Horizontal Mismatch between Employment and Field of Education: Evidence from a Systematic

Literature Review

Melline A. Somers, Sofie J. Cabus, Wim Groot and Henriëtte Maasen van den Brink

Maastricht University

Author Note

Melline A. Somers, Top Institute for Evidence Based Education Research, Maastricht

University; Sofie J. Cabus, Top Institute for Evidence Based Education Research, Maastricht

University; Wim Groot, Top Institute for Evidence Based Education Research, Maastricht

University; Henriëtte Maasen van den Brink, Top Institute for Evidence Based Education

Research, Maastricht University.

Correspondence concerning this paper should be addressed to Melline Somers, Top

Institute for Evidence Based Education Research, Maastricht University, Kapoenstraat 2,

6211KW, Maastricht, The Netherlands.

Contact: melline.somers@maastrichtuniversity.nl

Abstract

This paper provides a systematic review of the growing body of literature on the poor match between employees' field of education and the job profile, also referred to as horizontal mismatch. We identify methodological issues concerned with measuring horizontal mismatch and provide prevalence rates of horizontal mismatch. The ensuing findings offer guidance to prevent horizontal mismatch as well as a roadmap for future research in this domain.

Keywords: labour market; skills; horizontal mismatch; field of education

Horizontal Mismatch Between Employment and Field of Education: Evidence From a

Systematic Literature Review

A good match between labour supply and labour demand is indispensable for graduates and companies and, consequently, for the economy as a whole. Job mismatches can have serious consequences, not only for the individual because of unemployment risks (http://ec.europa.eu/social); wage penalties (Groot & Maassen van den Brink, 2000); or job dissatisfaction (McGuinness & Sloane, 2011); but also for society. Education is an expensive investment that society makes through public investments in education (Levin, Belfield, Muennig & Rouse, 2007; Levin & Rouse, 2012). The highest return to this investment for society comes about when individuals are well-matched to employers, such that knowledge acquired through education and on-the-job training can be optimally utilized on the labour market. Mismatched employees may be less productive than they would have been in a job that allows them to fully deploy their skills. Moreover, as a result of job dissatisfaction, mismatched employees may exhibit counterproductive behaviour on the job through higher absence and quit rates (Büchel, 2002; Tsang, 1987). Suboptimal productivity may lead to wage penalties which, in turn, reduce the return to public investments in educational provision (Quintano, Castellano & D'agostino, 2008; Zhu, 2014; McGuinness & Sloane, 2011). From an economic point of view, job mismatch is not optimal for society as we all pay a 'social price' for job mismatches. These costs may pertain to foregone return to public investments in education, but also to unemployment allowances, social security benefits, and reduced fiscal taxes.

Mismatch between labour supply and labour demand can take on different shapes and is usually measured by comparing employees' acquired education with the educational requirements of the job. Acquired education or educational requirements can be expressed in

terms of the level or quantity of education a are considered to be over-educated, while employees with less schooling than required are defined as being under-educated. This type of mismatch is also referred to as vertical mismatch (Heijke, Meng & Ris, 2003). The incidence, determinants and consequences of vertical mismatch have been well-documented (see e.g., Alba-Ramirez, 1993; Chevalier, 2003; Chevalier & Lindley, 2009; Dolton & Silles, 2008; Dolton & Vignoles, 2000; Duncan & Hoffman, 1981a; Groeneveld & Hartog, 2004; Kiker, Santos & de Oliveira, 1997; McGuinness & Bennett, 2007; Verdugo & Verdugo, 1989; Verhaest & Omey, 2006), and various studies have provided useful summaries of this stream of literature by means of reviews as well as meta-analyses (e.g., Groot & Maassen van den Brink, 2000; Hartog, 2000; McGuinness, 2006; Rubb, 2003; Sloane, 2003). Research confirms the adverse outcomes associated with vertical mismatch and various hypotheses have been proposed to explain what determines the incidence of vertical mismatch and its consequences to persist.

During the past two decades, the concept of mismatch has been broadened to include the type or field of education as a source of mismatch. A situation in which employees' attended field of education is unrelated to the field required for the job is also referred to as horizontal mismatch (Robst, 2007a).[1] This type of mismatch is of special relevance as employees are not solely matched based on their level or quantity of education. Given that particular fields of education aim to prepare students for a range of occupations, matching job requirements with employees' field-specific skills is essential for an efficiently functioning labour market. Moreover, students are assumed to make their schooling choices based upon educational preferences and with the expectation of finding future employment in field-related occupations (Betts, 1996; Holland, 1985). As such, horizontal mismatch can be considered undesirable and

---

[1] Instead of referring to horizontal mismatch, some studies simply refer to the match between an employee's field degree and his/her job. In this study we will use both terms.

result in an underutilization of skills. Although attending a field that fits individuals' interests plays an important role in motivating and preventing young students from dropping out of school (Spady, 1970), many graduates end up having a job that does not match their educational qualifications. At the same time, skill shortages are repeatedly reported by specific sectors across various OECD countries (e.g., Enequist, Kahlroth, Mähler Lejon, Lönn, Rosengren & Wahlén, 2006; De Jong & Berger, 2006; Smyth et al., 2006).[2] One potential explanation for the presence of skill shortages is that too many students choose to study subjects that do not correspond to the labour market demands (Machin & McNally, 2007). And although the U.S. Census Bureau shows that many graduates obtain a degree in fields that do offer good career prospects, a substantial share of these graduates still end up in jobs unrelated to the field of study ("Where do college graduates work?", 2014).

Considering the potential economic losses associated with an underutilization of skills, from a human capital theory perspective, horizontal mismatch is an undesirable phenomenon. Given that a proper allocation of skills on the labour market is in the best interest of society, an important question to be raised is how prevalent mismatch is and which welfare losses are generated by horizontal mismatch. We aim to address this question through answering four sub questions: (1) How is horizontal mismatch defined and measured? (2) To what extent is horizontal mismatch observed? (3) What are the determinants of horizontal mismatch? And (4) What are the consequences of horizontal mismatch? We answer the questions by means of a systematic review of the literature on mismatch between employees' job and the attended field of education. In particular the third question, allow us to develop policy recommendations with regard to preventing and reducing horizontal mismatch. The objective of this paper is to present

---

[2] According to the OECD's review of tertiary education, shortages are often reported in the health care and engineering sectors. Likewise, the Employers Skill Survey conducted in the UK indicates a shortage of science, mathematics and engineering graduates (McIntosh, 2005).

an integrated summary of the existing body of knowledge of horizontal mismatch. We identify where the conclusions of previous research converge and diverge and set the agenda for future research.

This paper proceeds as follows. Section 2 describes the literature search strategy. In Section 3 we address how horizontal mismatch has been defined and measured in the literature and what the advantages and drawbacks are of these definitions. Section 4 discusses the incidence of horizontal mismatch and Section 5 turns to the determinants of horizontal mismatch. In Section 6 we discuss the consequences of mismatch between the field degree and employees' job. Finally, Section 7 discusses the main conclusions of this study and provides suggestions for future research.

Literature Search Strategy

To conduct our review, we set a series of inclusion criteria to narrow the extensive body of research down to a manageable set of studies for a thorough analysis: (1) The study is published between 1995 and 2015 in peer-reviewed academic journals in the Dutch or English language. (2) Studies that are empirical are included, whereas theoretical, conceptual and case studies are excluded. Potential empirical studies encompass descriptive, correlational as well as causal (experimental) studies. And (3) The study has to deal with a mismatch between employees' job and the attended field of education. Studies that focus on other types of mismatch (e.g. over- and under-education) were not retained.

First, we limit our literature search to the time window 1995-2015 since concerns about employees' education-job match, with respect to the type and field of schooling, were first raised in 1995 by Witte and Kalleberg. Prior to the publication of this paper, studies on education-job mismatch only focused on employees' attained level of education. Second, our systematic review

is restricted to publications in the Dutch or English language due to a lack of resources and facilities for translation.[3] Moreover, we only consider empirical articles published in academic journals and therefore exclude non empirical studies such as qualitative research methods based on interviews, case studies or conceptual work, but also studies published on the internet, in books or in other non-peer reviewed journals. This will leave us with a better comparable body of research which improves the quality of our systematic literature review. Finally, given that we explore whether a mismatch between job requirements and the skills acquired through the field of study contributes to an inefficient allocation of skills on the labour market, we restrict our search to studies focusing on horizontal mismatch. Therefore, we exclude studies that concentrate on other types of mismatch such as under-education and over-education, as these do not answer our main research question and have already been well-documented in other reviews (e.g., Groot & Maassen van den Brink, 2000; Hartog, 2000).

We performed a computerized systematic search using a wide range of search terms or keywords, namely, "mismatch", "match" or "fit" combined with "education", "study", "major", "programme", "program" or "college" and "job", "employment", "work", "occupation", "labour" or "labor" and "field" (see Appendix 2. for the exact combination of search terms). The search was conducted in the following electronic databases: ERIC, EconLit and SocINDEX. ERIC is used as the main search engine as it is the largest education database worldwide, providing access to about 1 000 scientific journals. EconLit and SocINDEX were used in order

---

[3]   We recognize that this restriction potentially introduces language bias as studies conducted in non-English speaking countries are more likely to be published in an international English-language journal when significant results are found (Egger, Zellweger-Zähner, Schneider, Junker, Lengeler, & Antes, 1997b; Moher et al., 1996). However, the problem of language bias has been reduced in recent years due to the shift toward publication of studies in the English language (Galandi, Schwarzer & Antes, 2006). As can be seen in Appendix 1, the majority of the records we consider for our review have been published after 2000 and we therefore consider the problem of language bias to be minimal.

to add potentially missing articles to our search results. Figure 1 provides an overview of the selection process of relevant studies.

ERIC initially presents 424 studies that were published between January 1995 and December 2015, whereas EconLit and SocINDEX provide us with 99 and 237 potential records, respectively. Excluding the duplicated, non-peer-reviewed, non-English and non-Dutch records leaves us with 378 studies. Consequently, the studies were sorted based on the title and abstract which further allowed us to exclude 354 studies that did not meet our inclusion criteria. Reading the articles' full text, we keep 24 relevant papers.

Table 1 presents the selected studies and provides an overview of the data that was extracted: the year of publication, the number of countries included, the type of data, the year of data collection, the type of study, the sample size, and, the determinants and effects examined. As can been seen in Table 1, the studies selected for our review show several noticeable characteristics. Most studies on horizontal mismatch have been published recently, namely, after 2010. The majority of studies included in our review are correlational and make use of cross-sectional data, whereas no studies were causal or experimental in nature. The mismatch determinants that were subject to examination in the reviewed studies can be categorized into four major clusters: education-related, labour market-related, job-related and individual-related determinants. The first cluster can be further categorized into education-related determinants on the individual level and on the country level. Concerning the effects of horizontal mismatch, the emphasis has been on employees' wages in most studies.

Measurement

Horizontal mismatch is usually defined by comparing an employee's attended field of study and the field required for the job the employee holds. The literature on horizontal mismatch distinguishes between 'subjective' and 'objective' definitions. The subjective approach measures the educational requirements for a job based on employees' self-report. The objective method, on the other hand, determines the educational requirements for an occupation using an expert or by assigning occupational codes for statistical purposes to educational fields.

Subjective Measure

In many subjective specifications of horizontal mismatch, the respondent specifies the job requirements in terms of the attended field of education. For instance, Kucel and Vilalta-Bufí (2013) classified employees as horizontally matched if s/he reported that exclusively the own attended field or a related field was appropriate for the job, while employees were classified as horizontally mismatched when a completely different field or no particular field was most appropriate for the job. Other studies based their definition on the degree to which employees perceive a fit between their field degree and their current job. An example of a question aiming at measuring this degree is: 'Thinking about the relationship between your work and your education, to what extent is your work related to your doctoral degree? Was it closely related, somewhat related, or not related?' (see for instance Bender & Heywood, 2011; Bender & Roche, 2013; Robst, 2007a; Robst, 2007b).

Objective Measure

In addition to employees' self-assessment, several studies used an objective indicator of horizontal mismatch. Béduwé and Giret (2011) derived horizontal mismatch measures from a normative correspondence table which is established by experts and depicts the match between

occupations and the field and level of education. This table categorizes the distinct areas of vocational knowledge into 25 groups to which both educational qualifications and occupations can belong. When the knowledge group of the field degree and occupation do not correspond, there is 'horizontal mismatch'. Other studies use the International Standard Classification of Occupations to assign occupational codes to a field of study (e.g., Wolbers, 2003). The matching process is based on the extent to which the skills acquired through a specific field degree correspond to the job requirements. Accordingly, a discrepancy between the skills obtained in initial education and the skills needed on the job is defined as horizontal mismatch.

The potential advantage of the subjective approach is that it is specifically concerned with the content of the respondent's job and not with any type of aggregate of that occupation. In contrast, the normative correspondence table used by Béduwé and Giret (2011) allows occupations and educational qualifications to be categorized into only 25 groups. Some occupations or educational qualifications will better fit into one of the categories than others. Having too many categories, however, increases the likelihood that the combination of jobs and field degrees are defined as mismatched despite a large congruence of skills and knowledge (Malamud, 2011). Therefore, the subjective approach might provide a more valid measure of horizontal mismatch as employees' attended field is directly being compared with the content or the educational requirements of the job. A potential disadvantage of the subjective method is that employees' perception of horizontal match is by definition subject to self-report bias. Two employees with the same educational background in similar jobs might have a different perception of the degree to which their job is related to their field of education. From this perspective, a method such as the normative correspondence table can provide a less biased indicator of horizontal mismatch. Moreover, asking employees whether their field degree was a

requirement for the job might not be the best indicator for a mismatch between the skills

acquired through the field degree and the job requirements. Some employers might simply

require more general skills that can be obtained through various fields of study. Hence, there

might be considerable variation in what the different subjective definitions measure.

Prevalence of Horizontal Mismatch

Table 2 summarizes the findings of 20 studies that report the incidence of horizontal

mismatch. Not all 24 studies selected for our review estimate the prevalence of horizontal

mismatch. The literature identifies at least four ways to measure horizontal mismatch: definition

A – based on employees' assessment of whether a specific field of education was required for the

job or not; definition B – based on employees' assessment of whether their attended field of

education is related to or relevant for their current occupation; definition C – respondents'

assessment of whether or not they have been trained for their current job; and definition D -

based on an objective evaluation where occupations and educational fields are categorized

according to the assumed congruence between the skills acquired the field degree and those

needed to perform a specific occupation.

Table 2 shows that there is considerable variation in the mismatch incidence reported by

the studies under review. Note that some studies make a distinction between severely

mismatched and moderately mismatched employees when reporting the incidence rate of

mismatched employees (e.g., Robst, 2007a; Robst, 2007b), while other studies combine such

categories into one (Allen & van der Velden, 2001).[4] The incidence rates reported by the studies

under review vary from 7 to 63 percent. The incidence rate, however, seems to depend on how

---

[4] As will be shown in Section 5 and 6, some studies choose to estimate the effects of the somewhat mismatched and severely mismatched categories separately (e.g., Bender & Roche, 2011), while other studies choose to combine categories to create a dichotomous outcome variable for horizontal mismatch (e.g., Farooq, 2011). This possibly affects the results of these studies.

horizontal mismatch is specified. For instance, Malamud (2011) finds 63 percent of employees in England to be mismatched when using a narrow classification, while he finds an incidence rate of 44 percent based on a very broad classification. While the narrow classification allows fields and occupations to be categorized into 42 categories, the very broad classification distinguishes 6 categories. Hence, employees are more likely to be defined as mismatched according to the narrow classification. On average, studies using definition A find that almost 21 percent of the employees are horizontally mismatched. According to definition B, 21.8 percent of the employees hold a field degree that is either only somewhat relevant or only slightly relevant for the job they hold (column 4). Based on the same definition, 23.3 percent of the employees hold a degree that is either somewhat relevant or completely irrelevant for their job (column 5). One study used definition C and finds that 46 percent of the employees are in a job for which they are not trained. Finally, according to definition D, 22.1 of the employees hold an occupation for which their field has some relevance (column 4). Again adopting definition D, column 5 shows that 35.4 percent of the employees are fully mismatched or hold a degree that only has low relevance for their job.

According to the studies that distinguish between genders, there does not appear to be a clear pattern in favour of men or women with respect to finding a matching job. Furthermore, Bender and Heywood (2011) find that the prevalence of horizontal mismatch is greater among employees in the middle or late stage of their career than among employees early in their career. The share of graduates experiencing horizontal mismatch also differs per country. Moreover, the extent to which employees are mismatched based on their field of study varies between different types of employment. Horizontal mismatch appears to be present more often among self-employed employees than among employees in a wage or salary job (Bender & Roche, 2013).

Finally, the reason for being horizontally mismatched differs across employees (Robst, 2007a; Robst, 2007b; Bender & Heywood, 2011). While a large share of employees reports to be mismatched because a job in a related field was unavailable, a substantial proportion of employees also accepts horizontal mismatch for pay or promotion opportunities or because of a change in career interests.

Determinants

In this section, we report which variables were considered potential determinants of horizontal mismatch in the studies under review. We discuss whether the studies at hand found positive, negative or no relationship between horizontal mismatch and the explanatory variables. The findings are summarized in Table 4 and were categorized into education-, labour market-, job-, and individual-related determinants. The number of potential determinants examined by the studies under review is substantial. Due to length restrictions, we limit our discussion to those determinants that have been investigated by at least two studies or to those determinants that were found to affect mismatch. The determinants that were subject to examination in only one study, but that were not found to influence mismatch, can be found in Appendix 1.

Education-related Determinants

Several factors predicting horizontal mismatch relate to the education the individual has acquired. The education-related factors can be classified according to two levels; the individual level and the country level. With education-related determinants on the individual level we refer to factors that are rather a choice of the individual such as the field and level of education. In contrast, education-related determinants on the country level are rather exogenous to the individual and may for instance pertain to the vocational orientation of a country's education system.

Education-related determinants – individual level. The prevalence of horizontal mismatch among graduates depends among other things on the characteristics of the attended study programme such as the field and level of education, but also on the type of education. With respect to the field degree, the highest mismatch rates are found among liberal arts graduates, while the mismatch rates are lowest for graduates from health related fields (Robst, 2007a; Wolbers, 2003). Health related fields are characterized by providing students with occupation-specific skills which reduces graduates' likelihood to search for jobs outside their own field (Wolbers, 2003). Mismatch can also be ascribed to a discrepancy between the supply and demand for graduates in a certain field. Cosser (2010) shows that while in South Africa the demand for graduates is mainly in the field of science, engineering and technology, most graduates have obtained a degree in the field of humanities. The field degree also interacts with the relation between mismatch and the career stage. This can be attributed to the pace of human capital depreciation associated with the field of study (Bender & Heywood, 2001). For instance, science- and engineer-based careers are more sensitive to mismatch due to the high frequency of technological changes which induce rapidly changing skill requirements (Bender & Heywood, 2001).

Besides the field degree, individuals' level of education predicts the likelihood of being horizontally mismatched. Employees who are not able to find a job that matches their level of education might compete with less-educated employees for a job below their level but in a related field (Borghans & de Grip, 2000). Given that the less-educated face fewer jobs for which they can deploy this strategy, accepting a job in a different field is more likely to be an alternative strategy for this group when a matching job is unavailable. Several studies selected for our review support this hypothesis when comparing university graduates with different

academic degrees, but also when comparing tertiary education graduates with upper secondary and post-secondary graduates (Bender & Roche, 2013; Boudarbat & Chernoff, 2012; Hensen, de Vries & Cörvers, 2011; Robst, 2007a; Wolbers, 2003).

While the level of education is negatively related to horizontal mismatch, at the same time, higher levels of education are often more general in nature. General skills lend themselves to a wider variety of jobs which positively affects one's chances to end up in a job not directly related to the field degree. Vocational programmes, on the other hand, provide students predominantly with occupation-specific skills, creating a strong link between the field degree and the jobs for which students are being prepared. As such, school leavers with a vocational degree are more likely to be horizontally matched than graduates without a vocational training (Levels, van der Velden & Di Stasio, 2014).[5]Also the type of vocational system influences horizontal mismatch. Employers can substantially reduce selection and allocation costs by hiring graduates who received workplace-based or apprenticeship training in their organization (Wolbers, 2003). Hiring these graduates removes the need for screening and offers the advantage of employing employees who already have acquired firm-specific skills.

In addition to study programme characteristics, study-related as well as non-study related activities during one's studies can affect the chances of finding a matching job. Robert (2014) finds that an increase in the number of months spent on acquiring study-related work experience decreases the likelihood of horizontal mismatch. Non-study related activities, however, increase the odds of horizontal mismatch. It might increase the time needed to complete studies and not provide any additional skills that are considered relevant by employers.

Also the activities in which graduates are involved before entering college relate to

---

[5] Levels et al. (2014) find that the strength of the relation between horizontal mismatch and having a vocational degree does not depend on the vocational orientation of a country.

horizontal mismatch. Compared to graduates who neither went to school nor worked, graduates who went to school, worked or combined both, are less likely to become matched (Boudarbat & Chernoff, 2012). Those who worked before programme entrance are more likely to become matched than graduates who only went to school before enrolling in university. Combining work with school is associated with the smallest probability of becoming matched. Another proxy for activities in which students were involved during their studies is whether they were enrolled in a part-time or full-time programme. Several studies find that graduates who studied full-time are more likely to obtain a job that matches their field compared to graduates who studied part-time (Boudarbat & Chernoff, 2012; Farooq, 2011).

Finally, the perceived quality of a study programme can be used by employers as a signal of the quality of graduates' skills and competencies and affect school leavers chances of ending up in a matching job. Kucel and Vilalta-Bufí (2012) demonstrate that those who attended a study programme that is considered academically prestigious by graduates face a reduced risk of becoming horizontally mismatched. In fact, the more employers are familiar with one's attended study programme, the lower the likelihood that a graduate is horizontally mismatched.

Education-related determinants – country level. The studies under review identified three factors that characterize a country's education system which determine horizontal mismatch; timing of academic specialization, vocational orientation and the strength of institutional linkages. Regarding the timing of academic specialization, late specialization might prohibit graduates less from switching to an unrelated occupation as the costs of not utilizing specific skills are lower than for graduates who specialized early. On the other hand, later specialization might offer students more time to acquire valuable information about their preferences and abilities by taking courses in different fields. Hence, later specialization

conceivably provides students more insight into the probabilities of obtaining a field-related occupation given the acquisition of a specific field degree. Malamud (2011) finds support for the second hypothesis as graduates who attended the Scottish education system, which is characterized by late specialization, are less likely to hold a job unrelated to the field of study compared to graduates from the English education system in which students specialize early.[6]

Also the extent, to which an education system is vocationally oriented, is strongly country-dependent. Wolbers (2003) defines countries as being more vocationally oriented when the share of upper secondary education students, who are enrolled in school-based or apprentice-type vocational education, is larger. Surprisingly, graduates are found to be more often mismatched in vocationally oriented countries. Nonetheless, the results are not significant. Levels et al. (2014) also find that the horizontal mismatch incidence is greater in countries with a strong vocational orientation (i.e. the share of vocational education offered as a combination of school-based education and learning at the workplace). Arguably, the competition between graduates with a vocational degree is fiercer in countries with a large share of vocationally educated employees. Hence, the advantage of a vocationally oriented education system might vanish when the share of graduates with a vocational education increases.

However, the degree to which vocational education increases the likelihood of horizontal mismatch also depends on the strength of institutional linkages in a country. The strength of institutional linkages is reflected by the share of vocational education that is organized as a combination of school-based education and training at the workplace (Breen, 2005). Strong institutional linkages improve students' chances to obtain a job that matches their education

---

[6] As a robustness check, Malamud (2011) investigates whether there are differences between the incidence of graduates ending up in an occupation that is unrelated to the field of study between England and Wales. The timing of academic specialization is similar in England and Wales and there appears to be no difference in the incidence of mismatched graduates. This supports the idea even further that the timing of specialization matters for students to acquire valuable information about their match quality in different fields of study.

through various channels. First, countries with strong institutional linkages provide employers an opportunity to teach students skills that are required by existing jobs (Andersen & van de Werfhorst, 2010). Second, strong institutional linkages allow employers to design jobs in a way such that it meets the expected skills of vocational graduates. Levels et al. (2014) confirm a positive relation between being vocationally educated and horizontal mismatch and show that this relation is stronger in countries with strong institutional linkages.

This section has addressed the characteristics of a graduates' study programme that predict their chances of being horizontally mismatched. What can be noticed is that several education-related determinants of mismatch share similar properties, on the individual as well as on the country level. The field degree, level of education, attending vocational education, the type of vocational education, the vocational orientation of a country's education system and the strength of institutional linkages within a country all determine the degree to which graduates possess occupation-specific or general skills. Compared to graduates who have mainly acquired general skills through formal education, graduates who predominantly obtained specific skills are more likely to end up in a job that is closely related to their field degree. Although graduates with more general skills are more likely to be horizontally mismatched, based on the definitions identified in the literature, their skills are valued in a wider variety of jobs. The degree to which horizontal mismatch among graduates with general education is accompanied by skill-underutilization might therefore be smaller than most definitions actually suggests. According to the human capital theory, general skills increase workers' productivity in a wider range of occupations than specific skills (Becker, 1964). In fact, as Section 6 will point out, the wage penalties incurred by employees who received general education are less severe as opposed to those who received more occupation- specific education.

Labour Market-related Determinants

The previous section discussed the role of study programme characteristics in the likelihood that graduates experience horizontal mismatch. Once students complete formal education, labour market conditions as well as the state of the economy affect graduates' chances of finding a matching job. Graduates who face an economic recession upon labour market entry adjust their goals and are more likely to accept a job that does not match their field of education. Wolbers (2003) finds that the aggregate unemployment rate in the year of labour market entry increases the odds of being horizontally mismatched. In contrast, Hensen et al. (2011) do not find a relation between the regional unemployment rate and horizontal mismatch.

Another measure for the state of the economy is the opportunity structure. The opportunity structure refers to the number and type of available vacancies and how well an employee's and other potential job candidates' skills match the requirements for a job (Witte & Kalleberg, 1995). Witte and Kalleberg (1995) find that fluctuations in the opportunity structure negatively influence the probability for women to hold a job that matches their field degree, but not for men.

Also the search duration to find the first job reflects the labour market conditions graduates face upon labour market entry. An increase in the number of months a graduate has been unemployed before finding the first job therefore increases the odds of being horizontally mismatched (Robert, 2014).

Job-related Determinants

Once graduates are employed, job-related factors influence the probability being horizontally matched. One of the job-related factors predicting employees' horizontal match is how long an employee has been in his/her current job. Employees' employment tenure appears to be positively related to horizontal mismatch (Witte & Kalleberg, 1995; Wolbers, 2003). A potential explanation for this finding is that once employees find a job that matches their

education and the returns to schooling meet a certain level, the employee will not be incentivized to change jobs (Witte & Kalleberg, 1995). Another possible explanation is that as job tenure increases, employees accumulate firm-specific skills which are less attractive to other firms. Consequently, it is more difficult for mismatched employees with a longer tenure to search for a matching job outside the firm.

Besides job tenure, also employees' type of contract determines horizontal mismatch. Temporary jobs offer limited opportunities to acquire relevant work experience and productive skills as opposed to permanent employment. Given that employees with a temporary contract are expected to leave the company earlier, employers are generally reluctant to offer company-funded training due to the shorter payback period of such investments (Becker, 1964; Booth, Francesconi & Frank, 2002). Consequently, job-education mismatch can serve as a compensation for the lack of human capital that is typically gained through on-the-job training and work experience (Groot & Maassen van den Brink, 1996). In fact, graduates with a temporary contract are more likely to be mismatched than employees with a permanent contract (Wolbers, 2003). Also employees in a part-time job are more likely to be mismatched compared to employees in a full-time job (Boudarbat & Chernoff, 2012; Wolbers, 2003). Robert (2014) finds that the odds of being horizontally mismatched are higher for employees with a permanent contract than for employees with a fixed term contract or self-employed employees. Arguably, employees might accept horizontal mismatch in return for job safety provided by a permanent contract.

Variation in the prevalence of horizontal mismatch are also found across occupational groups and sectors. Bender and Roche (2013) indicate that self-employed workers are more likely to be severely mismatched than wage or salary workers.[7] While self-employed men are

---

[7] Bender and Roche (2013) examine the robustness of their analyses by controlling for heterogeneity between the self-employed and wage and salary employees (choosing self-employment to obtain a better work-life balance or

more likely to be mismatched predominantly due to working conditions, self-employed women tend to accept horizontal mismatch mainly for family-related reasons. Witte and Kalleberg (1995) hypothesize more matches in white-collar occupations as the duties and requirements for such jobs, also in terms of the education acquired, are less specifically defined. The authors also expect employees in civil servants positions to be matched more often due to the consistency of educational requirements as a result of state bureaucracy. While no significant differences were found for men across the different types of occupations, women in white collar and civil service occupations were more likely to be matched than women in blue-collar jobs. Along similar lines, Farooq (2011) shows that employees in specialized occupations; managers, professionals and associate professionals are less likely to be horizontally mismatched than employees in elementary occupations.

Occupational groups are also characterized by how well vocational education is established within this occupation (Witte & Kalleberg, 1995). Whether occupational groups are characterized by the so called 'cultures of training' is reflected by the ratio of trainees to the total number of employees in an occupational group. A large share of trainees would imply that training is standardized and occupation-specific instead of firm-specific which should result in better matches. A large proportion of apprentices relative to the total workforce in an occupational group positively relates to the probability of being matched for men (Witte & Kalleberg, 1995). This does not hold for women, which could potentially be explained by the limited variation of how well 'cultures of training' are established in the organizations in which

---

due to prior labour market experiences). Interacting these variables with self-employment did not significantly change the relation between being self-employed and the probability of being mismatched. The authors also check whether the results change when managers are left out of the dataset. Employees who climb up the career ladder into management use skills that deviate from those acquired through formal education. Excluding managers, however, did not significantly change the results. Finally, the authors attempt to account for endogeneity as employees might select themselves into self-employment for instance because they were mismatched in a wage or salary job. The results are relatively robust to corrections for endogeneity.

women work. With respect to the sector in which individuals are employed, the likelihood of horizontal match is greater in the public sector than in the private sector (Wolbers, 2003). This can be attributed to the fact that the public sector consists of all healthcare and educational organizations which, on average, employ more graduates who received vocationally oriented education.

With respect to firm characteristics, being employed in a large firm can provide a relatively large set of opportunities to find a matching job (Hamilton, 1987). Wolbers (2003) finds that employees in larger firms are more likely to be horizontally matched. Contrariwise, Witte and Kalleberg (1995) find that the likelihood of horizontal mismatch for men increases with the size of the firm (Witte & Kalleberg, 1995). Arguably, individuals employed in large firms might be more incentivized to accept horizontal mismatch due to higher wages, job security and other job advantages offered by large firms (Kalleberg & van Buren, 1992). The authors provide another potential explanation for their findings; tasks are defined more narrowly in large firms as a result of the greater division of labour. Specialized jobs can elicit the feeling among employees that the skills acquired through formal education are not fully utilized.

Finally, the method to obtain a job influences an employee's chances of finding a job that matches the field degree. Possible methods encompass; responding to a job advertisement, directly contacting an employer, through a campus placement agency, through an employment agency and through a head hunter. Boudarbat and Chernoff (2012) find that only the method of finding a job through a campus placement agency increases the probability of finding a matching job.

Individual-related Determinants

Finally, several characteristics related to the individual are known to influence employees' labour market outcomes. For instance, labour market prospects and outcomes are found to differ between men and women along various dimensions (Altonji & Blank, 1999). This also holds for obtaining a job that matches one's field degree. Bender and Heywood (2011) demonstrate that males are more likely to be mismatched than females. Other studies providence evidence that females are more likely to be mismatched opposed to their male counterparts (Farooq, 2011; Hensen et al., 2009). For men, mismatch is more likely to be the result of career-oriented reasons like pay and promotion opportunities or changing career interests, while women are more likely to report mismatch due to amenity or constraints reasons such as family-related reasons, the job location or working conditions (Bender & Heywood, 2011; Robst, 2007b). Bender and Roche (2013) find that, ceteris paribus, in the wage and salary sector, women are less likely to be severely mismatched than their male counterparts. In contrast, self-employed women are more likely to be severely mismatched than self-employed men.

The probability of being horizontally mismatched also related to employees' age (Bender & Roche, 2013; Wolbers, 2003). Using a panel framework, Bender and Heywood (2011) demonstrate that an additional year since graduation is positively related to mismatch. Employees in their early career are most likely to make the transition from a state of mismatch to a state of match. This is consistent with the idea that mismatch is a result of employees' career evolution and not necessarily an indicator of labour market inefficiency. Besides the fact that career interests might change over time, the value of the stock of human capital accumulated through formal education depreciates over time and reinvesting in rapidly depreciating skills becomes less attractive as the length of the payback period shortens. Moreover, the skills

acquired through vocational education become less relevant over time in the presence of technological changes (Witte & Kalleberg, 1995). Hensen et al. (2009), on the other hand, find that employees' age is positively associated with holding a job that matches the field of education. Robert (2014) also finds a negative relation between horizontal mismatch and age; however, this effect vanishes when the sample is reduced to respondents who left their first job. Since the latter two studies use samples consisting of recent graduates, it is possible that it takes some employees more time to find an appropriate job upon labour market entry. After some point, however, the probability of becoming horizontally mismatched arguably increases.

In addition to gender and age, a substantial amount of studies indicate the presence of racial differentials in labour market outcomes (Altonji & Blank, 1999). Empirical evidence suggests that compared to white employees, the likelihood of being horizontally mismatched is higher for Asian men and lower for black employees and Hispanics (Bender & Roche, 2013; Robst, 2007a).[8] Black employees are more likely to be mismatched because a related job was unavailable, while they are less likely to report mismatch as a result of the job conditions, changing career interests, or family-related reasons. Also native employees are less likely to be horizontally mismatched as opposed to immigrant workers (Boudarbat & Chernoff, 2012; Hensen et al. 2011).

An individual factor that strongly predicts educational as well as labour market outcomes is individuals' ability. Boudarbat and Chernoff (2012) investigate whether graduates' ability affects their chances of finding a matching job. Graduates' grades are used here as a proxy for

---

[8] Robst (2007b) uses the same dataset as Robst (2007a). With respect to the probability of horizontal mismatch, Robst (2007a) finds compared to white employees a significant positive effect for Asian men, but no effect for women. Robst (2007b), however, finds an overall positive effect for Asian employees, compared to white employees. In contrast to Robst (2007a), Robst (2007b) combines the samples of men and women. Separate analyses for men and women might have given the same results. Furthermore, while Robst (2007a) finds a significant negative effect for black employees, Robst (2007b) finds no significant differences between white and black employees.

graduates' ability. Employers could use high grades as a signal for the quality of an individual's subject-related skills. Boudarbat and Chernoff (2012) find that graduates in lower grade categories are significantly less likely to find a job that relates to the field of study compared to graduates in the highest grade category. Similarly, Kucel and Vilalta-Bufí (2012) find that university graduates' grades in secondary education decreases the likelihood of horizontal mismatch.

Another strong predictor of educational as well as labour market outcomes is parental education. Prior research points at parents' educational background and its link with their offspring's schooling choices and subsequent educational attainment (e.g., Dustmann, 2004; Ermisch & Francesconi, 2001; Haveman & Wolfe, 1995). Consequently, parental background also relates to subsequent labour market outcomes such as wages (Dustmann, 2004). As such, one could hypothesize that parental education is positively related to being horizontally matched. Robert's (2014) findings partially support this hypothesis. While graduates with high-educated parents (ISCED5-6) are less likely to be horizontally mismatched than counterparts whose parents received less education (ISCED 3-4), graduates with low-educated parents (ISCED1-2) do not seem to be disadvantaged compared to graduates with high-educated parents.[9]

In addition to individual-related determinants that are exogenously determined, individuals make choices that affect their labour market outcomes. The extent to which employees are willing to seek for a job outside the place of residence can affect the probability of education-job mismatch. Büchel and van Ham (2003) demonstrate that German employees, who are spatially flexible, have better chances of obtaining a job that matches their level of education. However, Hensen et al. (2009) find that geographic mobility has a negative effect on the likelihood of being horizontally matched. Besides geographic job mobility, active job search

---

[9] Here, the parental education is measured by taking the highest level of education of either the mother or father.

behaviour or changing jobs can increase the likelihood of finding a matching job. However, Robert (2014) finds that having left the first job has no significant effect on horizontal mismatch. Moreover, intensive jobs shifts (the number of jobs a graduate had before participating in the survey) are associated with a greater chance of being horizontally mismatched. This might suggest that intensive job search merely reflects an instable labour market position. Employees, who have left their first job, are more likely to be horizontally mismatched in the current job when they were mismatched in the first job.

Finally, having a disability and individuals' marital status are also determinants of horizontal mismatch. According to Robst (2007a), disabled employees face a higher chance of obtaining a job that does not match the attended field of education. The difference between the disabled and the non-disabled is particularly evident when a job is accepted outside the field degree for the reason that a related job was not available. Bender and Heywood (2011) find that being disabled only slightly affects the probability of being somewhat or severely mismatched for employees in their early career. For employees in their late career stage or when the mismatch category only consists of severely mismatched employees, no effect is found. Regarding individuals' marital status, individuals who are not or have never been married are more likely to be mismatched in terms of the field degree than employees who are married (Bender & Roche, 2013; Robst, 2007a).[10]

---

[10] In contrast to Robst (2007a), Robst (2007b) finds while using the same dataset that employees who have never been married are less likely to be mismatched compared to employees who are or have been married. Those who have never been married are more likely to accept horizontal mismatch due to pay and promotion opportunities and because a job in the field degree was not available, but less likely to accept mismatch as a result of working conditions or family-related reasons.

Effects

Table 4 provides an overview of the effects associated with horizontal mismatch. As Table 4 depicts, a substantial amount of economic research has been conducted on the effect of horizontal mismatch on employees' earnings. Social stratification research, on the other hand, has been concerned with the consequences of horizontal mismatch for employees' occupational status. Furthermore, the studies selected for our review have examined what horizontal mismatch implies for on-the-job search, training participation, job satisfaction and regret of the chosen field of study.

Most studies assessing the wage implications of horizontal mismatch compare well-matched employees to their mismatched counterparts who hold the same field degree. Employees who are horizontally mismatched generally incur a wage penalty. Some employees are despite being mismatched still able to utilize some of the skills acquired through their field degree and, therefore, only incur small wage penalties (Bender & Heywood, 2011; Bender & Roche, 2013; Nordin, Persson & Rooth, 2010; Robst, 2007b; Yakusheva, 2010). Robst (2007b) shows that while mismatched men receive a wage penalty of 11.9 percent, partially mismatched men only incur a wage loss of 2.9 percent. The wage penalties incurred by mismatched and partially mismatched women are 10.1 and 2.1 percent, respectively.

The wage effect differs across reasons for accepting horizontal mismatch (Robst, 2007a). The wage loss accompanied with horizontal mismatch because of the job location or family-related reasons, ranges from 18.1 to 29.3 percent for men and from 17.2 to 21.5 percent for women (Robst, 2007a). The pay penalties incurred due to the inability to find a matching job is 18.5 percent for females and 26.5 percent for men. In contrast, accepting horizontal mismatch

because of pay and promotion opportunities is associated with a wage gain of 9.1 percent for

women and 6.1 percent for men (Robst, 2007a). Hence, accepting horizontal mismatch is not

always accompanied by negative wage consequences. Similarly, Zhu (2014) shows that 32.3

percent of the Chinese college graduates benefit from being horizontally mismatched as they

receive a wage premium.

The wage effects also vary among employees in different types of employment.

Compared to matched wage and salary workers, the severely mismatched self-employed incur

wage penalties twice as large as mismatched wage and salary workers (Bender & Roche,

2013).[11] In line with Robst (2007a), the greatest wage penalties are incurred when a matching job

is unavailable. Mismatch also carries different wage penalties depending on employees' career

stage. Bender and Heywood (2011) find greater wage penalties for mismatched employees later

in their career stage than for those in their early career stage. Since older mismatched employees

are being compared with matched employees in the reward phase of their earnings profile,

employees in later stages of their career face larger wage penalties in comparison to employees

early in their career.

Zhu (2014) finds relatively small wage penalties, namely, 1.2 percent for men and 1.5

percent for women. Zhu (2014) attributes these small wage losses to the strong emphasis of the

Chinese education system on providing students with general skills.[12] Such skills are believed to

be transferable and rewarded in all occupations. Similarly, Nordin et al. (2012) argue that

although employees who attended a field that mainly provides job-specific skills are less likely to

---

[11] These results were obtained while including heterogeneity controls, i.e. having children between the age of 6 and 11 and previous labour market experiences.

[12] The wage penalty associated with horizontal mismatch was found to be much larger with the OLS approach, namely, 5.9 percent. Given that the majority of studies use an OLS approach to estimate the wage effects of mismatch, the small wage penalties found by Zhu (2014) might merely be the result of employing a nonparametric model.

be horizontally mismatched, they generally incur a larger wage penalty than employees who predominantly acquired general skills through their field of study. In fact, it is graduates with a degree in medicine, which is known to provide highly job-specific skills, who suffer from the largest wage losses when experiencing horizontal mismatch (Zhu, 2014). Having a major in literature, on the other hand, provides rather general skills and is associated with the smallest wage penalties in the case of mismatch (Zhu, 2014).

In order to offset initial skill deficiencies, employees who are horizontally mismatched upon labour market entry might acquire additional skills on the job. Nordin et al. (2010) shows that the return to work experience for mismatched men is significantly greater than for matched men. This supports the idea that mismatched employees reduce their initially incurred wage penalty by gaining relevant skills on the job. Likewise, Malamud (2010) shows that being mismatched in the first year after graduation yields a wage loss of 7 percentage points. However, compared to graduates who are matched upon labour market entry, initially mismatched employees do not significantly earn lower wages six years after graduation. This suggests that horizontal mismatch is only a temporary phenomenon.

According to the job search theory, mismatched employees might also try to improve their fit by changing jobs until an optimal match is reached (Jovanovic, 1979). The probability to look for another job appears to be larger for employees who are horizontally mismatched than for well-matched employees (Béduwé & Giret, 2011; Malamud, 2010; Wolbers, 2003). Moreover, mismatched employees are more actively engaged in job search activities in countries with a low vocational orientation (Wolbers, 2003). This supports the view that vocational education functions as a safety net (Shavit & Müller, 2000), reducing the risk of unemployment or ending up in unskilled employment. Shevchuk, Strebkov and Davis (2015), Allen and van der

Velden (2001), do not find a relation between horizontal mismatch and on-the-job search.

A different strategy to cope with job-education mismatch is to participate in additional on-the-job training to offset the shortcoming of the skills acquired through initial education (Wolbers, 2003). The idea is that horizontally matched employees more optimally utilize their skills which reduces the need to invest in additional training. Unexpectedly, Wolbers (2003) finds that horizontally mismatched school-leavers participate significantly less in additional training than their well-matched counterparts. However, the effect of job mismatches on training participation turns out to be positive in countries characterized by low shares of school-based vocational education and apprenticeship trainings. Arguably, graduates who have acquired general education more often receive training on the job to acquire job-specific skills which were not offered through formal education.

Whereas most economic studies focus on the wage consequences of mismatch, most social stratification research assess what mismatch entails for employees' occupational status. On average, mismatched employees have an occupational status that is lower than for well-matched employees (Wolbers, 2003). The loss in occupational status associated with mismatch is lower in countries characterized by an education system that is more vocationally oriented.

Various studies have also assessed the effect of horizontal mismatch on employees' level of job satisfaction. The effect of horizontal mismatch on job satisfaction decreases when controlling for certain job attributes such as having a permanent position or being employed in an organization with large internal labour markets. To put it differently, individuals appear to be willing to accept a job that does not match their field of study in exchange for a job that offers satisfactory perspectives such as job stability and professional development. Bender and Roche (2013) find that the effects on job satisfaction are less severe for self-employed employees than

for wage and salary employees. This could indicate that despite the relative large wage penalties incurred by the mismatched self-employed, accepting horizontal mismatch in the self-employment sector might offer certain job attributes that compensate for those wage penalties. Prior research indicates that self-employment offers, for instance, greater flexibility in working hours than wage and salary jobs (Benz & Frey, 2008; Connelly, 1992).

Shevchuk et al. (2015) only find a negative association between horizontal mismatch and job satisfaction among women. Allen and van der Velden (2001) do not find any effect of horizontal mismatch on job satisfaction. However, skill underutilization does appear to negatively affect job satisfaction (Allen & van der Velden, 2001). Also Béduwé and Giret (2011) find that the horizontal mismatch coefficient reduces in size when including an indicator for skill utilization at the workplace. Hence, it appears to be skill underutilization that leads employees to experience job dissatisfaction. As such, defining employees as horizontally mismatched is not always a perfect proxy for the degree to which employees underutilize field-related skills. Finally, although it is not a direct assessment of employees' job satisfaction, Malamud (2010) finds that mismatched employees are significantly less likely to obtain a job that is considered interesting.

Horizontal mismatch in graduates' first job also increases the likelihood of regretting the chosen study programme. While mismatched graduates in Spain are 11.4 percentage points more likely to experience programme regret compared to their well-matched counterparts, in the Netherlands, horizontal mismatch increases the likelihood of regret with 16.2 percentage points (Kucel & Vilalta-Bufí, 2013). As the Spanish education system provides students with rather general skills, horizontal mismatch is more common among Spanish graduates than among

Dutch graduates. Since regret is often based on a comparison across individuals and horizontal mismatch is rarer in the Netherlands, its effect on regret is more severe for the Dutch graduates.

Conclusion and Discussion

Relying on a systematic literature review, the aim of this paper is to address how prevalent horizontal mismatch is and to what extent it contributes to an inefficiently functioning labour market. In addition, we discussed the approaches in which the concept of horizontal mismatch has been operationalized in prior research and identified the factors that determine horizontal mismatch.

Several specifications of horizontal mismatch can be found in the literature, each yielding different incidence rates. The highest incidence rates are proposed by studies using an objective definition (e.g, Béduwé & Giret, 2011; Malamud, 2011). On average, the different specifications generate incidence rates varying from 21 percent to 46 percent. The degree to which horizontal mismatch is accompanied by welfare losses is not homogenous across mismatched individuals and depends among other things on the reason for accepting horizontal mismatch as well as the degree to which skills are being underutilized. The reason for accepting a job that does not require employees' attended field of study may be demand as well as supply-related (Robst, 2007b). The source of horizontal mismatch is considered to be demand-related when a matching job is unavailable. Under this condition, horizontal mismatch can be considered a negative phenomenon given that students choose a field of study with the expectation of finding employment in field-related occupations (Betts, 1996; Holland, 1985). In fact, our review points out that horizontal mismatch often has unfavourable effects on employees' earnings, occupational status and job satisfaction (e.g., Bender & Roche, 2013; van de Werfhorst, 2002;

Wolbers, 2003). Horizontal mismatch also increases one's likelihood of experiencing programme regret which is associated with substantial costs (Borghans & Golsteyn, 2005; Kucel & Vilalta-Bufí, 2013; Somers & Fouarge, 2016). From this perspective, horizontal mismatch may reveal that the process of skill formation and the allocation of skills on the labour market are sub-optimal.

The welfare losses induced by horizontal mismatch are more ambiguous, however, when the source of mismatch is supply-related. Supply-related reasons for accepting horizontal mismatch may pertain to pay and promotion opportunities or a change in career interests (Bender & Heywood, 2011; Robst, 2007a; Robst, 2007b). The majority of these employees receive a wage premium over their well-matched counterparts, suggesting that horizontal mismatch does not necessarily indicate a severe underutilization of field-specific skills (Robst, 2007a; Zhu, 2014). Other employees might accept horizontal mismatch in exchange for favourable job attributes such as a permanent contract or a greater flexibility in working hours (Béduwé & Giret, 2011; Benz & Frey, 2008; Connelly, 1992). Hence, from an individual's perspective, accepting horizontal mismatch might be an economically rational decision under certain conditions. This also applies to employees in later stages of their career, especially in the presence of technological progress which induces skill obsolescence and the rise of new skill requirements (Bender & Heywood, 2011; Witte & Kalleberg, 1995). In fields that are sensitive to rapid changes, a greater value is being put on the skills acquired through work experience and on-the-job training. Whilst, from an individual's view, accepting mismatch can be economically rational, horizontal mismatch might still reflect an economic loss to society. This is the case when individuals' productivity level would be superior if a matching job or a different field of study would have been chosen. Whether horizontal mismatch in later career stages implies a

labour market failure depends on whether employees gain new skills on the job and whether educational institutions adjust their curricula to meet labour market demands.

This review proposes that future research could benefit from a more uniform measure of horizontal mismatch which identifies employees as mismatched when their labour market position is accompanied by welfare losses. As our study has pointed out, horizontal mismatch is more likely to reveal a situation of field-specific skill-underutilization when the source of mismatch is supply-related or when graduates mainly possess occupation specific skills. Hence, definitions of horizontal mismatch could potentially be enriched by incorporating indicators for: (1) the reason why employees accept a job unrelated to their field degree (see Robst, 2007a; Robst 2007b), (2) the extent to which employees utilize the skills acquired through their field of education, (3) whether the skills employees acquired through the field degree are still relevant for the job, and if not (4) whether employees' complete set of skills meet the requirements of the job. The third and fourth indicators reflect whether skill obsolescence plays a role in individuals' job and whether employees keep up with changing skill requirements. By incorporating these indicators into measurements of horizontal mismatch, researchers allow themselves to disentangle potentially statistical artefacts from an economic reality that should be addressed.   Tracing the reasons for horizontal mismatches remains important, given the negative effects often associated with mismatch. Based on the findings of our review, several recommendations can be made to prevent horizontal skill mismatches. With respect to the design of education systems, mismatch can significantly be prevented by providing students enough time to acquire valuable information on their preferences, abilities and job prospects offered by different field degrees (Malamud, 2011). Instead of delaying academic specialization, students might also benefit from services aimed at improving study choices before programme enrolment.

Finally, strengthening institutional linkages may benefit vocational education graduates as it encourages employers to hire graduates with occupation-relevant skills (Levels et al., 2014). Strengthening institutional linkages also offers employers the opportunity to provide students with skills that their organizations require which can greatly improve the match between skill demand and skill supply.

Appendix A

Overview of the Selected Studies

	Author (year of publication)	Country of study	Data source, type of data and year of data collection	Sample population	Statistical method	Determinants of horizontal mismatch subject to examination in reviewed studies	Effects of horizontal mismatch subject to examination in reviewed studies
1	Witte & Kalleberg (1995)	Germany	German Socioeconomic Panel (GSOEP) – cross-sectional data - 1984-1990 (7 waves)[a]	Nationally representative household panel (final sample for models of mismatch determinants: men: n = 1,008; women: n = 637. Final sample for models of mismatch effects: men: n = 1,881; women: n = 1,207).	-Logistic regression to examine determinants -OLS regression to examine effects	-Type of vocational education -Opportunity structure -Job tenure -Occupational group -Firm size -Occupation 'cultures of training' -Gender -Age	Wage
2	Allen & van der Velden (2001)	The Netherlands	Data were collected for the project 'Higher Education and Graduate Employment in Europe' - cross-sectional - 1998	Tertiary education graduates who graduated in 1990/1991 and held a job of at least 12 hours per week at the time of the survey (final sample: n = 2,460).	-OLS to examine wage effects -Logistic regression to examine effect on on-the-job search and job satisfaction		-Wage -On-the-job search -Job satisfaction
3	van de Werfhorst (2002)	The Netherlands	Survey from The Netherlands Institute for Social Research (SCP): Supplementary Use of Services Research - time series data - 1991, 1995	Employed individuals aged 21-64 years with a minimum of 15 working hours per week (final sample: n = 6,373).	OLS regression the examine wage effects		Wage
4	Wolbers (2003)	Austria, Belgium, Denmark, Spain, Finland,	2000 ad hoc module of the European Labour Force Survey (EU LFS 2000) - cross-	Individuals aged 15-35 years who left formal education within the past five years (Finland, Luxembourg, the	-Logistic regression to examine determinants -Logistic	-Field of study -Level of education -Type of vocational education -State of the economy	-On-the-job search -Training participation -Occupational status of the job

		France, Greece, Hungary, Italy, Luxembourg, The Netherlands, Sweden and Slovenia.	sectional data - 2000	Netherlands and Sweden) or ten years (all other countries) years (final sample: n = 36,268).	regression to examine effects	-Job tenure -Type of contract -Firm size -Sector -Gender -Age	(interaction terms between mismatch and the vocational orientation of a country's education system are introduced in all models.
5	Robst (2007a)	United States	National Survey of College Graduates (NSCG) from the National Science Foundation- cross sectional data - 1993	Nationally representative sample of individuals in the United States who indicated on the 1990 Census to have attained at least a bachelor's degree (final sample: n = 124,063).	-Ordered logit regression to examine determinants -OLS regression to examine effects	-Field of study -Level of education -Gender -Age -Ethnicity -Having a disability -Marital status	Wage
6	Robst (2007b)	United States	National Survey of College Graduates (NSCG) from the National Science Foundation- cross sectional data - 1993	Nationally representative sample of individuals in the United States who indicated on the 1990 Census to have attained at least a bachelor's degree (final sample: n = 124,063).	-Logit regression to examine determinants -OLS regression to examine effects	*Robst (2007b) uses the same dataset and includes the same independent variables as Robst (2007a). Footnotes in the text will report when different coefficients were obtained for these variables. Results will not be reported in Table 3.*	Wage
7	Hensen, de Vries & Cörvers (2009)	The Netherlands	Two surveys from the Research Centre for Education and the Labour Market (ROA): Registration of Outflow and Destination of Graduates (RUBS) and HBO-monitor time series - 1996-2001 (6 waves)	Individuals aged 16-30 years, surveyed 18 months after graduation, who attended full-time pre-secondary vocational, secondary vocational or higher vocational education. The individuals are in paid employment (final sample: n = 83,239).	Logistic regression to examine determinants	-Field of study -Level of education -State of the economy -Job density* -Gender -Age -Ethnicity -Job mobility	

8	Cosser (2010)	South Africa	Research Programme on Human Resources Development (HRD) - time series - 2001, 2002, 2006	(Final sample: 496,120).	Descriptive analysis		
9	Malamud (2010)	England and Scotland	National postal survey conducted by the British Department of Employment: 1980 National Survey of Graduates and Diplomates (NSGD) - cross sectional data – 1986/1987	Scottish and English university graduates who obtained their BA degree in 1980. Individuals were employed full-time in the first year after graduation (final sample NSGD: n = ± 4,800).	OLS regression to examine effects	*Malamud (2011) uses the same dataset and both studies examine the effect of the timing of academic specialization on the probability of horizontal mismatch. Since the focus of this paper is on wage comparisons, we will discuss the effect of academic specialization only for Malamud (2011). Results were similar.*	-Wage -Growth in annual earnings* -On-the-job search -Job satisfaction (getting an interesting job)
10	Mora (2010)	Spain	The Quality Assurance Agency for seven public universities in Catalonia - cross-sectional data – 2000	Individuals aged 23-33 years who graduated in 1997/98 from one of the seven public Catalan universities (final sample n > 3500)	Probit regression standard procedure and two-step probit regressions with endogenous regressor		Field of study regret
11	Nordin, Persson & Rooth (2010)	Sweden	Dataset constructed by Statistics Sweden (SCB): education variables of Swedish Register of Education (UREG) and income variables of National Tax Board were added to the register of the total population (RTB) - cross-sectional data - 2003	Swedish-born individuals with Swedish born parents in the age-group 28-39 living in Sweden in 2003, with a college /university degree, a well-defined occupation and field of education, and, positive earnings (final sample men: n = 67,607; final sample females: n = 116,750)	OLS regression to examine wage effects		Wage

12	Yakusheva (2010)	United States	Survey conducted by the U.S. department of education: High School and Beyond (HS&B) - longitudinal data - 1982, 1984, 1986, 1992	Representative sample of 1980 sophomores who graduated from high school and later on acquired some post-secondary education (4 years at most) (final sample: n = 2,268).	OLS regression to examine wage effects		Wage
13	Béduwé & Giret (2011)	France	Generation 98 survey - cross-sectional data - 2001	Graduates from secondary vocational education and the first level of higher education, 3 years after leaving the educational system (final sample: n = 21,780).	-OLS regression to examine wage effects -Probit regression to examine effect on on-the-job search and job satisfaction		-Wage -On-the-job search -Job satisfaction
14	Bender & Heywood (2011)	United States	Survey of Doctorate Recipients (SDR) - panel data - 1993, 1995, 1997, 1999, 2001, 2003 and 2006	Individual who obtained a PhD in a (hard or social) science, math, or engineering (SME) field and who reside in the United States (final sample > 200,000).	-Descriptive analysis to examine determinants -Fixed effects regression to examine effects	-Field of study -Sector -Gender -Age -Disability -Naturalized citizen* -Noncitizen*	Wage
15	Farooq (2011)	Pakistan	Survey of Employed Graduates (SEG) and Labour Force Survey (LFS) -time series data - 2010 (SEG) and 2006/2007, 2008/2009 (LFS)	Employed graduates working in the formal sector with a Bachelor's, Master's or doctoral degree. (final sample: n = 513).	Logistic regression to examine determinants	-Field of study -Level of education -Time devoted to studies -Occupational group -Gender -Socioeconomic background family* -Annual system* (vs. semester system)	
16	Malamud (2011)	England and Scotland	1980 National Survey of Graduates and Diplomates (NSGD) conducted by the British Department of	NSGD: graduates from Scottish and English universities who received their degree in 1980. USR: administrative	OLS regression and two stage least squares regression to examine determinants	Timing of academic specialization	

			Employment and Universities Statistical Record (USR)- cross-sectional data - NSGD:1986/1987 USR: 1972-1993 (focus on 1980)	data on all students in British universities and Scottish universities (final sample: n = 15,337).			
17	Boudarbat & Chernoff (2012)	Canada	Follow up of Canadian Graduates - Class of 2000 survey - cross-sectional data - 2005	University graduates (Bachelor and beyond) 5 years after graduation (final sample: n = 9,335)	Logit regression to examine determinants	-Field of study -Level of education -Major activity before programme entrance -Time devoted to studies -Type of contract -Method to obtain employment -Gender -Age -Ethnicity -Parental education -Ability (grades) -Family wealth (eligibility for student loan)*	
18	Kucel & Vilalta-Bufi (2012)	Poland	HEGESCO survey for Poland - cross-sectional data - 2008	Graduates who received their bachelor's or master's degree (ISCED5A) in 2002/2003. Self-employed and part-time employees are excluded. (final sample: n = 692)	Logistic regression to examine determinants	-Field of study -Level of education -Vocational education -Work experience during studies (internship) -Prestige of university -Employers' familiarity with programme -Extent to which study programme is demanding* -Extent of freedom to compose own study programme* -Broadness of study programme* -Job tenure -Firm size -Gender -Age	

						-Ability (grades) -Possessed competencies*	
19	Bender & Roche (2013)	United States	Dataset from the US National Science Foundation (NSF): National Survey of College Graduates (NSCG) - cross-sectional data -2003	Employees who have at least a bachelor's degree in a hard or social science, technology, engineering, or mathematics (STEM) field and/or work in that field (final sample: n = 74,229)	-Ordered probit to examine determinants -Ordinary least squares to examine wage effects -Ordered probit to examine effect on job satisfaction	-Level of education -Occupational group -Gender -Age -Ethnicity -Marital status -US citizenship (vs. noncitizens)*	-Wage -Job satisfaction
20	Kucel & Vilalta-Bufí (2013)	Spain and Netherlands	REFLEX survey data (Research into Employment and professional FLEXibility) - cross-sectional data - 2005	Tertiary education graduates who left the educational system in 1999/2000 (final sample Spain: n = 2,777; Netherlands: n = 2,683)	Logistic regression to examine effect on study programme regret		Study programme regret
21	Levels, van der Velden & Di Stasio (2014)	20 countries[b]	European Union Labour Force Survey 2009 Ad Hoc Module (EU LFS 2009) - cross-sectional data - 2009	Individuals aged between 15 and 34 years who attained education at the upper-secondary and post-secondary, non-tertiary level and entered the labour market between 1989 and 2009. (final sample: n = 30,805)	Multi-level logistic regression to examine determinants	-Vocational education -Vocational orientation education system -Strength institutional linkages -Standardization of curricula and outcomes*	
22	Robert (2014)	Hungary, Poland, Lithuania and Slovenia	HEGESCO survey, follow-up of REFLEX project (same questionnaire)– cross-sectional data - 2008/2009	Individuals who graduates five years before in 2002/2003 (final sample: n = 6,665)	Logistic regression to examine determinants	-Field of study- -Work experience during studies -Job search duration -Type of contract -Gender -Age -Job mobility -Parental education	
23	Zhu (2014)	China	2008 Chinese College Graduates' Employment and	Individuals who graduated in 2007 from 43 4-year colleges in the	OLS regression and nonparametric local linear kernel		Wage

			Work Skills Survey - cross-sectional data - 2008	Shandong province about 6-12 months prior to the survey (final sample: n = 5,879)	estimation to examine wage effects		
24	Shevchuk, Strebkov & Davis (2015)	Russia	Online questionnaire conducted by the authors - cross-sectional data - 2011	Russian-language internet freelancers with a completed tertiary degree (final sample men: n = 918; women: n = 684)	-Ordered probit to examine effects on wage and job satisfaction -Logistic regression to examine effect on on-the-job search		-Wage -On-the-job search -Job satisfaction

Note: * indicates that this variables was examined by only one study and no significant effect was found. b. Austria, Belgium, Czech Republic, Germany, Denmark, Spain, Finland, France, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Sweden, Slovenia, Slovak Republic and the U.K.

a. Wave 1987 is used to estimate the incidence and determinants of horizontal match. As a robustness check, cross-sectional logistic regressions were estimated separately for each year from 1984 to 1990. The estimated coefficients were consistent over the years. The wage regressions were estimated on the monthly gross earnings of 1984.

Appendix B
Strategy Used in Computerized Databases Search

ERIC [DECEMBER 2015]

- Keywords: 'mismatch OR match OR fit' AND 'education OR study OR major OR program OR college' AND 'job OR employment OR work OR occupation OR labour OR labor' AND 'field' +pubyear:1995

- Limit results to ' Peer reviewed only'

EBSCOhost EconLit [DECEMBER 2015]

- Keyword: 'mismatch OR match OR fit' AND 'education OR study OR major OR program OR college' AND 'job OR employment OR work OR occupation OR labour OR labor' AND 'field'

- Limit to: 'January 1995' to 'December 2015' within 'Select a Field (optional)'

- Source types: 'Academic Journals'

- Language: 'english'

EBSCOhost SocINDEX [DECEMBER 2015]

- Keyword: 'mismatch OR match OR fit' AND 'education OR study OR major OR program OR college' AND 'job OR employment OR work OR occupation OR labour OR labor' AND 'field' within 'Select a Field (optional)'

- Limit to: 'Scholarly (Peer Reviewed) Journals', 'January 1995' to 'December 2015'

- Language: 'english'

References

Alba-Ramirez, A. (1993). Mismatch in the Spanish labor market: overeducation? *Journal of Human Resources, 28*(2), 259-278. doi:10.2307/146203

Allen, J, & Van der Velden, R. (2001). Educational mismatches versus skill mismatches: effects on wages, job satisfaction, and on-the-job search. *Oxford Economic Papers, 53*(3), 434-452. doi:10.1093/oep/gpu024

Altonji, J. G., & Blank, R. M. (1999). Race and gender in the labor market. *Handbook of labor economics, 3*, 3143-3259. doi:10.1016/S1573-4463(99)30039-0

Andersen, R.T., & Van de Werfhorst, H. G. (2010). Education and occupational status in 14 countries: the role of educational institutions and labour market coordination. *The British Journal of Sociology, 61*(2), 336-355. doi:10.1111/j.1468-4446.2010.01315.x

Becker, Gary (1964). Human Capital. Chicago: The University of Chicago Press.

Béduwé, C., & Giret, J. (2011). Mismatch of vocational graduates: What penalty on French labour market? *Journal of Vocational Behavior, 78*(1), 68-79. doi:10.1016/j.jvb.2010.09.003

Bender, K. A, & Roche, K. (2013). Educational mismatch and self-employment. *Economics of Education Review, 34*, 85-95. doi:10.1016/j.econedurev.2013.01.010

Benz, M., & Frey, B. S. (2008). Being independent is a great thing: Subjective evaluations of self-employment and hierarchy. *Economica, 75*(298), 362-383. doi:10.1111/j.1468-0335.2007.00594.x

Betts, J. R. (1996). What do students know about wages? Evidence from a survey of undergraduates. *Journal of Human Resources, 31*(1), 27-56. doi:10.2307/146042

Booth, A. L., Francesconi, M., & Frank, J. (2002). Temporary jobs: stepping stones or dead
ends? *The Economic Journal, 112*(480), F189-F213. doi:10.1111/1468-0297.00043

Borghans, L., & Golsteyn, B. (2005). De kwaliteit van de studiekeuze. *De Arbeidsmarkt naar
Opleiding en Beroep tot 2010*, 93-119. Retrieved from
http://roa.sbe.maastrichtuniversity.nl

Borghans, L. & de Grip, A. (2000 (eds)). *The Overeducated Employee? The Economics of
Underutilization of Skills.* Cheltenham. doi:10.1016/0272-7757(95)00041-0

Boudarbat, B., & Chernoff, V. (2012). Education–job match among recent Canadian university
graduates. *Applied Economics Letters, 19*(18), 1923-1926.
doi:10.1080/13504851.2012.676730

Breen, R. (2005). Explaining cross-national variation in youth unemployment market and
institutional factors. *European Sociological Review, 21*(2), 125-134.
doi:10.1093/esr/jci008

Büchel, F. (2002). The effects of overeducation on productivity in Germany - the firms'
viewpoint. *Economics of Education Review, 21*(3), 263-275.
doi:10.1016/s0272-7757(01)00020-6

Büchel, F., & Van Ham, M. (2003). Overeducation, regional labor markets, and spatial
flexibility. *Journal of Urban Economics, 53*(3), 482-493.
doi:10.1016/s0094-1190(03)00008-1

Chevalier, A. (2003). Measuring over-education. *Economica, 70*(279), 509-531.
doi:10.1111/1468-0335.t01-1-00296

Chevalier, A., & Lindley, J. (2009). Overeducation and the skills of UK graduates. *Journal of the
Royal Statistical Society: Series A (Statistics in Society)*, *172*(2), 307-337.

doi:10.1111/j.1467-985x.2008.00578.x

Connelly, R. (1992). Self-employment and providing child care. *Demography, 29*(1), 17-29.

doi:10.2307/2061360

Cosser, M. (2010). The skills cline: higher education and the supply-demand complex in South

Africa. *Higher Education, 59*(1), 43-53. doi:10.1007/s10734-009-9231-z

Dolton, P.J., & Silles, M.A. (2000). The effects of over-education on earnings in the graduate

labour market. *Economics of Education Review, 27*(2), 125-139.

doi:10.1016/j.econedurev.2006.08.008

Dolton, P., & Vignoles, A. (2000). The incidence and effects of overeducation in the UK

graduate labour market. *Economics of Education Review, 19*(2), 179-198.

doi:10.1016/s0272-7757(97)00036-8

Duncan, G. J., & Hoffman, S. D. (1981a). The economic value of surplus education. *Economics

of Education Review, 1*(1), 75-86. doi:10.1016/0272-7757(81)90028-5

Duncan, G. J., & Hoffman, S. D. (1981b). The incidence and wage effects of

overeducation. *Economics of Education Review, 1*(1), 75-86.

doi:10.1016/0272-7757(81)90028-5

Dustmann, C. (2004). Parental background, secondary school track choice, and wages. *Oxford

Economic Papers, 56*(2), 209-230. doi:10.1093/oep/gpf048

Egger, M., Zellweger-Zähner, T., Schneider, M., Junker, C., Lengeler, C., & Antes, G.   (1997).

Language bias in randomised controlled trials published in English and

German. *The Lancet, 350*(9074), 326-329. doi:10.1016/s0140-6736(97)02419-7

Enequist, G., Kahlroth, M., Mähler Lejon, H., Lönn, M., Rosengren, P., & Wahlén, S. (2006). OECD Thematic Review of Tertiary Education – Country Background Report for Sweden. Retrieved from http://www.oecd.org/

Ermisch, J., & Francesconi, M. (2001). Family matters: Impacts of family background on educational attainments. *Economica*, *68*(270), 137-156. doi:10.1111/1468-0335.00239

Farooq, S. (2011). The Utilisation of Education and Skills: Incidence and Determinants among Pakistani Graduates. *The Pakistan Development Review*, *50*(3), 219-244. Retrieved from http://pide.org.pk/pdr/index.php/pdr

Groeneveld, S., & Hartog, J. (2004). Overeducation, wages and promotions within the firm. *Labour Economics, 11*(6), 701-714. doi:10.1016/j.labeco.2003.11.005

Groot, W., & Maasen van den Brink, H. M. (1996). Overscholing en verdringing op de arbeidsmarkt. *Economisch-Statistische Berichten, 81*(4042), 74-77. Retrieved from http://economie.nl

Groot, W., & Maasen van den Brink, H. M. (2000). Overeducation in the labor market: a meta-analysis. *Economics of education review, 19*(2), 149-158.

Hamilton, S. F. (1987). Apprenticeship as a transition to adulthood in West Germany. *American Journal of Education*, *95*(2), 314-345. doi:10.1086/444304

Hartog, J. (2000). Over-education and earnings: where are we, where should we go? *Economics of Education Review, 19*(2), 131-147. doi:10.1016/s0272-7757(99)00050-3

Haveman, R., & Wolfe, B. (1995). The determinants of children's attainments: A review of methods and findings. *Journal of Economic Literature*, *33*(4), 1829-1878. Retrieved from https://www.aeaweb.org/journals/jel

Heijke, H., Meng, C., & Ris, C. (2003). Fitting to the job: the role of generic and vocational
    competencies in adjustment and performance. *Labour economics, 10*(2), 215-229.
    doi:10.1016/s0927-5371(03)00013-7

Hensen, M. M., De Vries, M. R., & Cörvers, F. (2009). The role of geographic mobility in
    reducing education-job mismatches in the Netherlands*. *Papers in Regional
    Science*, *88*(3), 667-682. doi:10.1111/j.1435-5957.2008.00189.x

Holland, J.L. (1985). *Vocational preference inventory.* Consulting Psychologists Press.
    doi:10.1037/t09505-000

De Jong, J., & Berger, J. (2006). OECD Thematic Review of Tertiary Education – Country
    Background Report for The Netherlands. Retrieved from http://www.oecd.org/

Jovanovic, B. (1979). Job matching and the theory of turnover. *The Journal of Political
    Economy, 87*(5), 972-990. doi:10.1086/260808

Kalleberg, A. L., & Van Buren, M. E. (1992). Organizations and economic stratification: A
    cross-national analysis of the size-earnings relation. *Research in Social Stratification and
    Mobility*, *11*, 61-93. Retrieved from http://www.journals.elsevier.com/research-in-social-
    stratification-and-mobility/

Kiker, B. F., Santos, M. C., & De Oliveira, M. M.. (1997). Overeducation and undereducation:
    Evidence for Portugal. *Economics of Education Review, 16*(2), 111-125.
    doi:10.1016/s0272-7757(96)00040-4

Kucel, A., & Vilalta-Bufí, M. (2012). Graduate labor mismatch in Poland. *Polish Sociological
    Review, 3*(179), 413-429. Retrieved from http://polish-sociological-review.eu/

Kucel, A., & Vilalta-Bufí, M. (2013). Why do tertiary education graduates regret their study

    program? A comparison between Spain and the Netherlands. *Higher Education, 65*(5),

    565-579. doi:10.1007/s10734-012-9563-y

Levels, M., van der Velden, R., & Di Stasio, V. (2014). From school to fitting work: How

    education-to-job matching of European school leavers is related to educational system

    characteristics. *Acta Sociologica, 57*(4), 341-361. doi:10.1177/0001699314552807

Levin, H., Belfield, C., Muennig, P., & Rouse, C. (2007). *The costs and benefits of an excellent*

    education for all of America's children (Vol. 9): Teachers College, Columbia University

    New York.

Levin, H. M., & Rouse, C. E. (2012). The true cost of high school dropouts. *The New York*

    Times, A31. Retrieved from www.nytimes.com

Machin, S., & McNally, S. (2007). Tertiary education systems and labour markets. *Education*

    and Training Policy Division, OECD. Retrieved from http://www.oecd.org/

Malamud, O. (2010). Breadth versus depth: The timing of specialization in Higher Education.

    Labour, 24(4), 359-390. doi:10.1111/j.1467-9914.2010.00489.x

Malamud, O. (2011). Discovering one's talent: learning from academic specialization. *Industrial*

    & Labor Relations Review, 64(2), 375-405. doi:10.1177/001979391106400209

McGuinness, S. (2006). Overeducation in the labour market. *Journal of Economic Surveys,*

    20(3), 387-418. doi:10.1111/j.0950-0804.2006.00284.x

McGuinness, S., & Bennett, J. (2007). Overeducation in the graduate labour market: A quantile

    regression approach. *Economics of Education Review*, *26*(5), 521-531.

    doi:10.1016/j.econedurev.2005.12.003

McGuinness, S., & Sloane, P. J. (2011). Labour market mismatch among UK graduates: An

analysis using REFLEX data. *Economics of Education Review, 30*(1), 130-145.

doi:10.1016/j.econedurev.2010.07.006

McIntosh, S. (2005). Evidence on the balance of supply and demand for qualified employees. In

S. Machin & A. Vignoles (Eds.), *What's the Good of Education? The Economics of

Education in the UK* (pp. 169-188). Princeton University Press.

Mora, T. (2010). Why do higher graduates regret their field of studies? Some evidence from

Catalonia, Spain. *Education Economics, 18*(1), 93-109.

doi:10.1080/09645290802018001

Nordin, M., Persson, I., & Rooth, D. (2010). Education–occupation mismatch: Is there an income

penalty? *Economics of Education Review, 29*(6), 1047-1059.

doi:10.1016/j.econedurev.2010.05.005

Quintano, C., Castellano, R., & D'Agostino, A. (2008). Graduates in economics and educational

mismatch: the case study of the University of Naples 'Parthenope'1. *Journal of

Education and Work, 21*(3), 249-271. doi:10.1080/13639080802214118

Robert, P. (2014). Job mismatch in early career of graduates under post-communism.

International Journal of Manpower, 35(4), 500-513. doi:10.1108/ijm-05-2013-0113

Robst, J. (2007a). Education and job match: The relatedness of college major and work.

Economics of Education Review, 26(4), 397-407. doi:10.1016/j.econedurev.2006.08.003

Robst, J. (2007b). Education, college major, and job match: Gender differences in reasons for

mismatch. *Education Economics, 15*(2), 159-175. doi:10.1080/09645290701263070

Rubb, S. (2003). Overeducation in the labor market: A comment and re-analysis of a meta-

analysis. *Economics of Education review, 22*(6), 621-629.

doi:10.1016/s0272-7757(02)00077-8

Shavit, Y., & Muller, W. (2000). Vocational secondary education. *European Societies*, *2*(1), 29-50. doi:10.1080/146166900360710

Shevchuk, A., Strebkov, D., & Davis, S. N. (2015). Educational mismatch, gender, and satisfaction in self-employment: The case of Russian-language internet freelancers. *Research in Social Stratification and Mobility, 40*, 16-28. doi:10.1016/j.rssm.2015.02.004

Sloane, P. J. (2003). Much ado About Nothing? What does the Overeducation Literature Really Tell us. In F. Büchel, A. de Grip & A. Mertens (Eds.), *Overeducation in Europe. Current Issues in theory and Policy* (pp. 11-45). Cheltenham: Edward Elgar.

Smyth, R., McClelland, J., Lister, P., Steenhart, K., Sargison, A., Westwater, K., Green, N., & Huntingdon, N. (2006). OECD Thematic Review of Tertiary Education – Country Background Report for New Zealand. Retrieved from http://www.oecd.org/

Somers, M., & Fouarge, D. (2016). The Role of Unanticipated Labour Market Conditions in Graduates' Regret of Study Choice. *Mimeo, Maastricht University.*

Spady, W.G. (1970). Dropouts from higher education: An interdisciplinary review and synthesis. *Interchange, 1*(1), 64-85. doi:10.1007/bf02214313

Tsang, M. (1987). The impact of underutilization of education on productivity: A case study of the US Bell companies. *Economics of Education Review, 6*(3), 239-254. doi:10.1016/0272-7757(87)90003-3

Where do college graduates work? A Special Focus on Science, Technology, Engineering and Math (July 10, 2014). Retrieved from: https://www.census.gov/dataviz/visualizations/stem/stem-html/

Van de Werfhorst, H. G. (2002). Fields of study, acquired skills and the wage benefit from a

    matching job. *Acta Sociologica, 45*(4), 286-303. doi:10.1080/000169902762022879

Verdugo, R. R., & Verdugo, N. (1989). The impact of surplus schooling on earnings: Some

    additional findings. *Journal of Human Resources, 24*(4), 629-643. doi:10.2307/145998

Verhaest, D., & Omey, E. (2006). The impact of overeducation and its measurement. *Social

    Indicators Research*, *77*(3), 419-448. doi:10.1007/s11205-005-4276-6

Witte, J.C., & Kalleberg, A. L. (1995). Matching training and jobs: The fit between vocational

    education and employment in the German labour market. *European Sociological Review,

    11*(3), 293-317. Retrieved from http://esr.oxfordjournals.org/

Wolbers, M. H. J. (2003). Job Mismatches and their Labour-Market Effects among School-

    Leavers in Europe. *European Sociological Review, 19*(3), 249-266.

    doi:10.1093/esr/19.3.249

Yakusheva, O. (2010). Return to college education revisited: Is relevance relevant? *Economics of

    Education Review, 29*(6), 1125-1142. doi:10.1016/j.econedurev.2010.06.006

Zhu, R. (2014). The impact of major–job mismatch on college graduates' early career earnings:

    evidence from China. *Education Economics, 22*(5), 511-528.

    doi: 10.1080/09645292.2012.659009

Tables

Table 1. General description of publications included in the analysis (24 publications reviewed)

Classification category	Sub-categories	N	Reference index in Appendix 1
Year of publication	1995-2000	1	1
	2001-2005	3	2, 3, 4
	2006-2010	8	5, 6, 7, 8, 9, 10, 11, 12
	2011-2015	12	13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24
Number of countries included in the study[a]	Single country	18	1, 2, 3, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 17, 18, 19, 23, 24
	Several countries	6	4, 9, 16, 20, 21, 22
Type of data	Cross sectional data	18	1, 2, 4, 5, 6, 9, 10, 11, 13, 16, 17, 18, 19, 20, 21, 22, 23, 24
	Time series data	4	3, 7, 8, 15
	Panel data	2	12, 14
Year of data collection	1980-1985	2	1, 12
	1986-1990	4	1, 9, 12, 16
	1991-1995	5	3, 5, 6, 12, 14
	1996-2000	5	2, 4, 7, 10, 14
	2001-2005	8	7, 8, 11, 13, 14, 17, 19, 20
	2006-2011	8	8, 14, 15, 18, 21, 22, 23, 24
Type of study	Descriptive	1	8
	Correlational	23	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24
	Causal/experimental	0	
Sample size	Less than 1,000	2	15, 18
	1,000 - 2,000	1	24
	2,000 - 3,000	3	1, 2, 12
	3,000 - 4,000	2	9, 10
	4,000-5,000	0	
	5,000 - 10,000	5	3, 17, 20, 22, 23
	Greater than 10,000	11	4, 5, 6, 7, 8, 11, 13, 14, 16, 19, 21
Determinants subject to examination	**Education related determinants - individual level**		
	Field of study	9	4, 5, 6, 7, 14, 15, 17, 18, 22
	Level of education	8	4, 5, 6, 7, 15, 17, 18, 19
	Attending vocational education	2	18, 21
	Type of vocational education	2	1, 4
	Work experience during studies	2	18, 22
	Major activity before programme enrolment	1	17
	Time devoted to studies	2	15, 17
	Study programme's prestige	1	18
	Education related determinants - country level		
	Timing of academic specialization	1	16
	Vocational orientation education system	1	21
	Strength institutional linkages	1	21
	Labour market related determinants		
	State economy	2	4, 7
	Job search duration	1	22
	Opportunity structure	1	1
	Job related determinants		
	Job tenure	3	1, 4, 18
	Occupational group	3	1, 15, 19
	Type of employment contract	3	4, 17, 22

	Sector	2	4, 14
	Firm size	3	1, 4, 18
	Occupational 'cultures of training'	1	1
	Method to obtain employment	1	17
	Individual related determinants		
	Gender	11	1, 4, 5, 6, 7, 14, 15, 17, 18, 19, 22
	Age	10	1, 4, 5, 6, 7, 14, 17, 18, 19, 22
	Ethnicity	5	5, 6, 7, 17, 19
	Disability	3	5, 6, 14
	Marital status	3	5, 6, 19
	Job mobility	2	7, 22
	Parental education	2	17, 22
	Ability	2	17, 18
Effects subject to examination	Wage	13	1, 2, 3, 5, 6, 9, 11, 12, 13, 14, 19, 23, 24
	On-the-job search	5	2, 4, 9, 13, 24
	Occupational status	1	4
	Training participation	1	4
	Job satisfaction	5	2, 9, 13, 19, 24
	Field of study regret	2	10, 20

Note: studies can fall into more than one subcategory. a. An overview of the examined countries can be found in Appendix 1. The numbers in the last column of the table refer to 1 of the 24 studies for which more detailed information is provided in Appendix1.

Table 2. Incidence of horizontal mismatch

Author (year of publication)	Country of study and definition used[a]		Year of data collection	Moderately mismatched (male/female) (%)	Severely mismatched (male/female) (%)	Incidence of horizontal mismatch for other sample characteristics
Witte et al. (1995)	Germany	C	1984-1990		Not trained for job: 46.35 (51.0/39.0)	
Allen et al. (2001)	The Netherlands	A	1998		Own/related field not most appropriate: ±20.0	
Robst (2007a, 2007b)[b]	United States	B	1993	Somewhat related: 25.1 (28.3/20.8)	Not related: 20.1 (19.1/21.4)	Most important reason for accepting HM (male/female) (%): -Pay, promotion: 32.7/18.8 -Working conditions:8.8/11.1 -Job location: 4.3/3.5 -Change career interests: 19.0/19.3 -Family-related: 5.9/18.1 -Job in field degree unavailable: 16.0/16.3
Hensen et al. (2009)	The Netherlands	B	1996-2001		Own/related field not most appropriate: 30.0 (29.0/30.0)	
Mora (2010)	Spain	A	2000		No specific field required: 18.95	
Nordin et al. (2010)	Sweden	D	2003	Weak match: 11.67 (18.0/8.0)	Mismatch: 19.2 (23.0/17.0)	
Yakusheva (2010)	United States	D	1980, 1984, 1986, 1992	Knowledge associated with field has medium relevance for job: 32.45	" low relevance ": 14.55	
Béduwé et al. (2011)	France	D	2001		59.0	-No VM but HM: 30 -VM and HM: 29
Bender et al. (2011)	United States	B	1993, 1995, 1997, 1999, 2001, 2003, 2006	Somewhat matched: 24.7 (25.5/22.5)	Severely mismatched: 8.0 (8.3/7.0)	-Somewhat matched in early career: 22.8 -" in middle ": 25.3 -" in late ": 26.8 -Severely mismatched in early career: 5.9 -" in middle ": 8.5 -" in late ": 10.2 Most important reason for accepting HM **(early career/late career stage) (%):** -Pay, promotion: 22.1/19.3 -Working conditions: 5.1/4.9 -Job location: 4.6/5.2 -Change career interests: 25.6/38.9 -Family-related: 8.1/4.6 -Job in field degree unavailable: 26.7/18.3

Table 2. continued

Farooq (2011)	Pakistan	B	2006/2007, 2008/2009	-Slightly relevant: 13.8 (18.5/12.9)	-Irrelevant: 11.3 (14.8/10.6)
Malamud (2010, 2011) [b]	England and Scotland	D [c]	2011		Overall average: 45.17 -Very broad classification England: 44.0 -Broad classification England: 50.0 -Narrow classification England: 63.0 -Very broad classification Scotland: 29.0 -Broad classification Scotland: 34.0 -Narrow classification Scotland: 51.0
Boudarbat et al. (2012)	Canada	B	2005		Somewhat/not closely related: 35.1
Kucel et al. (2012)	Poland	A	2008		Other/ no specific field required: 18.0
Kucel et al. (2013)	Spain and The Netherlands	A	2005		Other/ no specific field required: -Spain: 27.0 -Netherlands: 20.0
Bender et al. (2013)	United States	B	2003	Overall weighted average: 23.64 -Moderately mismatched wage/salary employees: 23.7 (25.5/21.0) -Moderately mismatched self-employed: 23.3 (24.0/21.5)	Overall weighted average: 14.2 -Severely mismatched wage/salary employees: 13.3 (13.2/13.5) -Severely mismatched self-employed: 19.4 (17.5/24.4)
Levels et al. (2014)	20 countries [d]	D			38.8
Zhu (2014)	China	B	2008		Not related: 28.16 (27.2/29.7)
Shevchuk et al. (2015)	Russia	B	2011		Job fully/mostly mismatches 39.31 (43.4/35.6)

A. based on self-report on whether a specific field of education was required for the job B. based on respondents' assessment of the extent to which their attended field of education is related to or relevant for their current occupation C. respondents' assessment of whether or not they have been trained for their current employment D. objective measure. b. Note that these are two separate studies using the same dataset, we therefore we report the incidence of horizontal mismatch found in these studies once. c. Occupations and fields of study are categorized according to three gradations of classification: narrow (42 categories), broad (12 categories) and very broad (6 categories). An employee is defined to be horizontally mismatched when the field and occupation fall into different categories. Most analyses are based on the broad classification, but are robust to alternative classifications. d. Austria, Belgium, Czech Republic, Germany, Denmark, Spain, Finland, France, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Sweden, Slovenia, Slovak Republic and the UK.

Table 3. Parameter estimates of the determinants of horizontal mismatch (= treated as the outcome variable in this table)

Author (year of publication)	Country of study and definition used[a]		Education-related determinants - Individual level							
			Field of study	Level of educ.	Voca-tional educ.	Type of vocational education (men/women)	Work experience during studies (ref. cat.=no work experience)	Major activity before entering university (ref. cat.=not working/ studying)	Time devoted to studies (ref. cat.=full-time)	Study pro-gramme's prestige as a signal of quality
Witte et al. (1995)	Germany	C				Ref. cat=school-based vocational education -Industrial apprenticeship: +/n.e. -Commercial apprenticeship: +/n.e.				
Wolbers (2003)	13 countries[b]	D	s.e.	-		Ref. cat.=no vocational educ.: n.e.				
Robst (2007a)	United States	B	s.e.	-						
Hensen et al. (2011)	The Netherlands	B	s.e.	-						
Bender et al. (2011)	United States	B	s.e.							
Farooq (2011)	Pakistan	B	s.e.	n.e.					Part-time:+	
Malamud (2011)	England and Scotland	D	s.e.							
Boudarbat et al. (2012)	Canada	B	s.e.	-				-Studying: + -Working: + -Studying and working: +	-Part-time: + -Mix part-time and full-time: +	
Kucel et al. (2012)	Poland	A	s.e.	n.e.	n.e.		Internship: n.e.			-Employers familiar: - -Prestigious: -
Bender et al. (2013)	United States	B		-						
Levels et al. (2014)	20 countries[c]	D			-					
Robert (2014)	Hungary, Poland, Lithuania and Slovenia	A	s.e.				-Study-related work experience: - -Not study-related work experience: +			

Table 3. Continued

Author (year of publication)	Country of study and definition used[a]		Education-related determinants - Country level			Labour market-related determinants		
			Time of academic specialization (ref. cat.=early specialization)	Vocational orientation education system	Strength institutional linkages	State of the economy (unemployment rate)	Opportunity structure[d] (men/women)	Job search duration
Witte et al. (1995)	Germany	C					Ratio unemployed employees to number of available vacancies for a specific occupational group: n.e./+	
Wolbers (2003)	13 countries[b]	D		-Share of upper secondary students in school-based vocational education: + -" in apprenticeship type vocational education: n.e.		+		
Hensen et al. (2011)	The Netherlands	B				n.e.		
Malamud (2011)	England and Scotland	D	Late specialization: -					
Levels et al. (2014)	20 countries[c]	D		+ Interaction vocational orientation ×vocational education: n.e.	- Interaction institutional linkages × vocational education: -			
Robert (2014)	Hungary, Poland, Lithuania and Slovenia	A						+

Table 3. Continued

Author (year of pub.)	Country of study and definition used[a]		Job te-nure	Type of contract (ref. cat. = permanent/full-time contract)	Occupational group (men/women)	Occupational cultures of training (men/women)	Sector **(early career/late career)**	Firm size (men/women)	Method to obtain employment
Witte et al. (1995)	Germany	C	-		Ref. cat=blue-collar -White-collar: n.e./- -Civil servants: n.e./-	-/n.e.		+/n.e.	
Wolbers (2003)	13 countries[b]	D	-	-Part-time: + -Fixed term ": +			Ref.cat.=private -Public: -	-	
Bender et al. (2011)	United States	B					Government:+/n.e. Business: +/n.e.		
Farooq (2011)	Pakistan	B			Ref.cat=employees in elementary occupations: -Manager: - -Professional: - -Associate professional:				
Boudarbat et al. (2012)	Canada	B		-Part-time: + -Fixed term: n.e.					Ref.cat.=referred by someone: -Answered job ad: n.e. -Directly contacted employer: n.e. -Campus placement agency:- -Employment agency: n.e. -Head hunter: n.e.
Kucel et al. (2012)	Poland	A	n.e.					n.e.	
Bender et al. (2013)	United States	B			Ref. cat=wage and salary employees: -Severely mismatched self-employed: +				
Robert (2014)	Hungary, Poland, Lithuania and Slovenia	A		Temporary/ part-time: -					

Table 3. Continued

Author (year of pub.)	Country of study and definition used[a]		Individual-related determinants							
			Gender (ref. cat.= women)	Age	Abi-lity	Parental education	Ethnicity (men/women)	Job mobility	Marital status (ref. cat.= married)	Dis-ability
Witte et al. (1995)	Germany	C	+	+						
Wolbers (2003)	13 countries[b]	D	+	+						
Robst (2007a)	United States	B	+	+			Ref. cat.=white: -Asians: +/n.e. -Black: - -Native Americans:n.e. -Hispanics: -		+	+
Robst (2007b)	United States	B	+							
Hensen et al. (2011)	The Netherlands	B	-	-			Ref. cat.=natives: -Immigrants: +	Geographic:-		
Bender et al. (2011)	United States	B	+	+						n.e.
Farooq (2011)	Pakistan	B	-							
Boudarbat et al. (2012)	Canada	B	n.e.	n.e.	-	Ref. cat.=parents with less than secondary education: -Secondary: n.e. -Some postsecondary: n.e. -Trade: + -Postsecondary: n.e. -Bachelor: n.e. -Postgrad: n.e.	Ref. cat.=natives: -Immigrants: +			
Kucel et al. (2012)	Poland	A	n.e.	n.e.	-					
Bender et al. (2013)	United States	B	-Wage employees: + -Self-employed: -	+			Ref. cat=white: -Asians: n.e. -Black: n.e. -Hispanics: -		+	
Robert (2014)	Hungary, Poland, Lithuania and Slovenia	A	n.e.	n.e.		Ref. cat.=parents with ISCED 5-6: -ISCED 3-4: + -ISCED 1-2: n.e.		-Number of jobs: + -Left first job: n.e.		

Note: + indicates a positive relation between horizontal mismatch and the determinant, – indicates a negative relation, and n.e. indicates that no effect was found. a. Definition of horizontal mismatch: A. based on self-report on whether a specific field of education was required for the job B. based on respondents' assessment of the extent to which their current occupation is related to their attended field of education C. based on respondents' assessment of whether or not they have been trained for their current employment D. objective measure. b. The 13 countries comprise Austria, Belgium, Denmark, Spain, Finland, France, Greece, Hungary, Italy, Luxembourg, The Netherlands, Sweden and Slovenia. c. The 20 countries comprise Austria, Belgium, Czech Republic, Germany, Denmark, Spain, Finland, France, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Sweden, Slovenia, Slovak Republic and the UK.

Table 4. Parameter estimates of the effects of horizontal mismatch (= treated as the predictor variable in this table)

Author (year of pub.)	Country of study and definition used [a]		Rate of return to horizontal mismatch (male/female) (%)	On-the-job search (ref. cat.=no search) (male/female)	Training participation (male/female)	Occupational status (male/female)	Job satisfaction (male/female)	Field study regret (male/female)
Witte et al. (1995)	Germany	C	-Industrial apprenticeship: n.e. -Commercial apprenticeship: n.e./+ -School-based vocational educ.: n.e./+					
Wolbers (2003)	13 countries[b]	D		-Overall:+ Including HM×vocational orientation country: -	-Overall:- Including HM× vocational orientation country: -	-Overall:- Including HM× vocational orientation country: -		
Allen et al. (2001)	The Netherlands	A	n.e.	n.e.			n.e.	
van de Werfhorst (2002)	The Netherlands	D	-Overall average: -3.48 -'Cultural' related competencies are offered by employee's field of study *and* are demanded by the job: n.e. -'Economic' ": 4.1 -'Communicative' ": 7.1 -'Technical' " *but not* " (ref. cat.) -2.7					
Robst (2007a)	United States	B	-Overall:-10.2/-8.9 HM by reason: -Pay, promotion opportunities: 6.1/9.1 -Working conditions: -19.6/-17.2 -Job location: -29.3/-21.1 -Changed career interests: -8.3/4.7 -Family-related reasons: -18.1/-21.5 -No matching job available:-26.5/-18.5					
Robst (2007b)	United States	B	-Field not related: -11.9/-10.1 -Field somewhat related: -2.9/-2.1					
Malamud (2010)	England and Scotland	D	-HM in first year after graduation: -7.0 -HM six years after graduation: n.e.	+			Getting an interesting job: -	
Mora (2010)	Spain	A						n.e.
Nordin et al. (2010)	Sweden	D	-HM: -19.5/-12.2 -Weakly HM: -1.4/-2.9 -HM+field gave specific skills:-19.8/-21.2 -HM+field gave general skills:-18.3/-9.1					

Author	Country	a					
			Controlled for experience: -HM: -6.8/6.9				
Yakusheva (2010)	United States	D	Ref. cat.= degree has low relevance -Highly relevant degree: 21.2 -Medium relevant degree: 6.3				
Béduwé et al. (2011)	France	D	-HM+not VM: -3.0 -HM+VM: -11.0 Controlled for job characteristics: -HM+ not VM: n.e. -HM+ VM: -7.0	-HM+ not VM: + -HM+VM: +		-HM+not VM:- -HM+VM:-	
Bender et al. (2011)	United States	B	Early career (<10 years since degree): -Partly/very HM: -1.9/n.e. -Very HM: -6.9/-7.7 Late career (>25 years since degree): -Partly/very HM: -4.5/-11.5 -Very HM: -21.1/n.e.				
Kucel et al. (2013)	Spain and The Netherlands	A					-Netherlands: + -Spain:+
Bender et al. (2013)	United States	B	Ref. cat.=wage/salary matched employees Wage/salary employees : -Moderately HM: n.e. -Severely HM: -21.1/-15.9 Self-employed: -Moderately HM: -8.8/-17.1 -Severely HM: -42.8/-33.0			Wage/salary employees: -Moderately HM:-/- -Severely HM:-/- Self-employed: -Moderately HM:-/- -Severely HM:-/-	
Zhu (2014)	China	B	-1.17/-1.45				
Shevchuk et al. (2015)	Russia	B	-Overall: -/- Controlled for caregiving (CA): -HM+CA: n.e./- -HM+not CA: -/-	-Overall: n.e. Controlled for caregiving (CA): -HM+CA: n.e./+ -HM+not CA: n.e.		-Overall: n.e./- Controlled for caregiving (CA): -HM+CA: -/- -HM+not CA: n.e./-	

Note: HM indicates horizontal mismatch, VM indicates vertical mismatch, + indicates a positive relation between HM and the outcome variable, – indicates a negative relation and n.e. indicates no effect. a. Definition of horizontal mismatch: A. based on self-report on whether a specific field of education was required for the job B. based on respondents' assessment of the extent to which their current occupation is related to their attended field of education C. respondents' assessment of whether or not they have been trained for their current employment D. objective measure. b. The 13 countries comprise Austria, Belgium, Denmark, Spain, Finland, France, Greece, Hungary, Italy, Luxembourg, The Netherlands, Sweden and Slovenia.

Figures

Figure 1: The selection process