Skills and Educational Mismatch in the Czech Republic: Comparison of Different Approaches Applied on PIAAC Data[1]

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Abstract

This paper aims to explain both related and different concepts of educational and skill mismatches. In the first part a clear distinction between skill and educational mismatch is made and advantages and disadvantages of using each approach are listed. An overview of meanings and characteristics of different types of mismatch is provided as well. This part of the paper deals also with potential causes of mismatches in the labour market as well as consequences of mismatches. Next section offers the information on measures of educational and skill mismatches and a new approach for measuring skill mismatch is introduced. Due to recently published results from PIAAC survey containing measures of skills and also information about qualifications, educational as well as skill mismatches can be investigated and several methods of their measurement can be compared. The comparison is drawn in relation to the distribution of mismatches among different demographic groups.

Keywords

Education, skills, mismatch, labour market, PIAAC

JEL code

I21, I25, J23, J24

INTRODUCTION

This article focuses on currently broadly discussed topic of mismatches on the labour market. Mainly due to an increasing global competition, rapid demographic change and huge technological progress this topic becomes more urgent. In the past, most of the studies dealt with educational mismatches,

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but recently released data of the Programme for the International Assessment of Adult Competencies (PIAAC) allow us to investigate also skill mismatches. Even though these concepts are interrelated, and overlap to a certain extent, there are some fundamental differences. They are described in the first part of this paper and pros and cons of particular concepts are listed. This part of the paper also presents a summary of existing literature on topic of mismatches and deals in detail namely with the implications and causes of mismatches.

The second part of this paper concentrates on methodological approaches for measurement of mismatches. When measuring the educational mismatch, subjective, objective or statistical approaches can be applied. Measurement of skill mismatches is based on two approaches, i.e. approach based on self-assessment of workers and on frequency of use of skills in the job. The main contribution of this article subsists in introduction of a new method to address the latter approach. It comes from original methodology developed by Krahn and Lowe (1998) which was slightly modified. New method is described in detail in methodological part.

Last section of this paper measures the incidence of both educational and skill mismatch in the Czech Republic. Empirical data used in this paper come from a first wave of the Programme for the International Assessment of Adult Competencies (PIAAC) carried out by OECD in 24 countries. Measuring educational and skills mismatch was an important part of PIAAC[4] and several different approaches were taken. Therefore we can compare the results of different estimates of the scope of mismatch and try to reveal their strengths and weaknesses. There are several studies comparing levels of educational or skills mismatch internationally. Where comparable methodology can be ensured, our results are interpreted in relation to the situation in other countries where the analyses are available.

1 DISTINGUISHING MISMATCH RELATED CONCEPTS

In recent years there has been a growing interest in phenomenon of mismatches in the labour market and their effects. In the past, literature has dealt mainly with education mismatches (e.g. Duncan and Hofmann, 1981, Sicherman, 1991, Green, McIntosh and Vignoles, 1999, Hartog, 2000) rather than skills mismatches (e.g. Allen and van der Velden, 2001, Green and MacIntosh, 2007). This was caused particularly by the lack of data to address the latter. Still, large-scale surveys such as IALS, ALL and from the latest PIAAC containing measures of skills were carried out, which enabled the investigation of skill mismatches. Although educational and skill mismatches are related concepts, and they both measure discrepancy between skill supply and demand on the labour market, they should be clearly distinguished. It is mainly due to the fact that they lead to a different type of analyses and implications.

Educational mismatch[5] (or qualification mismatch) refers to a situation when the educational qualifications held by the worker differ from those perceived to be required either by the employer or worker for performance of tasks associated with his/her job adequately. In order to compare worker´s qualification and the qualification requirements for the job, four categories of qualifications were derived from PIAAC survey. Answers on highest level of formal education according to classification ISCED 97 were aggregated into four levels i.e. elementary education, secondary education without school-leaving exam, secondary education with school-leaving exam and tertiary education.

Three alternative categories can be then distinguished, namely overeducation (or over-qualification), undereducation (under-qualification) and educational match (qualification match). Educational mismatch has an advantage of being easier to measure and broader in its coverage of "skills", but has also a disadvantage of being much less precise than skill mismatch. It is mainly due to the fact, that even though

[4] Detailed information on PIAAC survey can be found in OECD (2013c).

[5] In this paper we investigate vertical dimension of educational mismatch. Horizontal dimension refers to situation when graduates are matched to occupation outside their own educational domain (Heijke, Meng, Ris, 2002).

education (or qualification) has been used extensively in the literature as a proxy for skills, it does not have to be good skills indicator. Firstly, it does not reflect the existence of skill heterogeneity within educational classes and secondly it does not take account of the possibility for skill gain or loss over the lifespan.

Skill mismatch, in contrast to educational mismatch, is more direct concept of measuring mismatches on the labour market. It refers to the situation when level of the actual workers´ skills differs from the level necessary to perform required job tasks successfully. Skill mismatch is more precise measurement than educational mismatch and thus in the last years there was a noticeable shift from focus on education mismatch to skill mismatch (Mavromaras at al., 2010). Still, literature on skill mismatch is rather limited mainly due to the lack of quality data and difficulty of identifying good measures of skills. Determining which skills should be measured is a complex and difficult task. Many scholars are concerned with the diversity of human skills and determined so–called core competencies or key competencies (Rychen, Salganik, 2003). Nevertheless, it is clear that core competencies form a general skills background only and that in every occupation there are also other specific skills that one needs to acquire in order to make up the professional domain of particular occupation.

Similarly to education mismatch, in the measures of the skill mismatch there are typically three alternative categories that can be distinguished. Over-skilling (or skill surplus or skill underutilization) is the situation when worker´s skills exceed those required by his/her job; under-skilling (or skill deficit) is the situation when the worker´s skills are inadequate to the requirements of his/her job and the required-skilled workers are the ones with adequate skills for the job. When analyzing skills or educational mismatches several approaches, which will be further discussed in methodological section, can be adopted.

2 BIBLIOGRAPHY

2.1 The implications of mismatch

For several years overeducation has been receiving significantly more attention than undereducation, due to the concern, that it may have been caused by sharp expansion of tertiary education. Duncan and Hoffman (1981) analyzed overeducation and identified the rate of overeducation of 42% in the US in 1976. To date, a growing interest has been monitored resulting in numerous similar studies in more than 20 countries. Metaanalysis of 25 studies by Groot and Maassen van den Brink (2000) showed that overeducation decreased from 29%, on average, in 1970s to 21% in 1990s. Such a situation can be explained by technology change that helped to sustain the demand for skilled labor in face of rising supply (Krueger, 1993, Acemoglu, 1999). Nevertheless, Galasi (2008) found that overeducation in Europe has risen again in last decade, which implies that education expansion is faster than technological progress. The expansion of tertiary education in Eastern European countries is a possible cause of this pattern. But such a conclusion is very limited and many aspects such as great differences among countries, economic cycle, system of education, etc., have to be taken into consideration when interpreting the results. Some authors (e.g. McGuinness, 2006) even report that the rate of overeducation is stable over time and no significant changes can be observed. While in the past the focus was put on the overeducation, recent years have witnessed growing interest in skill underutilization, because of its negative consequences for individuals and the economy as whole.

The implications and consequences of mismatch can be distinguished at three following levels: at individual level, at firm level and at aggregate level. Below are listed some of these implications that are broadly recognized and confirmed in several studies.

At the ***individual level*** it influences mainly job satisfaction and has also strong impact on wages and job mobility. Several studies have explored a linkage between job satisfaction and education or skill mismatch (Tsang, 1987, Battuu at al., 2000). Over-qualified workers were found to be less satisfied in their jobs than well-matched workers with the same qualifications (Verhaest and Omey, 2006). The same effect was found to be caused by skill underutilization (over-skilling), which leads to reduction

of a job satisfaction. On the other hand Allen, Levels and van der Velden (2013) identified mismatch also as a positive issue, because namely undereducation may be up to a point at least challenging and satisfying.

Another negative implication of mismatch was found by Krahn and Lowe (1998). They discovered that lack of use of some skills (for example due to overskilling) leads to "use it or lose it" effect, which means that skills can be lost if they are not used or further developed. Wage penalties connected with mismatch were firstly described by Sicherman (1991). It was found that mismatch workers suffer from substantial wage penalties in comparison with properly matched workers. Overeducated workers were paid less than if they were matched, but more than their matched co-workers with the lower qualification level. Secondly, undereducated workers were found to be paid more than if they were matched, but less than their matched co-workers with the higher qualification level. These results have been confirmed in a large number of subsequent studies. Effects of mismatch were also discovered in relation to job mobility. Numbers of studies have found that overeducated workers are more mobile than well-matched workers with the same education (Hersch, 1991). Again, it is necessary to remind, that only certain domains of skills are measured, and that the importance of these skills vary widely within different occupations.

At the ***firm level***, hiring overeducated workers can be a deliberate strategy to benefit from extra skills in the long term, despite negative impacts in the short term. On the other hand, according to Sichermann (1991), the undereducated are paid less than their matched co-workers which means that employing the undereducated may result in some productivity penalties (accepting the earnings reflect worker´s marginal product). Mismatch also increases on-the-job search and turnovers, and may increase firms´ expenditures.

At the ***aggregate level*** mismatch is considered to cause unemployment and increase unemployment persistence (Jackman et al, 1991). Other studies confirmed relation between mismatch and GDP. Reduction in productivity leads also to reduction of GDP. At the aggregate level, high rate of overeducation may be interpreted also as an over-investment in formal education or that educational system is ineffective in providing skills needed for the labour market. To limit these negative consequences it is necessary to identify the main causes of mismatch and design effective strategy to address them.

2.2 The causes of mismatch

It is broadly accepted fact that mismatch arises from the situation where there is heterogeneity both at the supply – experience, skills, and the diverse qualifications offered by individuals to potential employers – and demand side of the labour market - skills, experiences and the qualifications required to perform job tasks properly. There are numbers of hypotheses why mismatch occurs. In general, the existence of mismatches can be explained by imperfections of the labour market caused by information asymmetry between employers and employees, incomplete information in the labour market, differences between people and transactions costs. Generally, the causes of mismatches exist at the individual as well as on the macro level.

There are numbers of theories that can help us to understand the labour market imperfections. At the ***individual level***, educational mismatch can be for example explained through a fact that certain individuals may have low ability for their level of education in comparison with their peers. It results in situation where they will not be able to obtain a job commensurate with their education. Obviously, such an example is the case of overeducation. On the other hand, overeducation may also appear, when some individuals choose to accept a job for which they are overeducated because it offers them compensating advantages, such as less stress, or less commute to work, work time flexibility etc.

Another possibility is that employers actually prefer overeducated employees, because they are more productive and learn more quickly. For firms operating in rapidly changing markets, hiring overeducated or overskilled workers may be a strategy to avoid future expenditures and may serve as an insurance policy. Some studies (Crompton, 2002, Dekker et al, 2002) have also found that young people are more

likely to be overeducated because at the beginning of their career they are willing to accept jobs that do not reflect their qualifications. According to this theory, overeducation can be explained as temporary phenomena which should correct itself as the young people find the jobs that suit their skills better. Over a lifetime overeducation should thus decline with age. Skill mismatch may also appear when employers do not possess well developed hiring practices and hire workers with different skills than they require.

At the ***aggregate level***, overeducation is linked with the expansion of tertiary education which is growing faster than the share of highly qualified jobs. The economic or technological changes on the labour market cannot be immediately reflected in the changes of educational system. This situation can lead to both undereducation and overeducation since educational system produces qualifications that are inadequate to those required on labour market.

Undereducation is most often connected with the technological development. Technological progress upgrades requirements on the qualifications and mainly older workers may not fulfill those new requirements and thus are classified as undereducated. But this situation does not mean that they have to be underskilled. It is necessary to take non-formal education and skill development activities undertook by individuals since they have been hired into account. The rate of mismatch is also strongly related to economic cycle. During economic recession it can be more difficult to find an appropriate job and people may accept a job which does not suit their education or skills. Especially the rate of overeducation and overskilling is increasing mainly due to a combination of low number of vacancies and pressure on the supply side.

Causes of mismatches mentioned above do not represent a complete list of causes but are presented as an example of how different sources can cause the mismatch on the labour market. Some of the causes are described in more detail in separate theories, such as Human capital theory (Schultz, 1961, Becker, 1964), Technological change theory (Romer, 1990), Career mobility theory (Sicherman and Galor, 1991), Search theory, Signaling theory, Job competition theory or Labour market segmentation theory (see Desjardins, Rubenson, 2011).

3 METHODOLOGY – APPROACHES TO MEASURE MISMATCHES

3.1 Educational mismatches

The measurement of educational mismatches varies widely. Verhaest and Omey (2006) for example distinguish four major approaches to measurement of educational mismatches, whereas in most of the studies three measures of mismatch can be found. For example Cedefop (2010) distinguishes:

- ***Subjective*** method based on self-reported respondent´s assessment of match between his or her education and tasks required in job. Verhaest and Omey (2006) further distinguished direct self-assessment and indirect self-assessment method. While using direct self-assessment method respondents are being posed the question whether they feel over- or under- educated for their job or their education is just appropriate (*'Do you have a level of education which is according to your own opinion too high, too low or appropriate for your job?'*). Indirect self-assessment means that respondents evaluate appropriate level of education for their job or necessary qualification required for obtaining it. Under- and over-education is determined by comparing declared educational level with respondent´s actual educational attainment.
- ***Objective*** (normative) method based on expert evaluation of required qualification for specific job. Proper level of education for particular occupation can be for instance determined by using ISCO classification. In the Czech Republic occupational descriptions such as those in the National Register of Occupations (Národní soustava povolání – NSP) can be used as benchmark for determining appropriate educational levels in job analyses.
- ***Statistical*** (empirical) method uses data on educational distribution within specific occupation. The majority of studies using this approach labels respondent as "mismatched" in case that his or her

education (expressed by years spent by education) differs by more than one standard deviation from mean level of education in occupation (s)he performs (e.g. Verdugo and Verdugo, 1989).

All the approaches have several limitations. The main weakness of subjective approaches is that respondent´s opinion on required education may be different from employer´s point of view and doesn´t have to reflect current situation on the labour market. When applying objective methods researchers have to deal with an issue of level of disaggregation of occupations. The broader the definition of the occupation, the more heterogeneous workers it includes and the possibility to derive one single educational level for all of them is limited. In this paper, the character of PIAAC data enable us to easily measure educational mismatch by using subjective methods of direct and indirect self-assessment.

3.2 Skill mismatches

When measuring skill mismatches, two main approaches are typically applied. First approach labels workers as matched or mismatched according to self-evaluation of their skills and of the level of skills one need in the job they perform. The second approach compares workers specific skills with the frequency in which these skills are performed at work and uses some technique of skills measurement.

The first approach measures skill mismatch through subjective self-assessment of workers. Respondents are asked whether they use their skills in the job sufficiently or not, or in other words if their skills match the requirements of their job. This direct self-reported approach was used for example in HILDA survey (Household Income and Labour Dynamics in Australia) where employees evaluated their attitude towards the statement of *"I use many of my skills and abilities in my current job"* on seven point scale. Those who disagreed with the statement were labeled as overskilled and reversely, those who agreed were labeled as underskilled (Mavromaras, McGuinnes and Wooden, 2007). Subjective assessment by workers has been used in many studies, although it has several disadvantages. Firstly, workers may not possess all the information to assess skills properly and secondly, they might exaggerate their own abilities or requirements of the job. Detailed investigation of problems related to self-assessment in measuring skills can be found in Allen, Van der Velden (2005).

Two questions in PIAAC survey enabled us to perform skills mismatch analysis using subjective methods. Their exact wording was: *"Do you feel that you have the skills to cope with more demanding duties than those you are required to perform in your current job?"* and *"Do you feel that you need further training in order to cope well with your present duties?"*.

Second, the most developed approach of skills mismatch measurement derives the demand for skills on the labour market from the frequency that individuals perform skills related tasks at their workplace. By relating skills level of an individual with his job´s requirements on skills used we can find out whether one´s skills are appropriate, insufficient or underutilized for his or her job. Aggregation allows us to derive the extent of skills match and mismatch in the population. When applying this approach we have to keep in mind possible sources of bias. Firstly, frequency of skills use measured by questionnaires cannot possibly reflect all the dimensions of work performance and only several items can be used as representatives of numeracy or literacy use at work. For example PIAAC used 6 specific items to measure frequency of numeracy related tasks at work (see Figure 2). Moreover, tests of skills such as numeracy or literacy can only cover certain features of overall skills which doesn´t necessarily match skills demanded on the labour market. All objections against this approach can be summarized briefly: Particular skills level and frequency of performing certain tasks on the workplace both measured by questionnaire do not necessarily correspond with the supply of skills and the demand for them in the labour market.

The original methodology for relating skills use and skills level was developed by Krahn and Lowe in 1998 on IALS data. In their analysis they created 4 categories of skills use and equally 4 categories of skills level and compared the combination of these categories for an individual. In the analysis of ALLS data (OECD, 2005) their method has been slightly modified. The median value of skills utilization

in the whole economy was used as a borderline between high and low skill use and the level of skills above the value of 2 was considered as high skills. As an outcome four possible categories of skills level/skills use combination were created:

- Low-skill match (skills level 1 or 2 and skills utilization below the median level),
- High-skill match (skills level above 2 and skills utilization above the median level),
- Deficit mismatch (skills level 1 or 2 and skills utilization above the median level),
- Surplus mismatch (skills level above 2 and skills utilization below the median level).

In this paper, we build up on Krahn and Lowe´s methodology of measurement of skills mismatch described in final report of ALLS survey (OECD, 2005) and we further develop it. Reasons for modifying the original methodology are the following: firstly, it is a respect to respondents located very close to the median value of skills use. Median as a decisive point leads to the situation when even subtle difference on the scale of skills use may cause major difference in respondent´s classification as matched/mismatched. Consequently, differences between some of the workers labeled as matched and mismatched can be negligible. That´s why we considered the share of mismatched workers derived from this approach as overstated and decided to take up more apparent criteria of skills mismatch described below. As a minor modification we decided to take up different method of distinguishing between high and low level of skills. Instead of using skills level 3 as a borderline of high skills achievement we decided to work with percentiles as an expression of individual´s relative position on the skills scale. As a result, both skills and skills use are evaluated using the same measure, which is the position of individual in relation to others.

We consider the outcomes of newly developed methodology as an appropriate estimate of the share of skills mismatch in the Czech labour market. However, since 2005 when Krahn and Lowe introduced their methodology, it has been applied in several studies. Outcomes of these papers can be related to results from PIAAC study in the Czech Republic and provide us a broader context for our results. Krahn and Lowe´s original methodology thus appeared to be more suitable for international and intertemporal comparison. This is the reason why we decided to use it as an alternative measure of skills mismatch in this paper. Differences in the extent of skills mismatched derived from two methods will be discussed and their weak and strong sides will be pointed out.

4 RESULTS FROM PIAAC – SHARE OF SKILLS MATCH/MISMATCH AND EDUCATION MISMATCH IN POPULATION, INTERNATIONAL COMPARISON AND DISTRIBUTION OF MISMATCH AMONG DEMOGRAPHIC GROUPS

4.1 Educational mismatch

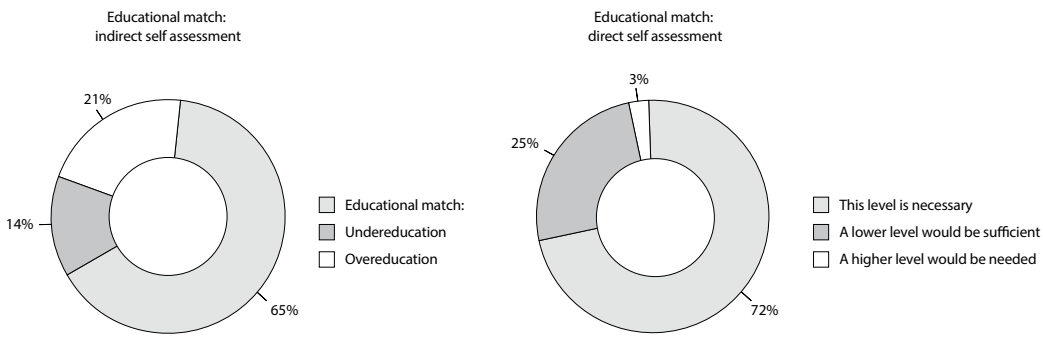
In PIAAC, two approaches were applied in order to measure the scope of educational mismatch. Indirect self-assessment is first of them. More specifically, question with following wording: *"Still talking about your current job: If applying today, what would be the usual qualifications, if any, that someone would need to GET this type of job?„* was posed in the PIAAC questionnaire. Declared level of required education was related to respondent´s actual educational level and three possible categories were derived:[6]

- ***educational match*** – in case when required education was in accordance with actual qualification,
- ***overqualification*** – in case respondent´s actual education was higher than qualification required for his/her job,
- ***underqualification*** – in case respondent´s actual education was lower than qualification required for his/her job.

[6] For the purposes of our analysis, we were working with four qualification levels that are commonly used in the Czech educational system. Levels of education we used were namely: elementary education, secondary education without school-leaving exam, secondary education with school-leaving exam and tertiary education.

Secondly, direct self-assessment method was applied by asking a question of *"Thinking about whether this qualification is necessary for doing your job satisfactorily, which of the following statements would be most true?"*. Respondents were supposed to subjectively assess whether their educational level is satisfactory for their job and they could choose between three answers *"This level is necessary"*, *"A lower level would be sufficient"* or *"A higher level would be needed"*.

Figure 1 Distribution of educational match and mismatch measured by indirect and direct self-assessment method



Source: PIAAC data

Figure 1 shows the distribution of educational match and mismatch and enable us to compare the outcomes of two different methods. According to the indirect self-assessment method jobs of 65% of workers are matched with education of their holders, the educational attainment of 35% doesn´t correspond to the level their job would require. More specifically, 21% of population is overqualified and qualification level of 14% is lower than their job would require. The comparability with direct self-assessment method seems to be rather limited. The main difference emerges from negligible share of underqualified population derived from the direct self-assessment method. Obviously, it is rather rare to directly state that higher level of education would be needed for somebody´s own job. When asking indirectly, the share of undereducated is 11 p.p. higher. The difference probably sources from the different perception of "qualification someone would need to get this job now" and "qualification necessary for doing the job satisfactorily". While the former expression is closely connected to formal requirement of employer, the latter one rather reflects evaluation of own abilities. The share of overqualified workers derived from direct as well as indirect method differs only slightly.

Meta-analysis of 25 studies focused on the scope of under/overeducation by Groot and Van der Brink (2000) estimates the average overeducation rate measured by self-reporting method of 28.6% and undereducation rate of 15.5%. Rates of educational mismatch in the Czech Republic derived from indirect self-assessment method do not seem to be exceptional. Groot and Van der Brink (2000) state that subjective methods based on self-assessment bring the highest estimates of overeducation rates. Presumably, future research based on objective and statistical methods applied on Czech data would bring lower shares of overeducated workers in the Czech population.

4.2 Skills mismatch

Skills mismatch measurement enables us to examine the scope of discrepancy between the skills offered by workers on the labour market and skills required by employers. The goal of this analysis

is to find an answer to the question of how many workers have insufficient skills for the job they perform and how many of them are overskilled for their jobs. As we stated above, we will use two methods of finding an answer to this question in this paper. We start with more sophisticated and analytically demanding method based on the frequency of use of skills in the job and in the next section we try to compare it with subjective method of skills self-assessment.[7]

The PIAAC dataset provides us with assessment of three domains of skills demanded on the labour market – literacy skills, numeracy skills and skills of problem solving in technology rich environment. According to OECD (2013b) literacy is defined as: *"the ability to understand, evaluate, use and engage with written texts to participate in society, to achieve one´s goal, and to develop one´s knowledge and potential. Literacy encompasses a range of skills from decoding of written words and sentences to the comprehension, interpretation, and evaluation of complex texts"*. Similarly, numeracy is described as: *"the ability to access, use, interpret and communicate mathematical information and ideas in order to engage in and manage the mathematical demands of a range of situations in adult life"*. Last domain of cognitive skills, problem solving in technology rich environment is defined as: *"the ability to use digital technology, communications tools and network to acquire and evaluate information, communicate with others and perform practical tasks"*. An individual´s score on the skills scale was derived using adaptive testing based on item response theory. For the purpose of this analysis, only the data on literacy and numeracy skills were used. The reason behind excluding scores of problem solving in technology rich environment was non-random distribution of missing data.[8]

Our strategy for direct measuring of skills mismatch was to compare individual´s skills level with extent of use of this skill in his/her job as a proxy for skills requirements of the employers. Respondents were asked to evaluate the frequency in which they need to perform narrowly defined set of activities in their job. Activities that are relevant to measured skills and reflect their use were examined in this analysis. For this purpose, two scales reflecting the frequency of tasks performed at workplace were created. The final scale was created in two steps. At the beginning there were data on frequency of narrowly defined tasks (such as writing reports, using calculator). Frequency of tasks was measured on 5 point scale ranging from "never" to "every day". Firstly, factor analysis was performed and broader groups of tasks (i.e. simple mathematics, technical reading) were created according to its outcome. Every individual can be assigned with a value (factor score) that indicates his or her relative position on the scale of frequency of performing these broader groups of tasks. Weighted average of factor scores was used in order to determine individual´s position on related general work activities scale (mathematics, reading and writing). The contribution of individual activities to the development of related skills is not identical. That is why partial correlation coefficients expressing the connection of groups of tasks and related skill were used as a weight for determining the final position on the general work activities scales. The more the specific group of tasks was related to corresponding skills, the more weight it was assigned. Both scales, the one reflecting skills use and the other one reflecting skills level, were transformed into percentiles scale in order to express performance of individual in relation to others.

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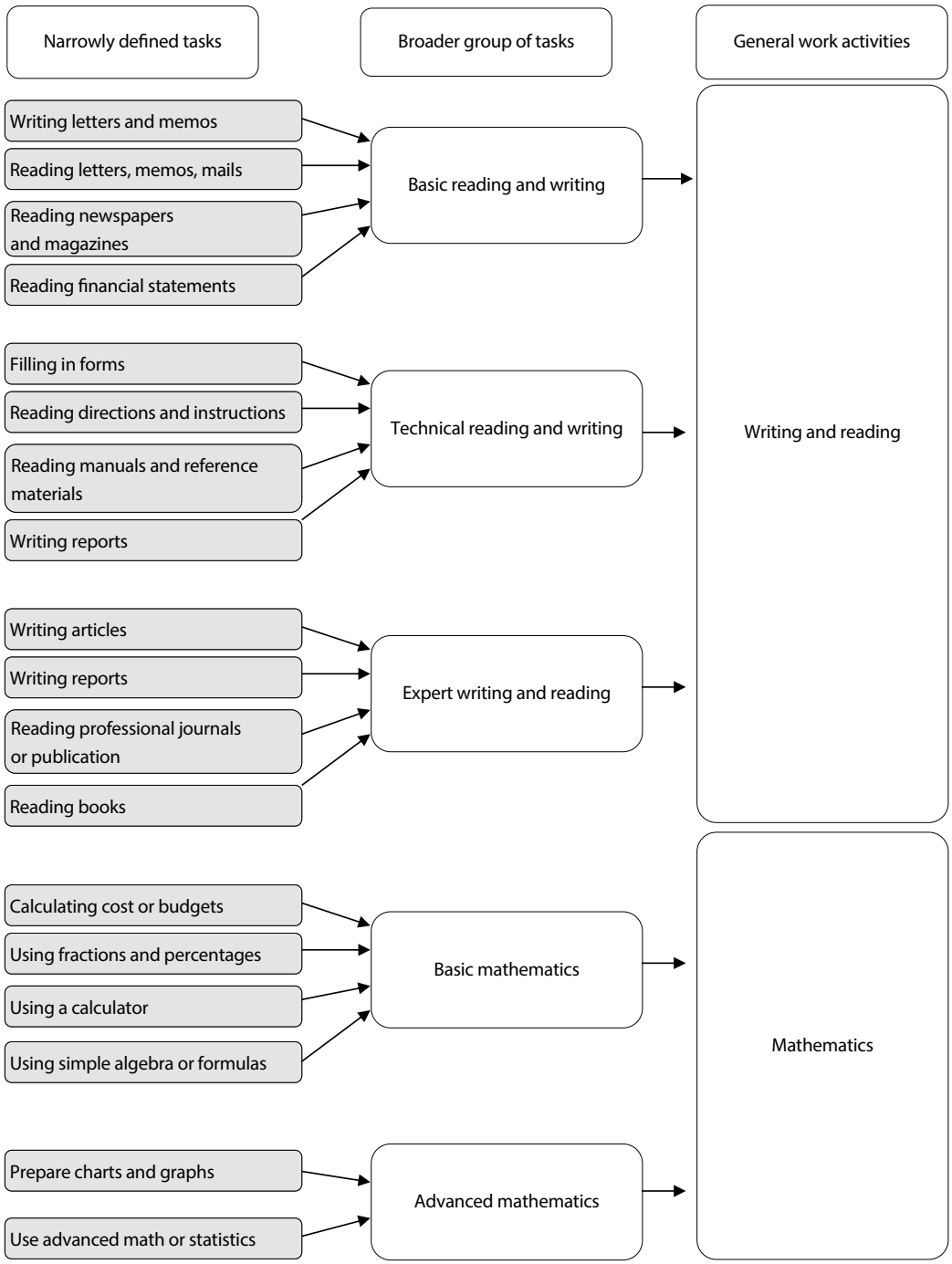
[7] These two methods don´t cover all the possibilities of skills mismatch analysis on PIAAC data. As a methodological innovation, OECD (2013a) took up a combination of subjective and statistical method in order to determine the level of skills mismatch. Skills level of workers who considered themselves as appropriately skilled in each country and occupational group were taken as a benchmark. Workers whose skills level was below this border were labeled as underskilled and workers whose skills were above were considered overskilled.

[8] Test of performance in problem solving in technology rich environment were taken up only by respondents who agreed on taking computer assisted test and reported they had at least some computer experience. In the Czech data 75% of respondents went through problem solving in technology-rich environment assessment.

Figure 2 A schema of composition of skills use scale



Source: Own construction

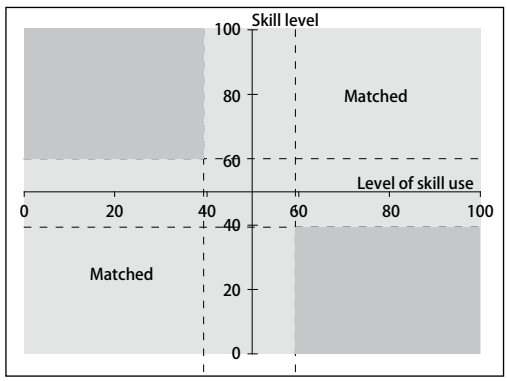
The method described above has several pros and cons. Weighted average of factor scores may seem a complicated way of determining the level of skills use. Another disadvantage is limited possibility of conducting international comparison due to the assumption that the results of factor analysis would differ among countries. However, we consider outcomes of this method as very precise way how to determine the level an individual uses reading, writing and mathematics on workplace. Some other author´s approach (e.g. Allen, Levels and Van der Velden, 2013) was to compute simple mean of items that measure skills use. This method doesn´t reflect unequal importance of measured tasks for indicating skills use and for example results in assigning the same weight to reading emails and writing articles for the evaluation of literacy use. This is why we decided to use more complicated method described above.

Another step was distinguishing three possible categories of skills and skills use combination. For the definition of mismatch the value of 40th and 60th percentile on both scales was crucial (see Figure 3).

1) ***Matched*** workers whose level of skill use is in accordance with the level of related skills. It concerns both situation of an individual who possesses low level of skills and performs a job where he or she just rarely use them, as well as of high-skilled professional who makes use of this skills on a daily basis.

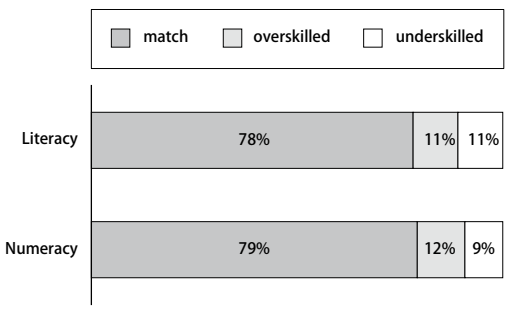
2) ***Overskilled*** workers have more skills than their job demands. It describes a situation when someone´s skills are above the level of 60% of the population but when it comes to skills use, at least 60% of the population uses them more often on their workplace.

Figure 3 Determination of categories of match mismatch



Source:

Figure 4 Distribution of skills match and mismatch in literacy and numeracy



Source: PIAAC data analyzed by the method developed in this article

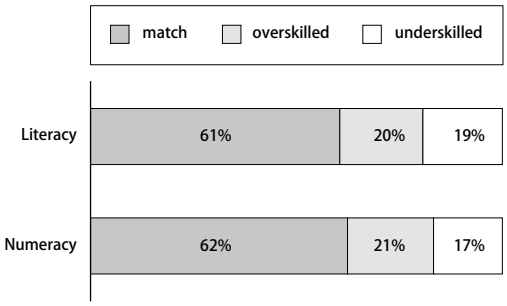
3) ***Underskilled*** workers have insufficient skills for performing their jobs. Individuals labeled as underskilled showed poorer performance in skills test than 60% of the population while their position on skill use scale ranks them among 40% of most frequent users.

An analysis based on newly developed methodology leads us to the conclusion that both literacy and numeracy mismatch concerns approximately one fifth of the Czech workforce (20.8% in case of numeracy and 21.8% for literacy). In the domain of literacy, 10.9% of the Czechs can be described as underskilled, in case of numeracy, skill deficit value over 9% is slightly less of a problem. This concept of skills mismatch will be elaborated in the following chapter, where we will take a closer look at the distribution of mismatch among various demographic groups.

In the previous chapter, we argued why we consider methodology used in this paper as the most appropriate for measuring skills mismatch. However, results for Krahn and Lowe´s methodology (2005) applied on PIAAC data will be introduced in order to perceive the extent of skills mismatch in the Czech Republic in broader context. Results are described in Figure 5.

As expected, the extent of mismatch based on Krahn and Lowe´s methodology was

Figure 5 Distribution of skills match and mismatch in numeracy and literacy according to Krahn and Lowe´s methodology

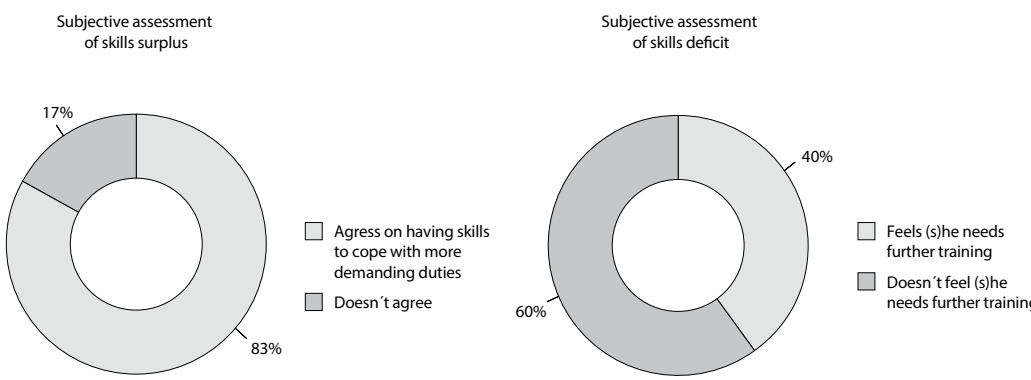


Source: PIAAC data analyzed by Krahn and Lowe´s methodology

higher reaching 37.6% in case of numeracy and 39.5% in literacy. Share of overskilled in literacy and numeracy is comparable; skills deficits are moderately higher in literacy. These results can be related to Desjardin´s and Rubenson´s (2011) work who applied the very same method of skills mismatch calculation on 9 countries participating in ALL survey.[9] Literacy and numeracy mismatch turned out to be a widespread phenomenon in all participating countries. In case of literacy the proportion of skills deficit ranged among 9 and 29% in literacy, in case of numeracy the range was from 6 to 20%. Skills surplus ranged from 12 to 32% in literacy and from 17 to 46 in numeracy. The scope of underskilled as well as overskilled workers in the Czech Republic derived from PIAAC survey doesn't seem to be exceptional in the international context and in both measured domains of skills represents values close to the average. When reading outcomes of skills mismatch analysis based on Krahn and Lowe´s methodology, we should keep in mind that significant part of respondents labeled as mismatched can in fact be only slightly deviated from the median values. In the methodology developed for this article the criterion of mismatch is stricter and just respondents, whose job is in severe discrepancy with their skills, are labeled as mismatched.

From PIAAC data we can directly compare how the extent of skills mismatch differs when we use analytically less demanding approach of subjective self-assessment (later in a text referred as subjective method). Figure 6 shows the extent of subjective skills surplus based on the answers on the question *"Do you feel that you have the skills to cope with more demanding duties than those you are required to perform in your current job?"*. 83% of respondents did agree with this statement in PIAAC and could be considered overskilled according to subjective measures.

Figure 6 Subjective assessment of skills surplus and deficit



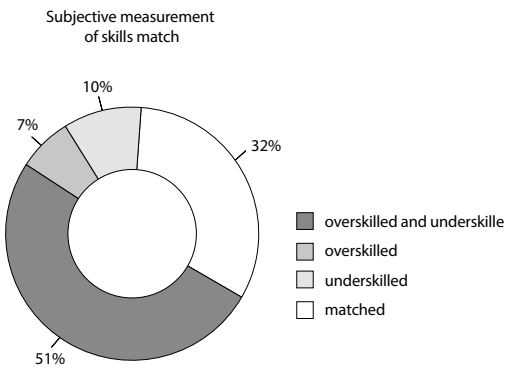
Source: PIAAC data

[9] Measurement of skills use in ALL and PIAAC surveys was not identical, but both approaches were very similar and therefore we consider their comparison as appropriate. Different approach of determining skills use scale has to be considered as well.

On the other hand, 40% of respondents agreed that they *"Feel they need further training in order to cope well with their present duties"*. That would indicate that 40% of population feel underskilled for the job they do.

The inconsistence of two methods of skills mismatch measurement is obvious. According to subjective approach only 9.6% of population feel appropriately skilled for their job. On the other hand, 32.5% stated they have skills to cope with more demanding duties in their job, but at the same time they would need further training to cope with their present duties. It can be the case of workers who feel confident about one domain of their work related skills, but realize insufficiencies in others. Manager who is fully competent in work with information technologies but lacks foreign language skills can be a good example of this phenomenon. These results indicate that subjective measurement of generally defined skills brings results whose benefit for skills mismatch analysis is questionable. Any comparison with outcomes of method based on frequency of skills use is hardly feasible and these methods cannot be considered as substitutes.

Figure 7 Subjective measurement of skills mismatch



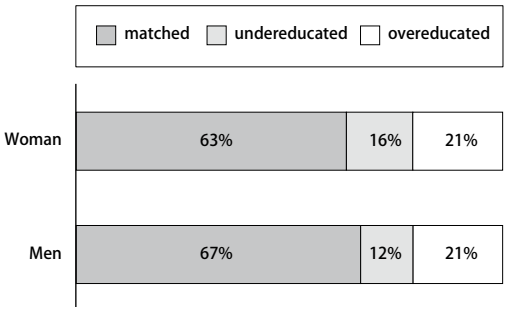
Source: PIAAC data

4.3 Distribution of educational and skills mismatch among demographic groups

This chapter will take a closer look at demographic determinants of skills and educational mismatch. Factors of age and gender will be examined.

According to Groot and Van den Brink´s meta-analysis, women are more likely to be overeducated, while undereducation is more frequent among male workers. There are several theoretical explanations for this pattern originating in Frank´s theory of differential overqualification (1978). Frank suggested that women are in greater risk of being overqualified because family´s decision to relocate is usually based on husband´s carrier. As a result, women accept jobs that are available, although not suitable for their qualification level. Explanations more appropriate for modern labour market concern invisible barriers for women´s advancement and gender stereotypes (see more in Luksyte, Spitzmueller, 2011). However, such a hypothesis cannot be confirmed when using indirect self-assessment method on PIAAC data from the Czech Republic. The share of overeducated men and women in the population is equal, i.e. 21%. On the contrary, 15.6% of women as opposed to 12.3% of men have lower qualification than their job would require (Figure 8). One possible explanation of unexpected patterns in the Czech data can be noticeably lower share of part-time jobs on total employment. Whereas in the EU 27 there is 31.5% of the population employed in part-time jobs, in the Czech Republic it is only 9.1% (LFS data), which is more than three times less than the EU average. Part-time jobs can be very often occupied by employers whose skills are not fully utilized. It is mainly due to a fact that they prefer such a situation and benefit from work time flexibility, or less commute to work, or because they simply need to harmonize family and working life. As a result of unavailability of flexible contracts on the labour market, activity rates of women in younger age groups are lower in the Czech Republic. In EU the rate of economic activity of women in age category 30–34 is 77.7%, in the Czech Republic it is only 64.7% (LFS data). For Czech women, parenting is connected with a switch to inactivity, whereas women in other countries stay at the labour market and contribute to increase of shares of overeducated.

Figure 8 Distribution of educational mismatch by gender using indirect self-assessment method

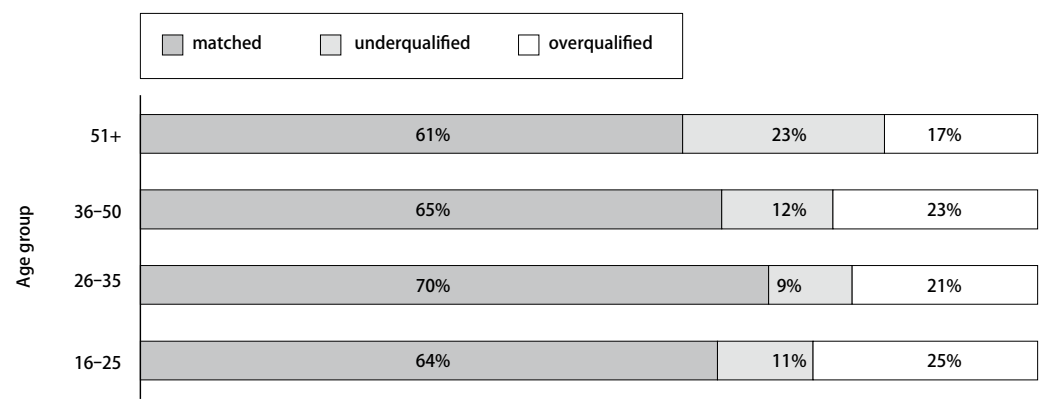


Source: PIAAC data

Surprisingly, there are also no gender differences in direct self-assessment of educational mismatch. It is equally one quarter of men and women that assume that lower level of education would be sufficient for their job and three percent of men as well as women that think they would need higher level of education for their job. Therefore, Figure 1 illustrating the direct self-assessment of educational mismatch in the entire population is identical with separate figures for men and women.

When we turn our attention to relation of underqualification and overqualification to age, Czech results are in line with internationally validated hypotheses (Quintini, 2011). Youth were more likely to be overeducated and older workers were more often underqualified. Growing educational level of the population provides us with an explanation why underqualification is a phenomenon closely related to older age groups. In accordance with that almost one quarter of workers in the youngest age group in our data has higher education then their work would require. When searching for a job young people may often face difficulties related to their lack of work experiences and therefore they may start their carriers taking up jobs that are less suitable for their skills and education. Temporary and usually unqualified student´s jobs may also contribute to high share of overqualified in the working population in this age group.

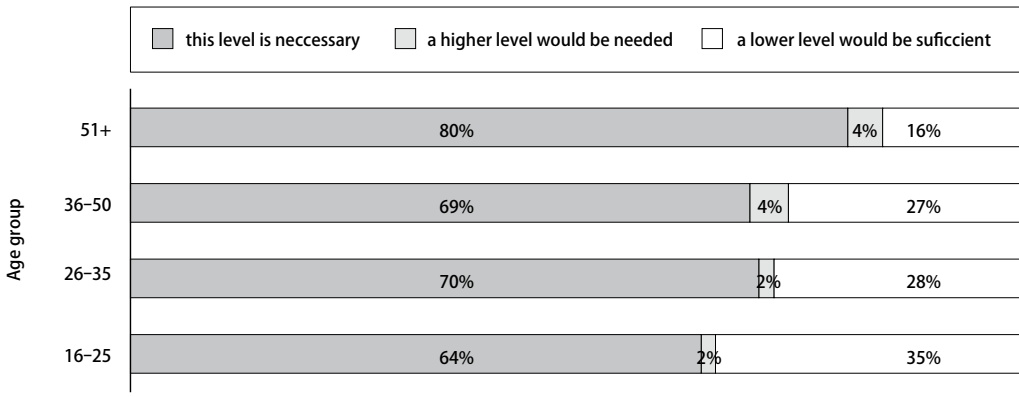
Figure 9 Distribution of educational mismatch by age using indirect self-assessment method



Source: PIAAC data

When assessing educational match directly (Figure 10), less than 4% of older workers consider themselves as underqualified. Once again perceived employer´s requirements do not correspond with evaluation of own abilities. Although respondents were aware that they wouldn´t comply with educational requirements of the employers, most of them believe they cope with their working duties satisfactorily even without additional formal qualification level.

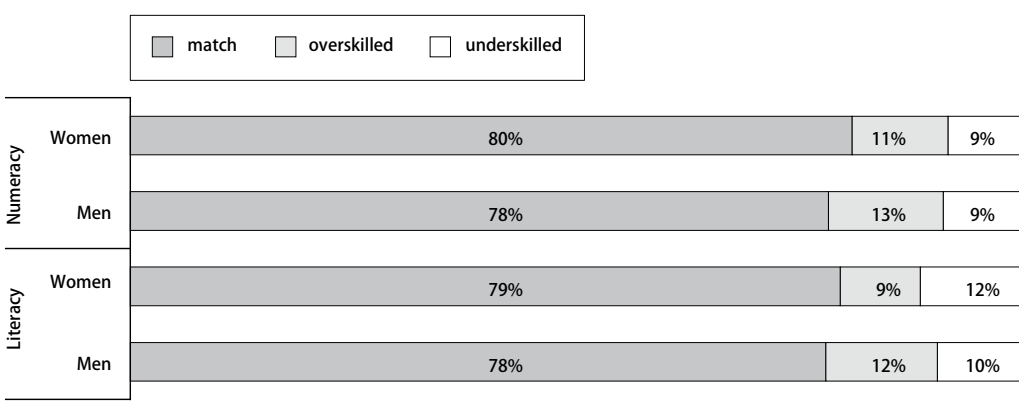
Figure 10 Distribution of educational mismatch measured by direct self-assessment



Source: PIAAC data

Available studies on educational and skills mismatch predominantly agree that women show an increased tendency to have skill as well as educational surplus while men more often lack sufficient skills and qualification for the job they perform. Above, we could see that our data did not confirm such a pattern in case of educational mismatch. Figure 11 shows us that Czech data are inconsistent with results of previous studies in the domain of skills mismatch as well. Although the differences were subtle (3.5 p.p. in literacy and 2.1 p.p. in numeracy), men were more likely to fall into the category of overskilled. The proportion of men and women lacking numeracy skills for satisfactory performance in their jobs was comparable (the share of men exceeds the share of women by 0.5 p.p.), the deficit of literacy skills was slightly more frequent among women (difference of 1.9 p.p.). A higher share of women working in professions requiring more literacy skills may be an explanation.

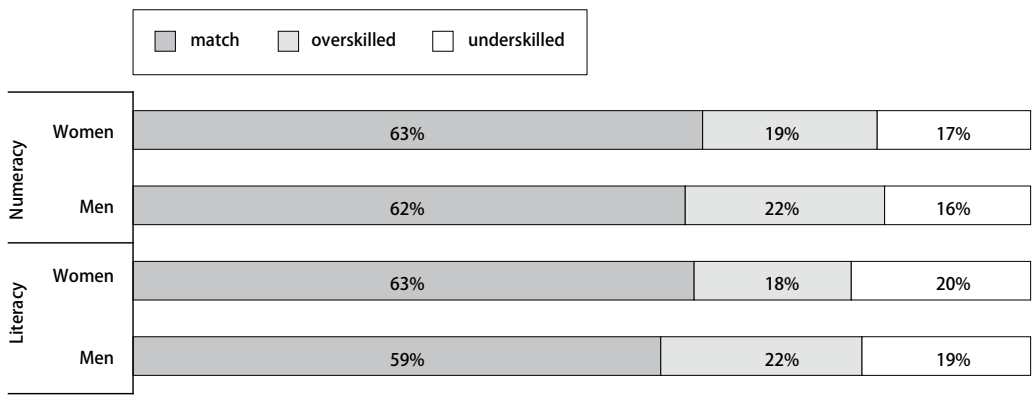
Figure 11 Skills mismatch distribution by gender



Source: PIAAC data analyzed by method developed in this article

In order to find out whether discrepancies with theoretically expected patterns are caused by different methodological approach of skills mismatch measurement or less usual situation on the Czech labour market we will proceed to direct comparison with Desjardin and Rubenson´s (2011) study that we mentioned earlier in this paper. According to Desjardin and Rubenson´s analysis of international data there was a significant predominance of women among overskilled workers in all countries they studied. On average, the share of overskilled women is 9% higher than that of men in case of literacy and 7% higher in numeracy. To provide comparable results we have to work with Krahn and Lowe´s methodology of skills mismatch identification. Results shown in Figure 12 confirm the same pattern of gender distribution of skills mismatch that we have revealed above. In contrast to other studies, men in the Czech Republic have higher probability of being overskilled in both numeracy and literacy than women. Results of educational and skills mismatch analysis point out to very similar phenomenon. Apparently, women are more likely to have a job that makes full use of their skills. We also haven´t found any evidence that women work in jobs requiring lower qualification level than the one they have achieved, more frequently than men. Analyses indicate that underutilization of women's workforce skills and qualification is not an issue in the Czech Republic. However, considering results of Desjardin and Rubenson´s analysis, gender based differences in skills mismatch distribution in the Czech Republic are less significant.

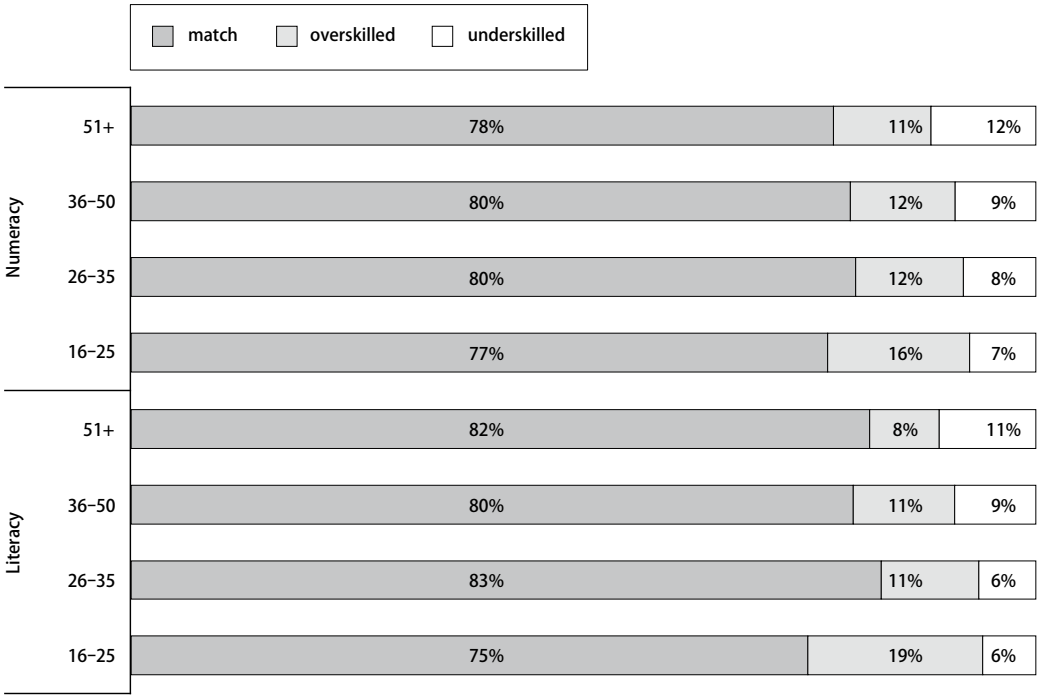
Figure 12 Skills mismatch distribution by gender according to Krahn and Lowe´s methodology



Source: PIAAC data analyzed by Krahn and Lowe´s methodology

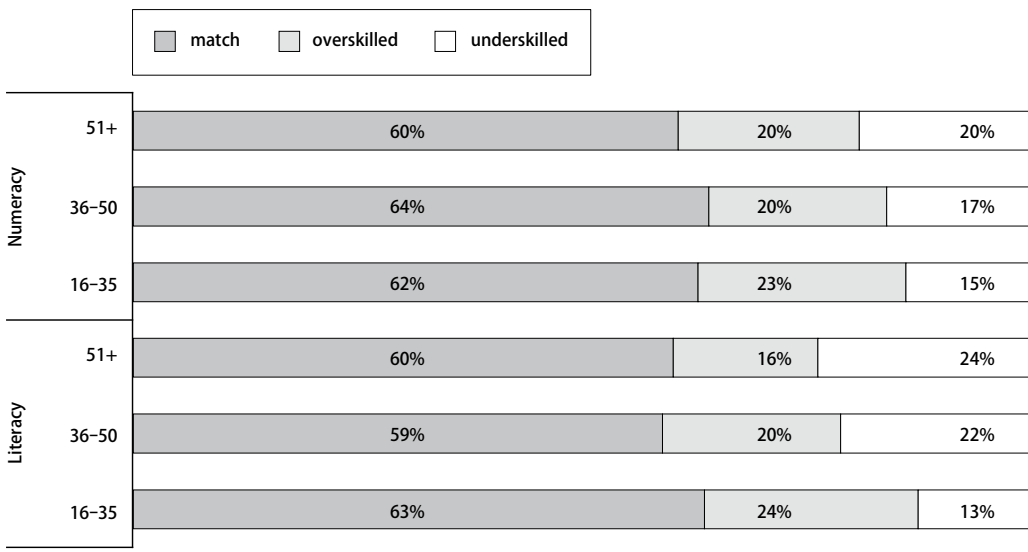
Age is the second characteristic that we investigated in relation to skills mismatch. Figure 13 shows results of this analysis. We can observe clear relation of young age and both numeracy and literacy skills surplus. In literacy, the differences are especially significant. In this domain, the share of overskilled in the age group under 25 is more than two times higher than among workers in the age group of 51–65. This difference stems from significant positive deviation from average skills surplus incidence among young people rather than from negative deviation of older workers. Consequently, the share of workers with literacy skills deficit increases with age. 11% of workers among 51–65 years lack literacy skills that their workplace requires. Part of the explanation can be provided by a general trend of age related skills decrease. According to the results of PIAAC study (OECD, 2013a) older adults score is lower on the literacy scale than any other age group. However, high incidence of skills surplus among young people also reflects difficulties they face while searching for job that suits their skills. Young people, regardless of their skills, take up less qualified workplaces to gain some experience, which can later help

Figure 13 Distribution of skills mismatch by age



Source: PIAAC data analyzed by methodology developed in this paper

Figure 14 Distribution of skills mismatch by age according to Krahn and Lowe´s methodology



Source: PIAAC data analyzed by Krahn and Lowe´s methodology

them to find a way to job that fits their skills better. Interestingly, in case of numeracy there is less clear evidence of relation of age and skills deficit incidence.

The pattern of highest probability of young people to fall into the category of overskilled has also been identified in all countries under focus of Desjardin and Rubenson´s study (2011). What might be interesting is the comparison of the difference in the share of overskilled between the youngest and the oldest age group. In Desjardin and Rubenson´s (2011) study there was in average 10% higher share of overskilled in literacy in the age group from 16 to 35 years than among workers from 50 to 65 years. The average difference for numeracy was 4%. When we used Krahn and Lowe´s methodology, we concluded that in the Czech Republic differences in the share of overskilled in the youngest and the oldest age groups were also more distinct in case of literacy (7.6 p.p.) than in numeracy (3.2 p.p.). Results are shown in Figure 14.

CONCLUSION

Skill and educational mismatch refer to the situations when workplaces are occupied by workers with insufficient or inappropriate skills or when workers skills are not fully employed which may lead to their atrophy. Their incidence and extent signalize persisting inefficiencies on the labour market. Existing academic literature suggests that skills and educational mismatches influence not only economy as a whole, but are also strongly related to individuals´ job satisfaction, wage and mobility (Tsang, 1987, Sicherman, 1991, Hersch, 1991). Skill mismatch should thus be of concern of all citizens, workers´ associations but mainly to those responsible for policy making. In this paper we discussed methodological approaches to measurement of mismatches and applied traditional as well as alternative methods in order to estimate the incidence of skills and educational mismatches on the Czech labour market. We build up on Krahn and Lowe´s work and developed and applied new method of measuring the extent of skills mismatches for the purposes of this paper. The advantage of our method is that it expresses both levels of skills and of skills use as a position of individual in relation to the rest of the workforce. Inconsistencies between actual skills and skills usage on workplace can therefore be easily captured by confronting these levels. The level of skills use was determined by using sophisticated and empirically grounded method of aggregation of narrowly defined work tasks into broadly defined work activities that have direct connection with the level of individual´s skills.

Our results indicate that 35% of the Czech population attained different educational level than their work would require. Overeducation, i.e. situation when individuals had higher education than employer would demand, was more frequent than undereducation. However, the outcomes of measurement of educational mismatch depend on the methodology applied. Direct and indirect self-assessment methods provide us with very different estimates of the share of educationally mismatched workers. The results of these two methods diverge especially in estimates of undereducation rates. Measurement of the scope of educational mismatch in the Czech Republic by methods not suitable for PIAAC data and therefore not used in this paper would be an interesting suggestion for future research.

In the domain of skills we found approximately one fifth of the Czech population mismatched in literacy and very similar share in numeracy. In the Czech labour market employers do not take fully advantage of literacy skills of 10.9% and numeracy skills of 11.6% of workers. At the same time, 10.9% of workers lack sufficient literacy skills which negatively affect their working performance. The same is true for 9.2% of the working population in case of numeracy. It also turned out that measuring skills mismatch by using subjective self-assessment can hardly be considered as substitute to the method based on the frequency of skills use. It is attested to the fact that individuals, when asked to assess the sufficiency of their skills, refer to specific rather than generic skills.

Distribution of mismatch is not equal among different demographic groups. Young age is strongly connected with the incidence of both educational and skill surpluses. This result brings us back

to the reflection that there are many other factors on the labour market but skills that matter. When hiring new workers, employers consider applicants´ education and skills as well as work experience, motivation, personality and many other characteristics. Young workers often lack work experiences and therefore the appropriate level of skills does not always have to be sufficient for being hired for a qualified job. The outcome that we have found surprising is that there is no gender difference in the distribution of labour market mismatches. This finding is rather unusual in academic literature dealing with this issue and suggests that conditions for finding suitable job are not very different for men and women in the Czech Republic and women skills are not underutilized.

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ANNEX

Table A1 Summary of results of measuring educational mismatch

	Educational mismatch		
Indirect self-assessment	**Educational match**	**Undereducation**	**Overeducation**
Total	65.1%	13.9%	21%
Women	63.4%	15.6%	21.1%
Men	66.7%	12.3%	21%
Age group:			
16–25	64.4%	10.6%	24.9%
26–35	70.0%	9.3%	20.7%
36–50	64.8%	12.4%	22.8%
51–65	60.5%	22.5%	17.1%
Direct self-assessment	**This level is necessary**	**A higher level would be needed**	**A lower level would be sufficient**
Total	71.4%	3.2%	25.4%
Women	71.7%	3.2%	25.1%
Men	71.1%	3.2%	25.7%
Age group:			
16–25	63.6%	1.6%	34.8%
26–35	70%	1.7%	28.3%
36–50	69%	4.3%	26.7%
51–65	79.9%	3.9%	16.2%

Source: : Own calculations, PIAAC

Table A2 Summary of results of measuring skill mismatch

	Skill mismatch					
New methodology	**Match**		**Overskilled**		**Underskilled**	
	Numeracy	**Literacy**	**Numeracy**	**Literacy**	**Numeracy**	**Literacy**
Total	79.2%	78.2%	11.6%	10.9%	9.2%	10.9%
Women	80.4%	79.1%	10.7%	8.9%	8.9%	12.0%
Men	77.7%	77.5%	12.8%	12.4%	9.4%	10.1%
Age group:						
16–25	77.0%	75.0%	16.0%	19.0%	7.0%	6.0%
26–35	80.0%	83.0%	12.0%	11.0%	8.0%	6.0%
36–50	80.0%	80.0%	12.0%	11.0%	9.0%	9.0%
51–65	78.0%	82.0%	11.0%	8.0%	12.0%	11.0%
Krahn and Lowe´s methodology	**Match**		**Overskilled**		**Underskilled**	
	Numeracy	**Literacy**	**Numeracy**	**Literacy**	**Numeracy**	**Literacy**
Total	62.4%	60.5%	20.9%	20.2%	16.7%	19.3%
Women	63.4%	62.5%	19.4%	17.5%	17.1%	20.0%
Men	61.5%	58.8%	22.2%	22.4%	16.3%	18.8%
Age group:						
16–35	62.4%	63.1%	23.0%	23.6%	14.6%	13.2%
36–50	63.6%	58.5%	19.7%	19.7%	16.7%	21.8%
51–65	60.2%	59.7%	20.0%	16.0%	19.7%	24.3%

Source: Own calculations, PIAAC