IS THERE ANY LINK BETWEEN THE WAGE LEVEL IN THE COMPANY AND THE SIZE OF THE COMPANY IN TERMS OF THE NUMBER OF ITS EMPLOYEES?

Diana Bílková

Abstract

This research is primarily focused on wage issues related to company size. The paper deals with the development of the wage level in the classification of companies by number of employees since the beginning of the world economic crisis. Because exploring the development of wage differentiation is not enough to focus solely on assessing the current situation and estimating future developments based on average and middle wages, it is useful to move from the level characteristics to the entire frequency distribution. Models of wage distributions based on three-parameter lognormal curves were constructed to capture wage developments since the beginning of the global economic crisis, broken down by the number of company employees. The beginning of these curves represents the minimum wage in the respective year. The remaining two parameters of these curves were estimated by the maximum likelihood method. Using these curves, the proportions of employees with a wage of no more than a certain threshold were calculated. The dependence of the wage level on the size of the company by the number of its employees has been tested. Using the exponential smoothing for the predictions not only the wage levels but also the whole wage distributions by 2019 were constructed. Research has shown that anyone who wants to be paid the best possible he would find a job place in a large foreign company.

Key words: Wage development by company size, Gini coefficient of diversification, models of wage distribution, three-parameter lognormal curves, maximum likelihood method

JEL Code: J31, E24, D31

Introduction

This paper deals with the question of whether and to what extent the size of the company affects the wage level in this company. The data used for this purpose comes from the official website of the Czech Statistical Office (CSO). In terms of company size, six categories of

companies are distinguished: companies with less than 10 employees, companies with a number of employees from 10 to 49, companies with a number of employees from 50 to 249, companies with a number of employees from 250 to 999, companies with a number of employees from 1,000 to 4,999 and companies with a staff of 5,000 or more. The data was in the form of an interval frequency distribution with unevenly wide intervals and with extreme open intervals, and it covers the period from 2009 to 2016. The researched period includes the period of the global economic crisis, the beginning of which is dated to the autumn of 2008, the consequences of its accession were mainly reflected in 2009 when the Czech economy recorded a decline of 4.8 percent. The data includes employees in the business and non-business sphere in the Czech Republic. The wage is paid to the employee for work done in the private (business) sphere, the salary in the budget (state, public, non-business) sector. In terms of data presented on the CSO website, both wages in the business sphere and salaries in the non-business sphere are included under the wage term. There is annual data and the gross (nominal) monthly wage in the Czech Republic is the main surveyed variable. The data was processed using the SAS and Statgraphics statistical packets and the Microsoft Excel spreadsheet.

Examination the wage level dependence on company size in terms of the number of employees is the main objective of this research. In examining the development of wage differentiation, it is not enough to focus only on assessing the current situation and estimating future developments on the basis of average wages, but it is useful to move from the characteristics of the level to the entire frequency distribution. Models of wage distribution demonstrating the development of these distributions in time by company size are constructed. The basis of these models is three-parameter lognormal curves, the beginning of which represents the minimum wage in the corresponding years, and the remaining two parameters are estimated by the maximum likelihood method. On the basis of the lognormal curves obtained, the shares of employees whose gross monthly wage reaches a maximum of 15,000, 20,000, 30,000, 40,000, 50,000, 60,000, 70,000, 80,000, 90,000, 100,000, 110,000 and 120,000 were calculated. Dependence of the wage level on company size is researched using one-way analysis of variance. The predictions not only of wage level, but also of the whole wage distribution until 2019 were constructed using exponential smoothing, the advantage of which is that the most recent observations have the highest weight. Appropriate exponential smoothing was selected using interpolation criteria. The statistical software automatically evaluates the most advantageous combinations of equalizing constants α and β.

Based on this research, it can be said that the level of wage increases with the company size and the employees of the largest foreign companies reach the highest wages in the Czech Republic.

1 Review to Literature

When searching for a new job, people would be also guided by the size of the company. Although small companies may have different advantages, for example, greater cohesiveness of co-workers or less bureaucratic management, but the problem is in the wage. The average wage may vary by more than CZK 15,000 in favor of large companies. For this reason, the question of the relationship between the amount of the wage and the size of the company was dealt with by a number of authors, we will mention only some of them. (Brian and Reilly, 1993) present estimates for the employeer plant size-wage gap for Britain. Using an ordered probit model, selectivity-corrected wage equations are estimated for three plant size categories. They detected that in comparison between plants with more than 500 workers and those with less than 100, a wage gap estimates 17 percent. (Reilly, 1995) examines the issue of the establishment size-wage effect. He analyzes a cross-section for the year 1979, with information on 607 individuals and the 60 private sector establishments where they work. (Brown and Medoff, 1989) consider six explanations for the positive relationship between employer size and wages: large employers, hire higher-quality workers, offer inferior working conditions, make more use of high wages to forestall unionization, have more ability to pay high wages, face smaller pools of applicants relative to vacancies, and are less able to monitor their workers. They find some support for the first of these, but there remains a significant wage premium for those working for large employers. (Kruse, 1992) explores two hypotheses for the employer size-wage effect using data from the 1980 Survey of Job Characteristics. He found that there is a strong establishment size effect in both medium and large companies and that employee-reported frequency of supervision has a negative relationship to pay but makes no difference in the effect. (Barron, Black and Loewenstein, 1987) examine the effects of employer size on hiring and training decisions when larger employers have greater monitoring costs, because an employer must choose a procedure for screening job applicants, a rate of hire, a training program for new employees, a criterion for the retention of new employees after observing their on-the-job performance, a compensation package, and a rate of capital investment so as to minimize production costs across time. A unique data set is employed to estimate the empirical relation among employer size and employer search, training, capital

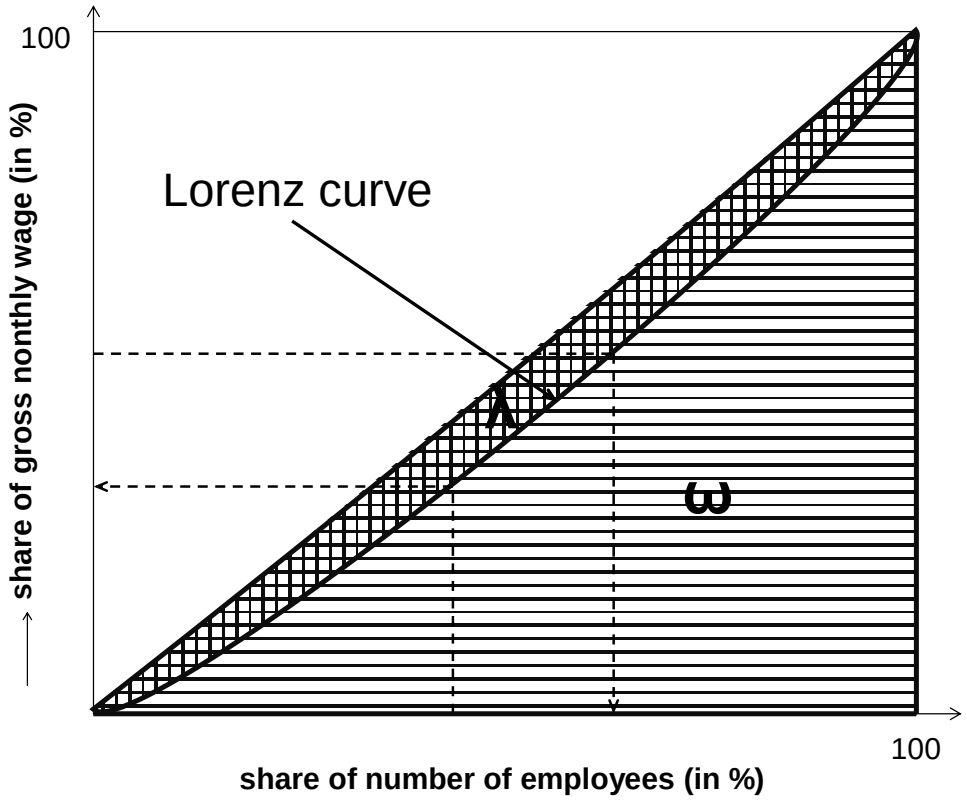
investment, and wages. (Hartog, Opstal, and Teulings, 1997) find suggest that there may be a systematic relationship between the magnitude of non-competitive wage differentials and the degree of centralisation in bargaining over employment contracts. (Velenchik, 1997) uses matched employer-employee data from a survey of 201 manufacturing firms and 1609 of their workers conducted in Zimbabwe in the summer of 1993. Their results indicate that there is a substantial premium associated with employment in larger firms, and that this premium cannot be explained by differences in worker quality and job characteristics, nor is it eliminated by controlling for unionization, minimum wages or other forms of government intervention. (Schmidt and Zimmermann, 1991) attemp to distinguish firm size from other wage determinants for a rich data source for West Germany and demonstrate the persistence of the size premium. (Dunne and Schmitz, 1995) find that plants that use the most advanced technology pay the highest wages and employ the greatest fraction of non-production workers (who are generarlly regarded as more skilled than production workers). The inclusion of standard wage regressions of variables that indicate the use of advanced technology reduces the size-wage premia by as much as 60 percent for some size categories. (Mellow, 1982) suggests that higher wages would be associated with larger plant size (to compensate workers for undezirable working conditions), larger firm size (a greater ability to pay), or both (to offset other factors in the employers cost function-particularly monitoring and turnover costs). He states that numerous empirical studies find that wages are in fact higher in large establishments or firms. (Allemand, Plasman and Rycx, 2007) examine the magnitude and determinants of the establishment-size wage premium in five European countries using a unique harmonised matched employer–employee data set (the 1995 European Structure of Earnings Survey). They find that a significant wage premium for workers employed in large establishments remains. (Brunelloa and Colussib, 1998) find out that empirical estimates are very sensitive to the assumptions made in the modelling of the allocation of workers to firm sizes; based upon preferred specification, the estimated unconditional firm-size average log earnings differential is not significantly different from zero. Hence, differences in the returns to similar characteristics for individuals working in small and large private firms, who are randomly drawn from the population, are small and not significantly different from zero; the raw average log earning differential is explained mainly by differences in observed individual characteristics and by selection effects. (Hollister, 2004) declares that large firms pay higher wages than small firms for workers with similar measured characteristics; however, an agreed-upon explanation for this firm size wage effect has not been reached.

This article deals with the issue of different wages between small and large enterprises in the Czech Republic, and it also examines, how the level of wage increases in enterprises, depending on the number of employees.

2 Theory and Methods

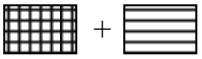
Simple descriptive characteristics are used to characterize the development of the empirical distribution of the gross monthly wage since 2009, see (Larson and Farber, 2015). The Gini coefficient was used to characterize the development of the diversification of wage distribution by company size in the given period.

Fig. 1: Lorenz curve



Source: (Chotikapanich, 2008)

The Gini coefficient is related to the famous Lorenz curve (see Figure 1), which is indicated in bold here (including its two extreme alternative shapes in cases of both zero and maximum possible diversification). The Lorenz curve is plotted in a rectangular chart with two scales from zero to a hundred percent. Cumulative relative frequencies (in percentage of

units) representing the research variable are on the horizontal coordinate axis. Employees represent the gross monthly wage variable in this case. Cumulative totals of the concentrated variable (in percentage) are located on the axis of ordinates, gross monthly wage being the concentrated variable in this case. Cumulative relative frequencies of units and their corresponding cumulative totals of the concentrated variable thus represent the coordinates of points on the Lorenz curve. The curve merges with the diagonal of the graph in the case of zero diversification, when the same proportion of the total sum of values of the research variable relates to each unit. This would be the case of all employees having the same gross monthly wage. The more the Lorenz curve bends, the higher is the diversification of the research variable, i.e. the concentration of a considerably large part of the total sum of variable values in a small number of statistical units. The highest diversification occurs when the total sum of values of the variable is concentrated into just a single unit. The Gini diversification coefficient is the ratio of the area content that defines the diagonal of the graph and the Lorenz curve, which indicats  (λ) in Figure 1, and the content of the total area of the triangle below the diagonal, which is indicated by an area of  ($\lambda + \omega$) in Figure 1. The value of the Gini coefficient after multiplying by one hundred thus ranges from zero to one hundred percent; i.e. from extreme leveling (zero diversification), where all employees have the same wage, to extreme diversification (maximum possible concentration), where the whole wage belongs to one employee.

The essence of three-parameter lognormal curves used in modeling wage distributions is explained in (Johnson, Kotz and Balakrishnan, 1994) or (Kleiber and Kotz, 2003) and the essence of the maximum likelihood method used for point parameter estimation of these lognormal curves is explained in (Johnson, Kotz and Balakrishnan, 1995).

The procedures and assumptions of one-way analysis of variance (known as ANOVA) used in the verification of dependence of the gross monthly wage on company size are explained in (Glantz, Slinker and Neilands, 2016). In practice, the tests used to verify assumptions of normality and the same variances are often omitted. From the point of view of normality, considering the large sample sizes concerning wage distributions (see Table 4), it is only judged whether utterly extreme values are not present in the groups of values of the explained variable *y* found at the individual levels of the factor *x*, and whether the values close to the conditional averages are more frequently present than the values more distant from these conditional averages. If this is fulfilled, we can assume that the conditional distributions of the explained variable *y* at the various levels of the factor *x* are not very different from the

normal distribution. Small deviations from the normal distribution do not usually affect the conclusions reached in the analysis of variance. In terms of the assumption of the same variances, we mostly proceed from an intuitive assessment of difference of the conditional variances. If this difference in not very large for small samples, and if it is very small for large samples, we can assume the assumption of the same variances to be fulfilled for all *k* normal distributions.

The fluctuation of the conditional averages of the explained variable (intergroup variability) is considered as a result of the dependence of the explained variable on the explanatory variable (factor *x*). The fluctuation of the explained variable's individual values within particular company size groups fixed by the level of the *x* factor (intragroup variability) is considered as a result of the dependence of the explained variable on other factors. The stronger the dependence of the explained variable on the factor *x*, the greater the proportion of intergroup variability and, therefore, the smaller the proportion of intragroup variability in the overall variability.

The essence of time series analysis and their simple characteristics are explained in (Shumway and Stoffer, 2017). The predictions of wage level (average and median-middle gross monthly wage) by company size until 2019 were created on the basis of the respective time series from the period 2009–2016. In the context of trend development, exponential smoothing was applied in time series analysis. Exponential smoothing is one of the adaptive approaches to modelling time series and it uses the weighted least square method, where scales exponentially decreasing towards the past. The advantage of exponential smoothing lies in the fact that the most recent observations have the highest weight. Appropriate exponential smoothing was chosen using interpolation criteria. The statistical software automatically evaluates the most advantageous combinations of equalizing constants α and β.

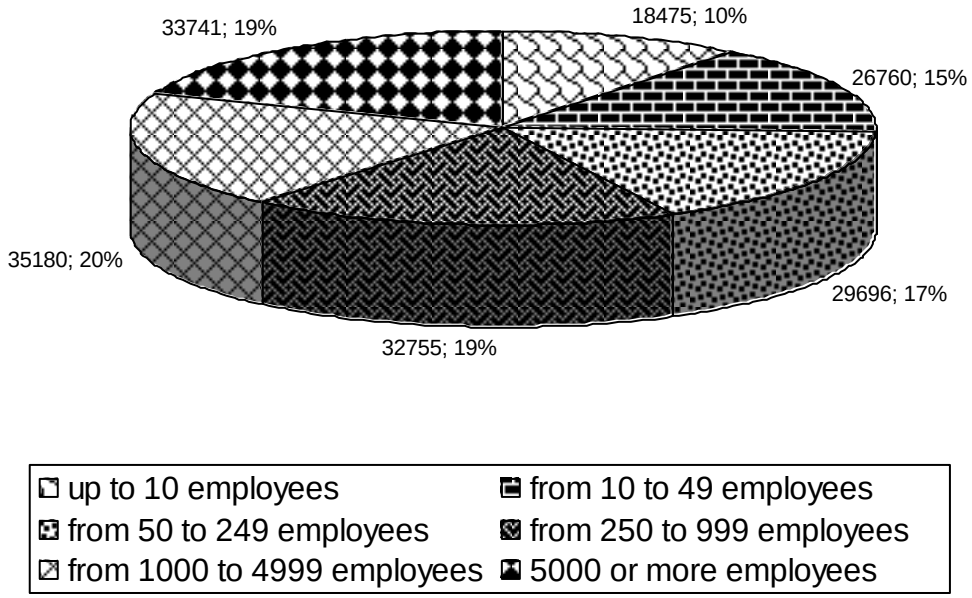
Sample residual autocorrelation functions and sample residual partial autocorrelation functions show that the non-systematic component does not show autocorrelation in all cases, and consequently the relevant exponential smoothing is satisfactory. The Durbin-Watson statistics are close to two in all cases, i.e. always in the interval (1.6, 2.4). Random faults can be therefore considered as independent. It can be approached to using Theil coefficient of mismatch to evaluate the model's quality. The annual time series are abbreviated of *m* observations (in this case, $m = 3$ observations), with forecasts for these $m = 3$ years being made using the corresponding exponential smoothing. Theil coefficient of mismatch gets the low zero boundary only in case of flawless forecasts. The more the Theil coefficient of

mismatch deviates from zero, the more the prediction differs from ideal flawless prognoses. The square root of the Theil mismatch coefficient can be interpreted as a relative prediction error. All calculated values of the Theil mismatch coefficient and relative prediction error indicate the high quality of the selected exponential smoothing models.

3 Results and Discussion

From the point of view of the size of companies, we basically distinguish six categories of companies. There are so called micro enterprises with 0 to 9 employees, very small enterprises with 10 to 49 employees, small enterprises with 50 to 249 employees, medium enterprises with 250 to 999 employees, large enterprises with 1,000 to 4,999 employees and very large enterprises with 5,000 or more employees. The size of company is one of the most important factors influencing the level of wages, especially for top managers, direct proportion applies. The larger the company is, the higher the wages are in this company.

Fig. 2: Average gross monthly wage (in CZK) according to the number of employees in the company in 2016

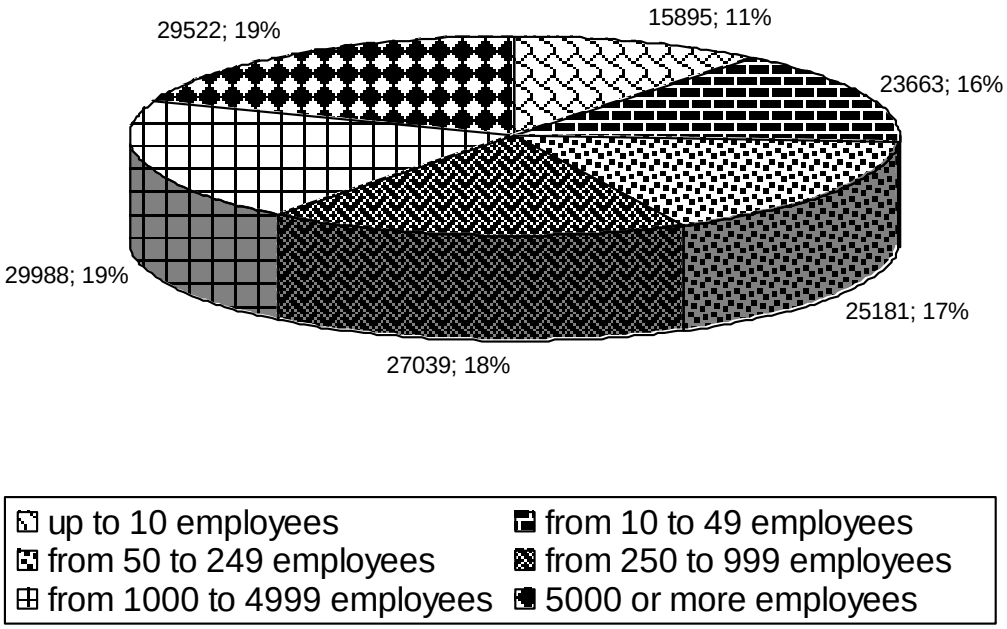


Source: Own research

Remuneration based on company access is pernamently increasly popular in the Czech Republic. The revenue of the Czech manager is about a third compared to a manager from Germany. In addition, companies experience a shortage of both, high and less qualified employees.

Figures 2 and 3 provide an information of average and middle (median) gross monthly wage according to company size in 2016. It is clear from Figure 2 that the difference in average wage of employees in very large enterprises and employees in micro enterprises reaches almost 15,500 CZK. This means that that average wage in micro enterprises represents only about 55 percent of average wage in very large enterprises. In the case of middle wage, the same difference is almost 14,000 CZK, e.g. the middle wage in micro enterprises represent only about 54 percent of middle wage in very large enterprises, see Figure 3.

Fig. 3: Middle gross monthly wage (in CZK) according to the number of employees in the company in 2016



Source: Own research

Figures 4 and 5 demonstrate the development of average and middle wage in the researched period. We can see a total slump of wage level for micro enterprises in 2011 and

2012. It also follows from the mentioned figures that the world economic crisis mainly affected enterprises up to 10 employees at the level of wages. We also see an appreciable downswing in average and median wages of very small enterprises in 2010 and 2011 and median wage even in very large enterprises in 2011. It follows from the mentioned research that the economic crisis affected at least the medium and larger enterprises.

Tab. 1: Average annual increase (+) or decrease (–) of the average of gross monthly wage (in %)

Period	Company size					
	up to 10 employees	10 to 49 employees	50 to 249 employees	250 to 999 employees	1,000 to 4,999 employees	5,000 or more employees
Ø 2009–2013	–4.19	–0.28	0.89	2.38	1.98	1.33
Ø 2013–2016	3.39	3.35	3.51	3.68	3.35	2.81
Ø 2009–2016	–1.01	1.26	2.01	2.94	2.57	1.96

Source: Own research

Tab. 2: Average annual increase (+) or decrease (–) of the median of gross monthly wage (in %)

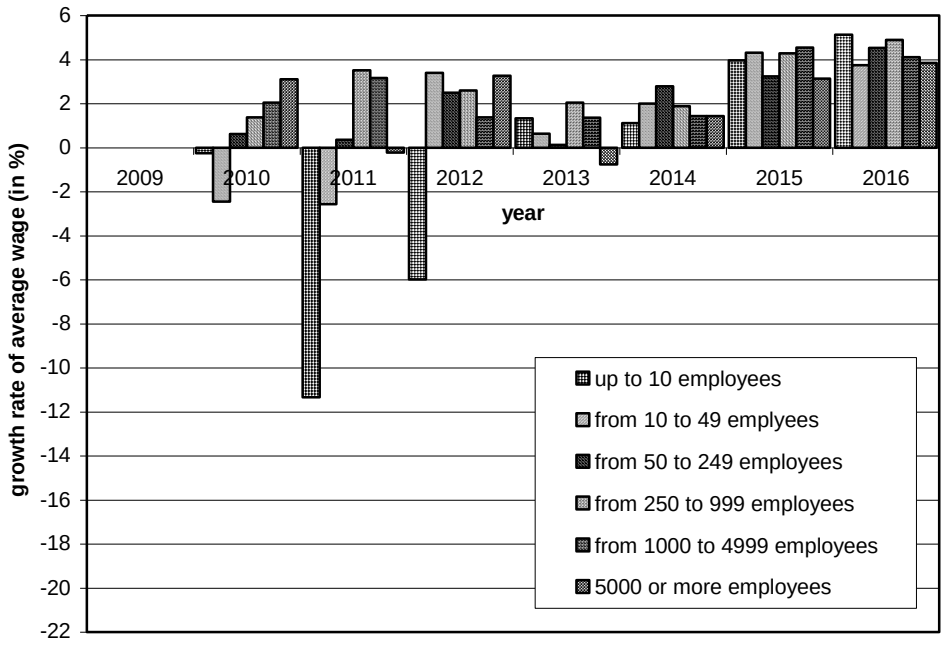
Period	Company size					
	up to 10 employees	10 to 49 employees	50 to 249 employees	250 to 999 employees	1,000 to 4,999 employees	5,000 or more employees
Ø 2009–2013	–6.34	0.98	1.44	2.59	2.60	0.32
Ø 2013–2016	2.38	3.28	3.97	3.98	3.20	3.56
Ø 2009–2016	–2.70	1.96	2.52	3.18	2.85	1.70

Source: Own research

The values in Tables 1 and 2, which represent the average annual growth rate of the average and middle monthly wages in the period of the global economic crisis (2009–2013), in the period past the global economic crisis (2013–2016) and during the whole period of research (2009–2016), are indicative of these conclusions, too. In the period of the global economic crisis for companies with up to 10 employees, the average gross monthly wage declined by an average of 4.19 percent per year, in the case of middle wage, this drop was even on average 6.34 percent per year. In the case of average wage, we still see a slight decrease on average of 0.28 percent a year for companies with 10 to 49 employees. Negative values of the average annual growth rate of average and middle gross monthly wages over the

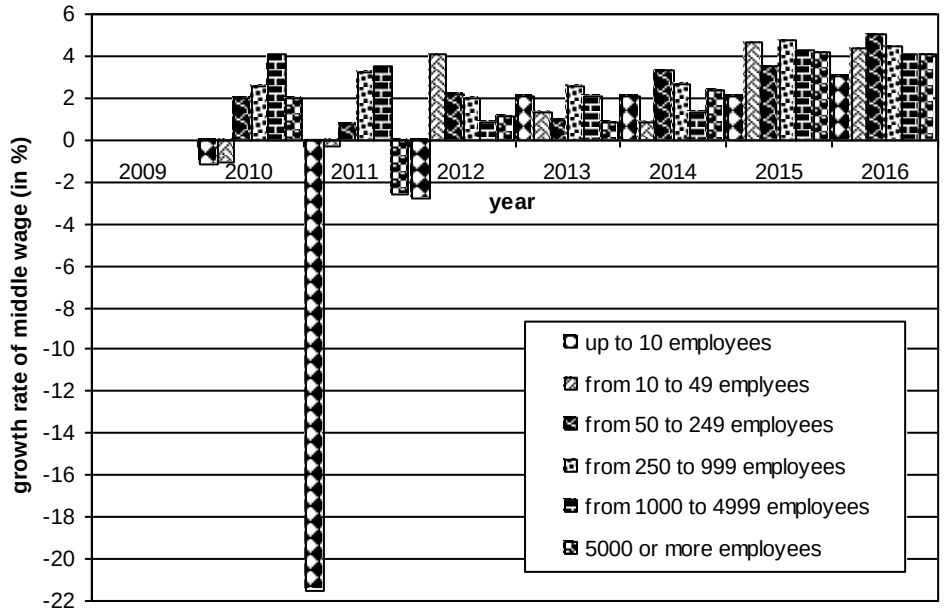
whole research period are due to the relatively high negative values of this indicator during the crisis.

Fig. 4: Growth rate (in %) of average gross monthly wage in the period 2009−2016



Source: Own research

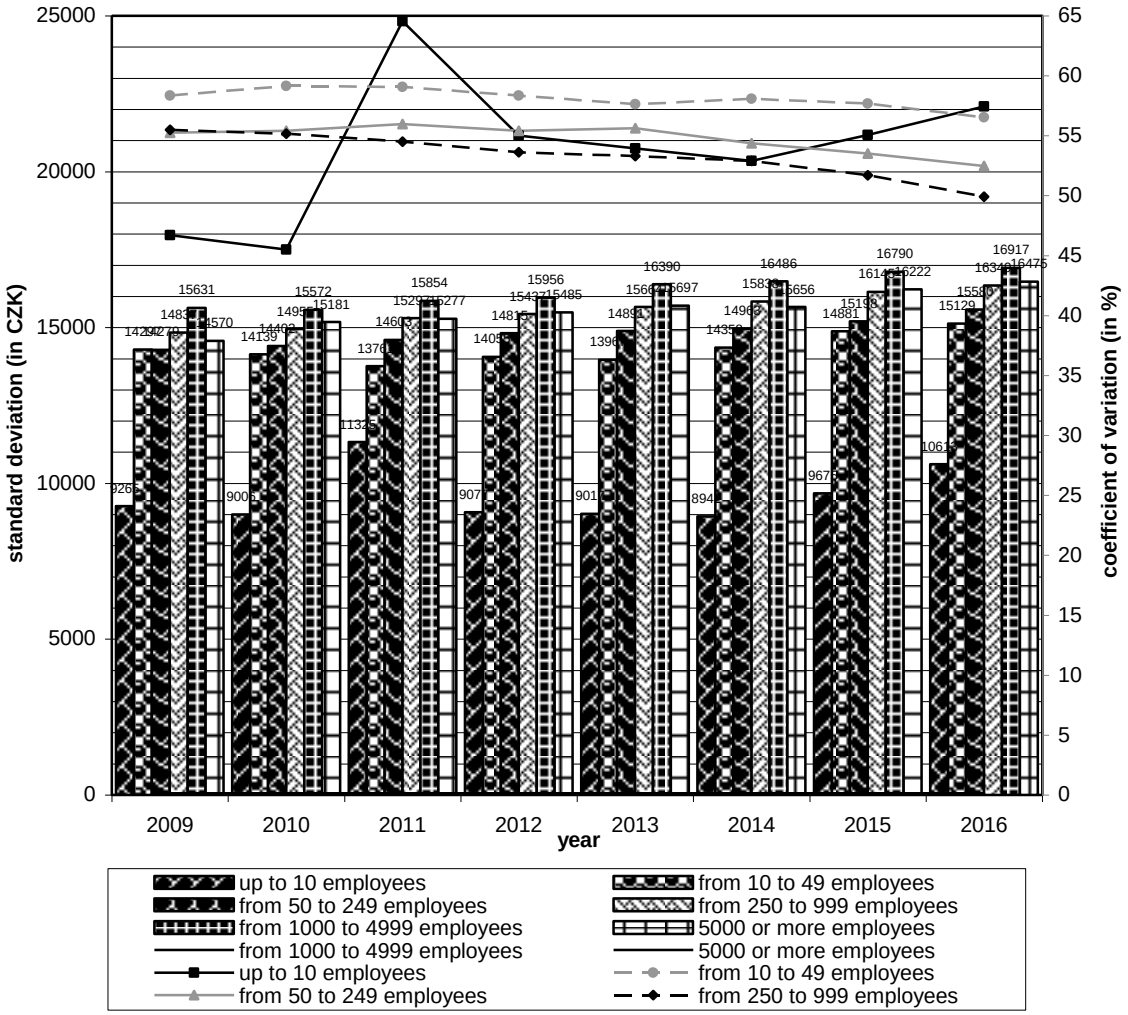
Fig. 5: Growth rate (in %) of middle gross monthly wage in the period 2009−2016



Source: Own research

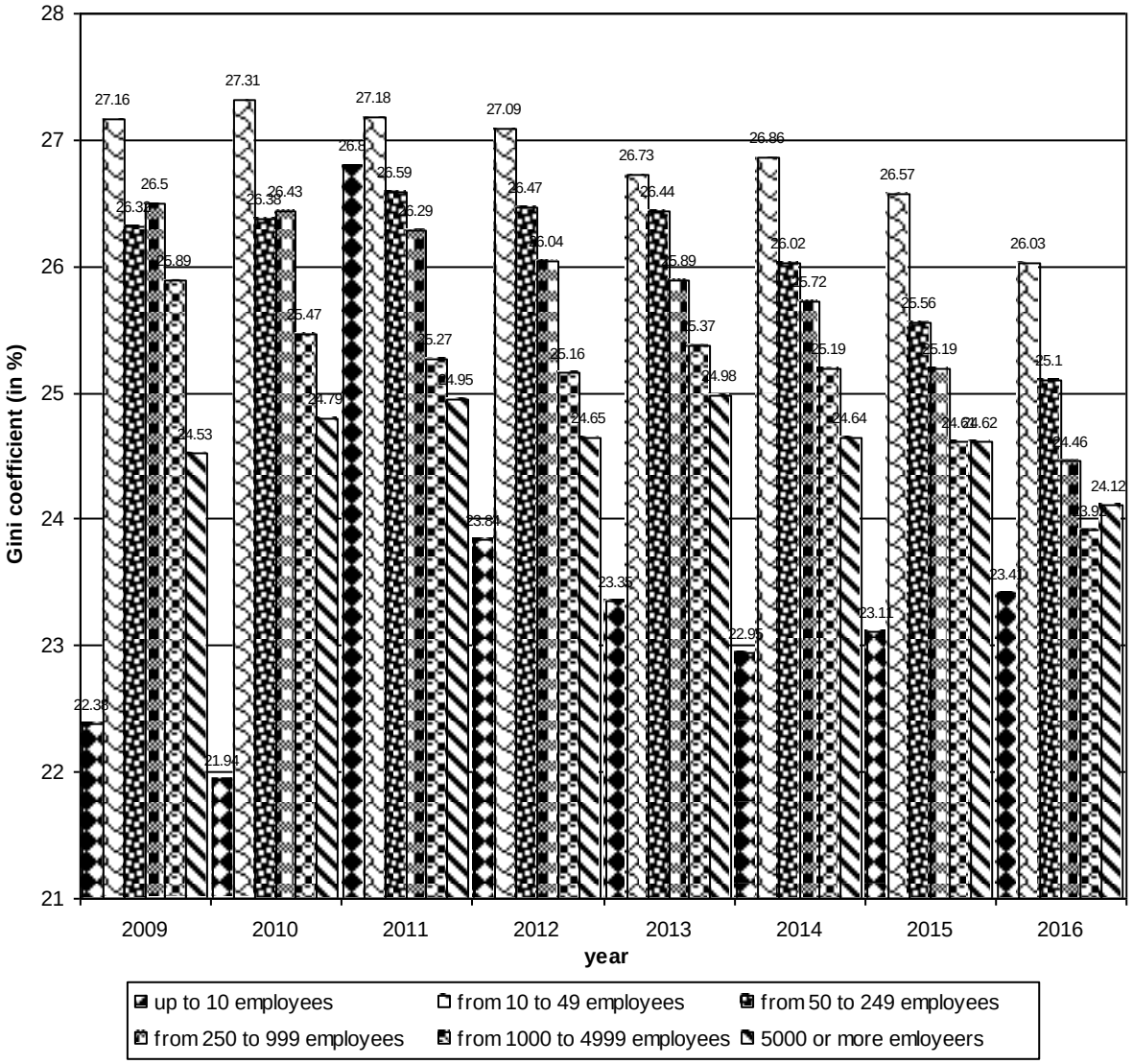
Figure 6 provides an information on the development of the absolute and relative variability of wage distributions within the research period. Absolute variability is here measured by the standard deviation (left-hand scale), which represents the quadratic average of all wage deviations of individual employees from their average wage. The standard deviation therefore indicates (in CZK) how wages of individual employees on average deviate from their average wage. The coefficient of variation represents the characteristic of the relative variability and it is defined as the ratio of the standard deviation of the wage to the average wage. After multiplying by a hundred, the variation coefficient therefore indicates how many percent the standard deviation of employees' wages participates on their average wage. Values of a variation coefficient greater than 50 percent indicate a substantial non-homogeneity in employee wages, see Figure 6.

Fig. 6: Development of characteristics of variability (standard deviation in CZK and coefficient of variation in %) in the period 2009−2016 according to the number of employees in the company



Source: Own research

Fig. 7: Gini coefficient of diversification



Source: Own research

Figure 7 represents the development of Gini coefficient according company size during the monitored period. The greater the value of Gini coefficient is closer zero percent, the wage distribution of employees comes to be absolutely egalitarian, i.e. the value of the Gini coefficient equal to zero percent theoretically becomes at extreme nivelisation. The values of Gini coefficient close to 100 percent point out to a state of absolute inequality in employee wages, i.e. the value of the Gini coefficient equal to 100 percent theoretically occurs in extreme diversification, where the whole wage belongs to one employee. However, the Gini coefficient values in the extremes of that interval are not achievable in the real world, because in the real world, individuals earning more on one side and individuals earning less on the other side will always exist.

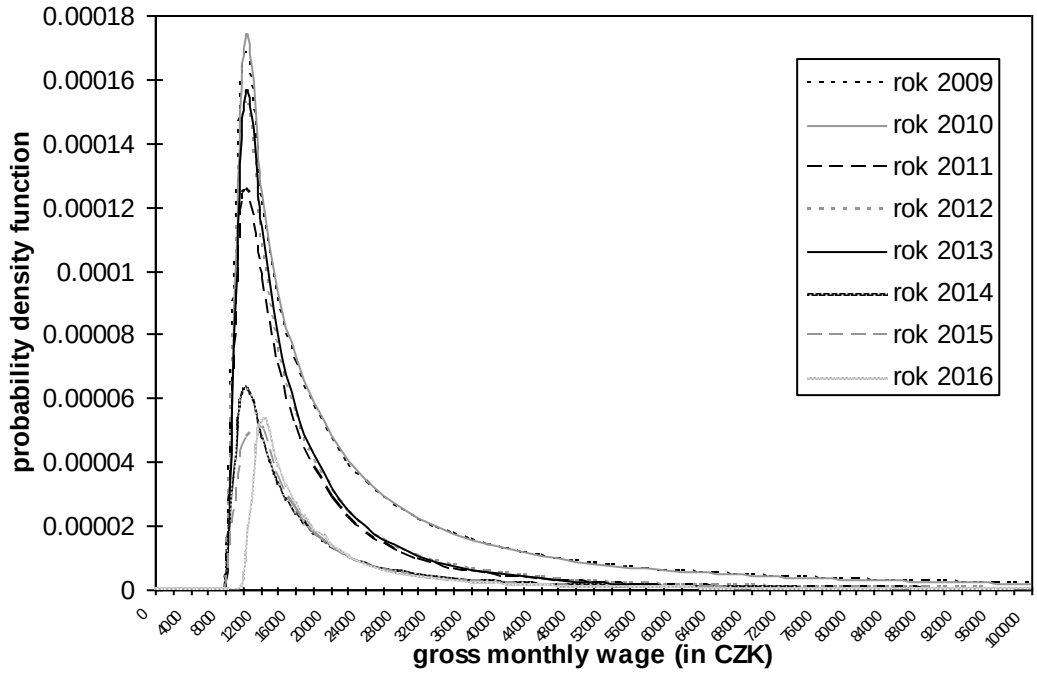
It is clear from Figure 7 that wages of companies with a staff of between 10 and 49 are the most diversified. On the contrary, we record the smallest wage diversification in the smallest firms by up to 10 employees over the entire monitored period (with the exception 2011, when the consequences of the economic crisis have fully affected wage distributions in the Czech Republic.

Figures 8–13 allow to assess the development of wage distributions over time by company size. We do not notice the considerable differences in the shape of wage distributions between companies of different sizes, except for micro enterprises up to 10 employees, where wages are characterized not only by low level and variability, but also higher positive skewness and kurtosis, which means that rather low wages dominate for the most employees. The wages of these employees are also the least diversified of all distinguished company sizes. For all distinguished company sizes, it is true that the wage level is rising after the global economic crisis, wage distributions loss to positive skewness and they have lower kurtosis, too.

Figures 14–17 enable to compare the wage shape distribution in the beginning of the world economic crisis (2009), in the year, when this crisis fully hit wage distributions in the Czech Republic (2011), the period completely after this crisis (2014) and in the year, which is the nearest to the present within the monitored period (2016), that all for the smallest and highest companies between these two groups of company sizes. In the period after the global economic crisis (Figures 16 and 17), it was necessary to change the scale on the vertical axis for reasons of legibility, because in this period the wage distributions of both the smallest and the largest companies are becoming much less kurtosis than during the crisis.

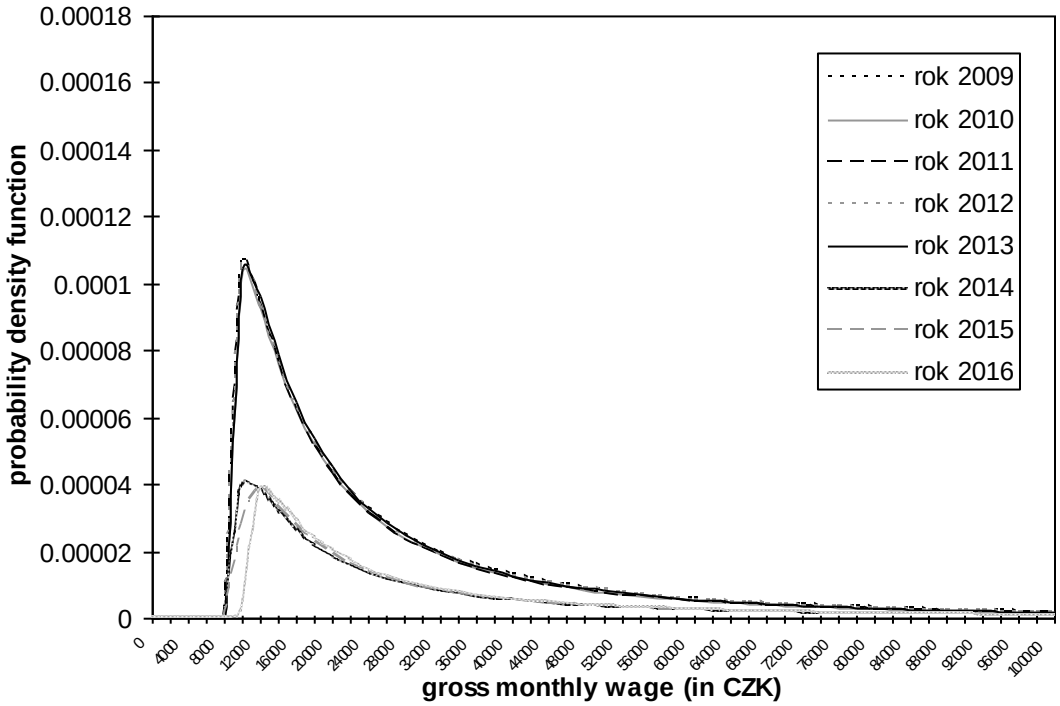
Using the lognormal curves obtained, the employee shares in Table 3 were calculated. This is for example evident from this table that estimated 47.72 percent of employees in micro enterprises (up to 10 employees) have a gross monthly wage of no more than 15,000 CZK, whereas this share is only 1 percent in large enterprises (from 1,000 to 4,999 employees) and 1.55 percent in very large enterprises (5,000 or more employees). At present the average gross monthly wage slightly exceeds 30,000 CZK. Table 3 shows that even estimated 91.40 percent of employees in micro enterprises (up to 10 employees) do not achieve average wage, whereas in large enterprises (from 1,000 to 4,999 employees), this share is estimated only at 47.10 percent and in very large enterprises (from 5,000 employees) at 51.56 percent.

Fig. 8: Development of theoretical model wage distribution in the period 2009−2016 for companies with employees up to 10



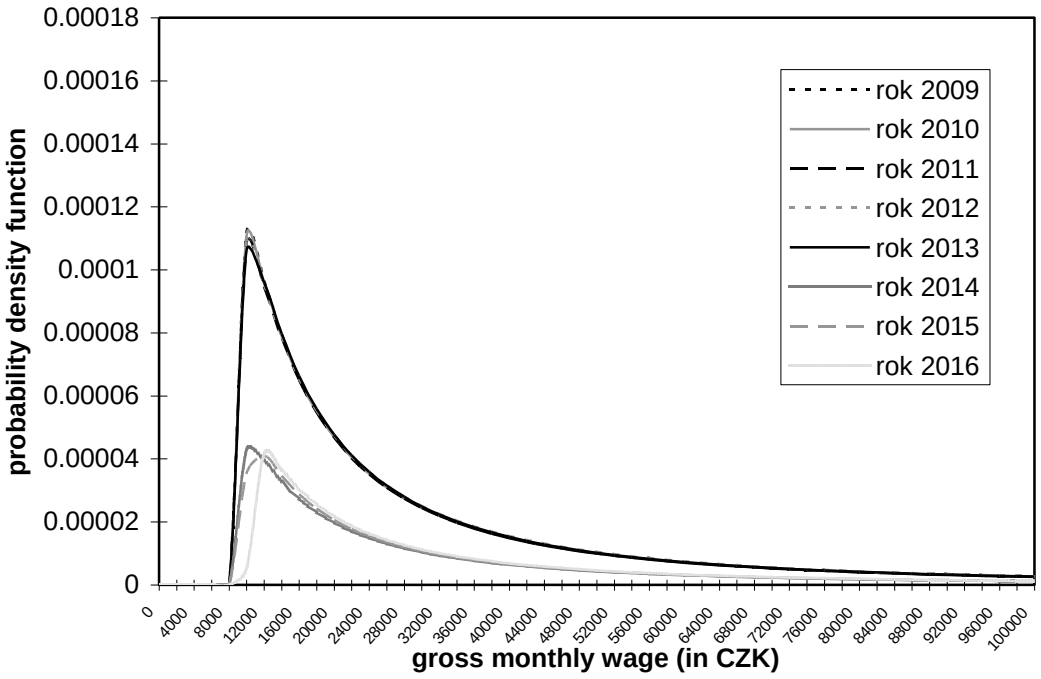
Source: Own research

Fig. 9: Development of theoretical model wage distribution in the period 2009−2016 for companies with employees from 10 to 49



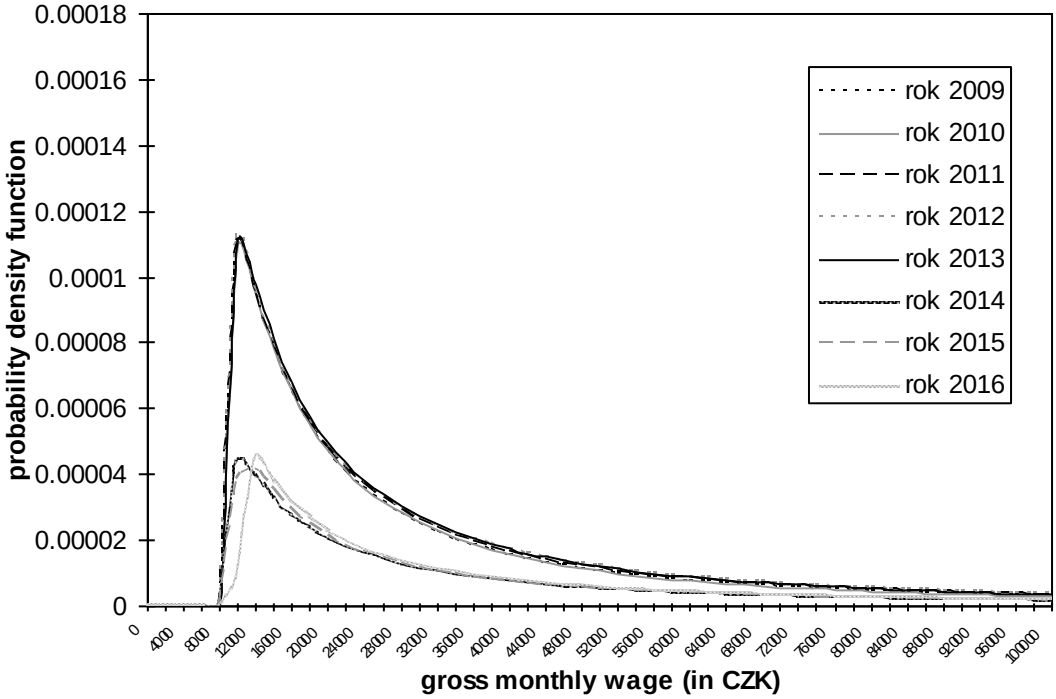
Source: Own research

Fig. 10: Development of theoretical model wage distribution in the period 2009−2016 for companies with employees from 50 to 249



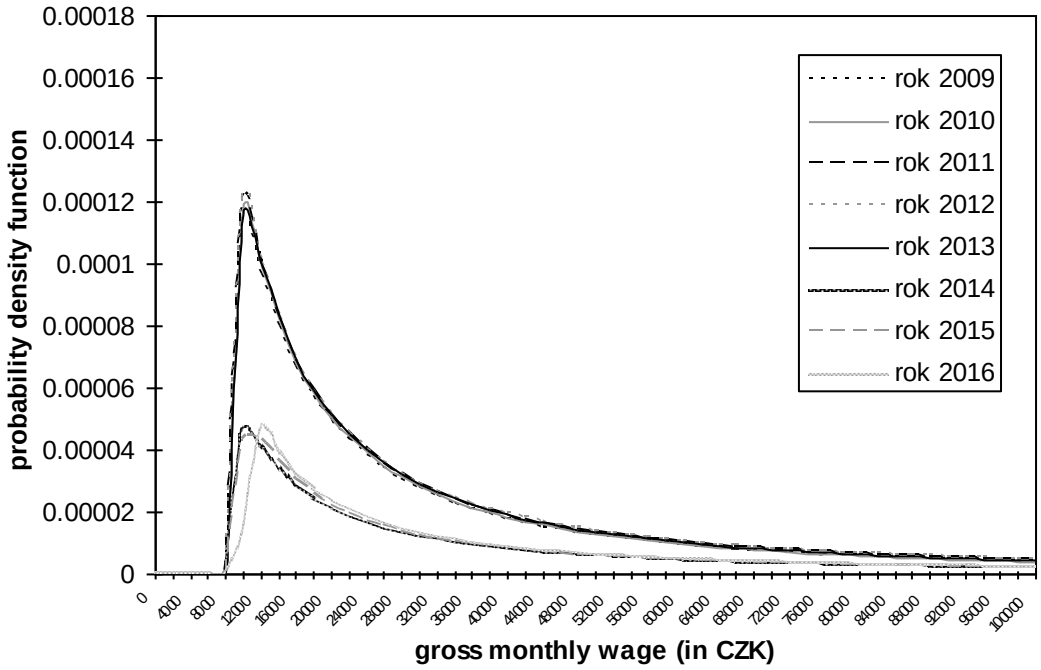
Source: Own research

Fig. 11: Development of theoretical model wage distribution in the period 2009−2016 for companies with employees from 250 to 999



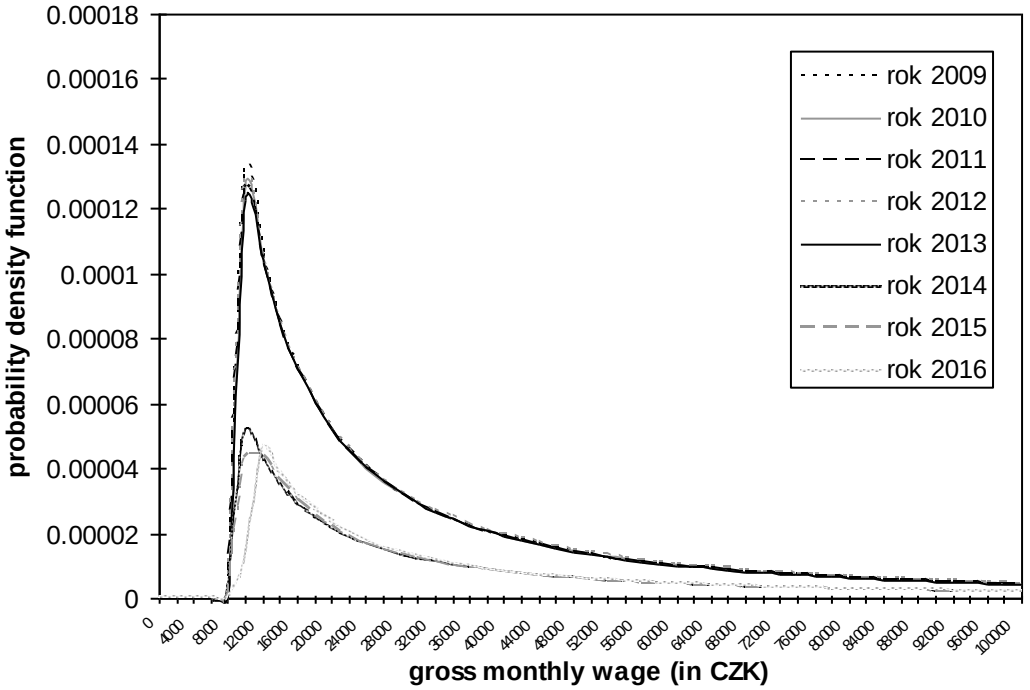
Source: Own research

Fig. 12: Development of theoretical model wage distribution in the period 2009−2016 for companies with employees from 1000 to 4999



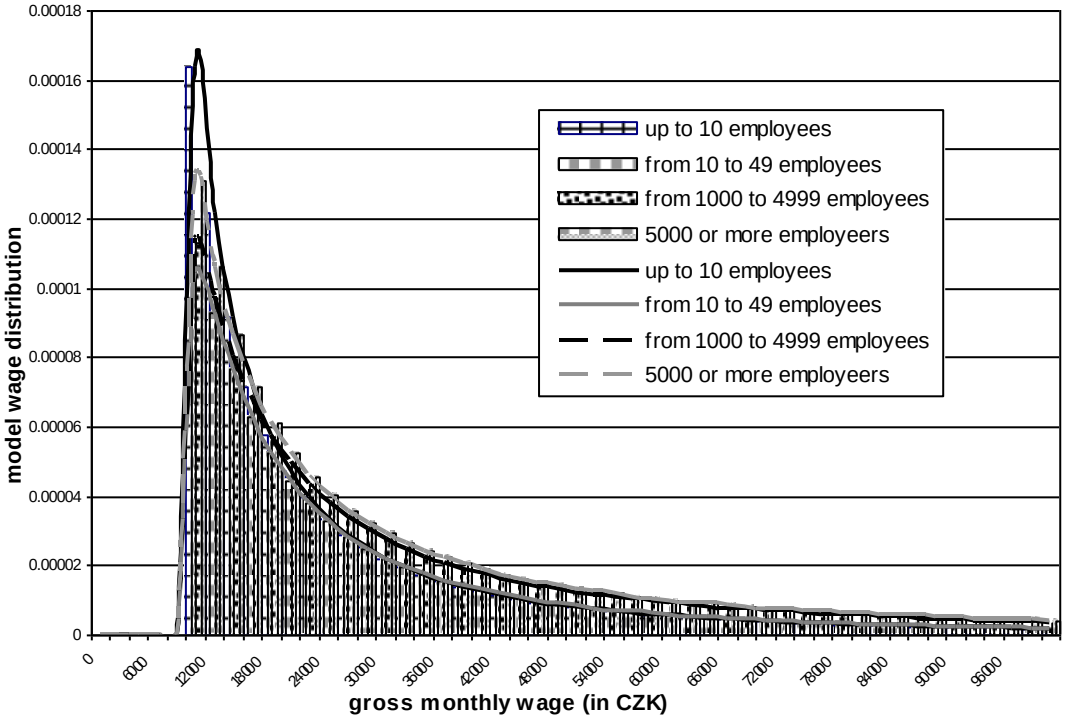
Source: Own research

Fig. 13: Development of theoretical model wage distribution in the period 2009−2016 for companies with employees 5000 or more



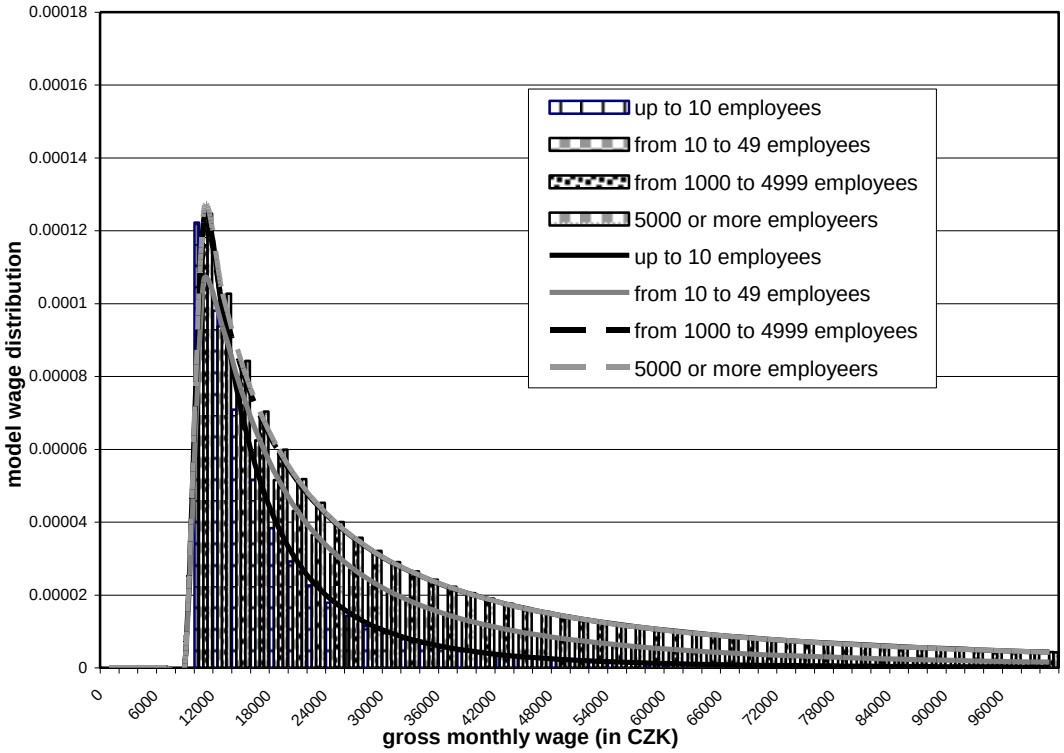
Source: Own research

Fig. 14: Model wage distribution of the smalles and largest companies in 2009



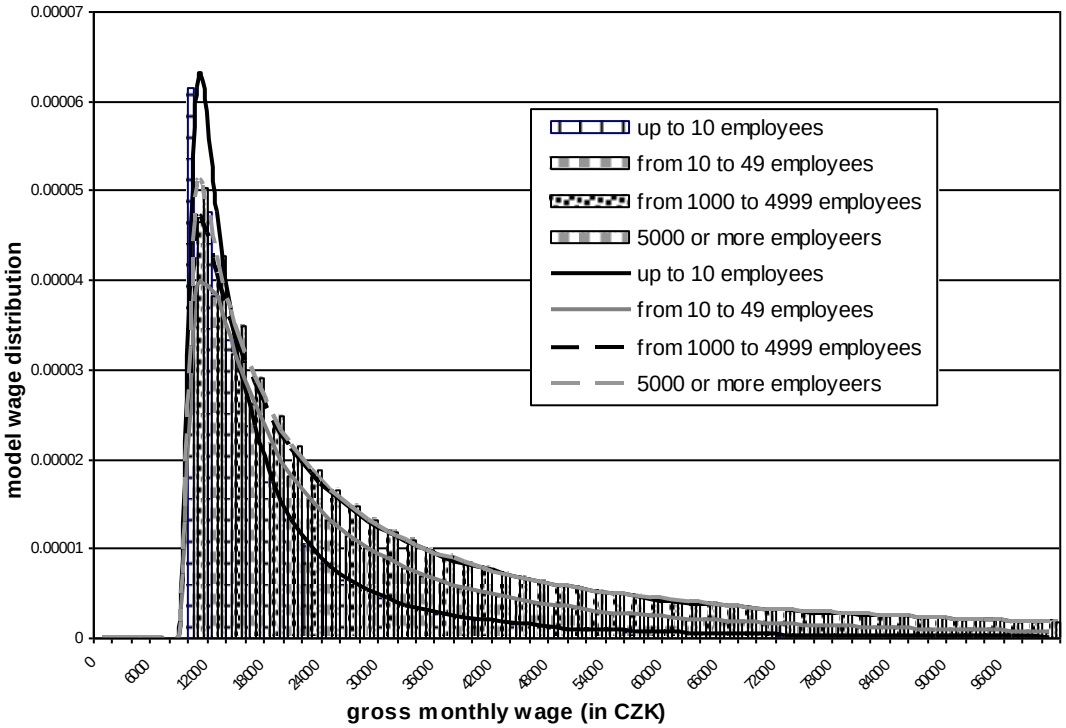
Source: Own research

Fig. 15: Model wage distribution of the smalles and largest companies in 2011



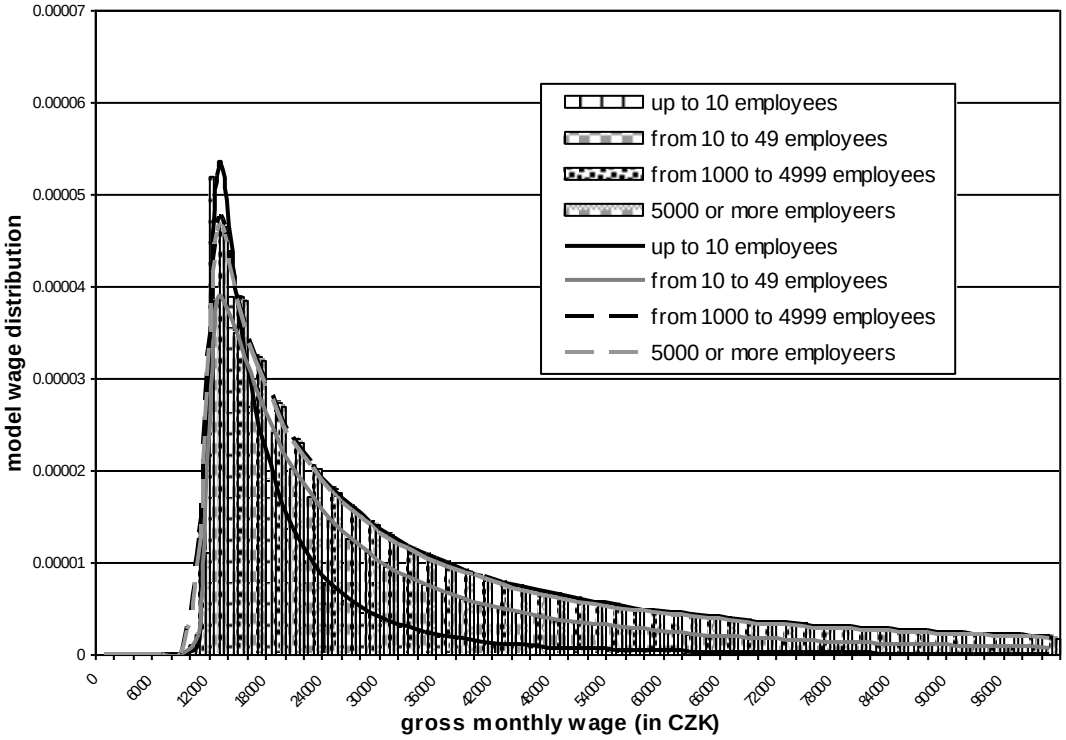
Source: Own research

Fig. 16: Model wage distribution of the smalles and largest companies in 2014



Source: Own research

Fig. 17: Model wage distribution of the smalles and largest companies in 2016



Source: Own research

It can be further noted that only about 1 percent of micro enterprise employees earn more than 60,000 CZK gross per month, while in large enterprises, nearly 8 percent of employees exceed this threshold, and in very large enterprises almost 7 percent of employees.

Overall, employees in micro enterprises up to 10 employees earn the least, employee wage levels are further increasing with company size, with employees in large enterprises with a staff of between 1,000 and 4,999 earning the most. Employees in very large enterprises of 5,000 employees or more earn a little less a month. Tables 4 and 5 serve to verify the dependence of the gross monthly wage on the company size. The values of the test criterion in Table 4 clearly exceed the critical values in Table 5. Thus, it can be stated that the gross monthly wage dependence on the company size is proven even at 1 percent significance level. This can be largely due to large sample sizes (see Table 4) with which we work in the case of wage distributions. With such large sample sizes, there is such a great test power that the test reveals all the negligible deviations from independence. However, the dependence of the gross monthly wage on the company size can be in any case regarded as proven even at a 1 percent significance level.

Tab. 3: Shares of employees with wage the highest equal to 15,000, 20,000, 30,000, 40,000, 50,000, 60,000, 70,000, 80,000, 90,000, 100,000, 110,000 and 120,000 CZK according to company size in 2016

Wage limit	Company size					
	up to 10 employees	10 to 49 emplyees	50 to 249 employees	250 to 999 employees	1,000 to 4,999 employees	5,000 or more employees
15,000	47.72	12.07	5.41	2.21	1.00	1.55
20,000	74.27	38.88	26.69	17.13	11.43	14.41
30,000	91.40	73.01	64.40	54.84	47.10	51.56
40,000	96.28	87.25	82.91	77.33	72.28	75.35
50,000	98.13	93.47	91.37	88.41	85.60	87.38
60,000	98.96	96.42	95.40	93.85	92.34	93.33
70,000	99.38	97.92	97.42	96.60	95.80	96.35
80,000	99.61	98.74	98.49	98.05	97.62	97.93
90,000	99.74	99.21	99.09	98.85	98.61	98.78
100,000	99.83	99.48	99.43	99.30	99.17	99.27
110,000	99.88	99.66	99.63	99.56	99.49	99.55
120,000	99.91	99.76	99.76	99.72	99.68	99.71

Source: Own research

Tab. 4: | Analysis of variance

Year	Total average	Total standard deviation	Average of conditioned variance (intragroup variability)	Variance of conditioned averages (intergroup variability)	Sample size	Test criterion F
2009	26,677	14,766	214,463,394	3,566,167	1,672,377	5,561.76
2010	26,881	14,912	217,084,872	5,282,892	1,683,891	8,195.70
2011	25,645	14,979	206,338,937	18,019,373	1,727,475	30,171.73
2012	26,033	15,058	203,556,169	23,173,968	3,502,598	79,751.06
2013	26,211	15,173	206,900,754	23,330,020	3,502,200	78,981.25
2014	26,802	15,351	211,968,465	23,698,584	3,513,000	78,552.37
2015	27,811	15,795	222,699,655	26,785,960	3,567,700	85,823.46
2016	29,060	16,165	232,772,541	28,536,954	3,627,900	88,953.12

Source: Own research

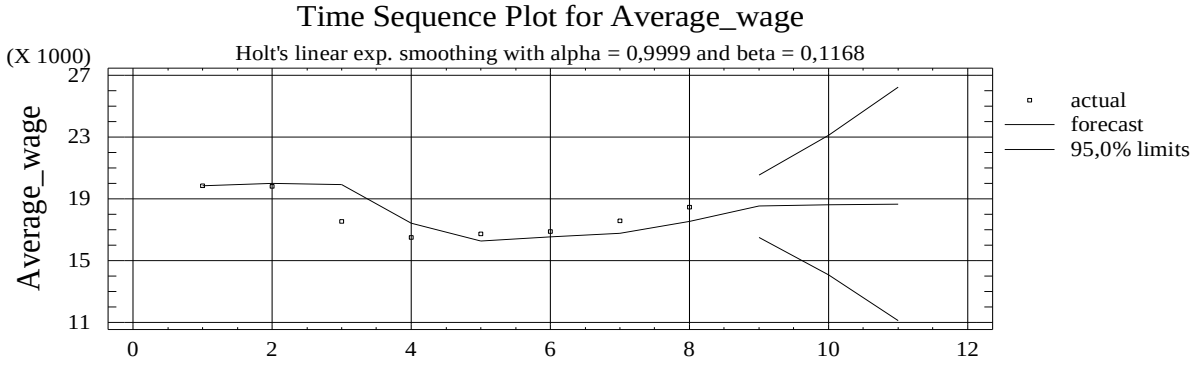
Tab. 5: Critical values for analysis of variance

Year	Significance level			Year	Significance level		
	$\alpha = 0.05$	$\alpha = 0.01$	$\alpha = 0.10$		$\alpha = 0.05$	$\alpha = 0.01$	$\alpha = 0.10$
2009	2.2141	3.0173	1.8473	2013	2.2141	3.0173	1.8473
2010	2.2141	3.0173	1.8473	2014	2.2141	3.0173	1.8473
2011	2.2141	3.0173	1.8473	2015	2.2141	3.0173	1.8473
2012	2.2141	3.0173	1.8473	2016	2.2141	3.0173	1.8473

Source: Own research

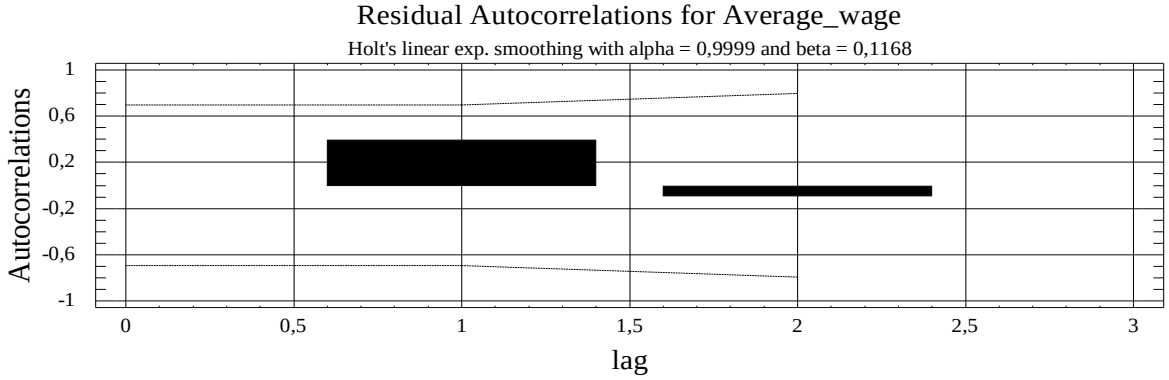
Figures 18 and 21 show Holt's linear exponential smoothing, which was chosen as the most appropriate using interpolation criteria in modeling the trend of the time series of the average and middle gross monthly wages of micro enterprises of up to 10 employees. Figures 19 and 22 show the respective sample residual autocorrelation functions, and Figures 20 and 23 further show the corresponding sample residual partial autocorrelation functions. Sample residual autocorrelation functions and sample residual partial autocorrelation functions show in all cases that the non-systematic component does not show autocorrelation and consequently exponential smoothing is satisfactory.

Fig. 18: Holt's linear exponential smoothing (α = 0.9999, β = 0.1168) for a time series of average gross monthly wage of companies up to 10 employees



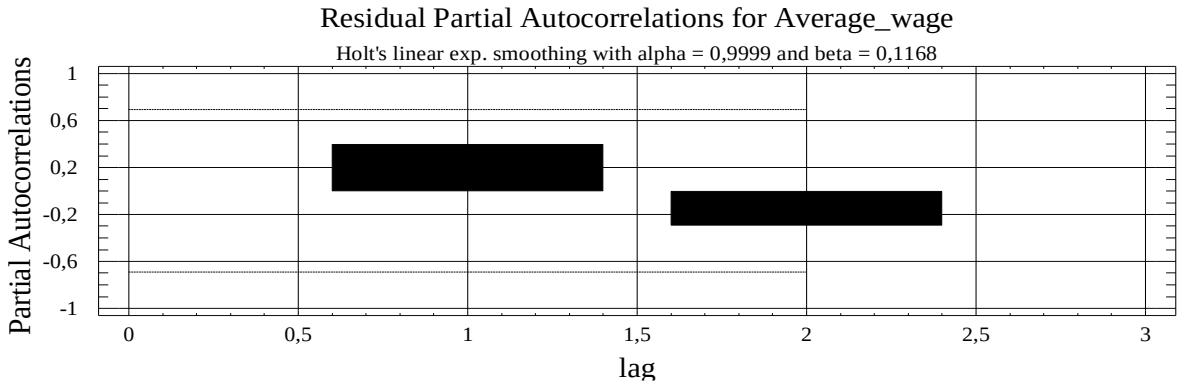
Source: Own research

Fig. 19: Sample residual autocorrelation function for a time series of average gross monthly wage of companies up to 10 employees



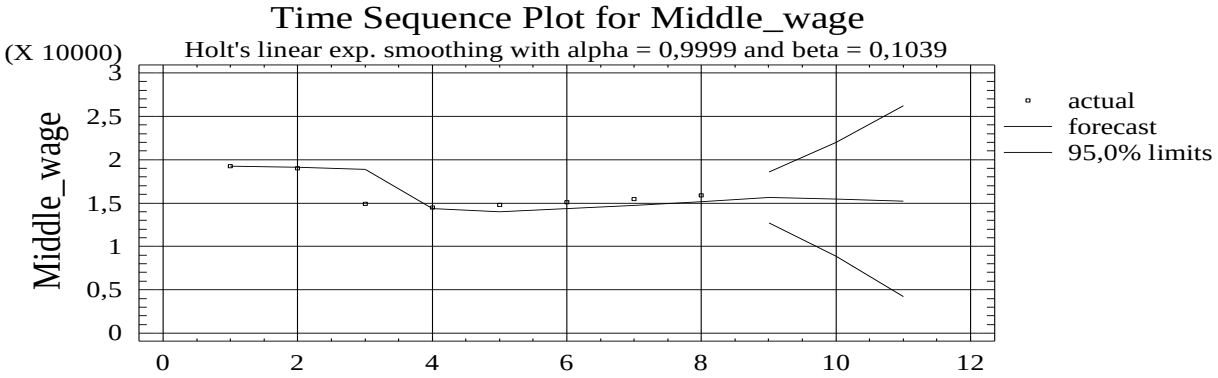
Source: Own research

Fig. 20: Sample residual partial autocorrelation function for a time series of average gross monthly wage of companies up to 10 employees



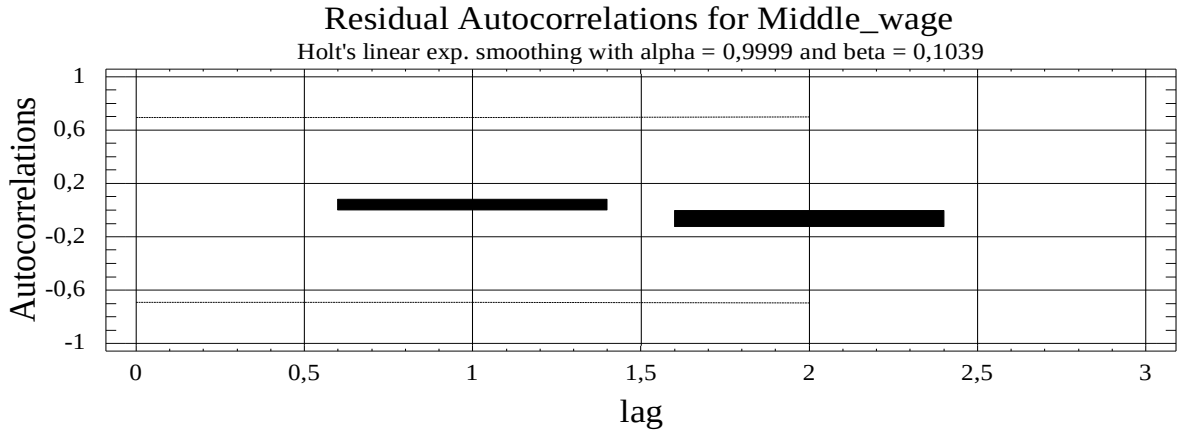
Source: Own research

Fig. 21: Holt's linear exponential smoothing (α = 0.9999, β = 0.1039) for a time series of middle gross monthly wage of companies up to 10 employees



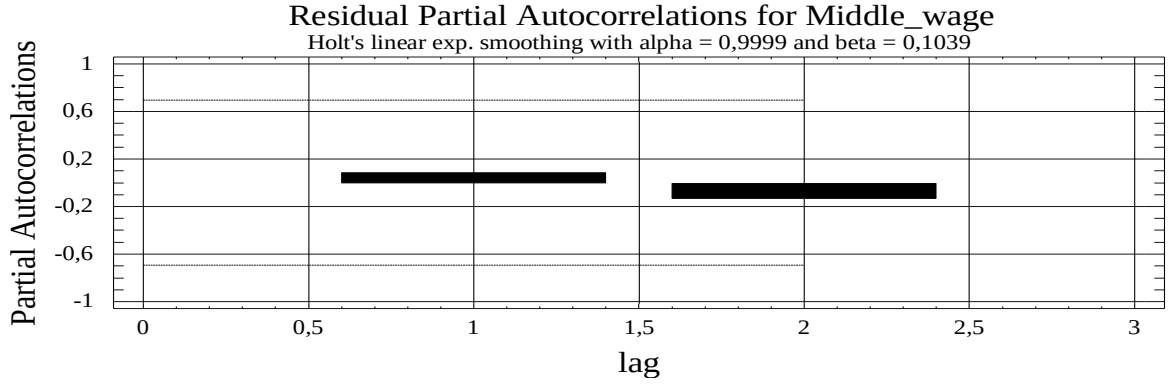
Source: Own research

Fig. 22: Sample residual autocorrelation function for a time series of middle gross monthly wage of companies up to 10 employees



Source: Own research

Fig. 23: Sample residual partial autocorrelation function for a time series of middle gross monthly wage of companies up to 10 employees



Source: Own research

Micro enterprises with up to 10 employees were chosen as an illustrative example of verification of the absence of autocorrelation of a non-systematic component of time series of average and middle gross monthly wages. A similar procedure was applied to the average and middle gross monthly wage series for other company size categories. The values of Durbin-Watson statistics are close to value two in all cases, i.e. there are always in the interval (1.6, 2.4). Random faults can be therefore considered as independent. There were approached to evaluate the model's quality using the Theil coefficient of mismatch and relative prediction error, too. All calculated values of the Theil coefficient of mismatch and relative prediction error indicate the high quality of the chosen exponential smoothing models.

Tab. 6: Predictions of average gross monthly wage by company size to 2019

Year	Company size					
	up to 10 employees	**10 to 49 emplyees**	**50 to 249 employees**	**250 to 999 employees**	**1,000 to 4,999 employees**	**5,000 or more employees**
2017	18,539	27,229	30,389	33,736	36,103	33,793
2018	18,597	27,699	31,082	34,717	37,025	34,402
2019	18,659	28,168	31,775	35,697	37,948	35,011

Source: Own research

Tab. 7: Predictions of middle gross monthly wage by company size to 2019

Year	Company size					
	up to 10 employees	**10 to 49 emplyees**	**50 to 249 employees**	**250 to 999 employees**	**1,000 to 4,999 employees**	**5,000 or more employees**
2017	15, 221	24,223	25,868	27,876	30,343	30,135
2018	15,445	24,783	26,554	28,712	31,075	30,748
2019	15,670	25,342	27,241	29,549	31,807	31,361

Source: Own research

Tables 6 and 7 show the prediction of average and middle gross monthly wages until 2019 according to company size based on the constructed exponential smoothing. It is evident from these tables that the smallest companies will continue to be the worst in terms of wage levels. According to projected prognosis, the average gross monthly wage for category of micro enterprises up to 10 employees would increase by an average of only 0.32 percent per year until 2019, while this percentage amount to 1.46 percent on average per year in the case of the middle gross monthly wage of the same category of company size.

Wage level would grow the fastest for medium and large companies. For the category of medium enterprises with 250 to 999 employees, the wage level would grow the fastest. This growth is projected on average by 2.87 percent per year in the case of average wage and an average of 2.96 percent per year in the case of the middle wage. For details, see Tables 6 and 7.

Tab. 8: Prediction of the whole wage distribution (in %) of companies from 50 to 249 employees and from 250 to 999 employees for the period 2017−2019

Middle of wage interval	Company size					
	50 to 249 employees			250 to 999 employees		
	2017	2018	2019	2017	2018	2019
2,500	0.00	0.00	0.00	0.00	0.00	0.00
7,500	0.00	0.00	0.00	0.00	0.00	0.00
12,500	3.51	1.76	0.26	0.96	0.25	0.01
17,500	20.88	20.30	18.93	12.69	10.05	6.84
22,500	22.21	23.01	24.46	20.14	19.90	19.50
27,500	16.53	16.96	17.59	18.22	18.92	19.80
32,500	11.31	11.51	11.70	13.86	14.59	15.44
37,500	7.62	7.73	7.78	9.91	10.48	11.09
42,500	5.16	5.24	5.26	6.94	7.36	7.77
47,500	3.54	3.61	3.63	4.85	5.14	5.42
52,500	2.46	2.53	2.56	3.40	3.61	3.81
57,500	1.74	1.81	1.84	2.40	2.56	2.69
62,500	1.25	1.31	1.35	1.71	1.83	1.93
67,500	0.91	0.96	1.00	1.23	1.32	1.40
72,500	0.67	0.72	0.75	0.90	0.96	1.02
77,500	0.50	0.54	0.58	0.66	0.71	0.76
82,500	0.37	0.41	0.44	0.49	0.53	0.56
87,500	0.28	0.32	0.35	0.37	0.40	0.43
92,500	0.22	0.25	0.27	0.28	0.30	0.32
97,500	0.17	0.19	0.22	0.21	0.23	0.25
102,500	0.13	0.15	0.17	0.16	0.18	0.19
107,500	0.10	0.12	0.14	0.13	0.14	0.15
112,500	0.08	0.10	0.11	0.10	0.11	0.12
117,500	0.36	0.47	0.61	0.39	0.43	0.50
Celkem	100.00	100.00	100.00	100.00	100.00	100.00

Source: Own research

The minimum wage in the given year was considered as the beginning of these lognormal curves (CZK 11,000 for year 2017 and CZK 12,200 for 2012). The minimum wage of CZK 13,700 was considered for the year 2019. The social democrats, together with trade unions demand this amount for minimum wages. Table 8 presents prediction of the whole wage distribution (in %) of companies from 50 to 249 employees and from 250 to 999 employees for the period 2017−2019. All wage intervals have a width of CZK 5,000 (in the first column of Table 8).

Conclusion

People would be also guided by the size of the copany in finding a suitable job. While small teams may have different strengths, for example, greater cohesiveness of co-workers or less bureaucratic management, but the problem is in the wage.

There are several reasons for differenct wages. The main reason is maybe the fact that large companies are able to negotiate better conditions with suppliers and customers thank to their strength. Small companies with few employees have not such a bargaining power, so they have mostly lower profits in proportion to other companies. This is not always true, of course, this depends a lot on the branch. A capable small IT company can reach and even exceed wages in a large company. Another reason for the difference is that trade unions mostly operate in large companies and they are able to negotiate a regular wage increase. In small companies, people themselves must usually say for wage increases, but this wage increase is usually much higher.

The smallest companies employing up to 10 employers dominate in the segment of small and medium companies in the Czech economy. There are very small companies (micro entreprises), which average size did not exceed 1.2 employed person in recent years. The wage level is lower in the smallest companies, the average wage does not reach even three quarters of the whole segment of the small and mmedium companies. The notion that the numbers of these companies are growing with the growth of economic activity is not entirely valid. Expecially, people who only employ themselves, stop their entrepreneurship in the boom, because large and partly likewise medium companies have absorbed workers as an amployee in the strong growth of the economy. The segment of small and medium companies plays an important role in the Czech economy. This participates about half of total employment over a long period, and about one third of outputs from the economy. The global economic crisis has deepened the negative proportion between the average wage in the

segment of small and medium companies and the average wage in the rest of the economy. In the boom, wage increases the most in companies employing rather more employees.

Small and medium entreprises are the overwhelming majority of companies doing business in the Czech Republic. This fact has a natural logic, because larger companies employing 250 or more persons are not significant in the size of the Czech economy. The influence of the economic cycle stage on the change in the number of small and medium companies in the Czech economy is very strong. Although it is generally believed that the economy in the growth phase also dynamises the activity in this business segment and the number of companies grows, according to the data mapping small and medium entreprises, this is exactly contrarily in the case of the Czech Republic. Increases and decreases in the number of small and medium entreprises by size classes are very diverse in the individual years of the research period in the Czech Republic. This is also evident in their dynamics that the smallest companies influence the overall development of this segment due to their weight on the total number.

The impact of the company size on wage level in this company is statistically significat even at 1 percent significance level. We can expect gradual wage growth in all size groups until 2019, but wages will grow faster in rather larger companies.

Acknowledgment

This paper was subsidized by the funds of institutional support of a long-term conceptual advancement of science and research number IP400040 at the Faculty of Informatics and Statistics, University of Economics, Prague, Czech Republic.

References

Allemand, T., Plasman, R., & Rycx, F. (2007). The Establishment-Size Wage Premium: Evidence from European Countries. *Empirica*, 34(5), pp. 427–451. DOI: https://doi.org/10.1007/s10663-007-9042-3.

Barron, J. M., Black, D. A., & Loewenstein, M. A. (1987). Employer Size: The Implications for Search, Training, Capital Investment, Starting Wages, and Wage Growth. *Journal of Labor Economics*, 5(1), 76–89. DOI: https://doi.org/10.1086/298138.

Brian, G. M., & Reilly, B. (1993). The Employer Size-Wage Gap: Evidence for Britain. *Economica*, 60(238), pp. 125–142. DOI: 10.2307/2554585.

Brown, C., & Medoff, J. (1989). The Employer Size-Wage Effect. *Journal of Political Economy*, 97(5), pp. 1027–1059. DOI: https://doi.org/10.1086/261642.

Brunelloa, G., & Colussib, A. (1998). The Employer Size-Wage Effect: Evidence from Italy. *Labour Economics*, 5(2), 217–230. DOI: https://doi.org/10.1016/S0927-5371(98)00006-2.

Chotikapanich, D. (2008). *Modeling Income Distributions and Lorenz Curves*. New York: Springer.

Dunne, T., & Schmitz, J. A. (1995). Wages, Employment Structure and Employer Size-Wage Premia: Their Relationship to Advanced-Technology Usage at US Manufacturing Establishment. *Economica*, 62(245), pp. 89–107. DOI: 10.2307/2554777.

Glantz, S., Slinker, B., & Neilands, T. (2016). *Primer of Applied Regression & Analysis of Variance*. New York: McGraw-Hill.

Hartog, J., Opstal, R. V., & Teulings, C. N. (1997). Inter-Industry Wage Differentials and Tenure Effects in the Netherlands and the U. S. *De Economist*, 145(1), pp. 91–99. DOI: https://doi.org/10.1023/A:1002977129905.

Hollister, M. N. (2004). Does Firm Size Matter Anymore? The New Economy and Firm Size Wage Effect. *Američan Sociological Review*, 69(5), pp. 659–679. DOI: https://doi.org /10.1177/000312240406900503.

Johnson, N. L., Kotz, S., & Balakrishnan, N. (1994). Continuous Univariate Distributions, Vol. 1. New York: Wiley-Interscience.

Johnson, N. L., Kotz, S., & Balakrishnan, N. (1995). Continuous Univariate Distributions, Vol. 2. New York: Wiley-Interscience.

Kleiber, C., & Kotz, S. (2003). Statistical Size Distributions in Economics and Actuarial Sciences. New York: Wiley-Interscience.

Kruse, D. (1992). Supervision, Working Conditions, and the Employer Size-Wage Effect. *Industrial Relations: A Journal of Economy and Society*, 31(2), pp. 229–249. DOI: https://doi.org/10.1111/j.1468-232X.1992.tb00307.x.

Larson, R., & Farber, B. (2015). *Elementary Statistics: Picturing the World*. Edinburgh: Pearson Education Limited.

Mellow, W. (1982). Employer Size and Wages. *The Review of Economics and Statistics*, 64(3), 495–501. DOI: 10.2307/1925949.

Reilly, K. T. (1995). Human Capital and Information: The Employer Size-Wage Effect. *The Journal of Human Resources*, 30(1), pp. 1–18. DOI: 10.2307/146188.

Schmidt, C. M., & Zimmermann, K. F. (1991). Work Characteristics, Firm Size and wages. *The Review of Economics and Statistics*, 73(4), pp. 705–710. DOI: 10.2307/2109410.

Shumway, R. H., & Stoffer, D. S. (2017). *Time Series Analysis and Its Applications: With R Examples*. New York: Springer.

Velenchik, A. D. (1997). Government Intervention, Efficiency Wages, and the Employer Size Wage Effect in Zimbabwe. *Journal of Development Economics*, 53(2), 305–338. DOI: https://doi.org/10.1016/S0304-3878(97)00019-9.

Contact

doc. Ing. Diana Bílková, Dr.
University of Economics, Prague
Faculty of Informatics and Statistics
Sq. W. Churchill 1938/4
130 67 Prague 3
Mail: bilkova@vse.cz