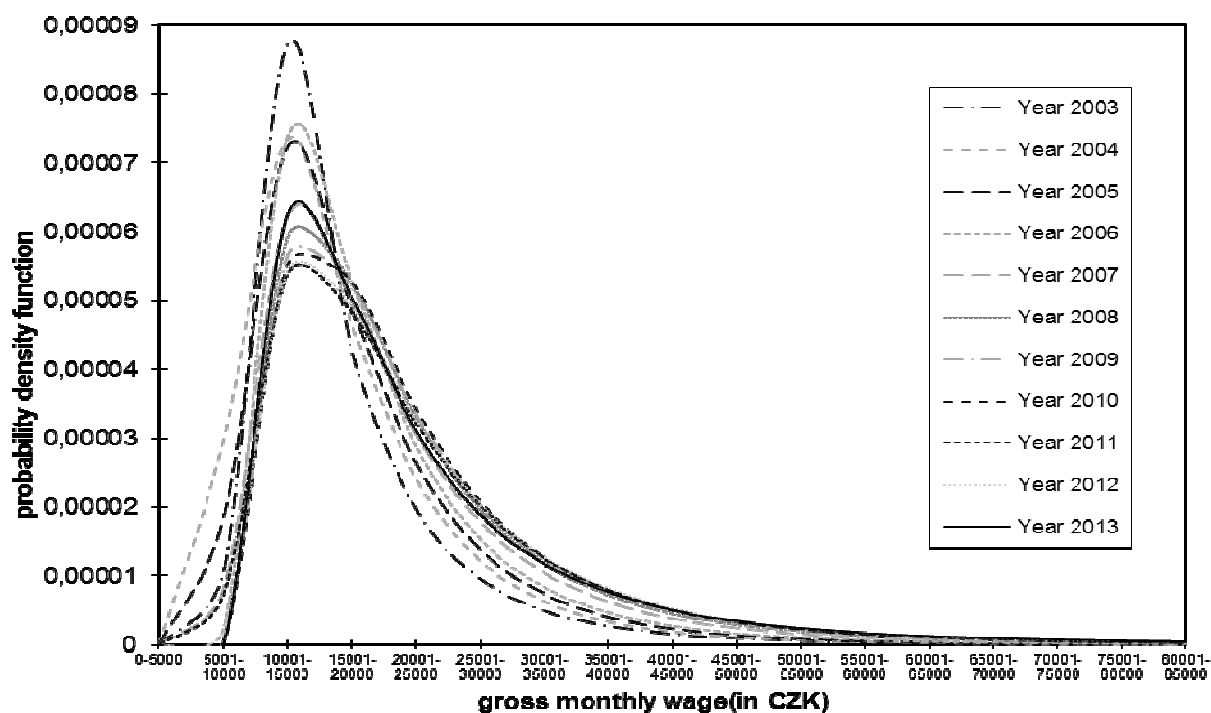

Source: Own research

Fig. 6: Development of probability density function of three-parametric lognormal curves of the distribution of gross monthly wage of women including forecasts for 2012 and 2013

Source: Own research

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We can see from Figures 5 and 6 a systematic tendency in the development of the shape of the wage distribution in time, the skewness and kurtosis of the distribution gradually decrease and the employee groups with very high wage increase. We can also see from these figures the differences between the wage distribution of men and women in the period. It is clear that the wage distribution of women has a higher skewness and kurtosis than the wage distribution of men throughout the period studied.

2　Wage dependence on gender

Tables 3 and 4 provide an overview of the statistical dependence of gross monthly wage upon gender. Having applied a test analysis of variance known as ANOVA (one-factor), the above mentioned dependence was verified for each year of the period.

The gross monthly wage dependence upon gender was demonstrated for virtually any commonly used significance levels ($\alpha = 0.05$ and 0.01) with regard to large sample sizes typical for the research of the wage and income distribution. However, from Table 3 can be seen that it is considerably weak intensity dependence. In terms of variance analysis, the decomposition of total variability into both intragroup and intergroup variability is performed, the source of dependence being just the intergroup variability.

Tab. 3: Decomposition of the variance of gross monthly wage − total average (in CZK); components of total variance − average variance (in CZK^2) and variance of averages (in CZK^2); total variance (in CZK^2); standard deviation (in CZK), coefficient of variation (in %) and determination ratio (in %)

Year	Total average	Average variance (intragroup variability)	Variance of averages (intergroup variability)	Total variance	Total standard deviation	Total coefficient of variation	Determinat. ratio
2003	18,810	81,875,828	5,111,767	86,987,595	9,327	49.59	5.88
2004	19,527	97,225,978	6,237,001	103,462,978	10,172	52.09	6.03
2005	20,573	105,443,765	6,652,731	112,096,497	10,588	51.47	5.93
2006	21,636	112,768,011	6,615,725	119,383,736	10,926	50.50	5.54
2007	23,631	193,359,436	10,023,726	203,383,162	14,261	60.35	4.93
2008	25,222	214,478,668	12,167,155	226,645,823	15,055	59.69	5.37
2009	25,442	224,057,727	10,486,153	234,543,880	15,315	60.20	4.47
2010	25,812	225,841,683	11,081,641	236,923,324	15,392	59.63	4.68
2011	24,747	227,345,475	6,703,741	234,049,216	15,299	61.82	2.86

Source: Own research

Tab. 4: Analysis of variance[2] of dependence of gross monthly wage on gender − average squares (in CZK²); test criterion F[3]; critical values[4] for 5 percent a 1 percent significace level[5] a P-value

Year	Average squares		Test criterion F	Critical value		P-value
	Intragroup variability	Intergroup variability		$\alpha = 0.05$	$\alpha = 0.01$	
2003	81,875,832	5,208,552,743,087	63,615.265	3.84147	6.63492	0.0000
2004	97,225,978	8,759,842,842,222	90,097.760	3.84147	6.63492	0.0000
2005	105,443,766	10,082,394,123,401	95,618.684	3.84147	6.63492	0.0000
2006	112,768,011	10,680,240,634,696	94,709.843	3.84147	6.63492	0.0000
2007	193,359,438	16,774,685,610,399	86,753.901	3.84147	6.63492	0.0000
2008	214,478,669	20,827,870,254,190	97,109.285	3.84147	6.63492	0.0000
2009	224,057,729	17,317,943,964,875	77,292.330	3.84147	6.63492	0.0000
2010	225,841,685	18,426,873,915,560	81,591.996	3.84147	6.63492	0.0000
2011	227,345,475	11,464,952,807,321	50,429.650	3.84147	6.63492	0.0000

Source: Own research

Table 3 indicates that the intragroup variability of gross monthly wages (variability within two single files of men and women) clearly prevails over the intergroup variability (that between two single files of men and women). It agrees in favour of a very weak dependence of gross monthly wage upon gender, the values of ratio determination being very low (2.86–6.03 %) in Table 3. Some relevant sample characteristics of variance analysis were estimated from the interval frequency distribution.

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[2] Hypothesis of equality of expected values of $k \geq 2$ normal distributions is the null hypothesis for this parametric test (in our case $k = 2$ variants of variable "gender"). The null hypothesis therefore assumes independence of gross monthly wage on gender. An alternative hypothesis supposes that at least one of the expected values of $k \geq 2$ normal distributions is different, therefore tho gross monthly wage dependents on gender.

[3] Test criterion F is the ratio of average squares (intergroup variability/intragroup variability).

[4] The critical value defines the critical range, i.e., in this case, if the value of the test criterion F is greater than or equal to the critical value, we reject the tested hypothesis of independence of gross monthly wage on gender. Dependence of gross monthly wage on gender is proved on the significance level in this case. If the test criterion F is less than the critical value, we do not reject the null hypothesis of independence.

[5] It is the upper limit for the probablity of error of the first kind, i.e. the probability that we reject the null hypothesis, although the null hypothesis is true.

Conclusion

This paper deals with the development of wage distribution of men and women in the Czech Republic since 2003. It evaluates the impact of the economic recession on the development of these distributions. Very distinctive impact of the global economic crisis on the development of the distributions is provable. The growth of wage level of men and women in the Czech Republic has virtually stopped during the economic recession, wage level even fell in 2011 for both genders (for men in 2009, too). The level of gross monthly wage of men is markedly higher than the level of gross monthly wage of women throughout the period. Table 5 presents the percentage ratio of wage level of women in wage level of men. We can see from this table that middle gross monthly wage of women presents only around 80 % of middle gross monthly wage of men and mean gross monthly wage of women is even about 77 % of mean gross monthly wage of men throughout the period, with the exception of 2011, when the difference between the wage level of men and women decreased slightly.

Tab. 5: Percentage ratio (in %) of wage level of women in wage level of men

Characteristic	Year								
	2003	2004	2005	2006	2007	2008	2009	2010	2011
Median	81,31	80,86	81,13	81,66	80,19	79,29	81,88	81,33	84,49
Arith. mean	78,21	77,29	77,68	78,73	76,29	75,63	77,35	77,09	81,01

Source: Own research

Absolute variability of gross monthly wage grows in time over the whole period 2003-2011 for both gender, the relative wage variability rather oscillates with increasing tendencies. Concentration of wage distribution in terms of the Lorenz curve shows a slightly increasing trend over the period.

The wage distribution of women has markedly higher skewness and kurtosis than wage distribution of men throughout the period studied, i.e. wage of women tends to be concentrated to the left of wage of men (in lower wages). Wage of men shows greater variability than wage of women, too.

Dependence of gross monthly wage on gender is significant using 5 percent and even 1 percent significance level, which is probably due to the considerable sample sizes with which we work in the case of wage distribution, since the power of the test is very high in the case of very large sample sizes, the test uncovers all minimum deviations from independence. Tightness of dependence is very weak probably for this reason.

Acknowledgment

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