

LABOUR PRODUCTIVITY OF ELDERS

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Abstract- Population ageing is a very relevant topic for contemporary Europe in the last decades. From economic point of view, the relevant question is whether the growing share of elders in the society will negatively influence economic output. It is the case of the Czech Republic, as well. One of the present effects of population ageing is the increase of statutory retirement age that leads to the higher share of older workers in all industries. We assume that industries will be differently affected by ageing workforce with respect to their specifics. We estimated the contribution of three age groups (young, middle and elders) to the gross value added and we also estimated labour productivity for each age group and industry. The key issue lies in the dependency of workers' productivity on the age and industry. Our paper also provides statistical analysis of the wages of market and non-market spheres. For the purposes of our analysis, we used data for the Czech Republic for the period 2000-2015.

Keywords- Labour productivity, ageing, older workers.

I. INTRODUCTION

The issue of population ageing is very relevant for current European countries. In western European countries, the preparation of society for population ageing began decades ago. In eastern European countries, the society is going to be confronted with population ageing in recent times. The life expectancy at birth of men increased from 67.6 to 75.8 years between 1990 and 2014 in the Czech Republic. Similar situation is for women where life expectancy rose from 75.5 to 82 in the same period. In comparison with France, it is still lower. The life expectancy at birth of men increased from 72.8 to 79.5 years and of women from 80.6 to 86 years between 1990 and 2014 in France. On the contrary, current life expectancy for China is 74.3 for men and 77.3 years for women born in 2014. Economic and social development is accompanied by demographic process. Population ageing is a natural event for very developed countries (Higo, Khan, 2015). We expect that this process will be sooner or later clearly visible in developing countries, as well. When we study our society, good example is Japan and changes in Japanese society and economy. Fundamental question is whether the changes in the age structure can influence the economy. In other words, do the changes influence productivity? For these purposes we compared figures about gross value added by industries and composition of labour force in these industries of the Czech economy between 2000 and 2015.

There are some analyses about the relationship of ageing and productivity at national level (e.g. Freyer, 2007 or Prskawetz et al., 2007), or industry level (e.g. Kuckulenz, 2006 or Mahlberg et al., 2012), at organization level (e.g. Aubert, Crépon, 2003 or Göbel, Zwick, 2009) or at individual level (e.g. Skirbekk, 2008) or at occupation level. For example, Diamond (1986) shows the effect of ageing for mathematicians and scientists, Oster and Hamermesh

(1998) for economists, Fair (1994) for athletes, and Bhattacharya and Smyth (2001) for Australian judges. But the other way around (Posner, 1995) show that judges might be an exception to this phenomenon. He argues that the productivity of judges increases with age as well as their creativity and achievements.

Population ageing will influence many areas of human life and economy. Labour market belongs to the areas where the increasing proportion of older people will be noticeable; they become important part of labour force.

II. METHODOLOGY

2.1. Data sources

Data on earning or wages is difficult to obtain by industries and age groups. With respect to our data sources we were able to prepare the division into three age groups:

- young: workers younger than 30 years,
- middle-age: workers between 30-50 years,
- older: workers older than 50 years.

The data comes from sample survey conducted in companies (see ISPV, 2016) and grossed up to the national accounts figures for compensation of employees. The Czech Statistical Office (CSZO) publishes annual national accounts six months after reference period, see CZSO (2002). The data were processed by commonly used RAS procedure to fit national accounts totals by industries.

2.2. Productivity analysis

Fundamental question is whether the composition of workers influence value added created in different industries of Czech economy. One possibility is to use the number of workers by age groups and compare these figures with gross value added. The results are described in 3.1.

The second possibility is to use the amount wages paid to the workers of all three groups in industries. Wages should better correspond to the amount of work provided by workers since they should include the mixture of individuals' work quality, knowledge and skills. We assume that the workers are paid according to their marginal productivity. Wages are deflated to the price level of 2015 by consumer price index (CPI). The results are presented in the section 3.1.

III. RESULTS AND DISCUSSION

3.1. Gross value added and age composition of labour
 The comparison of gross value added and number of workers is provided in real terms. Gross value added is expressed at constant prices of 2015.

We analyze if the composition of workers can influence the development of value added. The development of the growth of gross value added and number of employees in three groups is presented in Fig.1.

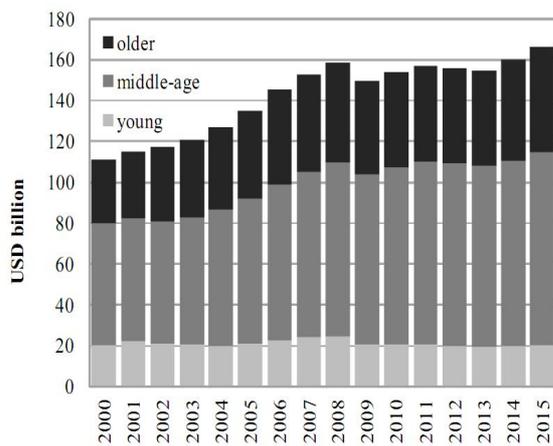


Fig.1. Gross value added at constant prices of 2015 by age group, Czech Republic, USD billion

The continuous increase in gross value added is visible in all three groups. Especially gross value added created by middle-aged and older workers has increased.

While gross value added created by young workers has increased between 2000 and 2015 one times, gross value added created by middle-aged and older workers has increased 1.6 times. Total gross value added was 166 USD billion in the Czech Republic in 2015.

Ageing of labour force affects especially industry of services (see Table 1). The share of young workers has decreased from 20.2% to 11.7% in the segment of services between 2000 and 2015, while the share of older workers has increased from 26.2% to 30.8% between 2000 and 2015.

The share of middle-aged workers remained more or less at the same level between 2000 and 2015.

Significant increase in the share of older workers has been also in agriculture in the reference period.

Table 1: Gross value added development by age between 2000 and 2015, Czech Republic, %

		Agriculture and forestry	Mining, manufacturing and energy	Construction	Services	Total
2000	young	12.3	18.6	17.0	20.2	19.2
	middle-age	48.4	51.5	55.2	53.6	52.9
	older	39.4	29.9	27.8	26.2	27.9
2015	young	9.6	13.7	11.9	11.7	12.3
	middle-age	44.5	56.0	56.4	57.5	56.6
	older	45.9	30.3	31.7	30.8	31.1

Generally, gross value added per worker has increased between 2000 and 2015. The most significant increase has been seen in labour productivity of young and middle-aged workers in agriculture (1.8 times) and in industry (1.7 times). Labour productivity of older workers has increased by slower rate. In services, labour productivity of young and older workers has increased by same rate between 2000 and 2015.

Table 2: Labour productivity development by age between 2000 and 2015, Czech Republic, prices of 2015, USD

		Agriculture and forestry	Mining, manufacturing and energy	Construction	Services
2000	young	15 646	15 476	15 823	23 952
	middle-age	19 656	23 433	30 496	35 252
	older	25 792	32 707	34 417	39 585
2015	young	27 677	26 743	24 176	24 822
	middle-age	35 227	40 557	35 175	39 301
	older	41 690	44 751	40 485	41 487
I _{2015/200}	young	1,769	1,728	1,528	1,036
	middle-age	1,792	1,731	1,153	1,115
	older	1,616	1,368	1,176	1,048

Similarly to the study written by Mahlberg et al. (2012), our results show that the higher labour productivity goes along with the increase age of workers. It emphasizes a positive sign for middle-aged and older workers.

3.2. Dependency of gross value added on the quality of the labour

We suppose that the development of a particular industry is also dependent on the quality of its workforce. Since the quality is difficult to measure, we use a proxy, the amount of wages paid to different age groups.

We compare the average wages in two economic spheres (market and non-market) with respect to three age groups (young, middle-aged and old). Because

our data has the form of time series (years 2000-2015) with linear trend, the usual analysis of variance (ANOVA) methods cannot be used since the assumptions are not valid. For these reasons, we used Kruskal-Wallis test by ranks. This test is applied for the first differences of both time series.

From statistical point of view, we test hypothesis H_0 vs. alternative hypothesis H_1 at usual level $\alpha = 0.05$:

$$H_0 : median1 = median 2 = \dots = median k ,$$

$$H_1 : non H_0$$

where $median_i$ is median in the sample i , $i=1, \dots, k$.

Kruskal-Wallis test statistic has the form

$$H = \frac{12}{N(N+1)} \sum_{i=1}^k n_i \bar{r}_i^2 - 3(N+1)$$

where

n_i is number of observation in sample i ,

N is total number of observation across all samples,

$$\bar{r}_i = \frac{\sum_{j=1}^{n_i} r_{ij}}{n_i}$$

is the average rank of all observation in

sample i , This statistic H has chi-squared distribution with $k-1$ degrees of freedom, where k is number of samples.

Our samples contain:

- sample 1 (S1) – young, market sphere,
- sample 2 (S2) – middle-age, market sphere,
- sample 3 (S3) – older, market sphere,
- sample 4 (S4) – young, non-market sphere,
- sample 5 (S5) – middle-age, non-market sphere,
- sample 6 (S6) – older, non-market sphere.

Because the data are different over time (see sample at Fig. 2), we divide our data set into two parts (first 9 observations and last 6 observations).

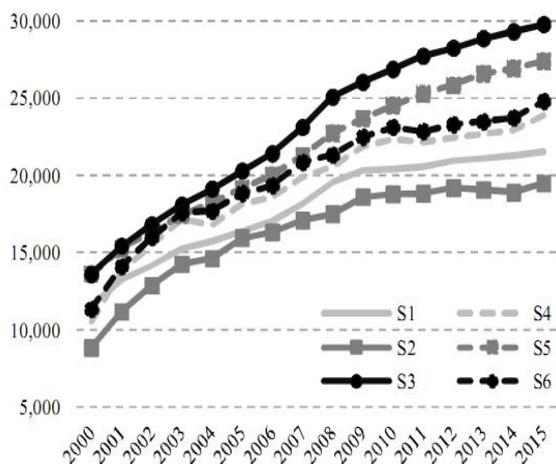


Fig.2. Sample of data set over 15 years (average gross monthly wage in CZK between 2000–2015)

Kruskal-Wallis test was performed two times. At first for Part 1, which included 9 observations, years 2001–2009 (the results are in the table 3) and secondly for Part 2, where is 6 observations, years 2010–2015 (the results are in the table 4).

Table 3 Results of Kruskal-Wallis test for Part 1

Null hypothesis	Results
$H_0 : median1 = \dots = median 6$	<i>we don't reject H_0</i>
$H_0 : median1 = \dots = median 3$	<i>we don't reject H_0</i>
$H_0 : median 4 = \dots = median 6$	<i>we don't reject H_0</i>

For all three tests in Part 1 we are not able reject null hypothesis at level $\alpha = 0.05$. It means that there is no significant statistical difference among the averages in all tested samples.

Table 4 Results of Kruskal-Wallis test for Part 1

Null hypothesis	Results
$H_0 : median1 = \dots = median 6$	<i>we reject H_0</i>
$H_0 : median1 = \dots = median 3$	<i>we reject H_0</i>
$H_0 : median 4 = \dots = median 6$	<i>we reject H_0</i>

For all three tests in Part 2 we are reject null hypothesis at level $\alpha = 0.05$. It means that there is significant statistical difference among the averages in all tested samples. The results describe the changes of our society. In the first part of selected period (2001–2009) there were no significant differences between the level of average wages in the economy by age groups. In the second period (2010–2015), we are able to prove that the differences between the level of average wages are statistically significant.

CONCLUSIONS

Population ageing is a process that affects everyday life in the Europe. The process affected eastern countries later than western and the preparation of the society for this process is not optimal. Population ageing is a complex issue that is visible in different areas, such as health, social services, and pensions and also in the economy. Necessary increases in the statutory retirement age means significant changes on the labour market. The increasing proportion of older people will influence the outcome of several industries. We can easily imagine older professors, doctors, and scientist. On the contrary, it is questionable if older bus drivers, masons and miners can still do their jobs without any concerns.

The differences between age groups are clearly visible. The composition of value added created by age groups significantly moved to middle-age and older groups. However, if we observe the labour productivity by age, we can see slower increase in labour productivity of older workers in comparison with young workers, especially in industries where manual work is needed. In services, labour

productivity of older workers has increased between 2000 and 2015 in the same way as for young workers. Our analysis also showed that Kruskal-Wallis test confirmed statistically significant difference between the level of wages in market sphere and non-market sphere and in last 6 years only. Before year 2010, there were no significant differences between levels of wages, widening the gap among wages by age can be observed only after 2010. The achieved results clearly prove that the gap between wages increases in time with respect to age.

Population ageing in the Czech Republic is visible in the economy significantly in last years. The issue of ageing is connected with many different areas ranging from availability of skilled labour force to availability of social services for elders.

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