Quality Adjusted Labour Input

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Abstract. The aim of this paper is to evaluate the contribution of quality adjusted labour input to increase of labor productivity in Slovakia. The development of productivity is compared regarding the qualitatively adjusted input of work and without considering the quality factor. The aim of these comparisons is to point out possible shortcomings in the current measurements of productivity, or at least the individual components that enter its calculation. The change in the methodology in the calculation of the contribution, considering the quality of work, is more adapted to current trends in the labor market and especially to its future development regarding growing demands on the qualitative aspect of work and increasing share of work with a high level of skills needed to perform it. This is influenced, among other things, by the development and greater involvement of information technologies, digitalization and robotization, the necessary complement of which is the adaptation of the skills of the workforce, a change in their structure and an increase in their level.

Keywords: Labour productivity. Quality adjusted labour input. Quality factor.

JEL classification: *O 40*

1 Introduction

The slowdown in economic growth is a phenomenon in recent decades affecting predominantly developed countries of the world. One of the theories that has been discussed for a long time is the impact of declining productivity on economic growth. According to an OECD study, this phenomenon is a global phenomenon affecting most developed economies. On average, in more than 17 advanced economies, productivity growth has fallen to less than 1% per year in the last decade, less than half the rate seen in the last 30 years. In the medium term, sustainable economic growth equals the sum of productivity growth and the growth rate of labor supply. For this reason, the slowdown in productivity growth will each be reflected in a slowdown in sustainable GDP growth (OECD, 2018).

2 Theoretical Perspectives on Productivity Growth

This finding is particularly striking in the face of the completely opposing expectation that advances in technology, especially in artificial intelligence and robotics, are set in such a massive increase in labor productivity that vast sections of some sectors of the current workforce will not be forced to work longer, on the contrary, there are concerns about redundancy, the replacement and automation of manpower and labor shortages. There is still not enough information, and it is not entirely clear where (in which sectors) this replacement is most likely, when it is likely to occur and to what extent it will be a good or bad thing for the whole economy. However, the question is why this is not yet visible in labor productivity statistics.

It emphasizes that the higher the level of education of the labor force, the higher the overall productivity of capital, because the more educated are more likely to innovate, and thus affect everyone's productivity. In other models, a similar externality is generated, because increased education of individuals increases not only their own productivity, but also the others with which they interact, so that overall productivity increases with increasing average level of education (Lucas, 1988). The study on economic growth and human development offers the complementary view that technical progress depends on the level of research and development in the economy. By investing labor and capital in research and development, the company is able to improve not only its own profitability, but also the productivity of research and development, which consumes its production. Several empirical studies have shown the positive impact of education on economic growth at the macro level, varying in size according to the level of education and the specific macro space model adopted (Ramirez, 1997).

Other growth studies also assume that the formal skills and experience contained in the workforce are a form of (human) capital. On one hand, it could be argued that human capital is subject to declining income, so that a highly skilled and skilled workforce would have higher income levels in the long run, but not necessarily a consistently higher rate of income growth. On the other hand, investment in human capital (eg expenditure on education and training) could have a more lasting impact on the growth process if high skills and training go hand in hand with more R&D and faster technological progress, or if adoption new technologies are facilitated by a highly skilled workforce (Bassanini, 2002).

According to Jackson (2019), the critical question is how politics should respond to this situation. The conventional response so far has been to find available conditions - technological, fiscal, monetary - to sustain growth regardless of price. The ongoing "rescue regime" relied on the assumption that, in addition to appropriate policy incentives, new technological discoveries would come and productivity growth would resume. Candidates for the so-called "rescuers" are different. For some, it will be innovation based on investment in clean, low-carbon technologies that is needed to tackle climate change, climate change and offset resource depletion. For others, it will be innovations based on the coming digital revolution: increased automation, robotics, artificial intelligence. So far, however, none of the productivity gains expected by these technologies have been reflected at the macroeconomic level, and this future world could lead to a complete replacement of the workforce and levels of inequality.

2.1 Factors affecting productivity

Measuring productivity is a key element in assessing living standards. A simple example is per capita income, probably the most common standard of living: per capita income in the economy varies directly according to one measure of labor productivity, namely value added per hour worked.

Multifactor productivity (MFP) affects economic growth through factors that are not attributable to capital or labor, but through technological change or the improvement of knowledge, methods and processes.

In terms of growth factors, it is necessary to examine more deeply the work, its volume and quality. The OECD (2001) states that the contribution of labor should reflect the "time, effort and skills of the workforce". A common standard for entering work is the use of hours as a unit of measure. However, the time dimension of the work does not reflect its quality (skills). However, these are captured in the aggregate productivity factors.

Labor productivity reflects how efficiently the workforce is combined with other factors of production, how many of these additional inputs are available per worker, and how quickly technical changes are taking place. As a result, labor productivity is a good starting point for analyzing some of these factors.

2.2 Labour Input

Work remains the most important input into many production processes. From the point of view of production analysis and at the same time ignoring differences in quality, the input force of labor is most appropriately measured as the total number of hours worked. However, several statistical problems arise in connection with the measurement of hours worked. The quality of the hours worked estimates and their degree of international comparability are therefore not always clear.

According to ONS study, labor income and labor shares should reflect the compensation paid to the labor force from the producer's point of view, including wage and salary supplements such as employers' contributions to social security payments. However, as with "hours actually worked", many seemingly straightforward concepts raise many conceptual and empirical questions about their measurement. This concerns issues such as the treatment of non-wage earnings for employees (eg stock options) or the treatment of the self-employed (ONS, 2007).

Because a worker's contribution to the production process consists of his "raw" work (or physical presence) and services from his human capital, one hour worked by one person does not necessarily represent the same amount of input working time as one hour worked by another person. There may be differences in skills, education, health and professional experience, leading to large differences in the contribution of different types of labor. Differentiation of labor input by type of skills is particularly desirable if we are to capture the effects of changing quality of work on output and productivity growth. However, explicit differentiation is data and research intensive. Minimum time series of hours worked broken down by one distinguishing characteristic must be available, together with the corresponding statistics on average compensation broken down by the same characteristic.

2.3 Quality Adjusted Labour Input

Jorgenson et al. (1987) state that “When measuring labor productivity, labor input is traditionally defined in understanding the sum of all hours worked by employees, owners and unpaid workers. As a result, the same amount of work is considered an hour worked by a highly experienced surgeon and an hour worked by a newly recruited teenager in a fast-food restaurant. It doesn't matter who worked or what kind of jobs the workers held. All workers are treated as if they were the same. "

To estimate changes in productivity, the question is whether the composition of the labor force changes over time, whether there is an increase or decrease in the average quality of labor force inputs. According to most measurements, the quality of work has been and continues to increase. An increase in the average quality of work means that the adjusted labor input rate, which includes the quality aspect, would grow faster than the unadjusted labor input rate. As stated by ONS (2007), successful quality adjustment is equal to measurements of work in units of constant quality. Measuring consistently high quality labor input is interesting in several respects.

On the one hand, it provides a more precise indication of the share of labor in production. This can be usefully interpreted as one aspect in the formation of human capital. It is a step towards measuring one important aspect of the effects of "intangible investment" (Britain, 2007).

In the literature and in statistical practice, there are different approaches to differentiating labor input. The differences between these approaches are closely related to the measurement of "skills". One possibility is to assume a direct relationship between skills and occupations, to rank occupations according to their skill intensity, and then to use information on the distribution of hours worked in employment to derive differentiated rates of labor entry. This is, for example, the approach chosen by Lavoie and Roy for Canada (Lavoie, Roy, 1998), or the OECD (2001) for several OECD countries.

However, the assumption of capturing all relevant differences in skills when looking at occupations may not be correct. Other distinguishing features, such as age, health, or educational attainment, can reasonably be considered significant. Jorgenson et al. (1987) used up to five characteristics (age, education, class of workers, occupation, and gender) to cross-classify labor force entry into a detailed industry. Because different characteristics correlate, the resulting rate of labor composition reflects both the direct contribution of these characteristics to production growth and the interaction effects between them.

Another possibility is to use a small number of differentiation characteristics, but to choose them to minimize the correlation. This is the approach taken by the US Bureau of Labor Statistics: hours worked are only cross classified according to education and work experience. Furthermore, there is no sectoral distinction. This reduces the effects of the interaction between variables and facilitates the identification of independent sources of change in quality of work (BLS, 1993).

Regardless of whether there are one or more distinguishing features, hours of highly qualified persons and hours worked by unskilled persons cannot simply be added to the aggregate rate of input labor - they must be weighted according to their relative productivity to take account of differences in skills. The theory of the firm states that under certain conditions (a firm is a price maker in labor markets and focuses on minimizing its total costs) a certain type of work will be hired up to the point where the cost of the next hour of work will be equal only to the additional income work generates. This equality means that for the rate of total labor input, individual labor inputs of different quality can be weighted by the respective relative wage or, more precisely, by the share that each type of work occupies in the total remuneration.

Thus, the growth rate of the total input adjusted for the quality of work L is measured as:

$$(\frac{d\ln L}{dt} = \sum_{i=1}^{M} v_i \frac{d\ln L_i}{dt}) \qquad (1)$$

where L_i represents a specific type of work and where v_i is the share that the total type of work occupies in the total compensation of work (Britain, 2007).

We can notice that even if only a simple trait, such as a profession, is chosen to differentiate the input of the workforce, the information requirements are high.

Standard measures of labor productivity express the growth of output with regard to the volume of labor input, whether in terms of employment, the number of jobs or hours worked. The implicit assumption underlying this approach is that the workforce is homogeneous because it does not consider the composition or quality of the workforce (Acheson, 2011).

However, the workforce is far from homogeneous, and the "value" of hours worked, or marginal productivity varies significantly between workers. When measuring labor productivity, the most representative measurements of input power (labor contribution, labor input) are measurements adjusted for the composition of work (often referred to as "adjusted for quality" measurements). The contribution of quality adjusted labor input - QALI seeks to solve the erroneous assumption of work homogeneity and provides measures that explicitly recognize the heterogeneity of work by adjusting the volume of hours worked according to certain characteristics (Zealand Statistics, 2008).

Thus, there is general agreement that work as a factor of production is highly heterogeneous and varies in different dimensions. Improper consideration of different dimensions of work will result in an overestimation of overall factor productivity. The full work rate should therefore consider the characteristics of the workforce, such as working time, experience, education, effort, age and gender, in order to allow a more comprehensive assessment of the contribution of work. Depending on the focus of the research and the availability of data, it is possible to compile different indices of a well-adjusted workforce. However, the creation of a measure that captures all these impacts requires a considerable amount of data, especially when dealing with data at sectoral level (O’Mahony, 2005).

QALI is therefore a conceptually more powerful method for use in productivity and growth accounting analyzes and is a useful tool for assessing human capital developments over time. It is used in conjunction with experimental estimates of capital services (e.g., Appleton, 2011) to generate multifactor productivity estimates (Acheson, 2011).

While the importance of differences in the quality and composition of labor inputs has long been recognized (Jorgenson, 1967), the increase in educational attainment in all OECD countries has increased the emphasis on the importance of considering the quality of labor inputs. In addition, the importance of the quality of the workforce has recently been emphasized in the context of the extensive use of ICT capital and the increased investment in additional resources (including skills) to support their expansion. Investing in the skills of the workforce is part of this additional investment, and therefore an assessment of the quality of the workforce is needed to distinguish between returns on ICT capital and returns on the labor force. Investment in ICT and education together are among the most important sources of growth at the level of industry as well as the whole economy (Keeney, 2009).

Measuring the skill dimension is particularly important in productivity studies, as workers with different qualifications will have different effects on productivity growth. A more complex level of labor, which corresponds to the skill level of the labor force, usually increases the share of labor income within the production function and reduces aggregate productivity. This helps to understand the factors that determine productivity growth. In addition, a comparison of adjusted and unadjusted labor input rates provides a measure of the corresponding change in the composition or quality of labor input (O'Mahony, 2005).

The concept of adjusted work considering quality has been introduced and incorporated in many statistical institutions into productivity measurements. Institutions, including the Australian Bureau of Statistics (ABS), the Bureau of Labor (BLS), the Bureau of National Statistics, and Canadian Statistics, have used this approach, but there are significant differences in specific concepts and methods (Acheson, 2011).

3 Methodology

In practice, estimating the labor composition index requires calculating the number of hours worked by each type of worker, as well as the weighting of the share of costs for each type of worker. Cost-share weights can be calculated either by observed wages or, as the BLS does, by replacing actual wages with imputed wages, where imputations are obtained from Mincer's standard wage regression. The key components for identifying different categories of workers are the equation with the Törnqvist index as the difference in the natural logarithm of consecutive observations, with weights equal to the average of the proportions of the factors in the corresponding years. The group must theoretically have a different output elasticity to other employees, which should be demonstrated in the data by the wage difference for this group. In addition, working hours should change compared to other groups (Zealand Statistics, 2008).

A key requirement for the successful application of the workforce composition model is extensive skills measurement to distinguish hours worked between different groups. In similar studies, the theory of human capital has been used to address this situation. The OECD defines human capital as "the knowledge, skills, competences and attributes contained in individuals that facilitate the creation of personal, social and economic well-being." Human capital theory states that there is a positive relationship between wage levels, education and work experience. Education and training, which improve workers' skills and productivity, can be seen as an investment in human capital. In addition to assigning staff to qualification groups, each group needs to be valued to provide an indicator of their relative quality. At the international level, nominal wages play an integral role in adjusting composition as the best available, albeit imperfect, variable for weighting groups when adjusting their composition.

As soon as each species is given a weight, a composition-based labor force index can be compiled based on its share of total labor costs (wages). It would, of course, be naive to assume that wages are determined solely by one's skills. Factors such as discrimination, trade union bargaining, signaling, minimum wages, effective wages and non-compliance can jeopardize the validity of the use of wages as a measure of worker productivity (Turunen, 2006). This has a particular effect when the nature of these factors (trade union membership) changes over time. Other factors need to be considered, such as the short-term increase in labor shortages in the labor market with specific skills and the resulting impact on the wages of these occupations. As overseas case studies, such as the BLS study, have shown, there are measures that can be taken to control some of these factors.

In this work, we will derive the rate of labor input (LII - denominator of the labor productivity equation) using the chained Törnqvist index, in which the weights are based on the wage shares of the industry in the measured nominal income of the labor force. Assuming that cross-sectoral wage differences reflect differences in skills, this assumption is to adjust the composition of the series by a quality factor, as the weights will be comparably large for industries that pay above-average wages and, conversely, for industries that pay below-average wages. (Zealand Statistics, 2008).

After cross-referencing, the weights are calculated by putting the wage shares of each category in the Törnqvist formula and creating an index number for each period.

$$(lnT_t = \frac{1}{2}\sum(v_{it-1} + v_{it})xln\frac{H_{it}}{H_{it-1}}) \tag{2}$$

Where v_{it} and v_{it-1} represent the weight of labor in the i-th category in the current and previous years, and H_{it} a H_{it-1} represent hours worked in the i-th category, also in the current and previous years. T represents the movement in the compositional work, which is the sum of the weighted movements for each category.

As the above equation shows, two periodic weights are used in this analysis. Weights for individual years are calculated as:

$$(v_{it-1} = \frac{W_{it-1}H_{it-1}}{\sum_j W_{jt-1}H_{jt-1}}) \quad (8)$$

$$(v_{it} = \frac{W_{it}H_{it}}{\sum_j W_{jt}H_{jt}}) \quad (9)$$

Where W_{it} and W_{it-1} present the hourly wage of work in category i.
The current methodology replaces wages in the given period with imputed wages. Thus, instead of a simple sum of hourly growth rates, it is a weighted sum, where weights are average shares of labor costs (Zoghi, 2010). The growth of the composition of labor is the difference between this growth of the input of labor by the adjusted composition and the unadjusted growth of the input, which is measured as:

$$(\Delta H = ln\frac{H_{it}}{H_{it-1}}) \quad (10)$$

Where H_{it} and H_{it-1} represent hours worked in the i-th category in the current and previous year.

Since official productivity statistics are a relatively new phenomenon in many countries, data series are generated depending on what relevant and how many appropriate data sets have been compiled before, leading to differences in methodologies between countries. The OECD describes adjusting the composition as "desirable but complex", highlighting its potential benefits, but recalls that explicit differentiation is both data-intensive and research-intensive. Although only a simple trait, such as a profession, is chosen to differentiate the workforce, the information requirements are high: data are needed that break down the total hours worked in different occupations by sector and by year. In addition, in order to construct weights for aggregation, quantitative labor input rates (hours) must be accompanied by relative average compensation price measures (Zealand Statistics, 2008).

4 Conclusion

The post-crisis period brought the Slovak economy several changes in the dynamics not only of economic growth, but also in the contribution of its factors to growth. As a result of the decline in employment, the impact of the labor factor on the dynamics of gross domestic product decreased and the pro-growth effect of capital increased. This approach takes employment into account as such, does not take full account of its qualitative aspects, which are, in particular, the level of education, skills and abilities of workers. This option is brought about by an approach which, in addition to the number of hours worked, also emphasizes a change in the quality of the workforce in changes in employment.

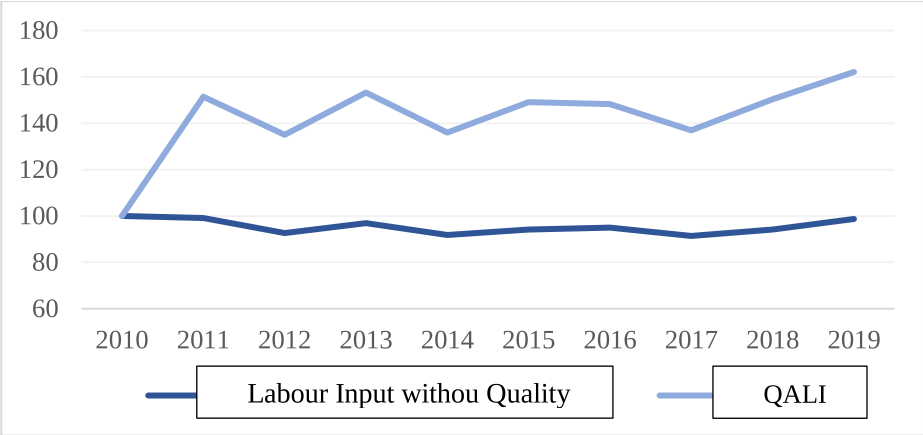

Fig. 4. Development of labor productivity (b. p. in %, year 2010 = 100%)

If we look at a well-adjusted input of labor (Fig. 1), we see that its contribution to the development of productivity increased in the period under review. The gradual growth of employment in the post-crisis period caused a more dampening effect on the growth of labor productivity, a positive tendency, albeit with fluctuations in time, seen in the qualitatively adjusted input of labor.

	QALI (11)	QALI (12)	QALI (13)	QALI (21)	QALI (22)	QALI (23)	QALI (31)	QALI (32)	QALI (33)	QALI for industry
Agriculture, veterinary and fisheries	-0,15	-0,01	0,43	-0,35	-0,34	0,03	-0,56	-0,01	0,14	-0,82
Mining and processing of raw materials, geology	0,43	-0,40	-0,52	-0,21	-0,51	-0,02	-0,31	0,05	0,13	-1,37
Food industry	0,16	-0,57	-0,23	-0,32	-0,29	0,04	-0,34	0,11	0,20	-1,24
Textiles, clothing, footwear and leather processing	0,43	-0,71	-0,15	-0,36	-0,46	0,29	-0,65	-0,03	0,11	-1,53
Forestry and wood processing industry	0,47	-0,43	-0,26	0,03	-0,17	0,17	-0,33	0,15	0,48	0,12
Pulp and paper printing industry	1,27	-0,47	-0,23	-0,19	-0,32	0,12	-0,41	0,08	0,36	0,20
Chemistry and pharmacy	0,33	-0,12	0,03	-0,21	-0,04	0,21	-0,52	0,23	0,16	0,07
Metallurgy, foundry, blacksmithing	0,30	0,05	-0,08	-0,27	-0,16	0,04	-0,50	0,23	0,56	0,15
Glass, ceramics, mineral products, non-metallic materials	0,27	-0,33	-0,32	0,03	-0,37	-0,23	-0,65	-0,11	0,16	-1,55
Automotive industry and engineering	0,86	-0,02	0,14	0,58	0,17	0,60	-0,22	0,36	0,33	2,79
Electrical Engineering	-0,27	-0,58	-0,34	-0,42	-0,09	0,53	-0,33	0,36	0,46	-0,66
Energy, gas, electricity	-0,33	-0,11	-0,19	-1,16	-0,47	0,04	-0,59	-0,02	0,08	-2,74
Water, waste and the environment	0,20	-0,12	0,01	-0,04	-0,24	0,39	-0,03	0,21	0,40	0,79
Construction, geodesy and cartography	0,07	-0,48	-0,23	-0,06	-0,27	0,07	-0,23	-0,03	0,17	-0,99
Business, marketing, gastronomy and tourism	0,15	-0,44	0,00	-0,15	-0,13	0,12	-0,24	0,26	0,32	-0,11
Transport, logistics, postal services	0,22	-0,23	0,07	-0,37	-0,15	0,37	-0,47	0,19	0,44	0,09
Information technology and telecommunications	1,16	-0,35	-0,18	0,10	0,13	0,50	0,25	0,29	0,74	2,65
Banking, financial services, insurance	0,00	-0,47	-0,21	-0,34	-0,30	0,17	-0,39	0,25	0,38	-0,91
Culture and publishing	0,01	-0,58	-0,10	-0,88	-0,42	0,30	-0,47	0,00	0,13	-2,00
Education, training and sport	0,92	-0,27	-0,15	-0,25	-0,15	0,29	-0,17	0,28	0,26	0,77
Public services and administration	1,25	-0,45	-0,03	0,48	-0,25	0,22	0,06	0,22	0,29	1,78
Administration, economics, management	0,88	0,02	-0,19	0,90	0,52	0,76	1,41	0,69	0,41	5,40
Healthcare, social services	-0,45	-0,19	0,38	-0,49	-0,24	0,46	-0,36	0,22	0,55	-0,13
Crafts and personal services	0,52	-0,02	0,66	0,32	0,00	0,37	0,11	0,28	0,42	2,66

Tab. 5. Development of qualitative input of work and its segments (year 2009 = 100%, in%)

The positive development of the qualitative input of work in the whole monitored period was most significantly influenced by the branches of administration, economy and management (Table 1). Qualitative factors have also increased positively in the automotive, information and communication technology, and public services and administration sectors.
Examining the development of the QALI indicator for individual groups in all 24 sectors of the Slovak economy, we found that the QALI indicator in all sectors fluctuated significantly in the period under review, between 2010-2019 and thus in none of the sectors there was continuous growth or decline periods of growth alternated between periods of decline and decline in growth.

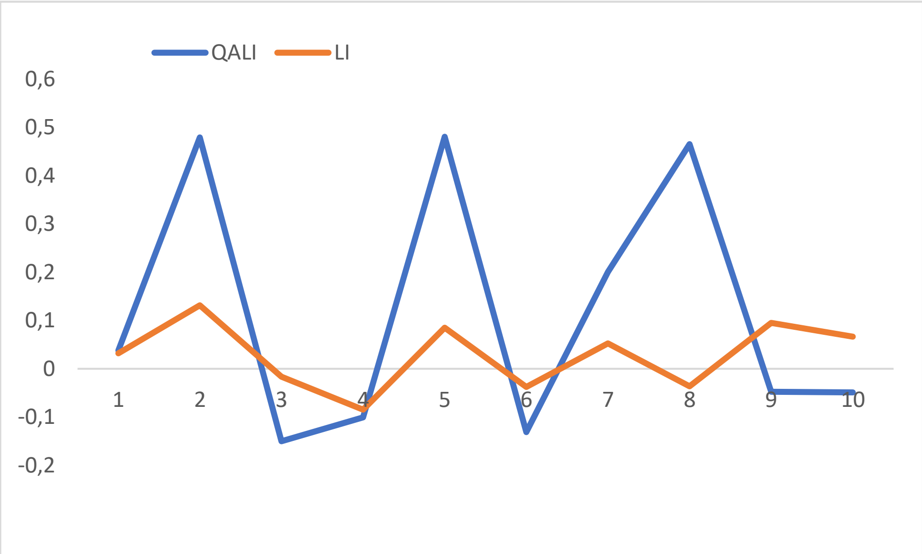

Fig. 2. Comparison of the development of the labor contribution considering the quality factor (QALI) and the labor contribution without considering the quality factor (LI) in the observed period

Comparing 2009 and 2019, we evaluated in which sectors the qualitative aspect of work grew the most and identified five main sectors, which are administration, economics and management, automotive and engineering, craft and personal services, information technology and telecommunications, and public services and administration. On the other side of the spectrum, the most significant decline was recorded in sectors such as energy, gas and electricity, culture and publishing or glass, ceramics, mineral products, non-metallic materials.

We use wages when calculating the QALI indicator as a weight of average shares of costs for a specific category of employees from the average hourly wage for a given category, which we use to weight changes in time worked. The wage variable plays an important role here, as it ensures the qualitative aspect of this indicator. Wages are not the same among heterogeneous types of workers. According to the theory, these wages

should reflect differences in marginal productivity of workers, and on the basis of this assumption, the types of workers are divided into groups according to certain predetermined characteristics with different corresponding wages. Thus, the wage in the formula represents the factor of qualification, education or age.
We use the regression model primarily as a supplement, which serves to support the QALI indicator. Since the weights entering its calculation are just hourly wages, the regression model should underline their validity and importance in the calculation. It is generally accepted that age, and especially education, has a positive effect on wage developments over an individual's life. As we have mentioned many times in our work, taking a closer look at the development of wages between 2009 and 2019 in individual sectors, we could see significant differences in average hourly wages between individual educational and age groups. Our regression model also confirms this.
The regression model in our work is a Mincer type model, consisting of panel data with 2376 observations. We used the log-lin model for simple data interpretation. In Picture 1: Regression model for 24 branches of the Slovak Republic, we can see that all variables entering the model are statistically significant at the 95% confidence interval and have a positive effect. Based on the model, we can state that age, but especially the level of qualification (education) have a significant positive effect on the change in the average hourly wage.

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Model 1: Pooled OLS, using 2376 observations
Included 216 cross-sectional units
Time-series length = 11
Dependent variable: l_avg_e_i

             coefficient   std. error   t-ratio    p-value
  ---------------------------------------------------------
  const       0,889341     0,0214228     41,51    1,20e-283 ***
  ED          0,365481     0,00727695    50,22    0,0000    ***
  age         0,105140     0,00727695    14,45    2,05e-45  ***

Mean dependent var   1,830583   S.D. dependent var   0,424582
Sum squared resid    199,0452   S.E. of regression   0,289619
R-squared            0,535093   Adjusted R-squared   0,534701
F(2, 2373)           1365,625   P-value(F)           0,000000
Log-likelihood      -425,5838   Akaike criterion     857,1676
Schwarz criterion    874,4871   Hannan-Quinn         863,4716
rho                  0,969927   Durbin-Watson        0,078537
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Pic. 1. Regression model for 24 industries of the Slovak Republic

A closer look at the structure of the components contributing to the growth of values found that the development in individual sectors was different and the growth in the sectors was of a different nature. In some sectors it came from an increase in the contribution of the skilled workforce, in others it was caused by an increase in the number of hours worked by the lower skilled workforce.

5 Discussion

There are also methodological shortcomings of the QALI indicator. The calculation, which uses wages as weights of average shares of costs for a particular category of workers from the average hourly wage for a given category, by which we weight changes in hours worked, is largely dependent on the development of the number of hours worked. Especially in sectors where wages do not sufficiently reflect the qualifications of the workforce, this workforce is underestimated, such as in the education sector. In this case, the wage, which in the calculation represents the qualitative aspect of the labor force, is not the most suitable variable for weighting the change in hours worked, but a conceptually better indicator has not yet been devised to represent a quality factor that would sufficiently capture and quantify it to such an extent as wages. As our regression model also pointed out, age, but especially the level of qualification (education) have a significant positive effect on the change in the average hourly wage.

However, it is clear from our results that the qualitative aspect contributes to a greater extent to the growth of the values of the contribution of labor and to the reduction of the falls in its values. Considering the qualitative aspect brings the possibility to better assess the structure of the growth of the contribution of labor, allows its easier decomposition and points to the difference in values, compared to the contribution of labor without considering the quality factor that would not otherwise be considered.

References

1. ACHESON, Jean; FRANKLIN, Mark. Quality-adjusted labour input: new quarterly estimates for 1993 to 2009 and annual estimates from 1970. Economic & Labour Market Review, 2011, 5.4: 22-46.
2. APPLETON, John; WALLIS, Gavin. Volume of capital services: new annual and quarterly estimates for 1950 to 2009. Economic & Labour Market Review, 2011, 5.5: 46-66.
3. BASSANINI, Andrea; SCARPETTA, Stefano. The driving forces of economic growth: panel data evidence for the OECD countries. OECD Economic studies, 2002, 2001.2: 9-56.
4. BRITAIN, Great. The ONS productivity handbook: a statistical overview and guide. Palgrave Macmillan, 2007.
5. BUREAU, OF LABOR STATISTICS. Labor composition and us productivity growth, 1984-1990. Bureau of Labor Statistics Bulletin, 1993, 2426.
6. GOLLOP, Frank M.; FRAUMENI, Barbara M.; JORGENSON, Dale W. Productivity and us economic growth. 1987.
7. JORGENSON, Dale Weldeau; GRILICHES, Zvi. The explanation of productivity change. The review of economic studies, 1967, 34.3: 249-283.
8. KEENEY, Mary, et al. Adjusting for Quality of Labour and Labour Services in Productivity Measurement. Central Bank and Financial Services Authority of Ireland, 2009.
9. LAVOIE, Marie; ROY, Richard. Employment in the knowledge-based economy: A growth accounting exercise for Canada. Human Resources Development Canada, Applied Research Branch, 1998.

10. LUCAS JR, Robert E. On the mechanics of economic development. Journal of monetary economics, 1988, 22.1: 3-42.
11. O'MAHONY, Mary; ROBINSON, Catherine; VECCHI, Michela. Heterogeneity of the labour input: methodological issues in constructing labour quality measures. In: EUKLEMS consortium meeting, Helsinki. 2005. p. 9-11.
12. OECD (2018), OECD Economic Outlook, Volume 2018 Issue 2, OECD Publishing, Paris, https://doi.org/10.1787/eco_outlook-v2018-2-en.
13. OECD. PUBLISHING. Measuring productivity-OECD Manual: Measurement of Aggregate and Industry-Level Productivity Growth. Organisation for Economic Co-operation and Development, 2001.
14. RAMIREZ, Alejandro; RANIS, Gustav; STEWART, Frances. Economic growth and human development. Center Discussion Paper, 1997.
15. TREXIMA Bratislava, spol. s r.o.
16. TURUNEN, Jarkko; SCHWERDT, Guido. Growth in Euro Area Labour Quality. 2006.
17. ZEALAND, Statistics New. Accounting for changes in labour composition in the measurement of labour productivity. Statistics New Zealand, Wellington, 2008.
18. ZOGHI, Cindy. Measuring labor composition: a comparison of alternate methodologies. In: Labor in the New Economy. University of Chicago Press, 2010. p. 457-485.