Wage Determinants and Economic Crisis 2008 – 2014: Evidence from the Czech Republic[1]

Jiří BALCAR – Jaromír GOTTVALD*

Abstract

The economic crisis, which began in 2008, is over. The Czech economy experienced strong GDP growth in 2015 and predictions for further years are also positive. Now, it is the time to assess impacts of the crisis period 2008 – 2014 on wage determination. Therefore, this paper focuses on a) identification of wage determinants, whose remuneration changed significantly during the examined period; b) assessment of sensitivity of wage returns to GDP development. The analysis was performed on individual data on ca 36% of all employees in the Czech Republic. The results showed significant increase of returns to white-collar occupation and a decrease of returns to education during the years 2008 – 2014. Also remuneration of many company characteristics was affected significantly. Further analysis revealed that returns to particular wage determinants are only rarely influenced by GDP development.

Keywords*: wage, human capital, education, business cycle, economic crisis, Czech Republic*

JEL Classification*:* J24, J31

Introduction

Research on wage determinants in the Czech Republic, as a transitional country, has been very intensive since the fall of the communist regime in 1989. Firstly, attention was nearly exclusively paid to the changes in returns to education and work experience in the first decade of transition from a planned to a market economy (e.g. Flanagan, 1998; Chase, 1998; Večerník, 2001; Gottvald, 2002;

* Jiří BALCAR – Jaromír GOTTVALD, VŠB – Technical University of Ostrava, Faculty of Economics, Department of National Economy, Sokolská třída 33, 701 21 Ostrava, Czech Republic; e-mail: jiri.balcar@vsb.cz; jaromir.gottvald@vsb.cz

Münich, Švejnar and Terrell, 2005; Flabbi, Paternostro and Tiongson, 2007; Gottvald, Vašková and Janíková, 2012). Later, great attention was paid also to the examination of gender wage gap (e.g. Jurajda, 2003; Mysíková, 2012; Filipová, Pytliková, Balcar and Gottvald, 2012; Filipová, Janíková and Gottvald, 2012; Eriksson, Pytliková and Warzynski, 2013; Hedija, 2015). However, there are many papers investigating the influence of other specific factors on wages, wage determinants or returns to education. For instance, there are papers exploring the effect of minimum wage increases on wages and employment (Eriksson and Pytliková, 2004), company performance and unemployment on wages (Basu, Estrin and Švejnar, 2004), the highly educated labour force supply on wage returns to university degree (Jurajda, 2005), immigration on wage structure (Dybczak and Galuščák, 2010), investigating foreign ownership wage premia (Eriksson and Pytliková, 2011), regional differences in returns to schooling (Jurajda, 2011), public-private pay gap (Picka, 2014) or returns to soft skills (Balcar, 2016).

The economic crisis in years 2008 – 2014 brought new questions, which this paper is going to answer:

1. Most of empirical studies suggest that returns to education and work experience changed significantly only in the first years of transition, whereas they were rather constant later (see review of literature). We use data from years 2008 – 2014 for an estimation of returns to education and work experience, which enable us to assess their current trend.

2. There were two downturns during years 2008 and 2014, and it took 6 years to return to pre-crisis levels of GDP. What effects did this crisis have on employment, hours worked and wages? Are there any statistically significant differences in remuneration of particular wage determinants before and after the economic crisis? We will focus on both supply and demand side factors. We expect minimal changes of supply side wage determinants, but significant changes among demand side wage determinants.

F i g u r e 1
GDP in years 2008 – 2014 (Czech Republic)
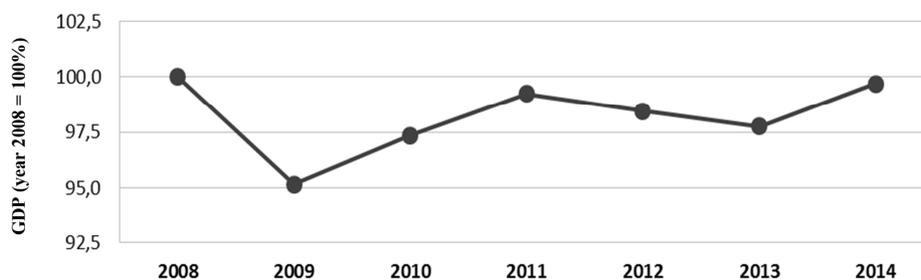
Source: Czech Statistical Office (2015).

3. Examination of effects of the crisis period on wage determinants' remuneration (see previous point) will be replenished with an analysis on its sensitivity on business cycle. It provides us with information on wage determinants whose market value is sensitive on GDP changes. Also in this case we expect that remuneration of demand side wage determinants will be more sensitive on the business cycle than supply side wage determinants. To the authors' knowledge, there is no evidence on this topic for CEE countries thus far.

The paper is organized as follows. The next section summarizes empirical evidence on remuneration of education, work experience and selected demand side wage determinants since year 1989, which provides a solid benchmark for our results. In section 2, the data and model will be described. Section 3 discusses results and answer research questions specified in the introduction. The last section will summarize findings of the paper.

1. Review of Literature

There are many empirical studies focused on wages, wage determinants and related topics in the Czech Republic (see the introduction). Their review can show us present trends of variables in which we are interested, and help us to evaluate the relevancy of our research questions. This overview will focus only on those determinants, which will be examined in this paper (see next section).

Returns to education and work experience have been investigated since late 1990s in order to assess the influence of the transition on wage determination. However, also thematically different papers often provide relevant information to this topic. Table 1 summarizes available estimates of returns to a year of schooling (usually approximated by the number of years required to obtain certain degree) and work experience (often approximated by age or number of years since finishing education). Although many papers provide information also on these returns by gender (not only for pooled sample) and particular educational levels, these results are not reported due to space limitation.

Several important facts stem from Table 1. Returns to education rose sharply at the beginning of the transition period, but remain relatively stable after years 1996 – 1997. However, Jurajda (2005) and Eriksson, Pytliková and Warzynski (2013), who examined wage returns to university education (related to high school education), concluded that some limited increase of returns to education could occurred up to years 2001 – 2002. Returns to work experience show similar time patter with an exemption that these returns were decreasing up to a year 1997. Subsequently, the returns were stable or slightly increasing. The table also shows that the development of returns to education and work experience is not well documented after the year 2002, which prevent us from making solid conclusions on their development in last decade.

T a b l e 1
Estimations of Returns to a Year of Schooling and Work Experience (in %)

Source	Data	Gr.	1984	–	1988	1989	–	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	–	2008	–	2011	2012
Returns to year of schooling																										
Flanagan, 1998	MC, SEEA	A				4.3							5.7														
Chase, 1998	SSS	M			3.0				4.9																		
Chase, 1998	SSS	F			4.8				5.2																		
Večerník, 2001	MC	A				4.4			6.9				8.8														
Münich, Švejnar and Terrell, 2005	Survey	M				2.7						5.8		5.7													
Münich, Švejnar and Terrell, 2005	Survey	F				3.9						7.1		6.8													
Flabbi, Paternostro and Tiongson, 2007	ISSP	A									2.8	3.3	4.8	6.6		3.0	6.3	3.4									
Gottvald, 2002	ISAE	A											4.0	5.1	2.8	4.8	4.5	4.2	5.1								
Dybczak and Galuščák, 2010	ISAE	M																			5.1						
Dybczak and Galuščák, 2010	ISAE	F																			5.4						
Myšíková, 2012	EU-SILC	M																				4.2					
Myšíková, 2012	EU-SILC	F																				4.4					
Balcar, 2016	Survey	A																						2.5			
Returns to a year of work experience (linear trend)																										
Flanagan, 1998	MC, SEEA	A				3.6							2.2														
Chase, 1998	SSS	M			3.6				1.6																		
Chase, 1998	SSS	F			3.0				1.1																		
Večerník, 2001	MC	A				2.8			3.2				3.2														
Münich, Švejnar and Terrell, 2005	Survey	F				1.4						0.9		1.1													
Gottvald, 2002	ISAE	A											3.9		0.4	0.9	2.8	2.5									
Eriksson, Pytliková and Warzynski, 2013	ISAE	A												3.5	4.2	3.9	3.6	3.6	3.8	3.9	3.9						
Dybczak and Galuščák, 2010	ISAE	M																			2.6						
Dybczak and Galuščák, 2010	ISAE	F																			3.3						
Gottvald, Vašková and Janíčková, 2012	ISAE	A																			0.2	3.0					
Myšíková, 2012	EU-SILC	M																				2.6				3.2	
Myšíková, 2012	EU-SILC	F																				1.2					
Balcar, 2016	Survey	A																								1.0	
Picka, 2014	ISAE	A																									1.0

Note: ***Group abbreviations***: A – All, M – Male, F – Female. ***Data source abbreviations***: MC – Microcensus, SEEA – Surveys of economic expectations and attitudes, SSS – Social stratification survey, ISSP – International Social Survey Program, ISAE – Information system on average earnings; *Source*: Authors.

Unfortunately, empirical literature pays significantly less attention to demand-side wage determinants. Authors of empirical studies always control relevant demand-side variables in their models, but they rarely report or comment on their estimated coefficients.

Find methodically consistent results describing trends in remuneration of demand-side wage determinants is even more difficult. Only five of the above reviewed studies provide at least some description of these trends (Eriksson, Pytliková and Warzynski, 2013; Gottvald, Vašková and Janíková, 2012; Dybczak and Galuščák, 2010; Gottvald, 2002; Chase, 1998).

Occupation is a demand-side factor with a similar relevancy for wage determination as education in the case of supply-side determinants. It is trivial to conclude that more demanding occupation (e.g. ISCO 1 occupations) brings higher remuneration than less demanding ones, but results of Dybczak and Galuščák (2010) and Gottvald, Vašková and Janíková (2012) suggests that the returns to different occupations change in time significantly and may embody significant gender differences. Estimations of Dybczak and Galuščák (2010) show that returns to particular occupational groups were slightly decreasing for men, but stable for women between years 2002 and 2006.

On the other hand, Gottvald, Vašková, Janíková (2012) reported increasing returns between years 2005 and 2011. It raises a number of questions on factors influencing these trends. Are they driven by the business cycle or changes in educational and gender structure in particular occupational groups? How do returns to education and work experience differ in these groups? Similar questions can be asked also in case of a development of remuneration of different NACE branches (see e.g. Chase, 1998; Dybczak and Galuščák, 2010; Gottvald, Vašková and Janíková, 2012).

Not only personal and job characteristics, but also firm characteristics matter. The size of a company is a significant predictor of wages – the bigger the company, the higher the wage (Gottvald, 2002; Gottvald, Vašková and Janíková, 2012; Mysíková, 2012; Eriksson, Pytliková and Warzynski, 2013; Picka, 2014), but also this relationship is changing. Eriksson, Pytliková and Warzynski (2013) report a decreasing role of firm size as wage determinant during the period 1998 – 2006. Ownership is the other firm characteristic with a significant effect on wages. Eriksson and Pytliková (2011) showed that foreign ownership, especially from Western Europe and USA, have a positive effects on wages. However, this quantitative effect of foreign ownership is very unstable over time (see Gottvald, 2002; Eriksson, Pytliková and Warzynski, 2013). It can be expected that both the firm size and the foreign ownership premia are closely related to firm productivity (see Eriksson and Pytliková, 2011) and business cycle.

2. Data

An Information System on Average Earnings (thereinafter ISAE) was employed as a dataset in this paper. ISAE is a linked employer-employee dataset covering all companies with more than 250 employees and a rotating random panel of companies with 10 – 249 employees in the Czech Republic. Data on wages and employment are harmonised with the Czech Statistical Office. It means that the sample is weighted according to representation of particular characteristics in population. (The weighted OLS is, in fact, used for wage models estimations.) This paper employs a subsample consisting exclusively of private sector companies in the period 2008 – 2014. It can be noted that the ISAE is a firm sample as it provides longitudinal data with respects to firms, but not individuals.

The data used in this paper provides information on characteristics of individual employees (gender, age, education and citizenship), performed jobs (occupation, role of supervisor and workload) and their employer (prevailing economic activity, company size approximated by the number of employees, ownership, firm's wage bargaining regime and NUTS 3 region).[2] These vectors of variables will be used for explanation of differences in gross hourly wage among employees. It can be emphasized that the gross hourly wage is reported directly by an employer (and thus is not counted from aggregate earnings and number of working hours), which increase accuracy of this dependent variable significantly. Estimated wage models will be used for an assessment whether wage returns to particular variables changed significantly during the period of economic downturn in 2008 – 2014. The ISAE dataset was replenished with data on GDP growth in each year of the period, which enables estimation of the impact of business cycle on wages and returns to particular wage determinants.

As the impact of real GDP changes on wages is investigated in this paper, it was necessary to adjust wage data for a) inflation, i.e. wages in constant prices of the year 2014 are used, b) impacts of minimal wage changes and c) changes of tax system in the examined period. These adjustments were based on methodology developed by private consultancy company TREXIMA, which has built the ISAE and ensures its performance on the basis of a contract with the Ministry of Labour and Social Affairs of the Czech Republic.

As the paper examines an impact of the business cycle on wage determination in the period 2008 – 2014, it would be ideal to have a stable panel of companies over the examined period. However, the sampling method of ISAE (coverage of all companies with more than 250 employees and use of a rotating random sample of companies with 10 – 249 employees) do not allow having stable panel of all

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[2] See online Appendix 1 at <http://homen.vsb.cz/~bal112/app-03-01.pdf for descriptive statistics>.

size companies over long period – the sample would shrink to large companies only. The restriction of the sample to large companies could bring some bias of results as it can be expected that reaction of large companies to the crisis period was different than those of small and medium size companies. Therefore, a non--stable panel of companies with 10 and more employees was used for an analysis performed in this paper. Authors believe that the sample consisting of ca 1.5 million employees, i.e. ca 36.1% of all employees in the Czech Republic, brings robust results. In order to support this assumption, all models in the paper will be estimated also for a panel of large companies, which is stable over the examined period (it covers ca 24.5% of all employees). The results for the stable sample of companies will be discussed and compared with results for a full sample.

3. Influence of Business Cycle on Wage Determination

Employees can be threatened by economic downturn in three ways: a) wage decrease, b) workload decrease and c) job loss. Table 2 presents percentage changes in these values in particular phases of the business cycle in years 2008 – 2014. It suggests that changes in employment and partly also in hours worked per employee represented the most significant channels for coping with changes in aggregate demand. It can be noted that wages did not react at all to the shock in 2009 – GDP declined by –4.84%, but wages continued to grow. The develop-ment of wages in the following years suggests that they started to play a role of coping mechanism.

T a b l e 2

Changes in Wages, Hours Worked and Employment (in %)

	2009 downturn	2010 – 2011 upturn	2012 – 2013 downturn	2014 upturn
GDP growth	–4.84	4.30	–1.50	1.99
Full sample				
Average hourly wages	3.02	1.05	–1.21	1.22
Median of hourly wages	1.45	1.20	–1.14	1.37
9th and 1st decile gross wage ratio	5.71	0.90	2.38	0.29
Average number of hours worked	–0.59	1.62	–0.47	–0.43
Number of employees	–	–	–	–
Large companies, stable panel				
Average hourly wages	2.95	1.06	–0.77	1.21
Median of hourly wages	2.27	1.15	–0.48	1.30
9th and 1st decile gross wage ratio	4.36	–0.32	3.23	0.00
Average number of hours worked	–0.28	1.87	–0.70	–0.29
Number of employees	–5.26	2.47	0.08	2.28

Note: Changes in employment in case of full sample are not presented as companies in the sample do not represent a stable panel. See online Appendix 2 at <http://homen.vsb.cz/~bal112/app-03-02.pdf> for absolute values in particular years of the period.

Source: Authors.

However, small and statistically insignificant correlation coefficients between mean/median wage and GDP growth, incl. lagged GDP growth, confirm the limited role of wages in coping with changes in aggregate demand in 2008 – 2014. Also the wage level in absolute terms changed negligibly during the period 2009 – 2014; it changed only by 1 – 2% depending on a sample and whether median or mean of hourly wage is discussed. On the other hand, it is noteworthy that wage inequality (measured by a ratio of 9th and 1st deciles) rose by 3.60% in the full sample (driven by a rise of differences between the 5th and 1st decile) and 2.89% in large companies (driven by a rise of differences between the 9th and 5th decile) in the period 2009 – 2014.

What is the impact of the economic crisis on wage determination? Did the remuneration of particular wage determinants changed significantly during the crisis? First, gross returns to human capital (i.e. without controlling for occupation or company variables) can be mentioned briefly. Table 3 shows that gross returns to a year of schooling increased slightly from 9.63% to 10.09% in the period 2008 – 2014 (the change of regression coefficient is statistically significant at the level 0.01), but the change occurred in the first period of the crisis (i.e. 2008 – 2011). The same development is also observable for work experience approximated by age, which increased from 4.10% to 4.51%. Some minor changes are observable also in remuneration from having different citizenship. The remuneration of employees from EU-15 or OECD countries decreased slightly in the examined period (the change is statistically insignificant from the perspective of the whole period), but remuneration of employees from other EU countries increased (mainly in the period 2011 – 2014). However, the gross returns to human capital can provide only a basic clue to the effects of the crisis on remuneration, but its rigorous assessment require an inclusion of many other variables on occupation and company, which have crucial effects on wages determination.

Therefore, Table 4 provides an estimation of wage models taking into account variables on individual, occupational and company characteristics (company characteristics are controlled by using company fixed effects). Controlling for these additional variables enables better capture of impacts of the crisis period on wage determinants as R^2 of models in Table 4 reach the value 73.8 – 76.5% (compare with R^2 of models in Table 3). The results show that only few statistically significant changes in remuneration of particular wage determinants occurred between 2008 and 2014. They are significant increase of returns to white collar occupations (ISCO 1 – 4) related to elementary occupations (ISCO 9), which was concentrated mainly in the period 2008 – 2011, and a decrease of returns to a year of schooling concentrated in later period 2011 – 2014. It may

be concluded that a slight increase of gross returns to education and work experience (see Table 3) was caused by an increase of returns from white collar occupations, which are occupied by more educated and experienced employees. Conclusions on an increase of wage returns to white-collar occupations are also consistent with a high increase of wage inequality in 2009 (see Table 2).[3]

It can be very interesting to also examine changes in remuneration of firm characteristics during the crisis period 2008 – 2014. Therefore, wage models presented in Table 4 were re-estimated with variables on number of employees, ownership, collective agreement arrangement and NACE instead of using company fixed effects. Estimated coefficients for mentioned variables can be found in Table 5 (regression coefficients of other variables are not presented because of space limitation). Results show that wage returns to company size did not change significantly during the examined period with an exception of companies with 1 000+ employees (however, the growth of coefficient was statistically significant at the level 0.1). Also remuneration in companies owned by foreign capital and cooperatives (related to private companies owned by home capital) increased significantly, mainly in the period 2011 – 2014. Firm-level of collective agreement was the only form of collective bargaining, which embodied statistical significant change of regression coefficients. Field of economic activity was a variable, which was the most often affected by economic development in years 2008-2014. Statistically significant increase or decrease of remuneration of a particular branch (related to manufacturing, NACE C) was identified in 11 of 18 cases. For details see Table 5.[4]

It can be concluded that statistically significant changes in returns to particular wage determinants were limited during the crisis period 2008 – 2014. It is possible to identify decrease of returns to education (employees' characteristics), increase of returns to white-collar occupations, ISCO1-4 (occupational characteristics) and several changes in remuneration of different types of ownership, field of economic activity and company size (company characteristics). It suggests that the crisis affected mainly remuneration of demand-side wage determinants.

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[3] These conclusions are valid also for a stable panel of large companies. It is possible to identify a statistically significant increase of returns to ISCO 1-3 occupations (relative to ISCO 9 occupations) in the period 2008 – 2011 and decrease of returns to education in the period 2011 – 2014. Further, it is possible to find also a statistically significant decrease of coefficients for leaders and citizens from EU-15 or OECD countries. Some changes occurred on behalf of part-time employees, but part-time workload is not statistically significant wage determinant. See online Appendix 3 at <http://homen.vsb.cz/~bal112/app-03-03.pdf> for more details.

[4] Wage returns to company characteristics were estimated also for the stable panel of large companies (see online Appendix 4 at <http://homen.vsb.cz/~bal112/app-03-04.pdf>). Results showed similar trends as those described for full sample, although the list of branches showing significant changes in remuneration in the period 2008-2014 differs slightly.

T a b l e 3
Gross Returns to Human Capital

VARIABLES	2008 ln gross hourly wage	2009 ln gross hourly wage	2010 ln gross hourly wage	2011 ln gross hourly wage	2012 ln gross hourly wage	2013 ln gross hourly wage	2014 ln gross hourly wage	Change 08/11	Change 11/14	Change 08/14
Female	-0.2252***	-0.2287***	-0.2284***	-0.2313***	-0.2308***	-0.2310***	-0.2391***	***		**
	(0.007)	(0.007)	(0.008)	(0.007)	(0.008)	(0.008)	(0.007)			
Years of schooling	0.0963***	0.1007***	0.0982***	0.1001***	0.1001***	0.1017***	0.1009***	***		***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)			
Age	0.0410***	0.0422***	0.0423***	0.0439***	0.0445***	0.0451***	0.0451***	**		***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)			
Age squared	-0.0005***	-0.0005***	-0.0005***	-0.0005***	-0.0005***	-0.0005***	-0.0005***			
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)			
Citizenship: Slovak	-0.0062	-0.0315*	-0.0381	-0.0642**	-0.0014	-0.0107	-0.0234	*	**	
	(0.023)	(0.019)	(0.030)	(0.027)	(0.017)	(0.019)	(0.020)			
Citizenship: EU-15 or OECD	0.4742***	0.4932***	0.4609***	0.5119***	0.4377***	0.4304***	0.4065***			
	(0.060)	(0.052)	(0.055)	(0.048)	(0.046)	(0.041)	(0.030)			
Citizenship: other EU members	-0.0975**	-0.0604	-0.0669**	-0.0786*	-0.0253	-0.0236	0.0116			
	(0.044)	(0.043)	(0.033)	(0.044)	(0.042)	(0.041)	(0.040)			
Citizenship: former states of USSR	-0.0612	-0.1281**	-0.1421*	-0.0839	-0.0689*	-0.0059	0.0025			
	(0.038)	(0.050)	(0.078)	(0.060)	(0.040)	(0.053)	(0.024)			
Citizenship: others	-0.1543***	-0.2261**	-0.1372***	-0.1344***	-0.0992***	-0.0783***	-0.0805***		*	**
	(0.051)	(0.104)	(0.045)	(0.036)	(0.035)	(0.027)	(0.025)			
NUTS 3 region	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Constant	3.1438***	3.0625***	3.0694***	3.0047***	2.9573***	2.8928***	2.9092***			
	(0.035)	(0.041)	(0.036)	(0.034)	(0.037)	(0.035)	(0.033)			
Observations	1,507,646	1,430,648	1,426,944	1,459,890	1,456,372	1,465,203	1,515,660			
R-squared	0.361	0.371	0.359	0.361	0.355	0.354	0.357			

*Note: **Omitted variables** are male, Czech citizenship; **Statistical significance**: *** p < 0.01, ** p < 0.05, * p < 0.1.*

Source: Authors.

Thus far, the main attention was paid to the identification of significant changes in wage returns occurring during the crisis period 2008 – 2014 through a comparison of returns at the beginning and the end of the examined period. To acquire better knowledge of these changes two sub-periods were examined separately (2008 – 2011 and 2011 – 2014) as they can be considered as two short business cycles.

Now, the development of wage returns during the period 2008 – 2014 will be examined through their dependence on GDP development. Table 6 presents estimations of various specifications of the wage model extended by variables for GDP growth and year. It shows that GDP growth is not a statistically significant wage predictor in equations consisting only of human capital variables (models presented in Table 3), without regard that the full sample or stable panel of large companies was used (see columns 1 and 4). If models with human capital, occupational and company variables are discussed (models presented in Tables 4 and 5), the result would be different. In these cases, coefficients on GDP growth are statistically significant, except model with company fixed effects estimated for the panel of large companies (see column 5). The statistical significance of lagged GDP growth variables was tested as well (not shown here), but it showed that upturns and downturns during the period 2008 – 2014 changed so quickly that lagged variables are not statistically significant or provide irrelevant values.

Sensitivity of particular wage determinants to business cycle was tested by re-estimation of equations 2 and 3 in Table 6 extended by interaction terms of all explanatory variables and GDP growth. Results show that wage returns are sensitive to business cycle only in few cases. The equation with company fixed effects identified tenure (regression coefficient 0.0001, significant at 0.01 level) and its square (coef. –0.0000, sig. at 0.05 level) as the only variables with statistically significant integration with GDP growth. Re-estimation of a model with company characteristics (column 3) expand the list of variables with wage returns sensitive to business cycle also by NACE L – real estate activities (coef. 0.0068, sig. at 0.1 level), higher and central level of collective agreement (coef. –0.0044, sig. at 0.05 level) and 4 NUTS 3 regions with positive coefficient signs.[5]

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[5] In the case of large companies, the model with fixed effects identified tenure squared as the only variable with statistically significant interaction variable. On the other hand, equation 6 extended by interaction terms identified quite a number of variables sensitive to GDP changes. They are years of schooling (coef. –0.0002, sig. at 0.05 level), tenure (coef. 0.0002, sig. at 0.01 level) and its square, occupational groups Managers, ISCO 1, Craft and related trades workers, ISCO 7, and Plant and machine operators, and assemblers, ISCO 8 (coef. with positive sign in all cases), and particular branches of economic activity, i.e. NACE D, E, L, R (coef. with negative sign) and NACE I, Q (coef. with positive sign).

T a b l e 4

Estimation of Wage Model with Company Fixed Effects

VARIABLES	2008 ln gross hourly wage	2009 ln gross hourly wage	2010 ln gross hourly wage	2011 ln gross hourly wage	2012 ln gross hourly wage	2013 ln gross hourly wage	2014 ln gross hourly wage	Change 08/11	Change 11/14	Change 08/14
Female	-0.1580***	-0.1607***	-0.1584***	-0.1628***	-0.1617***	-0.1598***	-0.1607***			
	(0.008)	(0.009)	(0.010)	(0.009)	(0.010)	(0.009)	(0.009)			
Years of schooling	0.0406***	0.0412***	0.0393***	0.0383***	0.0369***	0.0354***	0.0341***		***	***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)			
Age	0.0192***	0.0198***	0.0196***	0.0200***	0.0212***	0.0208***	0.0205***			
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)			
Age squared	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***			
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)			
Tenure	0.0141***	0.0124***	0.0132***	0.0136***	0.0130***	0.0128***	0.0132***			
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)			
Tenure squared	-0.0003***	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***			
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)			
Citizenship: Slovak	0.0193	0.0206	0.0198	0.0159	0.0153	0.0214	0.0165			
	(0.025)	(0.019)	(0.032)	(0.028)	(0.018)	(0.020)	(0.021)			
Citizenship: EU-15 or OECD	0.3073***	0.2872***	0.2571***	0.2859***	0.2363***	0.2555***	0.2058***			
	(0.054)	(0.056)	(0.043)	(0.050)	(0.048)	(0.038)	(0.042)			
Citizenship: other EU members	0.0034	0.0243	0.0301	0.0382	0.0391	0.0337	0.0395			
	(0.061)	(0.055)	(0.041)	(0.056)	(0.048)	(0.046)	(0.042)			
Citizenship: former states of USSR	-0.0149	-0.0306	-0.0004	0.0056	-0.0112	0.0088	0.0194			
	(0.043)	(0.057)	(0.076)	(0.068)	(0.043)	(0.052)	(0.026)			
Citizenship: others	0.0384	0.0284	0.0321	0.0423	0.0254	0.0345	0.0233			
	(0.076)	(0.129)	(0.047)	(0.048)	(0.041)	(0.031)	(0.029)			
ISCO 1	0.5840***	0.6002***	0.6386***	0.6691***	0.6910***	0.7062***	0.7054***	***		***
	(0.024)	(0.033)	(0.026)	(0.026)	(0.026)	(0.027)	(0.026)			
ISCO 2	0.3921***	0.4148***	0.4430***	0.4634***	0.4835***	0.4946***	0.4936***	***		***
	(0.026)	(0.034)	(0.027)	(0.026)	(0.025)	(0.024)	(0.025)			
ISCO 3	0.2761***	0.2943***	0.3204***	0.3285***	0.3395***	0.3495***	0.3432***	**		***
	(0.019)	(0.027)	(0.021)	(0.020)	(0.018)	(0.018)	(0.020)			
ISCO 4	0.1620***	0.1756***	0.2006***	0.2120***	0.2262***	0.2370***	0.2293***	*		**
	(0.021)	(0.028)	(0.022)	(0.022)	(0.020)	(0.022)	(0.025)			

ISCO 5	0.0618	0.0706	0.0833**	0.0821**	0.1010**	0.1004**	0.0959**
	(0.043)	(0.053)	(0.042)	(0.041)	(0.045)	(0.044)	(0.040)
ISCO 6	0.2047***	0.2053***	0.2014***	0.2045***	0.2071***	0.2052***	0.2124***
	(0.032)	(0.038)	(0.033)	(0.036)	(0.042)	(0.039)	(0.037)
ISCO 7	0.1573***	0.1565***	0.1738***	0.1693***	0.1815***	0.1852***	0.1800***
	(0.020)	(0.027)	(0.022)	(0.022)	(0.020)	(0.021)	(0.023)
ISCO 8	0.1229***	0.1198***	0.1347***	0.1290***	0.1357***	0.1353***	0.1197***
	(0.021)	(0.028)	(0.023)	(0.022)	(0.021)	(0.021)	(0.023)
Leader	0.2220***	0.2203***	0.2061***	0.2031***	0.2056***	0.1962***	0.2018***
	(0.013)	(0.015)	(0.014)	(0.013)	(0.016)	(0.018)	(0.012)
Work load: 0.75 – 0.99	-0.0309	-0.0279	-0.0305	-0.0255	-0.0248	-0.0230	-0.0178
	(0.025)	(0.080)	(0.073)	(0.035)	(0.042)	(0.041)	(0.038)
Work load: 0.50 – 0.74	-0.0527***	-0.0412*	-0.0353	-0.0281	-0.0194	-0.0200	-0.0178
	(0.017)	(0.023)	(0.023)	(0.021)	(0.024)	(0.026)	(0.026)
Work load: 0.25 – 0.49	-0.0333	-0.0473	-0.0514	-0.0203	-0.0222	-0.0023	-0.0187
	(0.048)	(0.033)	(0.034)	(0.036)	(0.037)	(0.041)	(0.038)
Work load: 0 – 0.24	-0.0426	-0.0406	-0.0609	-0.0296	-0.0083	0.0234	0.0051
	(0.069)	(0.079)	(0.074)	(0.068)	(0.084)	(0.065)	(0.059)
NUTS 3 region	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	3.9407***	3.9228***	3.9240***	3.9291***	3.8934***	3.8944***	3.9359***
	(0.061)	(0.068)	(0.062)	(0.058)	(0.059)	(0.060)	(0.056)
Observations	1,507,646	1,430,648	1,426,944	1,459,890	1,456,372	1,465,203	1,515,660
R-squared	0.738	0.750	0.749	0.753	0.759	0.761	0.765

Note: **Omitted variables** are male, Czech citizenship, ISCO 9, Full workload; **Statistical significance**: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: Authors.

T a b l e 5

Estimation of Wage Returns to Company Characteristics

VARIABLES	2008 ln gross hourly wage	2009 ln gross hourly wage	2010 ln gross hourly wage	2011 ln gross hourly wage	2012 ln gross hourly wage	2013 ln gross hourly wage	2014 ln gross hourly wage	Change 08/11	Change 11/14	Change 08/14
Number of employees: 50 – 249	0.0681*** (0.012)	0.0653*** (0.012)	0.0660*** (0.011)	0.0569*** (0.012)	0.0547*** (0.012)	0.0675*** (0.012)	0.0657*** (0.010)			
Number of employees: 250 – 999	0.0918*** (0.012)	0.0940*** (0.013)	0.1031*** (0.012)	0.1016*** (0.013)	0.0922*** (0.013)	0.1047*** (0.013)	0.1068*** (0.011)			*
Number of employees: 1 000+	0.1208*** (0.016)	0.1349*** (0.018)	0.1573*** (0.017)	0.1489*** (0.018)	0.1458*** (0.018)	0.1575*** (0.018)	0.1558*** (0.016)			**
Ownership: Foreign	0.1382*** (0.010)	0.1371*** (0.010)	0.1302*** (0.009)	0.1456*** (0.010)	0.1603*** (0.010)	0.1622*** (0.010)	0.1668*** (0.009)		**	**
Ownership: State	0.0440** (0.018)	0.0501** (0.021)	0.0219 (0.020)	0.0491*** (0.018)	0.0497*** (0.018)	0.0447** (0.019)	0.0419** (0.019)			
Ownership: Cooperative	0.1659*** (0.035)	0.1841*** (0.034)	0.1479*** (0.044)	0.1880*** (0.047)	0.2492*** (0.038)	0.2493*** (0.036)	0.2640*** (0.034)		*	**
Collective agreement: Firm level	-0.0230** (0.010)	-0.0090 (0.010)	-0.0148 (0.010)	0.0029 (0.010)	0.0076 (0.011)	0.0068 (0.010)	0.0079 (0.010)	**		***
Collective agreement: Higher and central level	-0.0469*** (0.018)	-0.0011 (0.015)	-0.0710*** (0.016)	-0.0122 (0.015)	-0.0259* (0.016)	-0.0332** (0.017)	-0.0331** (0.016)			
Collective agreement: Not available	-0.0280 (0.026)	-0.0181 (0.023)	0.0173 (0.019)	0.0078 (0.016)	-0.0259 (0.028)	-0.0447* (0.026)	-0.1263*** (0.052)		**	*
NACE A	-0.1397*** (0.019)	-0.1423*** (0.016)	-0.0803*** (0.020)	-0.1204*** (0.019)	-0.0814*** (0.019)	-0.0737*** (0.019)	-0.0708*** (0.023)		***	***
NACE B	0.2045*** (0.037)	0.1577*** (0.041)	0.2193*** (0.052)	0.2106*** (0.056)	0.2185*** (0.050)	0.1933*** (0.049)	0.1286*** (0.023)			***
NACE D	0.1394*** (0.034)	0.1744*** (0.039)	0.1768*** (0.035)	0.1527*** (0.031)	0.1355*** (0.025)	0.1699*** (0.030)	0.1441*** (0.026)			*
NACE E	-0.0283 (0.021)	-0.0269 (0.024)	-0.0223 (0.020)	-0.0630*** (0.021)	-0.0557** (0.024)	-0.0773*** (0.024)	-0.0710*** (0.024)			*
NACE F	0.0033 (0.017)	-0.0365*** (0.014)	0.0055 (0.017)	-0.0553*** (0.017)	-0.0293* (0.018)	-0.0389** (0.019)	-0.0560*** (0.017)	***	***	***
NACE G	0.0015 (0.015)	0.0093 (0.017)	0.0074 (0.015)	0.0159 (0.015)	-0.0008 (0.016)	-0.0180 (0.015)	-0.0360** (0.014)		***	**

NACE									
NACE H	0.0036 (0.019)	0.0153 (0.021)	-0.0354* (0.020)	-0.0496** (0.020)	-0.0579*** (0.021)	-0.0519** (0.021)	**		***
NACE I	-0.2431*** (0.031)	-0.2744*** (0.032)	-0.2303*** (0.031)	-0.2461*** (0.029)	-0.2475*** (0.028)	-0.2582*** (0.023)			
NACE J	0.1620*** (0.029)	0.1645*** (0.026)	0.1392*** (0.024)	0.1184*** (0.022)	0.1160*** (0.023)	0.1038*** (0.022)		*	*
NACE K	0.1709*** (0.022)	0.1452*** (0.022)	0.1166*** (0.023)	0.1065*** (0.022)	0.1463*** (0.028)	0.1225*** (0.024)	***		*
NACE L	0.0110 (0.028)	-0.0470 (0.041)	0.0447 (0.041)	0.0238 (0.038)	0.0513 (0.040)	-0.0077 (0.042)			
NACE M	0.0947*** (0.025)	0.1100*** (0.026)	0.0846*** (0.022)	0.0697*** (0.023)	0.0447** (0.022)	0.0347* (0.019)		**	**
NACE N	-0.1795*** (0.026)	-0.1812*** (0.026)	-0.2052*** (0.024)	-0.2267*** (0.023)	-0.2334*** (0.023)	-0.2478*** (0.019)		**	**
NACE O	-0.0623 (0.042)	-0.0428 (0.044)	0.0155 (0.024)	0.0247 (0.040)	0.0634* (0.035)	0.0557 (0.035)	*		**
NACE P	-0.1557*** (0.027)	-0.1539*** (0.028)	-0.2357*** (0.030)	-0.2386*** (0.024)	-0.1880*** (0.028)	-0.1795*** (0.027)	***	**	
NACE Q	-0.0457** (0.019)	-0.0203 (0.019)	-0.0139 (0.016)	-0.0320* (0.017)	-0.0494*** (0.019)	-0.0437*** (0.017)	*	*	
NACE R	-0.0378 (0.055)	-0.0565 (0.055)	-0.1059*** (0.035)	-0.0438 (0.049)	-0.0384 (0.041)	-0.0590 (0.041)			
NACE S	-0.2181*** (0.057)	-0.1654*** (0.063)	-0.1207** (0.050)	-0.1440*** (0.033)	-0.1471*** (0.035)	-0.1355*** (0.030)	*		

*Note: **Omitted variables** are NACE C, $10-49$ employees, private ownership, not signed collective agreement; **Statistical significance:** *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.*
Source: Authors.

T a b l e 6

Estimation of Wage Models with GDP Growth Variable

VARIABLES	Full sample			Stable panel of large companies		
	(1) ln gross hourly wage	(2) ln gross hourly wage	(3) ln gross hourly wage	(4) ln gross hourly wage	(5) ln gross hourly wage	(6) ln gross hourly wage
Female	-0.2303***	-0.1616***	-0.2000***	-0.2603***	-0.1671***	-0.1981***
	(0.007)	(0.008)	(0.004)	(0.011)	(0.013)	(0.005)
Years of schooling	0.0997***	0.0381***	0.0462***	0.0947***	0.0430***	0.0496***
	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.001)
Age	0.0432***	0.0203***	0.0205***	0.0476***	0.0188***	0.0196***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)
Age squared	-0.0005***	-0.0002***	-0.0002***	-0.0005***	-0.0002***	-0.0002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Tenure		0.0128***	0.0145***		0.0132***	0.0162***
		(0.001)	(0.001)		(0.002)	(0.001)
Tenure squared		-0.0002***	-0.0003***		-0.0002***	-0.0003***
		(0.000)	(0.000)		(0.000)	(0.000)
Citizenship	Yes	Yes	Yes	Yes	Yes	Yes
ISCO, Leader, Work load		Yes	Yes		Yes	Yes
Company fixed effects		Yes			Yes	
NACE, Number of employees, Ownership, Collective agreement			Yes			Yes
NUTS 3 region	Yes	Yes	Yes	Yes	Yes	Yes
Year	-0.0034***	-0.0030**	-0.0011	-0.0014	0.0013	0.0016
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
GDP growth	0.0006	0.0008**	0.0013***	0.0002	-0.0000	0.0010**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	3.0262***	3.9185***	3.7188***	3.0793***	3.9440***	3.8226***
	(0.029)	(0.045)	(0.021)	(0.047)	(0.051)	(0.034)
Observations	10,262,363	10,262,363	10,262,363	6,942,386	6,942,386	6,942,386
R-squared	0.359	0.740	0.597	0.395	0.725	0.637

*Note: **Statistical significance** *** p < 0.01, ** p < 0.05, * p < 0.1.*

Source: Authors.

Results suggest that an effect of the business cycle on wages is quite small. GDP growth at a level of 1% increases wages by 0.08 – 0.13%. Also its effect on returns to particular wage determinants is limited regardless the number of affected wage determinants or the magnitude of its effect on wage returns is discussed.

Conclusions

Research on wages, wage determinants and related topics has been very intensive in the Czech Republic. It was given mainly by its transition from plan to market economy, which created ideal conditions for an examination of wage returns to education and work experience, development of gender wage gap, effects of minimal wage increase and other specific topics. At present, the research covers mainly the period up to the year 2006; research from later periods is rare. This paper focuses on the crisis period 2008 – 2014 in order to a) bring new evidence on development of wage returns to education and work experience, b) identify wage determinants whose returns changed significantly during the crisis period, c) assess sensitivity of wage returns to particular factors to business cycle.

Information System on Average Earnings, a linked employer-employee dataset, was used for this purpose. The analysis was performed on individual data on 1.5 million employees (ca 36.1% of all employees in the Czech Republic). As the panel of companies was not stable during the examined period, because of sampling method of ISAE, all models were estimated also for a stable panel of large companies (it covers ca 24.5% of Czech employees), which enabled confirmation of the robustness of the results.

What is an impact of the economic crisis on wage determination? Did the remuneration of particular wage determinants change significantly during the crisis period 2008 – 2014? Estimation of gross returns to human capital, i.e. without controlling for occupation or company variables, revealed statistically significant increase of gross returns to years of schooling (from 9.63% to 10.09%) and work experience approximated by age (from 4.10% to 4.51%) during the period 2008 – 2014. However, rigorous assessment of the wage returns development required replenishment of models with variables on occupation and company characteristics. These models showed that the growth of gross returns to education and work experience was pulled by an increase of returns to white collar occupations (ISCO 1 – 4) related to elementary occupations (ISCO 9) in 2008 – 2011, while wage returns to schooling decreased. Besides those changes in employee and occupation characteristics, statistically significant changes in

remuneration was identified also in some NACE branches, types of ownership, company size and collective bargaining arrangement. It suggests that the crisis affected mainly remuneration of company characteristics.

After the examination of changes in returns to particular wage determinants during the period 2008 – 2014, the attention was paid to their dependence on GDP development. Estimation of wage models replenished with GDP growth variables showed that economic development is a statistically significant wage predictor. Its effect is, however, quite small. GDP growth at a level of 1% increases wages only by 0.08 – 0.13% (it can be expected that changes in GDP are intermediated mainly by their effects on particular NACE branches). Extension of the models by interaction of all explanatory variables and GDP growth enabled identification of those wage determinants, whose returns changed significantly in connection with the GDP development in the period 2008 – 2014. It revealed that effects of GDP growth on returns to particular wage determinants is limited as only a few interaction variables were statistically significant and the value of their regression coefficient was small.

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