THE EFFECTS OF VOCATIONAL EDUCATION ON ADULT SKILLS AND WAGES. WHAT CAN WE LEARN FROM PIAAC?

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SUMMARY

Vocational education and training are highly valued by many. The European Ministers for Vocational Education and Training, the European Social Partners and the European Commission have issued in 2010 the Bruges Communiqué, which describes the global vision for VET in Europe 2020. In this vision, vocational skills and competencies are considered as important as academic skills and competencies. VET is expected to play an important role in achieving two *Europe 2020* headline targets set in the education field: a) reduce the rate of early school leavers from education to less than 10 percent; b) increase the share of 30 to 40 years old having completed tertiary or equivalent education to at least 40 percent. However, there is limited hard evidence that VET can improve education and labour market outcomes. The few existing studies yield mixed results partly due to differences in the structure and quality of VET across countries.

In this report we investigate the effects of VET on adult skills and labour market outcomes by using the PIAAC survey. Data comparability across countries, the breath of countries involved, and the almost unique presence of information on assessed skills, training, earnings and employment makes this survey especially valuable to study the different facets of VET as compared to more academic education.

Our approach is to think of the possible education careers available to individuals as alternative treatments in a multivalued treatment framework. Focusing mainly but not exclusively on upper secondary, post-secondary and tertiary education, we assume that individuals are exposed to four alternative treatments: 1. vocational education at the upper secondary or post-secondary level; 2. academic education at the upper secondary or post-secondary level; 3. vocational education at the tertiary level; 4. academic education at the tertiary level. In most of this paper, comparisons between vocational and academic education are made at the same level of educational attainment, hence outcomes of treatment 1 (3) are compared to those of treatment 2 (4). Depending on the research question being investigated, other comparisons are possible and may deliver a different picture than the one presented here.

Isolating the effect of VET courses is difficult in the absence of students' ability at the time of entry. In this paper, we assume that the assignment of individuals to the treatments listed above is explained by parental education, country of birth, the number of books in the house at age 16 as well as the pupil/teacher ratio in primary school and the proportion of residents in rural areas at the age of selection. We discuss in the report how plausible this assumption is in the context of the data being used. This is important for the interpretation of our results. Only if this assumption holds we can treat our estimates of the effects of alternative treatments as causal effects. If it does not, a more modest interpretation is in order that views our findings as interesting correlations at best. In particular, if there are factors affecting selection into different curricula that we cannot control for with the data at hand, our estimates may still be affected by selection bias, which could amplify the estimate gap in labour market outcomes associated to alternative curricula.

The results are encouraging in some ways while disappointing in others. Overall, at the ISCED 3 and 4 level, we find that VET performs about as well as academic education as far as earnings are concerned and a bit better in terms of employment outcomes. VET at the ISCED 3-4 level is also associated with higher training incidence. Finally, our findings support the view that the presence of vocational tracks helps keeping students with limited academic attitudes in school. On the other hand and despite the

emphasis put on creating and/or expanding VET opportunities at the ISCED 5 level, we find a clear advantage of academic education at this level across all outcomes considered.

Unsurprisingly, there are large cross-country differences in the estimates reported above, most likely explained by differences in the quality of VET instructions. For instance, there is evidence that the wage and employment returns to VET are higher in countries where the relative supply of VET graduates is lower. In these countries, skill performance by VET graduates is also better. However, in spite of the growing interest attracted by dual systems, which alternate school and work, we do not find systematic evidence that returns to VET are higher in the countries where vocational education systematically combines school and work.

More specifically, at the ISCED 3-4 level, a vocational curriculum is associated to only slightly lower hourly earnings but a higher probability of being currently employed, and a higher share of the completed working life spent in paid employment. The estimated differences are small: for earnings, the negative gap ranges between -1.3 percent for males and -4.8 percent for females; for the probability of employment and the share of time spent in paid employment, the estimated positive gaps are 2.2 and 3.3 percentage points for males and 1.9 and 0.6 percentage points for females.

On the other hand, the comparison between vocational and academic education is much more disappointing when we consider tertiary education (ISCED 5). In this case, the earnings gap between vocational and academic education at the time of the interview is as big as -19 percent for males and -21.7 percent for females. There is also a small negative gap in the probability of being currently employed. This gap should however be contrasted with the positive gap in the share of the working life spent in paid jobs, estimated at 6.9 percentage points in the case of males and at 3.7 percentage points in the case of females. Overall, the evidence we have on different ISCED levels suggests that vocational education does not perform as well as academic education when earnings are concerned, and performs slightly better than academic education when employability measures are considered.

VET also performs less well than academic education on a number of other non-monetary outcomes. Independently of the ISCED level, we find that individuals with vocational education have a higher likelihood of being NEET (not employed and with no education or training in the past 12 months), report poorer health and have poorer civic behaviour than comparable individuals with academic education. There is also evidence that vocational education is associated to poorer labour market returns among older than younger cohorts. Whether these differences simply reflect cohort effects or also indicate the presence of age effects is impossible to tell with the data at hand, which are a cross section of individuals. This issue is important but must be left to better data and further research.

When we consider the proficiency in foundation skills we find individuals with vocational education to be less proficient than those with academic education, for any ISCED level. This is true for both genders and, in spite of some heterogeneity, for all countries. The negative gap is larger for those with tertiary education and increases with the country-specific share of vocational students. In particular, we estimate that the negative percentage gap associated to vocational education at the secondary or post-secondary level ranges from -2.0 to -2.2 percent for literacy, from -1.9 to -2.9 percent for numeracy and from -1.8 to -2.3 for problem solving skills. In the case of tertiary education, the negative gap is larger and ranges from -5.7 to -5.9 for literacy, from -6.7 to -7 percent for numeracy and from -4.4 to -4.7 percent for problem solving skills.

We also find that the relationship between initial vocational education and training and continuing vocational education and training varies with the level of education. When we consider upper secondary or post-secondary education, there is evidence that VET is associated with higher training incidence. The estimated positive gap with respect to academic education ranges from 2.4 percentage points for females to 4.0 percentage points for males. When we focus instead on tertiary education, the evidence

suggests that those who have completed vocational curricula have on average a much lower investment in further training than those with an academic curriculum. In this case, the estimated negative gap is close to 10 percentage points. These results hold for both genders, even when we distinguish between on-the-job and off-the-job training. Interestingly, the negative effect of a vocational curriculum is larger in absolute value in countries with higher employment protection.

Finally, we compare the labour market outcomes and the current skills of individuals who have completed upper secondary or post-secondary vocational education and individuals who have completed at most lower secondary education (ISCED 2). It is often said that the presence of vocational tracks helps keeping students with limited academic attitudes in school. Our empirical evidence shows that upper secondary VET is associated to substantially higher hourly earnings, employability and skills with respect to lower education. For males, we estimate an hourly earnings premium of 10.3 percent and an employment premium of 11.9 percentage points. VET graduates also enjoy close to 11 percent higher level of measured numeracy skills with respect to comparable individuals with at most lower secondary education. In spite of spending more time at school than the latter, the former also end up spending a higher percentage of time in paid employment.

RÉSUMÉ

L'Éducation et le Formation Professionnelle (EFP) sont très valorisées par la plupart des agents. Les Ministres Européens en charge de l'EFP, les partenaires sociaux européens et la Commission Européenne ont approuvé en 2010 le Communiqué de Bruges qui décrit la vision d'ensemble pour l'EFT dans le cadre de la stratégie *Europe 2020*. Dans cette optique, les compétences professionnelles sont considérées comme aussi importantes que les compétences académiques. L'EFP est censée jouer un rôle crucial dans la poursuite de deux objectifs clés de la stratégie *Europe 2020* dans le domaine de la formation, à savoir : a) d'au moins 10 pourcent le taux de décrochage scolaire ; b) augmenter d'au moins 40 pourcent la part d'individus âgés de 30 à 40 ans ayant achevé un niveau d'éducation tertiaire ou équivalent. Toutefois, il y a peu d'indications suggérant que l'EFP puisse améliorer les résultats de l'éducation ou du marché du travail : le peu d'études existantes décrivent une situation assez contrastée liée à des différences en termes d'organisation et de qualité des systèmes d'EFP entre les pays.

Ce rapport examine, à l'aide de l'enquête du PIAAC, les effets de l'EFP sur les compétences et les débouchés professionnels des adultes. La comparabilité des données entre pays, le nombre de pays couverts, et la richesse presque unique d'information concernant les compétences, la formation suivi, les salaries et l'emploi rendent cette enquête particulièrement adaptée pour étudier les différents aspects de l'EFP comparés à d'autres formations plus académiques.

L'idée est de réfléchir aux différents parcours éducatifs que les individus ont la possibilité de suivre. Axé principalement, mais pas exclusivement, sur l'enseignement secondaire du deuxième cycle ou supérieur, le rapport part du principe que les étudiants ont le choix entre quatre options : 1. une formation professionnelle au niveau de l'enseignement secondaire du deuxième cycle ou post-secondaire ; 2. une formation générale au niveau de l'enseignement secondaire du deuxième cycle ou post-secondaire ; 3. une formation professionnelle supérieure ; 4. une formation générale supérieure. Dans le cours de cette étude, les comparaisons sont réalisées entre l'EFP et la formation académique à niveau d'éducation équivalent : ainsi, les résultats de la première option (3^{e} option) sont comparés à ceux de la deuxième option (4^{e} option). Selon les objectifs poursuivis, d'autres comparaisons sont possibles et pourraient dresser un tableau différent par rapport à celui présenté dans cette étude.

Il est très difficile d'isoler les effets de l'EFP en l'absence de données sur le niveau de compétences des étudiants au moment du choix du cursus. Dans cette étude, on suppose que l'attribution par chaque individu d'une des quatre options mentionnées ci-dessus est expliquée par le niveau de formation des parents, le pays de naissance, le nombre de livres disponibles au domicile quand la personne était âgée de 16 ans, le ratio du nombre d'élèves par enseignant à l'école primaire et la proportion de résidents dans les zones rurales à l'âge du choix du cursus. Dans ce rapport, ces différentes hypothèses sont discutées (dans le contexte des données disponibles) compte tenu de leur importance quant à l'interprétation à donner aux résultats. En effet, dans le cas où cette hypothèse est valide, on peut considérer les effets estimés comme des relations de causes à effets. Dans le cas contraire, on devra se contenter d'une interprétation plus modeste des résultats présentés, qui seront alors de simples corrélations. En particulier, en présence de facteurs qui affectent la sélection dans certains programmes et qu'on ne maitrise pas avec les données disponibles, les estimations présentées ici pourraient être affectées par un biais de sélection, pouvant amplifier l'écart estimé des résultats sur le marché du travail entres les différentes options considérées.

Les résultats sont encourageants d'un côté mais décevants de l'autre. Globalement, aux niveaux 3 et 4 de la CITE, on constate que l'EFP comparé à des formations plus académiques fait presque aussi bien en termes de salaire et un peu mieux en termes de taux d'emploi. L'EFP aux niveaux 3 et 4 de la CITE est aussi associée à un taux de formation professionnelle continue plus élevé. Enfin, les résultats de cette étude sont cohérents avec l'idée que l'EFP aide les jeunes en plus grande difficulté à poursuivre leurs études plus longtemps. D'autre part, et malgré l'importance attribuée à la création et l'expansion de l'EFT au niveau 5 de la CITE, on constate à ce niveau un avantage assez net de la formation universitaire pour tous types de résultats examinés.

Comme on pouvait s'y attendre, d'après les données disponibles, la performance de l'EFP en termes de salaire et d'emploi est supérieure dans les pays où l'offre relative de diplômés de l'EFP est moindre. Dans ces pays, le niveau de compétences de ces derniers est également meilleur. Cependant, malgré l'intérêt grandissant que suscitent les systèmes de formation en alternance, qui combinent travail et études, nous ne disposons pas de données indiquant que la performance de l'EFP est plus importante dans les pays où elle combine systématiquement école et entreprise.

Plus précisément, si l'on compare la performance sur le marché du travail de la formation professionnelle et de la formation générale des niveaux 3 et 4 de la CITE (enseignement secondaire du deuxième cycle et post-secondaire), on trouve que la première est associée à une rémunération horaire légèrement moindre, à une plus forte probabilité d'occuper un emploi, et à une part accrue de temps de travail potentiel consacré à un emploi rémunéré. Les différences estimées sont faibles : en ce qui concerne la rémunération, l'écart négatif va de -1.3 pourcent pour les hommes à -4.8 pourcent pour les femmes ; pour ce qui est de la probabilité d'emploi et de la part du temps de travail consacrée à un emploi rémunéré, les écarts positifs estimés sont respectivement de 2.2 et 3.3 points de pourcentages pour les hommes et de 1.9 et 0.6 points de pourcentage pour les femmes.

Le contraste entre les études professionnelles et générales est beaucoup plus marqué dans l'enseignement supérieur (niveau 5 de la CITE ou supérieur). Dans ce cas, l'écart de revenus entre les individus issus d'un cursus professionnel et ceux ayant suivi un enseignement général était assez prononcé au moment de l'enquête, avec -19 pourcent pour les hommes et -21.7 pourcent pour les femmes. Un écart négatif faible est également observé en ce qui concerne la probabilité d'occuper un emploi. Comme pour les individus ayant un niveau d'études moindre, la formation professionnelle diminue le temps passé dans des emplois rémunérés, de 6.9 points de pourcentage chez les hommes et de 3.7 points de pourcentage chez les femmes. Globalement, cela suggère qu'à différents niveaux de la CITE l'EFP ne se traduit pas par des salaries aussi élevés que ceux résultants d'une formation académique mais donne accès à des opportunités d'emploi légèrement meilleures.

L'EFP donne aussi de moins bons résultats que la formation académique dans un nombre de domaines non liés à l'emploi et aux rémunérations salariales. Indépendamment du niveau de la CITE, on observe que les individus ayant suivi une formation professionnelle sont davantage susceptibles d'être déscolarisés et inactifs, d'être en moins bonne santé et d'avoir un comportement moins civique que leurs homologues ayant fait des études générales. D'autres données indiquent que la formation professionnelle est associée à une performance moindre des cohortes plus âgées par rapport aux plus jeunes sur le marché du travail. Les données disponibles, qui portent sur un échantillon d'individus, ne permettent cependant pas de dire si ces différences reflètent simplement des effets de cohorte ou si elles indiquent aussi la présence d'effets liés à l'âge. Cette question est importante mais de meilleures données et de nouveaux travaux de recherche sont nécessaires pour y répondre.

En ce qui concerne la maîtrise des compétences de base, la formation professionnelle a tendance à être moins efficace à tous les niveaux de la CITE. Ce constat est vrai pour les deux sexes et, malgré une certaine hétérogénéité, pour tous les pays. L'écart négatif est plus important pour les individus diplômés de l'enseignement supérieur, et augmente avec la part d'étudiants en formation professionnelle dans chaque pays. En particulier, l'écart négatif associé à la formation professionnelle au niveau secondaire ou post-secondaire va de -2.0 à -2.2 pourcent en lecture et en écriture, de -1.9 à -2.9 pourcent en calcul et de -1.8 à -2.3 pourcent en résolution des problèmes. Pour ce qui est de l'enseignement supérieur, l'écart négatif est plus important ; il va en effet de -5.7 à -5.9 pourcent en lecture et en écriture, de -6.7 à -7 pourcent en calcul et de -4.4 à -4.7 pourcent pour les compétences en matière de résolution des problèmes.

On constate en outre que la relation entre la formation professionnelle initiale et la formation professionnelle continue varie avec le niveau d'études. Au niveau de l'enseignement secondaire du deuxième cycle ou post-secondaire, les données disponibles indiquent que l'EFP est associé à une fréquence accrue des formations. L'écart positif estimé par rapport à l'enseignement général va de 2.2 points de pourcentage pour les femmes à 4.9 points de pourcentage pour les hommes. En revanche, dans l'enseignement supérieur, on constate que les étudiants ayant suivi une formation professionnelle participent en moyenne beaucoup moins à une formation continue que ceux ayant fait des études générales. Dans ce cas, l'écart négatif estimé avoisine les 10 points de pourcentage. Ces résultats valent pour les deux sexes, même lorsque l'on distingue la formation en cours d'emploi et la formation hors poste de travail. Il est intéressant de noter que l'effet négatif des études professionnelles est plus important en valeur absolue dans les pays où la protection de l'emploi est plus forte.

Enfin, les débouchés professionnels et le niveau de compétences des individus ayant terminé des études professionnelles secondaires du deuxième cycle ou post-secondaires sont comparés à ceux des individus n'ayant pas dépassé le deuxième cycle du secondaire. On dit souvent que les filières professionnelles permettent de maintenir dans le système scolaire des élèves ayant peu de dispositions pour les études. Les données disponibles montrent que l'EFP du deuxième cycle du secondaire est associée à des salaires horaires beaucoup plus élevés et à de bien meilleurs niveaux de compétences et taux d'employabilité qu'à un niveau d'études inférieur. Les hommes bénéficieraient d'un avantage de 10.3 pourcent en termes de salaire horaire et de 11.9 points de pourcentage en termes d'emploi. Les diplômés de l'EFP bénéficient, en outre, d'un niveau de compétences en calcul supérieur de 11 pourcent à celui de leurs homologues n'ayant pas dépassé le premier cycle du secondaire. Même si les premiers passent plus de temps à l'école que les derniers, ils affichent, en fin de compte, un pourcentage plus élevé de temps passé dans un emploi rémunéré.

TABLE OF CONTENTS

INTRODUCTION

1. Vocational education and training are highly valued by many. The European Ministers for Vocational Education and Training, the European Social Partners and the European Commission have issued in 2010 the Bruges Communiqué, which describes the global vision for VET in Europe 2020. In this vision, vocational skills and competencies are considered as important as academic skills and competencies. VET is expected to play an important role in achieving two *Europe 2020* headline targets set in the education field: a) reduce the rate of early school leavers from education to less than 10 percent; b) increase the share of 30 to 40 years old having completed tertiary or equivalent education to at least 40 percent.

2. In its review of vocational education in England, the Wolf Report (Wolf, 2011), also highlights the importance of vocational studies. They teach valuable skills, often to a very high standard, offer a direct route into higher education and prestigious apprenticeships which are massively over-subscribed. According to this report, conventional academic study encompasses only part of what the labour market values and demands: vocational education can offer different content, different skills, different forms of teaching.

3. Yet this emphasis on vocational studies is not shared by all. As discussed by Hanushek, Woessmann and Zhang (2011), in the United States vocational education as a separate track in secondary schools has been largely eliminated, mainly because the specific skills provided by these schools are expected to become obsolete very quickly in a world characterised by rapid and continuous innovation.

4. At the heart of these different views is the presence of a potential trade-off between short term and long term costs and benefits: in the short run, vocational education is likely to facilitate labour market entry. In the long run, the faster obsolescence of vocational skills may facilitate premature labour market exit and complicate the employability of older workers. Too much emphasis on vocational skills may even affect long term growth, and may be a source of the growth rate differential between the US and Europe (see Krueger and Kumar, 2004).

5. Importantly, the value of vocational studies can differ sharply both within and between countries. For many, vocational education offers a successful pathway into employment or higher education. For many others, it does not. In the case of the UK, for instance, "…the staple offer for between a quarter and a third of the post-16 cohort is a diet of low-level vocational qualifications, most of which have little to no labour market value. Among 16 to 19 year olds … at least 350,000 get little to no benefit from the post-16 education system…" (Wolf, 2011 [p.7]).

6. The design of vocational education is also important. Eichhorst et al. (2012), classify VET systems around the world into three distinct systems: (i) school based; (ii) a dual apprenticeship system combining school training with a firm-based approach; (iii) informal based. The dual system typical of Continental Europe (Germany, Austria, Denmark and Switzerland) is usually seen as more effective than the school-based VET prevailing in the British Isles, France and much of Southern Europe. Less is known about the merits and demerits of informal training, which prevails in less developed countries.

7. There is broad consensus on this classification of vocational systems. The OECD, for instance, in its study of VET (OECD, 2010) praises the dual system and recommends to: a) increase the involvement of

employers in the design of VET systems; b) provide students with adequate foundation skills (numeracy and literacy) to support lifelong learning and career development.

Defining VET

8. Our definition of VET follows closely the one provided by the OECD, 2010. Vocational education and training comprises education and training programs designed for, and typically leading to, a particular type of job. It normally combines practical training as well as more theoretical learning. It is customary to distinguish between initial vocational education and training (*IVET*) and continuing vocational education and training (*CVET*). The former concerns mainly young people at the beginning of their career and before labour market entry. The latter typically refers to adult education, lifelong learning practices and training. In this report, our definition of VET coincides with IVET, which we treat as an education choice typically occurring after compulsory education.

The purpose of this study

9. VET related policy design that is evidence – based requires adequate data and methods to investigate the different aspects of VET, including its economic payoffs, which accrue to the individual and to society. In the developed countries of the OECD, individuals who invest in their education face or have faced opportunities and constraints that differ, for instance because the design of school curricula varies. In some countries, vocational education starts as early as lower secondary education, in other countries one has to wait post-secondary education.

10. Since VET systems vary across countries, comparative research is valuable to identify best practices. For this, comparative data are required. Such data, that include information on individual education and its labour market outcomes – in terms of employability, training, foundation skills and earnings – have recently become available mainly because of the OECD long standing effort to collect comparative data on education and its outcomes both early on (the PISA project) and during the relevant lifetime. This effort has initially produced the International Adult Literacy Survey, which was conducted between 1994 and 1998 in a group of OECD countries. A first update was the Adult Literacy and Lifeskills (ALL), which covered fewer countries and was carried out between 2003 and 2008. Finally, the OECD has produced the Survey of Adult Skills (PIAAC) which was implemented in 2011. This survey is the focus of the current report.

11. The PIAAC survey is a cross sectional study of skills and skill usage in the OECD, that contains valuable information on education type, foundation skills (numeracy, literacy and problem solving), as well as on training, employment and earnings. The target population is composed of individuals aged 16 to 65 who reside in the national territory. The household survey covers 24 countries in its first round. We refer the interested reader to OECD, 2013, for a detailed description of PIAAC and for a comparison with the previous surveys focusing on adult skills.

12. In this report we ask the following question: what can we learn on VET and its effects on adult skills and labour market outcomes by using PIAAC? Our answer is twofold. On a positive side, we find that data comparability across countries, the breath of countries involved, and the almost unique presence of information on assessed skills, training, earnings and employment provides a wealth of information on the different facets of VET as compared to more academic education. This makes PIAAC a valuable instrument to orient policy in the area of VET.[1]

1. Almost contemporaneous to this study is the study by Lavrijsen and Nicaise, 2014, which covers similar topics.

13. On a less positive side, there are limits in these data that do not facilitate the implementation of rigorous empirical methodologies. Empirical research on the economic effects of VET is plagued by the difficult task of controlling for endogenous selection into different curricula. As reviewed below, this research has adopted a strategy based on selection on observables, and relied on the following "conditional independence assumption (CIA)": once observables are controlled for, potential outcomes are independent of assignment to treatment. Our own approach relies on a similar strategy. The credibility of this approach requires the availability of extensive controls on the individual economic and social background before the relevant school choices are made, possibly including measures of individual ability. Fortunately, PIAAC includes key background controls such as parental education, country of birth and the number of books in the household at age 16. However, information on parental occupation, individual ability at age 14 or earlier and on early individual conditions, including health and housing, is missing. Whether the available controls are sufficient to guarantee that the critical *CIA* assumption is met is an open question that cannot be answered with the data at hand. Because of this, estimates based on selection on observables should be interpreted with due caution.

Review of the empirical literature

14. Vocational education and training (VET) is frequently perceived as improving the opportunities of youths who lack the resources, skills or motivation to continue with higher education. Many have argued that VET provides useful skills to prepare these individuals for labour market entry and improve their chances of a successful professional career. In an influential paper, Ryan (2001), summarises the cross-country evidence, indicating that vocational programmes, and in particular apprenticeships, increase the chances of an early working life. Quintini and Manfredi (2009), study the patterns of school – to – work transitions in Europe and the US and confirm that the most successful European countries in terms of school-to-work transitions are those where apprenticeships are widespread.

15. More recently, CEDEFOP, 2013, has investigated the relationship between VET and school-to-work transition using the individual anonymised micro data from the core and ad hoc modules of the 2009 European Union labour force survey (EU-LFS), which provides detailed information on the transition of young individuals from education to work. The results indicate that VET is able to speed up this transition. Relative to graduates with medium-level academic education, VET graduates enjoy a faster transition to work, are more likely to have a permanent first job, and are less likely to find a first job with a qualification mismatch.[2]

16. It is often argued that vocational education has the advantage of providing ready to use skills, and therefore of facilitating the transition from school to work (e.g. Wolter and Ryan, 2011), but the drawback that the skills it imparts are likely to become quickly obsolete in modern economies with rapid technological change (e.g. Krueger and Kumar, 2004). Hanushek, Wößmann and Zhang (2011), study the employment patterns of several cohorts of graduates with academic and vocational education and find that younger individuals with academic education face worse employment conditions than individuals with similar age who specialise in vocational skills. Conversely, older individuals with academic education have better employment prospects, academic,[3] suggesting that occupation-specific knowledge depreciates faster and hence leads to lower employment opportunities later in life.[4]

2. According to a study by Eurofund (2014), the transition from school to the labour market is stronger/quicker in countries with an active labour market policy, and with education systems that are responsive in the sense that competences from VET are well integrated with labour market needs.

3. Their baseline estimates consider a sample of individuals aged between 35 and 54 to sidestep the selection problems associated to early retirement.

4. Since these authors use a cross – section of age cohorts, it is not clear whether these estimates uncover age rather than cohort effects.

17. While there are virtually no studies investigating the effects of VET on skills, substantial research has been devoted in the past few decades to explore how VET affects labour market outcomes, including earnings and current employment status. This research has produced estimates of the economic returns to different curricula, focusing in particular on the comparison between academic education and VET. Data limitations have generally restricted cross-country comparative analysis, limiting the focus to national case studies.

18. U.S. based research includes Hotchkiss (1993), who studies the effects of vocational schooling on employment and wages for high-school graduates in 1980, finding no returns to vocational schooling even after controlling for training-related occupation choice. In contrast, Bishop and Mañe (2004), find that students who take a certain percentage of vocational subjects in secondary school are more likely to earn higher wages and display higher participation rates compared with academic education students. Meer, (2007), also find positive wage effects, but smaller than in Bishop and Mane.

19. In the UK, earlier studies comparing the returns to vocational and academic schooling have frequently found a markedly lower return to vocational education, explained by academic jobs providing access to better paid occupations (Robinson, 1997). Dearden, McIntosh, Myck and Vignoles (2002), confirm the finding that academic education leads to higher returns, but also document that the majority of vocational education programs increase earnings relative to no vocational qualification, especially for low achieving school leavers. One exception is the NVQ2, a VET course often undertaken during employment, which seems to have a negative impact on the wages of individuals, even relative to those with no other qualification (Dearden, McGranahan and Sianesi, 2004). More recently, Bibby et al. (2014), compare returns to different curricula using matched administrative data and find that returns to workplace level VET are higher than those from classroom level VET.

20. Empirical research on the economic effects of VET is plagued by the difficult task of controlling for endogenous selection into different curricula in a credible way.[5] The few studies that have been able to use exogenous policy changes increasing the duration of academic schooling in vocational schooling tracks tend to find no statistically significant effects of vocational education on wages or employment probabilities.

21. Oosterbeek and Webbink (2007), evaluate the effect of extending 3-years basic vocational programs with one year of academic education – a policy that took place in the Netherlands in 1975 - on later wages. Adopting a difference-in-differences strategy, they investigate the effect of the change on wages twenty years later, but do not find any effect. Pischke and von Wachter (2008), exploit the gradual adoption of a one year increase in compulsory schooling in the lowest schooling track in Germany between the 1950 to the 1970s, investigating the changes on long-term wages, but also fail to find an effect. Hall (2012), assesses a policy change in Sweden in 1991 that increased the academic education content of vocational schooling at the upper secondary level. Exploiting random differences in time and the regional implementation of a policy pilot, she finds no effects of the policy on the wages earned up to 16 years after the beginning of secondary school. Using a natural experiment, Malamud and Pop-Eleches (2010), find that VET graduates in Romania are significantly more likely to be employed as manual workers and craftsmen. However, there is no significant difference between VET and academic education in terms participation rates, unemployment rates, periods of non-employment, and family income. Finally, Fersterer et al. (2008), find that Austrian apprentices earn no significant wage premium when compared to other forms of school based education, such as those taking place in colleges or vocational schools.

5. See the discussion in Altonji, Blom and Meghir (2012).

Our empirical approach

22. In this report, we consider the education careers available to individuals as alternative treatments in a multivalued treatment framework. We assume that individuals are exposed to four alternative treatments: 1. vocational education at the upper secondary or post-secondary level; 2. academic education at the upper secondary or post-secondary level; 3. vocational education at the tertiary level; 4. academic education at the tertiary level. We restrict our main analysis to individuals who have attained at least upper secondary education because PIAAC only registers vocational education as the highest attained education at ISCED levels 3 or 4 (upper secondary or post-secondary).

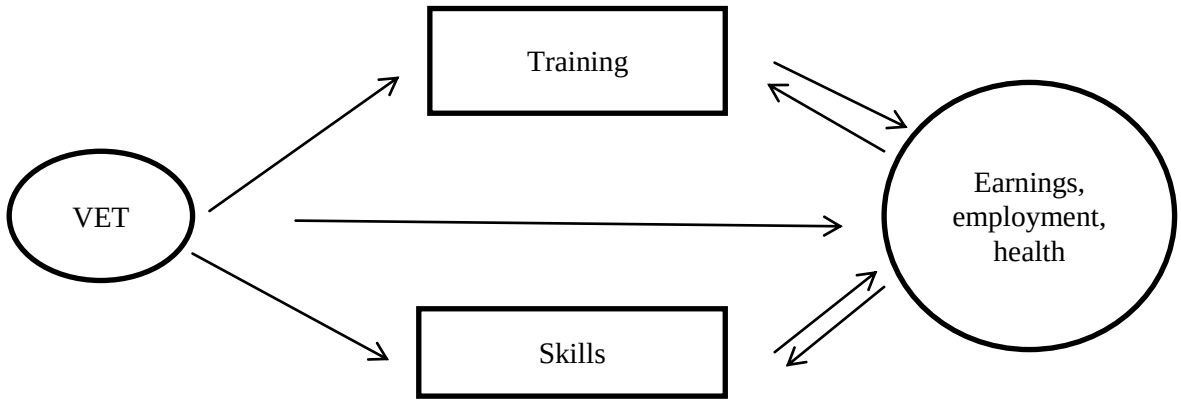
23. Our focus on individuals with at least upper secondary education excludes from most of the analysis those individuals who have completed at most ISCED 2 education (close to 16 percent of the total). Given the policy interest on early school leaving – especially in Europe[6] – it is important to compare economic outcomes for those who stop their education more or less at the end of compulsory education and those who go on to attain vocational upper secondary education. To this end, we also propose an extended version of our approach that incorporates less than upper secondary education as an additional treatment.

24. Since only one treatment is observed for each individual, the remaining treatments are considered as counterfactuals. We use the *IPWRA* method to estimate average treatment effects (ATE), defined as the means of the difference between each treatment and the benchmark treatment. The *IPWRA* method yields unbiased treatment effects under the *CIA* hypothesis, which states that, conditional on a set of pre-determined variables, potential treatments are as good as randomly assigned to individuals. This assumption requires that individual traits that have determined the choice of initial education are adequately captured by observed pre-determined variables, so that the residual variation in initial education, conditional on these characteristics, is either due to random and temporary circumstances or to factors that do not influence the outcomes of interest. We stress that we can give to estimated ATEs a causal interpretation only when the CIA hypothesis holds.

25. The relationship between VET and the economic outcomes included in the PIAAC dataset is illustrated in Figure 1 below. For the purposes of this report, we consider initial education and training, whether vocational or academic, as the key input, denoted IVET, training and skills as intermediary inputs, or X_1, and employment, wages, health and other non – market variables as outcomes *Y*. The figure below illustrates that the relationship between these variables is likely to be complex: we would expect, for instance, skills to influence wages and employment, but also that having a job helps maintain and accumulate skills. Similarly, individuals who have received more training may have higher wages, and better pay at the same time may induce workers to invest in further training.

6. See Brunello and De Paola (2014), for a review of early school leaving issues and related policies in Europe.

Figure 1. **The Relationship between VET and labour market outcomes**



26. Using a regression framework, the relationship between IVET, X_1 and *Y* can be written as

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 IVET_i + \beta_3 Z_i + \varepsilon_i \qquad (0.1)$$

where *Z* is a vector of individual controls, IVET is a dummy equal to 1 if the individual has had vocational education and to 0 otherwise, and the index *i* is for the individual. Since intermediate inputs depend on the key input IVET, we also write

$$X_{1i} = \gamma_0 + \gamma_1 IVET_i + \gamma_3 Z_i + v_i \qquad (0.2)$$

Substituting (0.2) into (0.1) we obtain

$$Y_i = \alpha_0 + \alpha_1 IVET_i + \alpha_2 Z_i + \omega_i \qquad (0.3)$$

where the marginal effect α_1 in Eq.(0.3) is the gross effect of IVET on the outcome *Y*, that compounds the direct effect β_2 and the indirect effects operating via changes in skills and in training opportunities ($\beta_1\gamma_1$). Conditional on Z, the effect of academic education on Y is given by α_0, and the effect of vocational education by $\alpha_0 + \alpha_1$.

27. In this report, we do not try to distinguish between direct and indirect effects – as Equation (0.1) does, and focus instead on estimating the marginal effects α_1 and γ_1 - using Equations (0.2) and (0.3). Including intermediary inputs such as skills or training in the earnings or employment equation is problematic from an empirical viewpoint because skills and training are endogenous variables. These inputs depend on initial education but also reflect individual decisions taken after the end of education. Furthermore, since intermediary inputs and outcomes refer to the same time period, simultaneity issues also arise. To address these issues, we would need additional sources of exogenous variation that we cannot find in the data at hand. We therefore take the more modest route that consists of focusing only on the gross (or total) effect of vocational education on several outcomes, including skills and training.[7]

7. Estimating Eq.(0.1) using standard techniques would be akin to estimating earnings functions by adding occupational dummies to the regressors. See Angrist and Pischke (2008), for a discussion of the problems associated to these estimates. In their recent study of vocational education in PIAAC, Lavrijsen and Nicaise (2014), overlook this problem and estimate equations similar to (0.1) by ordinary least squares. However, including skill scores does not change greatly the results.

Preview of results

28. When we compare the labour market payoffs accruing to vocational and academic education at ISCED 3 and 4 (upper secondary and post-secondary education), we find that a vocational curriculum – as measured in PIAAC - yields on average slightly lower hourly earnings, a higher probability of being currently employed, and a higher share of the potential working time spent in paid employment than a more academic curriculum, even after controlling for differences in the length of education programs. The estimated differences, however, are small: for earnings, they range between -1.3 percent for males to -4.8 percent for females; for the probability of employment and the share of time spent in paid employment, the estimated positive gaps are 2.2 and 3.3 percentage points for males and 1.9 and 0.6 percentage points for females.

29. The effects of curriculum type on earnings differ more sharply when we consider tertiary education (ISCED 5). In this case, the earnings gap between vocational and academic education is estimated to be as big as -19 percent for males and -21.7 percent for females. There is also a small negative gap in the probability of being currently employed, especially for females (-2.7 percentage points). On the other hand, as for the less educated, vocational education increases the time spent in paid jobs.

30. Independently of the ISCED level, we find that vocational education increases both the likelihood that those not in employment have not been in either education or training during the past 12 months and the probability of reporting poorer health and having poorer civic behaviour. There is also evidence that vocational education leads to poorer labour market outcomes for older cohorts, aged 45 to 59 in 2011. Whether these differences simply reflect cohort effects or also indicate the presence of age effects, however, is impossible to tell with the data at hand, which are cross sections of individuals. This issue is important but must be left to better data and further research.

31. When we consider the proficiency in foundation skills, we find that vocational education is always not as effective as academic education, for any ISCED level. This is true for both genders and, in spite of some heterogeneity, for all countries. The negative gap associated to vocational curricula is larger for those with tertiary education (ISCED 5A and 5B) and increases with the country-specific share of vocational students. In particular, we estimate that the negative percentage gap associated to vocational education at the secondary or post-secondary level ranges from -2.0 to -2.2 percent for literacy, from -1.9 to -2.9 percent for numeracy and from -1.8 to -2.3 percent for problem solving skills. In the case of tertiary education, the negative gap is larger and ranges from -5.7 to -5.9 percent for literacy, from -6.7 to -7 percent for numeracy and from -4.4 to -4.7 percent for problem solving skills.

32. We also find that the relationship between initial vocational education and training and continuing vocational education and training varies with the level of education. When we consider upper secondary or post-secondary education, there is evidence that VET is positively associated with training incidence. The positive estimated gap with respect to academic education at the same ISCED level ranges from 2.4 percentage points for females to 4.0 percentage points for males. When we focus instead on tertiary education, the evidence suggests that vocational curricula are associated on average to a much lower investment in further training than academic curricula. In this case, the estimated negative gap is close to 10 percentage points. These results hold for both genders, even when we distinguish between on-the-job and off-the-job training. Interestingly, the gap in the relative efficiency of vocational and academic curricula in stimulating further training is larger in absolute value in countries with higher employment protection.

33. Finally, we evaluate how upper secondary or post-secondary vocational education performs with respect to lower secondary (ISCED 2) or lower education. One of the alleged merits of having vocational tracks in upper secondary school is that they help keeping students with limited academic attitudes in school (see for instance Brunello and De Paola, 2014). Our empirical evidence confirms that, when compared with lower secondary education or less, upper secondary vocational education pays off in terms of earnings, employability and skills, and that the estimated gap in these outcomes is sizeable.

34. The report is organised as follows. Section 1 reviews VET systems and the trends in vocational education in the OECD countries for which we have data. Our empirical methodology is introduced and discussed in detail in Section 2. We start our presentation and discussion of the empirical results in Section 3, where we focus on the effects of VET on foundation and other skills. We examine the effects of VET on earnings, employment and non-monetary outcomes such as health and civic behaviour in Section 4, and the effects on continuing training in Section 5. In the final Section 6 we compare outcomes between two treatments, less than upper secondary education and vocational upper secondary education. Conclusions follow.

SECTION 1: Vocational education and training in the OECD. Institutional design and stylised facts.

1.1 VET systems in the OECD

35. Important differences in the design of VET systems in the OECD include: a) the type of differentiation between curricula; b) the timing of differentiation of school curricula into vocational and academic education; c) the duration of vocational studies; d) the percentage of pupils enrolled in vocational schools. In Europe and in Asia, secondary school students who attend VET programs and students in more academically oriented programs go to different schools and/or are exposed to different curricula. In the U.S., career and technology education (CTE) – which corresponds to vocational education in Europe and Asia – takes place in comprehensive high schools, post-secondary and tertiary education (see OECD, 2010).

36. Differentiation of curricula can start quite early, below age fourteen in a number of countries (Austria, Germany, the Czech Republic, Slovakia, Switzerland, Belgium, the Netherlands, Turkey, Mexico and Hungary), between age fourteen and fifteen in France, Greece, Italy, Korea, Japan and Portugal, and at age sixteen or later in Canada, New Zealand, the U.S., Denmark, Iceland, Poland, Spain, UK, Australia and Scandinavia. The age of initial differentiation has changed over time in several countries after the last world war, with a trend towards later differentiation, often in conjunction with increases in the length of compulsory education. The economic literature investigating the implications of school differentiation – or tracking – is reviewed among others by Betts (2011) and Brunello and Checchi (2007).

37. In a few countries, vocational studies start as early as ISCED level 2, before high school.[8] In most countries, however, VET starts at ISCED 3 (upper secondary education) and continues in post-secondary (ISCED 4) and tertiary education (ISCED 5B). Table 1 shows the presence of vocational studies by ISCED level in a sample of developed countries. The table is partly based on the mapping of national education programs done by UNESCO, which distinguishes between vocational, pre-vocational and academic orientation of programs.[9] In the table, we ignore pre-vocational programs and treat as vocational the tertiary programs that are classified as ISCED 5B.[10]

8. ISCED (International Standard Classification of Education) is a standard created by UNESCO to classify education degrees. ISCED 2: lower secondary; ISCED 3: upper secondary; ISCED 4: post-secondary; ISCED5: tertiary education.

9. Pre-vocational education is mainly designed to introduce participants to the world of work and to prepare them for entry into vocational or technical education programmes. Successful completion of such programmes does not yet lead to a labour-market relevant vocational or technical qualification. For a programme to be considered as pre-vocational or pre-technical education, at least 25 per cent of its content has to be vocational or technical. Vocational Education which is mainly designed to lead participants to acquire the practical skills, know-how and understanding necessary for employment in a particular occupation or trade or class of occupations or trades.

10. We are aware that using ISCED 5B to identify vocational programs at the tertiary level may be not fully adequate in some countries. In the Netherlands, for instance, almost two thirds of the programs classified in ISCED 5A are vocational rather than academic. In this case, our classification under-estimates the extent of vocational curricula.

Table 1. **Presence of vocational education by ISCED level (ISCED 3, 4 and 5) and by country**

Country	Vocational ISCED 3 (UNESCO)	Vocational ISCED 4 (UNESCO)	ISCED 5B (UNESCO)	Vocational education identified in PIAAC
Australia	o	o	o	yes
Austria	o	o	o	yes
Belgium (Flanders)	o	o	o	no
Canada	x	o	o	yes
Cyprus*	o	x	o	no
Czech Republic	o	o	o	yes
Denmark	o	x	o	no
Estonia	o	o	o	yes
Finland	o	o	o	yes
France	o	o	o	yes
Germany	o	o	o	yes
Greece	o	o	o	§
Ireland	o	o	o	yes
Italy	o	o	o	no
Japan	o	x	o	yes
Korea	o	x	o	yes
Netherlands	o	o	o	yes
Norway	o	o	o	yes
Poland	o	o	o	yes
Russian Federation	o	o	o	no
Slovakia	o	o	o	no
Spain	o	x	o	yes
Sweden	o	o	o	no
Switzerland	o	x	o	§
UK	o	o	o	yes
US	x	o	o	yes

Source: UNESCO, 2006 and UNESCO mappings of national educational programs.

Legend: o: vocational education present at this level; x: vocational education not present at this level; - : vocational/academic distinction not possible using PIAAC; §: data not available.

* Note by Turkey: The information in this document with reference to “Cyprus” relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the “Cyprus issue”.

* Note by all the European Union Member States of the OECD and the European Union: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

38. Vocational education is always present at the tertiary level (ISCED 5B) and present in all countries but Canada and the U.S. at the upper secondary level (ISCED 3).[11] For post-secondary education (ISCED 4), there are no vocational programs in Cyprus*, Denmark, Japan, Korea, Spain and Switzerland. The last column in the table shows for each country whether a meaningful distinction between vocational and academic programs is possible in the PIAAC dataset. We shall use this distinction in our empirical analysis. In a number of countries for which we have PIAAC data (Belgium, Cyprus*, Denmark, Italy, Russian Federation, Slovakia and Sweden) the information provided by national project managers is not sufficient to identify VET programs. In other countries (Greece and Switzerland) there are no data in the current PIAAC sample. Overall, there are seventeen countries for which we can use PIAAC data to study the economic effects of VET.[12]

39. Using UNESCO data, Table 2 shows the percentage of pupils enrolled in secondary schools in 2012, the latest available year.[13] This percentage varies substantially across countries, ranging from zero in the U.S. and Canada to close to 50 percent in The Netherlands. In the table, countries in italics are characterised by having an important share of their students in vocational tracks who attend combined school and work-based programs (see OECD, 2010).

Table 2. **Enrolment in vocational education. Secondary schools, 2012**

Country	percent enrolled in vocational education - secondary schools	Country	percent enrolled in vocational education - secondary schools
Australia	0.347	Lithuania	0.110
Austria	0.393	Mexico	0.166
Belgium	0.389	Netherlands	0.482
Canada	-	New Zealand	0.140
Cyprus*	0.067	Norway	0.290
Czech Republic	0.386	Poland	0.293
Denmark	0.269	Portugal	0.337
Estonia	0.193	Korea	0.099
Finland	0.323	Russia	0.172
France	0.197	*Slovakia*	0.342
Germany	0.189	Slovenia	0.359
Greece	0.166	Spain	0.177
Hungary	0.161	Sweden	0.270
Ireland	0.162	Switzerland	0.347
Italy	0.368	Turkey	0.236
Japan	0.116	UK	0.097
		US	-

Source: www.uis.unesco.org

11. Note that Canada's vocational education and training programmes are not directly comparable with other international estimates, as VET programmes are offered at the upper secondary level (predominantly in Quebec), at the post-secondary level through colleges or institutes through apprenticeship programmes. As Canada's PIAAC data capture only VET programmes at the upper secondary level in Quebec and at the postsecondary level through ISCED 5B, caution is advised when interpreting PIAAC results for VET in Canada.

12. The data for Australia are not publicly available.

13. 2011 for Greece and Italy.

40. Table 2 ignores vocational post-secondary and tertiary education, focuses on enrolment rather than attainment and does not allow us to classify data by age group. We therefore turn to PIAAC, which has information on the highest attained degree, the ISCED level and individual age for the seventeen countries where a meaningful distinction between vocational and academic education is possible. Tables 3 and 4 show the share of individuals with vocational education as their highest attainment by ISCED level (3, 4 and 5) and by age group (25 to 39 and 40 to 64 respectively). Focusing on the younger age group (Table 3), we notice that attainment at ISCED level 3 is highest in Austria, Germany and the Czech Republic – the countries in our sample with an extensive system of combined school and work programs - and Poland. In Ireland, close to 25 percent of the sample has post-secondary vocational education as their highest degree.[14] In Korea and Japan, a similar share of individuals holds vocational education at the tertiary level as their highest degree.

Table 3. **Percent with vocational education as highest attainment. 2011. Age group: 25-39. By ISCED level**

Country	Share of individuals aged 25-39 whose highest educational attainment is vocational - ISCED 3	Share of individuals aged 25-39 whose highest educational attainment is vocational - ISCED 4	Share of individuals aged 25-39 whose highest educational attainment is vocational - ISCED 5
Australia	0.170	0.099	0.170
Austria	0.524	0.167	0.066
Canada	-	0.134	-
Czech Republic	0.665	0.027	0.031
Estonia	0.211	0.065	0.209
Finland	0.313	0.029	0.100
France	0.373	-	0.177
UK	0.074	-	0.176
Germany	0.463	0.112	0.126
Ireland	-	0.242	0.187
Japan	0.131	0.017	0.247
Korea	0.191	-	0.258
Netherlands	0.396	-	0.031
Norway	0.267	0.08	0.038
Poland	0.415	0.053	-
Spain	0.050	-	0.169
US	-	0.107	0.119

Source: our computations using publicly available PIAAC data; -: data not available.

41. Vocational education as highest attainment generally declines with age, but there are exceptions. As shown in Table 4, the share of individuals aged 40 to 64 who have this type of education as their highest decreases in all countries with respect to the younger cohorts aged 25 to 39, with the notable exception of Japan, Korea, where it increases, and Spain and the U.S., where it remains more or less constant.

14. In PIAAC, upper secondary education at ISCED 3 in Ireland is classified entirely as academic, in contrast with UNESCO data on enrolments.

42. A potential problem with PIAAC is that measured educational attainment refers to the maximum attained level or degree, and therefore ignores transitions from one type of education to another. To illustrate, when somebody completes vocational upper secondary education and then moves to tertiary academic education, or vice versa, PIAAC registers only the highest attainment, therefore disregarding the nature of previous studies and their contribution to overall labour market returns. How serious is this problem? Since it is hard to tell with the data at hand, we recommend that caution should be used when interpreting our results.

Table 4. **Percent with vocational education as highest attainment. 2011. Age group: 40-64. BY ISCED level**

Country	Share of individuals aged 40-64 whose highest educational attainment is vocational - ISCED 3	Share of individuals aged 40-64 whose highest educational attainment is vocational - ISCED 4	Share of individuals aged 40-64 whose highest educational attainment is vocational - ISCED 5
Australia	0.211	0.080	0.155
Austria	0.646	0.095	0.104
Canada	-	0.162	-
Czech Republic	0.761	0.029	0.013
Estonia	0.247	0.077	0.177
Finland	0.390	0.061	0.259
France	0.517	-	0.118
UK	0.144	-	0.184
Germany	0.565	0.049	0.162
Ireland	-	0.279	0.190
Japan	0.167	0.019	0.188
Korea	0.240	-	0.156
Netherlands	0.385	-	0.069
Norway	0.326	0.125	0.067
Poland	0.633	0.060	-
Spain	0.062	-	0.150
US	-	0.107	0.098

Source: our computations using publicly available PIAAC data; -: data not available.

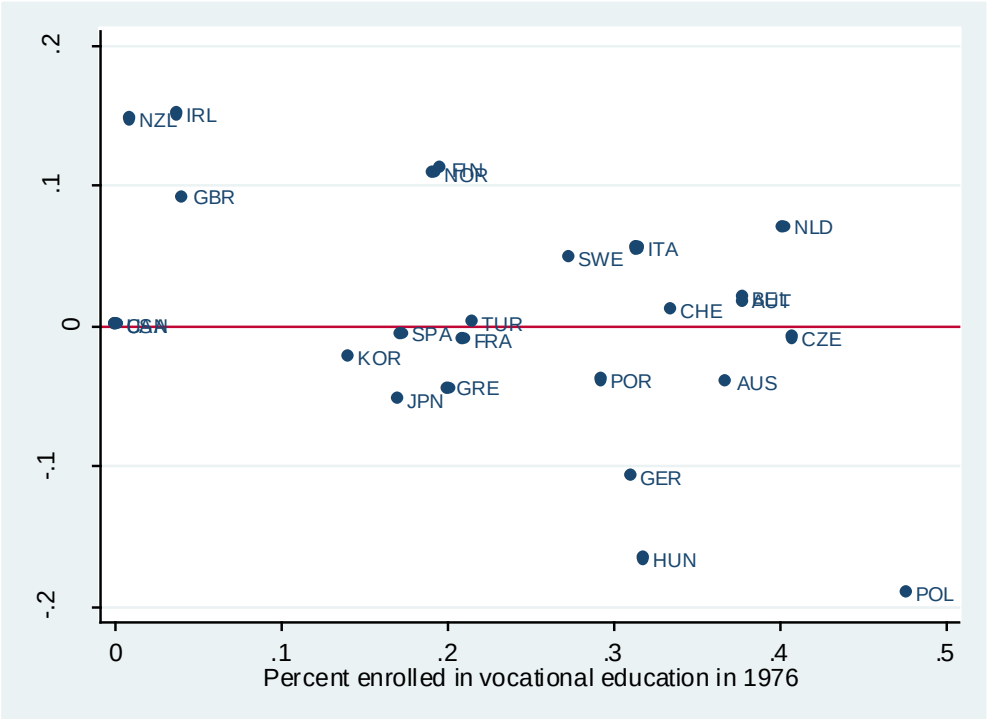
1.2 Trends in vocational education

43. The comparison of Tables 3 and 4 already indicates the presence of important cohort effects in the diffusion of vocational educational attainment. We further explore how the importance of vocational studies has changed over time in several OECD countries by using UNESCO data on enrolment in secondary education by educational programme, which cover the period from 1976 to 2010. Figure 2 plots for the 26 countries for which we have data the change in the percent enrolled in vocational education between 1976 and 2010 against the percent enrolled in 1976.[15] The cross country negative correlation between these two variables suggests convergence in enrolment rates. Enrolment has increased over time

15. For Germany and Australia we have data from 1993 to 2010 and 1991 to 2010; for Switzerland and Denmark, the data start in 1978.

in the countries where it was initially low (New Zealand, Great Britain and Ireland), has remained equal to zero in Canada and the U.S., and has declined sharply in Poland, Hungary and Germany. In the few countries where vocational education was initially relatively high, it has further increased during the 35 years of the sample period (The Netherlands, Italy, Belgium, Austria and Sweden).

Figure 2. **Convergence in vocational enrolment:**
Change in the percent enrolled in vocational education, 1976-2010 (26 developed countries).



Source: www.uis.unesco.org.

Legend : POL : Poland ; HUN : Hungary ; GER : Germany ; AUS : Australia ; CZE : Czech Republic ; NLD :Netherlands ; AUT : Austria ; BEL : Belgium ; CHE : Switzerland ; ITA : Italy ; SWE :Sweden ; POR : Portugal ; FIN : Finland ; NOR : Norway ; GBR : Great Britain ; CAN : Canada ; USA : United States ; KOT : Korea ; JPN : Japan ; GRE : Greece ; TUR : Turkey ; SPA : Spain ; FRA : France.

44. Taking a longer perspective, Bertocchi and Spagat (2004), show that the evolution of the ratio between vocational and academic education in developed countries was expansion between 1870 and the First World War, with a peak being reached during the interwar period, stability until the end of the Second World War and decline afterwards. They interpret this evolution as the outcome of the attempts made by the economic and social elites to maintain their dominant role in modern societies. In their theoretical model, decisions are made through majority voting, which is restricted by a minimum wealth requirement that is initially met only by the elite. Given the specification of preferences, the voting process is such that the median voter will want his children to enter academic high school, while excluding the children of everyone poorer than himself. They show that in a first stage of development the size of the vocational sector relative to the academic sector increases. At a later stage, once the pool of individuals with basic education is exhausted, the vocational sector reaches a ceiling. As lower class wealth levels cross the voting threshold, the political equilibrium generates an academic sector that expands relative to the vocational one. The resulting evolution of the educational system is best summarised by the ratio of vocational to academic education, which they interpret as a measure of the stratification of the educational system and society. They show that this ratio initially increases with income and then decreases, reflecting the complex interaction between economic and political forces in the society (pp. 560-561).

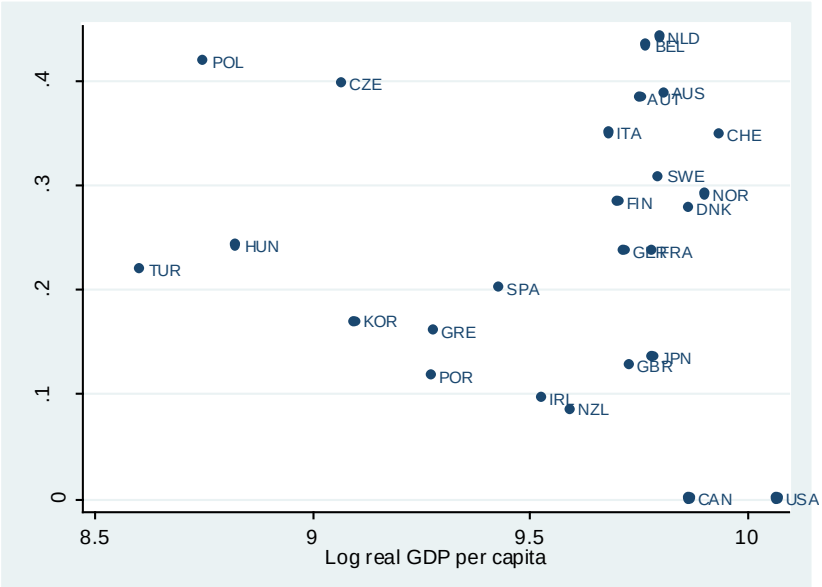
2.3 Cross country variations in the enrolment in vocational education

45. Is the share of students enrolled in vocational education correlated with the level or growth of economic wellbeing, measured by real GDP per capita? We plot in Figures 3 and 4 the 1976-2010 average share of students attending vocational education in secondary school against average real GDP per capita during 1976-2010 and its average growth during the same period. Figure 3 shows that countries with higher real GDP have both very low (Canada and the U.S.) and very high (Switzerland, Norway) shares of vocational students in secondary schools, suggesting that the correlation between these two variables has been rather low since the mid-1970s. Turning to the correlation with the growth rate, this is also quite low: there are several countries in our sample with an average rate of growth close to 2 percent and substantial differences in the share of students enrolled in vocational education.

46. In Figures 5 and 6 we explore the correlation between the share of students enrolled in vocational schools and a) the share of manufacturing GDP; b) the share of real expenditure in R&D on GDP; c) an indicator of product market competition; d) exports on GDP; e) the minimum wage relative to the median wage; f) an indicator of employment protection. All data are from the OECD and the World Bank online databanks. Due to data limitations, each dot in the figures is an average over the period 1995 to 2010.

Figure 3. **Cross country correlation between average real (log) GDP per capita and share of students enrolled in vocational education.**

(Averages 1976-2010)

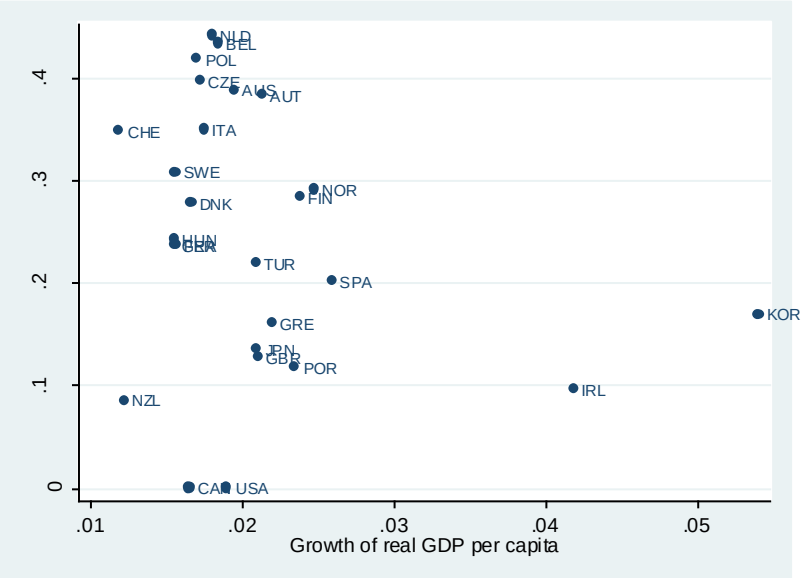


Source: www.uis.unesco.org.

Legend : POL : Poland ; HUN : Hungary ; GER : Germany ; AUS : Australia ; CZE : Czech Republic ; NLD :Netherlands ; AUT : Austria ; BEL : Belgium ; CHE : Switzerland ; ITA : Italy ; SWE :Sweden ; POR : Portugal ; FIN : Finland ; NOR : Norway ; GBR : Great Britain ; CAN : Canada ; USA : United States ; KOT : Korea ; JPN : Japan ; GRE : Greece ; TUR : Turkey ; SPA : Spain ; FRA : France.

Figure 4. **Cross country correlation between the growth of average real GDP per capita and share of students enrolled in vocational education.**

(Averages 1976-2010)



Source: UNESCO.

Legend : POL : Poland ; HUN : Hungary ; GER : Germany ; AUS : Australia ; CZE : Czech Republic ; NLD :Netherlands ; AUT : Austria ; BEL : Belgium ; CHE : Switzerland ; ITA : Italy ; SWE :Sweden ; POR : Portugal ; FIN : Finland ; NOR : Norway ; GBR : Great Britain ; CAN : Canada ; USA : United States ; KOT : Korea ; JPN : Japan ; GRE : Greece ; TUR : Turkey ; SPA : Spain ; FRA : France.

47. The first panel of Figure 5 illustrates the cross country correlation between the share of students enrolled in vocational schools and the share of manufacturing GDP. Since many vocational school graduates work in manufacturing jobs and learn manufacturing skills, one might expect a positive correlation between these two variables. Yet we find that enrolment in vocational schools is higher in the Netherlands than in Italy, in spite of the fact that the latter country has a much higher share of GDP in the manufacturing sector.

48. The second panel illustrates the relationship between enrolment and R&D expenditure on GDP. If we interpret the latter variable as an indicator of the intensity of innovation activities in the economy, we might expect that countries with higher enrolment in vocational education are slower in adopting new technologies (see Krueger and Kumar, 2004). However, we find that Switzerland spends about as much as the U.S. in research and development as share of GDP and yet has a much larger share of pupils enrolled in vocational schools.

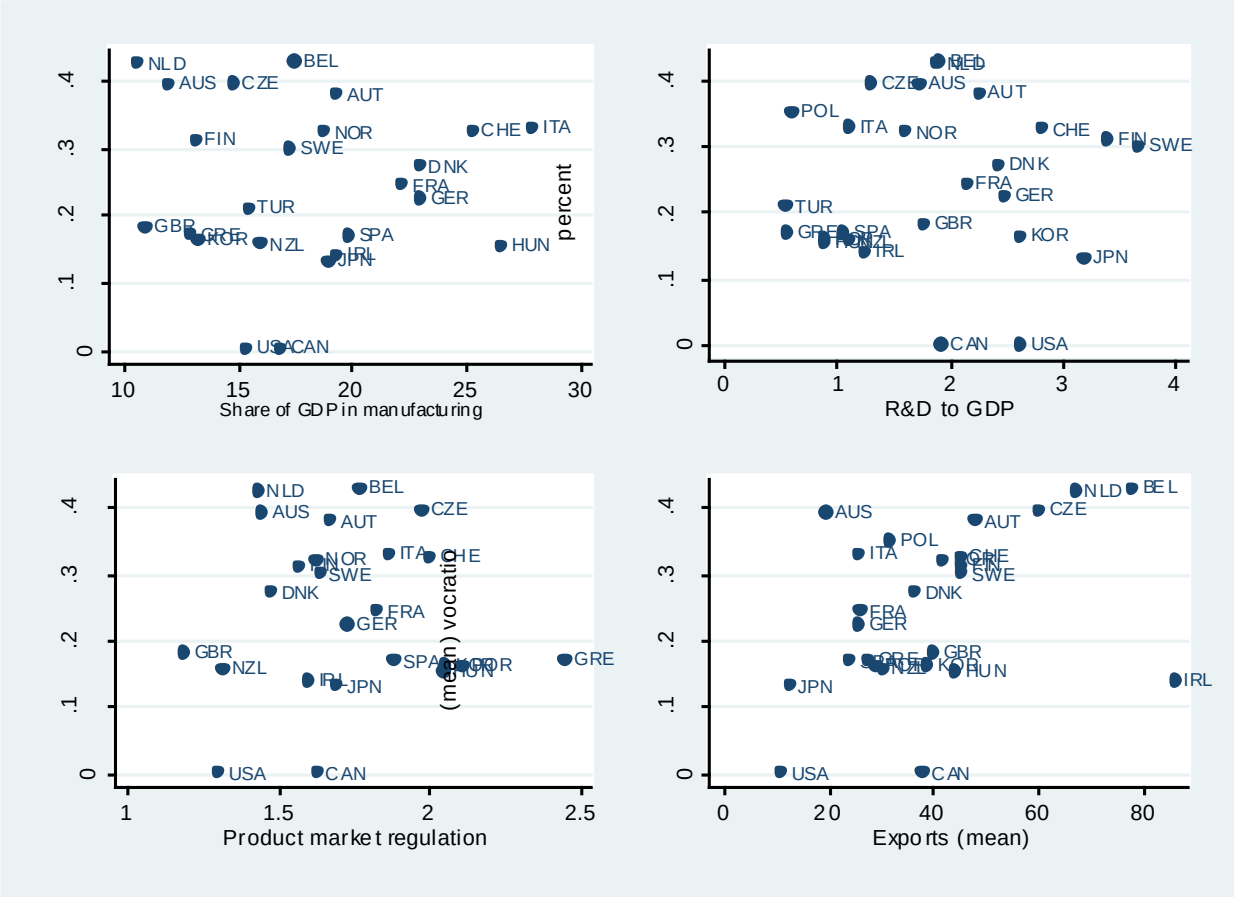
49. The third panel plots enrolment against the OECD index of product market regulation, showing virtually no cross country correlation between these two variables. Finally, the last panel in the figure illustrates the correlation between enrolment and the share of exports of goods and services on GDP. If we exclude Ireland, a clear outlier in the figure, the simple correlation between these two variables is positive and statistically significant.

50. Figure 6 suggests that a positive correlation exists between enrolment in vocational programs and the ratio of the minimum wage to the median wage or the OECD index of employment protection, indicating that high minimum wages and employment protection may encourage employers to seek a guarantee (in the form of a vocational qualification) that a new recruit will be a good recruit.

51. We hasten to stress that these correlations are only suggestive and do not imply causal relationships. Furthermore, simple correlations as shown in the figures fail to take into account the confounding effect of unmeasured country specific effects. We therefore supplement the graphical evidence presented above with a regression of the (log) annual share of students enrolled in secondary vocational education over the period 1995 to 2010 on country dummies, the index of employment protection legislation, the index of product market regulation, the share of manufacturing, exports and R&D expenditure on GDP. In these estimates, partial correlations are identified by time variations in the regressors.[16]

Figure 5. **Cross country correlation between the share of students enrolled in vocational education and macroeconomic variables**

(Averages 1995-2010)



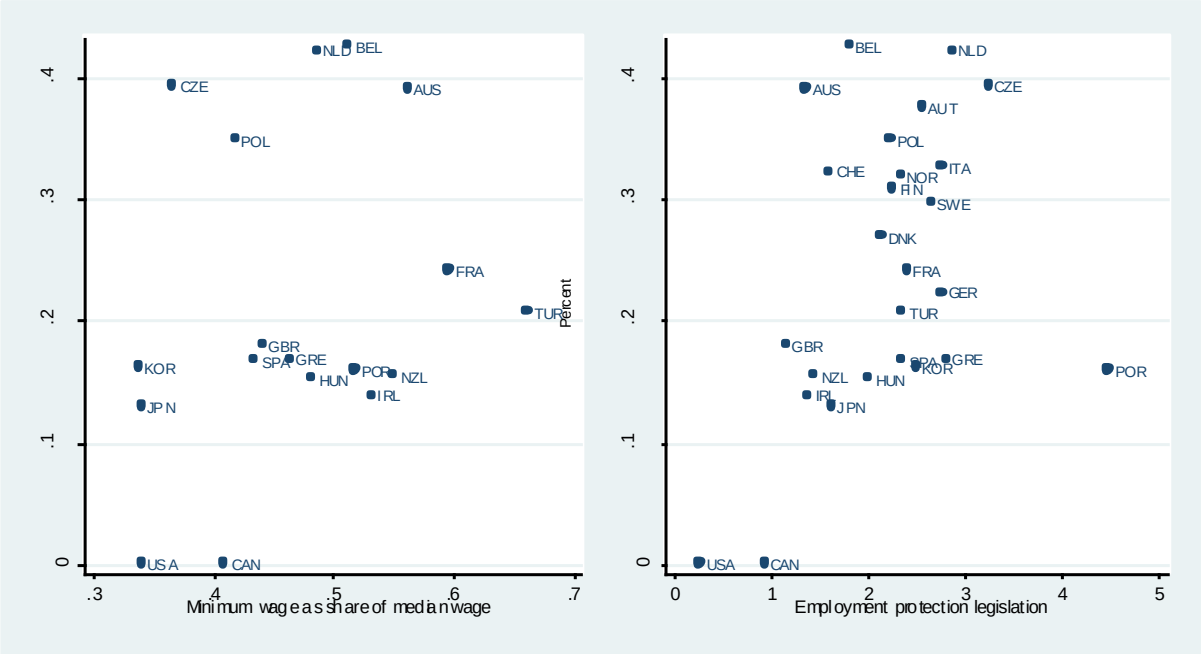
Source: OECD and World Bank data sets.

Legend : POL : Poland ; HUN : Hungary ; GER : Germany ; AUS : Australia ; CZE : Czech Republic ; NLD :Netherlands ; AUT : Austria ; BEL : Belgium ; CHE : Switzerland ; ITA : Italy ; SWE :Sweden ; POR : Portugal ; FIN : Finland ; NOR : Norway ; GBR : Great Britain ; CAN : Canada ; USA : United States ; KOT : Korea ; JPN : Japan ; GRE : Greece ; TUR : Turkey ; SPA : Spain ; FRA : France.

16. We omit the minimum wage because it is missing in several countries of our sample.

Figure 6. **Cross country correlation between the shares of students enrolled in vocational education, the minimum wage and EPL**

(Averages 1995-2010)



Source: OECD and World Bank data sets.

Legend : POL : Poland ; HUN : Hungary ; GER : Germany ; AUS : Australia ; CZE : Czech Republic ; NLD :Netherlands ; AUT : Austria ; BEL : Belgium ; CHE : Switzerland ; ITA : Italy ; SWE :Sweden ; POR : Portugal ; FIN : Finland ; NOR : Norway ; GBR : Great Britain ; CAN : Canada ; USA : United States ; KOT : Korea ; JPN : Japan ; GRE : Greece ; TUR : Turkey ; SPA : Spain ; FRA : France.

52. Table 5 reports our findings. In the table, reported standard errors are clustered at the country level. When we control for country – specific fixed effects, we find that the log share of students in vocational tracks is negatively correlated both with the share of manufacturing on GDP and with the share of R&D on GDP. Whether this correlation reflects a causal relationship, however, remains an open question.

1.4 Reforms to the vocational school system

53. In a number of European countries, the organisation of secondary schools have changed over time, with the clear pattern of increasing the comprehensive component of the education system and of reducing the length of time spent in separate curricula before college. Many reforms taking place since the end of the last World War have combined an increase in the years of compulsory education and a change in the duration and characteristics of school curricula after compulsory education (see for instance Brunello and Checchi, 2007, Murtin and Viarengo, 2011). In particular, the curricula of vocational tracks have often been modified to increase the academic content and improve the opportunities to switch from vocational to academic studies and to access tertiary education (see Green, Wolf and Laney, 1999).

Table 5. **GLM estimates of the effects of economic variables on the share of students enrolled in vocational education. Dependent variable: log of the share of pupils in secondary vocational education. Marginal effects.**

	Estimates
Employment protection index	-0.012
	(0.162)
Product market regulation index	-0.115
	(0.149)
Share of manufacturing on GDP	-0.049**
	(0.020)
Share of RD on GDP	-0.323**
	(0.151)
Exports on GDP	-0.003
	(0.004)
Constant	0.442
	(0.408)
Observations	212
R-squared	0.907

Note: One, two, three stars for statistical significance at the 10, 5 and 1 percent level of confidence.
Source: Own calculations based on OECD and World Bank data sets.

54. Several of these reforms have occurred in the 1950s and 1960s, most notably in Sweden, the UK and Italy (see Leschinsky and Mayer, 1990). More recent reforms have often taken place in concurrence with the demise of soviet-type economic arrangements in Eastern Europe. A 1999 reform in Poland, for instance, has shortened the length of school tracking and reduced the length of vocational education by one year (see Jakubowski et al., 2010). Similar reforms affecting the length of vocational tracks have occurred in Estonia and Romania (see Malamud and Pop-Eleches, 2010). While most reforms have either delayed tracking or reduced the length of the vocational component, there are also reforms that have anticipated tracking. In Bavaria, for instance, a 2000 reform has anticipated tracking from grade 6 to grade 4, with estimated negative effects on pupil performance (see Piopiunik, 2013).

SECTION 2. Measurement and methodological issues

55. In this Section we discuss several methodological issues. First, we summarise how initial vocational education is measured and defined in the international surveys that assess skills and competences, paying particular attention to PIAAC. Next, we define the sample used in this report and briefly discuss the problems associated to the task of identifying the causal effect of vocational education on outcomes in adult life. Finally, we describe the empirical method adopted in the reminder of the report.

2.1 Measurement of vocational education in international surveys

56. Several international surveys focus on individual schooling and skill proficiency. For instance, PISA,[17] TIMMS,[18] and PIRLS[19] measure proficiency in reading, mathematics and science among young people at school age.[20] International studies such as IALS, ALL and more recently PIAAC cover a broader sample of individuals, and measure the cognitive skills of adult people – aged 16 or older - either during or after school completion. Since these surveys typically include detailed information on the level and the type (academic / vocational) of initial education,[21] they can be used to investigate how initial education affects the quality and quantity of human capital and labour market performance.

57. IALS (the International Adult Literacy Survey), the first international survey on adult skills covering OECD countries, was carried out between 1994 and 1998.[22] It has been followed up by ALL (the Adult Literacy and Life Skills), between 2003 and 2008.[23] In the IALS survey, individuals report their highest education degree and its type. Furthermore, those attaining a degree at least as high as ISCED 3 also report the type of secondary education they have completed, either vocational or academic. In IALS, respondents are asked to report the number of grades successfully attained, including grades belonging to uncompleted degrees. Hence, by combining the type of education at different levels with the number of attained grades it is possible to reconstruct with some precision an individual education career, and determine how much time he or she has spent in academic and vocational education.

17. Programme of International Student Assessment, produced by the OECD. PISA surveys students at age 15 and measures their skills in reading, mathematics and science.

18. Trends in International Mathematics and Science Study, produced by IEA and Boston College. TIMSS focuses on skills in mathematics and science at grade fourth and eighth. Recently advanced TIMMS has been launched and it is carried out at the last year of secondary school.

19. Progress in International Reading Literacy Study, produced by IEA and Boston College. PIRLS is complementary to TIMSS as it focuses on reading at grade fourth.

20. The purpose of these surveys is that of permitting an evaluation of school effectiveness. For this reason besides the assessment of students' skills collect information about students' family background, teachers characteristics and school endowment.

21. TIMMS and PIRLS do not report the type of education attended by students. In PISA instead it is possible to know whether the program attended at age 15 is general, vocational or pre-vocational.

22. In IALS the population of reference are all individuals aged between 16 and 65. IALS was conducted between 1994 and 1998 and includes Canada, Switzerland, Germany, USA, Netherlands, Poland, New Zealand, Belgium (Flandres), Italy, Norway, Slovenia, Czech Republic, Denmark, Finland, Hungary and Chile.

23. In ALL the population of reference are all individuals aged between 16 and 65. Six countries participated in the first round in 2003 (Bermuda, Canada, Italy, Norway, Switzerland, and the United States) and four countries participated in the second round, between 2006 and 2008 (Australia, Hungary, Netherlands, and New Zealand).

58. In both ALL and PIAAC surveys, only the highest degree is reported, with no information being provided on intermediate education. In PIAAC, the type of education – whether vocational or academic – is derived ex-post[24] only for those countries where the national questionnaire allows to distinguish between paths A (academic education), B (technical education) and C (professional education) at ISCED levels 3 and 4. No such distinction is available for ISCED 2.

59. As discussed in Section 1, we retain in our final sample only the countries where the distinction between vocational and academic education at ISCED 3 and 4 is reasonably accurate. As regards ISCED 5, we classify type A (including both bachelor and master degrees) as academic education and type B as vocational education.[25] Hence, the distinction between vocational and academic education in this report relies exclusively on the highest attained degree, because by using PIAAC we cannot reconstruct the entire education career and control for eventual transitions from academic to vocational education and vice versa.

2.2 Our sample

60. Our sample consists of seventeen countries with reliable information on vocational education at ISCED levels 3 to 5. They are: Australia, Austria, Canada, Czech Republic, Estonia, Finland, France, Germany, Ireland, Japan, Korea, Netherlands, Norway, Poland, Spain, United Kingdom and United States. PIAAC includes individuals aged between 16 and 65. We restrict our sample by excluding those aged below 25, who are likely still in school. We also retain individuals aged 60 to 65 when considering proficiency in fundamentals skills and skill use, but exclude them when examining the effects of VET on labour market outcomes and continuing training, because of the selection problems associated to retirement. In most of our empirical analysis, we restrict our attention to those with at least ISCED 3, mainly because VET is defined in PIAAC only for this level and for ISCED level 4, and can be defined by us at ISCED 5. Yet, given the relevance of school dropouts in many countries, we also consider those with at most ISCED 2 in the final Section of this report.

61. Because of the empirical strategy explained below, we exclude from our final sample the individuals who have been through relatively uncommon education careers. To illustrate, possible education careers are: vocational education at ISCED 3 or 4, academic education at ISCED 3 or 4, vocational education at ISCED 5 and academic education at ISCED 5. While in all the countries in our sample there is a significant proportion of individuals with vocational education at ISCED 3-4 or with academic education at ISCED 5, vocational education at ISCED 5 is relatively less frequent in Canada, the Czech Republic and Poland, where it accounts for less than 5 percent of the sample. Academic education at ISCED 3-4 is also relatively uncommon in Austria and Germany. As a rule, when the share of individuals attaining a particular education career is below 5 percent in a country, we remove from the analysis the treatment and the corresponding observations for that country.

62. The final sample consists of about 73 thousand individuals, distributed across countries and education careers as in Table 6.

24. Derivation is based on the highest qualifications reported, supplemented by information provided by National Project Managers (NPMs) and OECD experts (see OECD 2013, Technical Report of the Survey of Adult Skills (PIAAC), Appendix 5).

25. ISCED 6, doctoral degrees, which represent about 1 percent of the sample, have been treated as ISCED 5A.

Table 6. **The Sample**

Country	Vocational education at ISCED 3-4	Academic education at ISCED 3-4	Vocational education at ISCED 5	Academic education at ISCED 5	Total
Australia	1,243	576	652	1,633	4,104
Austria	1,931		323	488	2,742
Canada	2,878	3,586		9,496	15,960
Czech Republic	2,431	158		823	3,412
Estonia	1,495	1,028	906	1,333	4,762
Finland	1,273	278	674	1,173	3,398
France	1,590	542	626	1,051	3,809
United Kingdom	503	1,468	758	1,931	4,660
Germany	1,959		552	906	3,417
Ireland	900	822	752	1,141	3,615
Japan	507	880	910	1,117	3,414
Korea	833	1,097	922	1,325	4,177
Netherlands	1,037	315	155	1,122	2,629
Norway	1,160	370	181	1,421	3,132
Poland	2,092	409		1,462	3,963
Spain	131	759	422	1,071	2,383
United States	323	1,323	343	1,203	3,192
Total	**22,286**	**13,611**	**8,176**	**28,696**	**72,769**

Source: PIAAC data.

2.3 Self - sorting and causal relations in our data

63. How can evaluate the causal effect of VET on earnings, employment, skill proficiency and training (CVET)? Answering this question is complicated because both education type and length, the two key attributes of any education career, are not exogenously assigned to individuals, but rather are decided by students, parents and teachers.[26] As suggested by standard economic theory, individuals decide the type and the quantity of education by maximising their utility across a number of alternatives. Their optimal choice depends on preferences, cognitive abilities and attitudes, parental background and the perceived economic benefits and costs of each education career. Benefits include expected labour market returns, and costs include both the direct costs of education and the opportunity costs of delaying access to the labour market.

64. For given expected returns and costs of education, individuals with a preference for practical activities are more likely to opt for vocational education and individuals more attracted by abstract

26. The combination of teacher recommendations, previous academic performance and parental choice varies across countries. See Checchi and Flabbi, 2007, for a comparison of Germany and Italy.

reasoning choose an academic track. Accordingly, while the average levels of manual dexterity and comprehension of practical problems tend to be higher among those who choose a vocational track, the average level of cognitive abilities tends to be higher among those who choose general or academic education. The asymmetric distribution of these individual characteristics is thus the result of the self-sorting of individuals across alternatives.

65. While preferences, abilities and attitudes determine education choices to a large extent, they also have a direct and autonomous effect on the outcomes we want to analyse in this report, including earnings, employment and skills, as well as on intermediate outcomes, such as training. Therefore, the evaluation of the differential effect of vocational and academic education on these outcomes cannot rely on the simple comparison of average outcomes across individuals with different education careers.

66. Ideally, the causal effect of vocational education on outcomes could be identified if the individuals were randomly assigned to vocational or academic education. While random allocation is unfeasible in the real word, exogenous events (such as reforms of the school system) can produce situations equivalent to random allocation. A particularly suitable reform of vocational education has been exploited for instance by Malamud and Pop-Eleches (2010), who have found that in Romania the causal differential effect of vocational education is close to zero and that the entire difference between raw average outcomes is driven by self-sorting.

67. The economics of education literature has adopted several empirical strategies to identify the causal effect of vocational education, for instance by exploiting reforms which have varied either the length of compulsory education or the length of the vocational track, or have transformed somehow the education system (see the introductory Section for a review). These exogenous changes have been used either as instruments in instrumental variable estimators or as discontinuities in regression discontinuity designs, generally in single-country settings. There are also studies that have adopted a selection-on-observables strategy (such as Hanushek, Woesmann and Zhang, 2011), by assuming that in the data there is enough information to adequately model and capture how individuals self-select into different educational careers. When this is the case, several empirical methods can be used, including regression and matching models.

68. In this report we have chosen to adopt a selection-on-observables strategy because 1) PIAAC has useful information to model selection into alternative education treatments; 2) our approach is multi-country and comparative; 3) suitable reforms have occurred only in a few countries, but often too early or too late to be useful,[27] and their effects are difficult to use in a multi-country setup.[28]

27. As discussed in Section 1, a number of relevant reforms have occurred in Europe. However, they simultaneously involved several aspects of vocational education, such as its length, the curriculum, teacher incentives (see the cases of Poland in 1999, Sweden in 1995, and Finland between 1972 and 1977). Since the process of reform involving vocational education has been rather continuous, as shown by CEDEFOP, (2012), it is difficult to isolate the effect of one particular reform.

28. Econometric techniques that exploit policy reforms produce local effects for the sub-population of "compliers" (LATE effects). Since different reforms could impact on different groups of individuals, LATE effects may be difficult to compare across countries.

2.4 Treatment effect in a context of multivalued treatments

69. In several countries, IVET could be attended either at the secondary level, at the post-secondary or at the tertiary level. In the early tracking countries of Central Europe (Austria, Czech Republic and Germany), pre-vocational education is an option already at lower secondary school. Depending on the organisation of education systems in each country, students are allowed to move from the academic to the vocational track and vice versa (bridging). For instance, students attending vocational education at the upper-secondary level can continue their education with a post-secondary or tertiary academic education. Generally, students are also allowed to change track before completing a given education level, possibly after passing a transfer exam. In spite of the possibility to bridge across tracks, the usual observed pattern involve initial academic education, which ends after ISCED 1 in the early tracking countries and could last until the completion of ISCED 3 in the late tracking countries, followed by a bifurcation between a vocational and an academic track, the length of witch mainly depends on the education system and on individual decisions on the optimal quantity of schooling.

70. In principle, students can leave education at any time after the end of compulsory education. In practice, there are three relevant exit points, at the end of compulsory education (that in many countries coincides with the completion of ISCED 2), at the end of upper-secondary education (or after one or two additional years of post-secondary non-tertiary education in the countries where this level is available) and at the end of tertiary education (ISCED 5). By combining education type and length, we define five possible education careers which fit with the schooling decisions of the vast majority of students: the early leavers, who abandon education at the end of compulsory school with at most a basic academic education (typically at ISCED 2); those who achieve an upper-secondary or post-secondary degree (ISCED 3 or 4), either vocational or academic; and those who continue studying and achieve a tertiary degree, either vocational (ISCED 5B) or academic (ISCED 5A).[29] In this report, we treat these five education careers as five alternative treatments that can ideally be administered to all individuals.[30]

2.4.1 A non-technical introduction to IPWRA

71. In this section we introduce some preliminary concepts. Education is considered as a multivalued treatment T, i.e. a treatment which can take several alternative modalities *t*. Specifically, let *t=0* denote education at or below ISCED 2; *t=1* vocational education at ISCED 3-4; *t=2* academic education at ISCED 3-4; *t=3* vocational education at ISCED 5; and *t=4* academic education at ISCED 5. Any individual *i* could be assigned ex-ante to any available modality t=0,…,4. Let the potential outcome of individual *i* under treatment t (i.e. the outcome that *i* would achieve ex-post if he was really administered treatment t) be denoted $Y_i(t)$. There are five potential outcomes associated with each individual in our setup.

72. Assessing the influence of IVET on whatever outcome requires the definition of a benchmark. Given that IVET can either be "short" (ending at ISCED 3-4) or "long" (ending at ISCED 5) the definition of the appropriate benchmark is not uncontroversial. For the most part of this report, we use two benchmarks, , academic education at ISCED 3-4 or 5, depending on the level of education we consider. In this case, treatment t=0 is excluded from the analysis. We also contrast vocational education at ISCED 3 – 4 with education at ISCED 2 or lower (t=0), using the latter as benchmark. In this case both the type and the level of education change between each treatment and the benchmark. We adopt this perspective in Section 6.

29. In countries where level ISCED 5B is available, the majority of students come from the vocational track, while ISCED 5A is attended mainly by students coming from an academic track. Thus ISCED 5 can often be intended as a continuation of the path started at ISCED 3 (or earlier).

30. We assume that treatment take-up and assignment coincide so that all individuals assigned to treatment comply.

The (differential) effect of treatment *t*, with respect to the benchmark *t'* for individual *i* is given by $Y_i(t)$-$Y_i(t')$. In the population, the average treatment effect (ATE) associated to the pair (*t*,*t'*) is

$$ATE(t,t') = E[Y_i(t) - Y_i(t')] = E[Y_i(t)] - E[Y_i(t')] \quad (2.1)$$

73. The problem here (known as the fundamental problem of statistical inference) is that we observe the potential outcome corresponding to the particular treatment administered to individual *i* but we don't know what outcome individual *i* would have achieved if he was administered any alternative treatment. Therefore, the effect of *t* accruing to a certain individual cannot be determined because the potential outcomes corresponding to the alternative treatments are missing.

74. The inverse-probability-weighting (IPW) plus regression-adjustment (RA) method, IPWRA hereafter[31] (Wooldridge 2007, Wooldridge 2010, Cattaneo, 2010), resolves this problem of missing data by imputing to each individual the missing potential outcomes. This is done by exploiting information on similar individuals that received alternative treatments. The IPWRA method overcomes the fundamental problem of statistical inference by generating "educated guesses" for all possible potential outcomes open to each individual. Consequently, all ATEs can be readily computed. A particularly attractive property of the IPWRA method is that it is naturally defined in the framework of multivalued treatments.

75. The imputation procedure implicit in the IPWRA method is valid only under the assumption that assignment to treatment is independent on potential outcomes, conditional on a set of predetermined characteristics X (the so called Conditional Independence Assumption CIA). When CIA holds, and conditional on X, assignment to treatment can be considered as good as random, implying that for each cell determined by X, each treatment group will have the same composition in terms of potential outcomes and individual characteristics.

76. In this report, the identification assumption is that assignment to treatment is as good as random conditional to a person age, a set of family background indicators (parents education, books at home, immigration status) and country specific conditions at the age when individuals were supposed to choose her schooling track (pupil/teacher ratio in primary school and proportion of residents in rural areas at the age of selection). The inclusion of family background is motivated by the fact that preferences, abilities and attitudes are largely influenced by the parents. Parental and children education levels are highly correlated. To illustrate, in our final sample 65 percent of the individuals aged between 25 and 64 whose father achieved a college degree also attained ISCED 5 education, compared to only 30 and 38 percent of individuals whose father attained ISCED 2 and 3C. The number of books at home at early age, that captures parental education, income and attitude towards education, has been shown to have far reaching consequences on returns to education and consequently on school choice (see Brunello, Weber and Weiss, 2012). Parental education is also a good proxy of parental income and of the presence of short run and long run constraints, as defined by Carneiro and Heckman, 2002.

77. We are aware that our identification assumption is rather strong. For instance, it is well known that students with motivation and behavioural problems tend to select into vocational tracks. In part, these problems are the result of the early environment these students grew up in, that we capture with parental education and books in the house. Our controls, however, fail to capture those components of motivation and behaviour that do not depend on parental background. If these components are correlated both with outcomes and with the selected school curriculum, our estimates may still reflect to some extent selection effects, and should therefore interpreted with due caution.

31. The IPWRA estimator is also known as Wooldridge's double-robust estimator.

78. Under CIA the average treatment effects $\mathrm{ATE}(t,t')$ can be identified. Conditional independence implies that, for all possible *t*, $\mathrm{E}[\mathrm{Y_i}(t)|\mathrm{X}]=\mathrm{E}[\mathrm{Y_i}(t)|\mathrm{t_i}(t)=1,\mathrm{X}]$, where the condition $\mathrm{t_i}(t)=1$ defines the set of individuals assigned to treatment *t* . Conditional on X, the average outcome in the population coincides with the average outcome in the sub-population receiving treatment *t*. It follows that

$$\mathrm{ATE}(t,t'|\mathrm{X})=\mathrm{E}[\mathrm{Y_i}(t)-\mathrm{Y_i}(t')|\mathrm{X}]=\mathrm{E}[\mathrm{Y_i}(t)|\mathrm{t_i}(t)=1,\mathrm{X}]-\mathrm{E}[\mathrm{Y_i}(t')|\mathrm{t_i}(t')=1,\mathrm{X}] \quad (2.2)$$

i.e. the ATE of treatment *t* with respect to *t'*, conditional to X, can be computed by comparing the average outcome of the individuals treated with *t* and the average outcome of the individuals treated with *t'*. Averaging over X, we have

$$\mathrm{ATE}(t,t')=\mathrm{E_X}[\mathrm{ATE}(t,t'|\mathrm{X})] \quad (2.3)$$

79. Note that for ATE to be correctly defined, the cell characterised by X = x, for all possible x, must include both subjects assigned to treatment *t* and subjects assigned to treatment *t'*. Otherwise ATE(t,t'|X=x) cannot be evaluated. This condition is called common support or overlapping. In our empirical estimates, we always verify that overlap holds.

80. We conclude this Section with two final remarks. First, compared to simple RA (regression adjustment) estimators, which require defining only the outcome model, the combination of IPW and RA has the advantage of being doubled robust to misspecification. Indeed, the IPWRA estimator is an RA estimator that uses estimated inverse-probability weights obtained from the treatment model to correct the estimator when the outcome model is misspecified. If the outcome model is correctly specified, the weights do not affect the consistency of the estimator (Wooldridge, 2007).

81. Second, the differential effect of vocational education depends on the quantity, quality and market value of the skills and competences that vocational and academic education contribute to accumulate (the direct effect) but also on occupational alternatives and, more in general, on the opportunities that the two types of schooling open up to the students later in their lives (the indirect effect). Typically, those with higher academic education are more likely to end up in high-skill jobs, compared to other education careers, and thereby have access to higher wages, longer working hours, and a stronger pressure to update and expand skills and competences. With PIAAC data and the setting presented in this Section, we cannot distinguish between the direct and the indirect effect and only estimate the total effect.

2.4.2 IPWRA implementation

82. The IPWRA method is composed of three steps:

1) From a multinomial logit model (the treatment model),

$$p(T=t)=\Lambda(X\gamma_t) \text{ for all } t=0,...,4 \quad (2.4)$$

the inverse predicted probabilities of treatment $d_i(t)=\frac{1}{p_i(t)}$ for $t=0,...,4$ are derived for all possible treatments;

2) Separately for each treatment *t*, the corresponding potential outcome is predicted for all individuals (both the individuals assigned to treatment *t* and those assigned to other treatments $t'\neq t$). Predictions rely on the parameters of the following linear model (the outcome model):

$$Y_i(t)=X\beta+\varepsilon \text{ for all } t=0,...,4 \quad (2.5)$$

which is estimated by weighted least squares, with weights given by the *normalised* inverse probability of treatment $\bar{d}_i(t) = \frac{d_i(t)}{\sum_{i|t_i(\theta)=t} d_i(t)} \div \frac{1}{N_t}$. Observations less likely to receive treatment *t*, according to the treatment model, but which are nonetheless administered treatment *t* are weighted more. The intuition behind this procedure is simple. Suppose that individuals with given characteristics $X=x$ tend to self-sort in treatment *t*.

83. Then in treatment *t* characteristics $X=x$ would be over-represented and characteristics $X=x'$ with $x' \neq x$ under-represented. This fact is acknowledged by the treatment model, which assigns a higher probability of been administered treatment *t* to individuals with $X=x$ and lower probability to those with $X=x'$. Thus, by weighting both groups with their inverse probability of treatment in the outcome model, the composition of the sample which has received treatment *t* is re-balanced.

3) ATEs are obtained by comparing the sample means (taken over the entire sample) of the predicted potential outcomes. Efficiency is achieved when weights, predictions and ATEs are simultaneously estimated by a GMM estimator (Cattaneo, 2010).

84. Alternatively, consistent point estimates with somewhat larger standard errors can be obtained by bootstrapping the three-steps procedure described above. In this report, we take this route because it readily offers the possibility of estimating ATEs for particular subgroups, such as the young and the old. Denote $\Delta_i(t,t')$ the difference in the potential outcomes predicted to individual *i* from step 2. We replace step 3 by estimating the following regression

$$\Delta_i(t,t') = a_0 + a_1 OLD + \varepsilon \qquad (2.6)$$

(where OLD is dummy that takes the value 1 for senior individuals and 0 otherwise), that yields $a_0 = ATE(t,t' \mid OLD = 0)$ and $a_1 = ATE(t,t' \mid OLD = 1) - ATE(t,t' \mid OLD = 0)$, i.e. the ATEs for the young and the differential ATE for the old. To compute any ATE of interest we bootstrap the entire procedure 250 times. Compared to the efficient simultaneous procedure, bootstrapped standard errors are only marginally larger.

85. We run the IPWRA procedure separately by country and gender for any outcome we consider. This strategy yields less precise estimates, because of the smaller sample size, but a better fit and more reliable estimates of the probability of treatment.

86. We have reported in Table 7 the multinomial logit estimates derived from step 1 of the IPWRA procedure for the U.S., by gender. In these estimates, we consider five treatments, including also low education (at least ISCED 2). The reference modality is $t=2$, i.e. academic education at ISCED 3-4. Results suggest that family background controls are highly relevant. For both genders, the probability of attaining an ISCED 5 degree is larger if at least one parent has higher education. The number of books at home at age 16 significantly increases the probability of attending academic education at the tertiary level and decreases that of abandoning schools at ISCED 2. In the U.S., being a second generation immigrant increases both the probability of leaving school early and that of achieving an academic degree at ISCED 5, compared to the reference education modality. We believe that this result is driven by the country of origin, with individuals of Latin American descent having lower education and individuals of Asian descent attaining higher education.

87. In Table 8 we report the multinomial logit estimates when the set of treatments is restricted by excluding ISCED 2. Importantly, dropping modality t=0 and the corresponding observations produces only marginal changes in the estimates affecting the probabilities of being assigned to the remaining treatments.

Table 7. **Multinomial logit estimates. Country: USA. By gender. Five modalities. Reference modality: T=2**

	Males				Females			
	T=0	**T=1**	**T=3**	**T=4**	**T=0**	**T=1**	**T=3**	**T=4**
At least one parent with tertiary education	-0.413	0.250	0.582***	1.168***	-0.628*	0.386*	0.752***	1.251***
	(0.275)	(0.220)	(0.214)	(0.143)	(0.330)	(0.204)	(0.188)	(0.134)
Number of books at home at age 16	-0.898***	0.306	0.138	0.957***	-1.218***	0.217	0.148	1.107***
	(0.217)	(0.213)	(0.211)	(0.158)	(0.232)	(0.190)	(0.183)	(0.145)
Share of rural residents	-0.058	-0.357	0.606	0.122	-0.445	-0.807*	-0.145	-0.238
	(0.459)	(0.459)	(0.460)	(0.316)	(0.466)	(0.417)	(0.413)	(0.295)
Pupil/teacher ratio	-0.349	0.065	-0.411	0.034	0.118	0.111	0.260	0.239
	(0.257)	(0.274)	(0.260)	(0.181)	(0.278)	(0.244)	(0.219)	(0.162)
Immigration status	1.160***	-0.225	-0.199	0.809***	1.304***	-0.322	-0.413	0.510***
	(0.229)	(0.346)	(0.335)	(0.196)	(0.220)	(0.300)	(0.292)	(0.179)
Age	0.217	0.196	-0.251	-0.123	0.296	0.576**	0.017	0.063
	(0.316)	(0.316)	(0.307)	(0.217)	(0.310)	(0.287)	(0.290)	(0.204)
Squared age	-0.001	-0.002	0.003	0.001	-0.003	-0.006*	-0.001	-0.001
	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)
Constant	0.219	1.020	-4.710	-2.481	0.521	2.841	-1.901	-0.544
	(3.609)	(3.470)	(3.706)	(2.395)	(3.728)	(3.293)	(3.109)	(2.289)
Observations	1,459	1,459	1,459	1,459	1,709	1,709	1,709	1,709

Note: the coefficients are structural parameters. One, two, three stars for statistical significance at the 10, 5 and 1 percent level of confidence

Source: calculation based on PIAAC (2012)

Table 8. **Multinomial logit estimates from step 1. Country: USA. By gender. Four modalities. Reference modality: T=2**

	Males			Females		
	T=1	T=3	T=4	T=1	T=3	T=4
At least one parent with tertiary education	0.248	0.581***	1.158***	0.386*	0.753***	1.253***
	(0.220)	(0.214)	(0.143)	(0.204)	(0.188)	(0.134)
Number of books at home at age 16	0.302	0.137	0.948***	0.215	0.147	1.099***
	(0.213)	(0.212)	(0.159)	(0.190)	(0.183)	(0.144)
Share of rural residents	-0.356	0.607	0.135	-0.796*	-0.134	-0.205
	(0.458)	(0.460)	(0.316)	(0.417)	(0.413)	(0.295)
Pupil/teacher ratio	0.053	-0.422	-0.006	0.107	0.255	0.229
	(0.273)	(0.259)	(0.181)	(0.243)	(0.219)	(0.162)
Immigration status	-0.230	-0.197	0.811***	-0.332	-0.434	0.478***
	(0.346)	(0.335)	(0.197)	(0.300)	(0.292)	(0.179)
Age	0.198	-0.247	-0.123	0.569**	0.011	0.044
	(0.315)	(0.306)	(0.217)	(0.287)	(0.290)	(0.205)
Squared age	-0.002	0.003	0.001	-0.006*	-0.001	-0.001
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.002)
Constant	1.106	-4.655	-2.202	2.798	-1.938	-0.721
	(3.457)	(3.698)	(2.395)	(3.291)	(3.108)	(2.289)
Observations	1,319	1,319	1,319	1,573	1,573	1,573

Note: see Table 7

Source: calculation based on PIAAC (2012)

SECTION 3. The effect of vocational education on skills and competences

88. Is the contribution of vocational education to adult proficiency in basic skills (literacy, numeracy and ICT skills) larger or smaller compared to that provided by academic education? And furthermore, does the type of education influence the intensity of skill use at home and at work? These questions are relevant because a proper command of basic skills is a necessary condition for an active and independent life, for updating and extending advanced skills and competences and for remaining competitive in the labour market, but also for being able to access administrative, financial and health services and to profit from the broad range of advantages offered by the new technologies. Literacy and numeracy are often described as "basic" skills, in that they provide a "foundation" on which the development of other competencies rests (OECD, 2013, p. 19). In PIAAC, literacy is defined as the ability to understand, evaluate, use and engage with written texts to participate in society, to achieve one's goals, and to develop one's knowledge and potential. Literacy proficiency is assessed by asking subjects to analyse a variety of written texts. Numeracy is defined as the ability to access, use, interpret and communicate mathematical information and ideas in order to engage in and manage the mathematical demands of a range of situations in adult life. To assess numeracy proficiency, individuals are asked questions involving numerical computation, geometrical representation, data manipulation, represented either as texts or graphically. Problem solving in technology-rich environments (simply problem solving or PSTRE hereafter) is defined as the ability to use digital technology, communication tools and networks to acquire and evaluate information, communicate with others and perform practical tasks. The assessment of problem solving proficiency focuses on the abilities to solve problems for personal, work and civic purposes by setting up appropriate goals and plans, and accessing and making use of information through computers and computer networks.

89. In this section, our sample includes individuals aged between 25 and 64. All seventeen countries assess literacy and numeracy proficiency. Problem solving, instead, is measured only in fifteen countries, with the exclusion of Spain and France.

3.1 Effect of vocational education on basic skills proficiency

90. We start our analysis of the influence of education on skill proficiency by presenting key summary statistics derived from raw data. Proficiency is measured over a continuum bounded between 0 and 500. Higher values represent higher proficiency levels. An individual assigned a given proficiency level *P* has a 67 percent probability of responding correctly to the questions designed to have a difficulty level equal to *P*, a much higher probability of responding correctly to question less difficult than *P*, and a much lower probability of responding correctly to questions more difficult than *P*.

91. In Figures 7 to 10 we plot the proficiency levels in literacy, numeracy and problem solving of adults who have attained vocational education (separately for ISCED level 3-4 and level 5) relative to the proficiency of adults with an academic education at the tertiary level (ISCED 5), by country and gender. As expected, in all countries and for both genders, adults with academic tertiary education achieve the highest proficiency in all basic skills. We take them as the reference group for comparisons.

92. The literacy proficiency of males with vocational education at ISCED 3-4 is between 84 percent (Poland) and 92 percent (Canada) of the proficiency of males with academic education at ISCED 5. Among females, the corresponding range is between 85 percent (Finland) and 94 percent (Canada) (Figure 7). Turning to vocational education at ISCED 5 (Figure 8), male proficiency ranges between 91 percent in Estonia and Germany and 96 percent in France while female proficiency is between 91 percent of the benchmark in Finland and 96 percent in Norway.

93. The gap in numeracy proficiency between individuals with vocational education at ISCED 3-4 and the reference group (Figure 9) is comparable to or only slightly larger than that observed for literacy. For both genders, relative numeracy proficiency is smaller in France (81 percent) and largest in Canada (92 percent). Furthermore, the numeracy proficiency of males with vocational tertiary education (Figure 10) lags behind that of males with academic tertiary education. The gap is more pronounced in the United States, Germany, Austria (ratio: 92 percent) and Estonia (ratio: 91 percent) and smallest in France (ratio: 97 percent). Among females, those with the worst performance live in the United States (ratio: 90 percent), while the gap almost disappears in Norway (ratio: 98.5 percent).

Figure 7. **Average proficiency in literacy of individuals with vocational ISCED 3-4 education relative to individuals with academic ISCED 5 education. By country and gender. Raw data**

Source: calculation based on PIAAC (2012)

Figure 8. **Average proficiency in literacy of individuals with vocational ISCED 5 education relative to individuals with academic ISCED 5 education. By country and gender. Raw data**

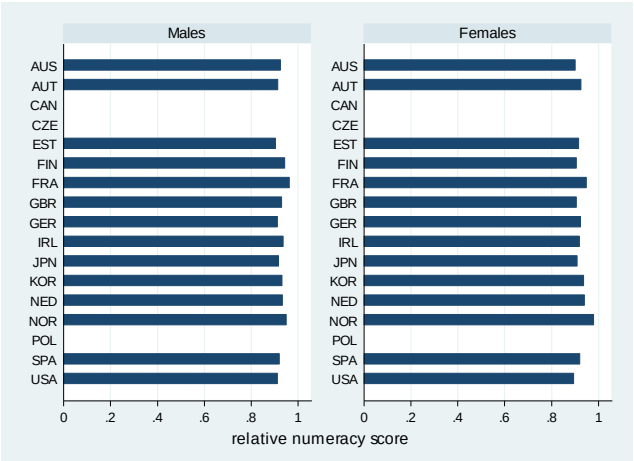
Note: we drop Canada and Poland because vocational ISCED 5 is not available, and the Czech Republic because vocational ISCED 5 education has few observations in our data.

Source: calculation based on PIAAC (2012)

Figure 9. **Average proficiency in numeracy of individuals with vocational ISCED 3-4 education relative to individuals with academic ISCED 5 education. By country and gender. Raw data**

Source: calculation based on PIAAC (2012) *:* see Figure 8.

Figure 10. **Average proficiency in numeracy of individuals with vocational ISCED 5 education relative to individuals with academic ISCED 5 education. By country and gender. Raw data**



Note: see Figure 8.

Source: calculation based on PIAAC (2012)

94. Differently from literacy and numeracy, the PIAAC assessment of proficiency in problem solving in technology rich environments (PSTRE) has been possible only for the individuals with had at least basic competencies in computer use, being the test computed based. Problem solving has been assessed only for those who reported having some preliminary computer experience, agreed in performing a computer based assessment (CBA) of their skills and passed a preliminary evaluation of their ICT competences.[32] Overall, evaluation of problem solving proficiency has been possible for 81 percent of our sample. For the remaining 19 percent, PSTRE proficiency is missing. There is heterogeneity in the proportion of missing values in this test across countries and educational careers (though not between genders), as documented in Table 9. Poland, Japan, Estonia, Ireland and Korea have the highest rates of missing data as opposed to the Netherlands, the U.S., Canada and Norway, where the proportion of missing data is smallest (problem solving has not been assessed in France and Spain). Missing values are more frequent among individuals with vocational education at ISCED 3-4, followed by individuals with academic education at ISCED 3-4.

32. Individuals were required to undertake two core ICT tests. Those who failed the first test were assigned to a paper based evaluation, including only the assessment of literacy and numeracy proficiency. Those who passed the first test but failed the second were evaluated only on a sub-set of items.

They are less frequent at ISCED 5. Overall, the differential missing rate between vocational and academic education is relatively small when taken at the same ISCED level, while we observe large differences across education levels. Major exceptions to this pattern are Poland, the Czech Republic and Finland at ISCED 3-4 and Japan and Estonia at ISCED 5.

Table 9. **Missing rates in PSTRE proficiency data. Both genders.**

Males & Females	Vocational ISCED 3-4	Academic ISCED 3-4	Vocational ISCED 5	Academic ISCED 5
Australia	0.25	0.17	0.16	0.10
Austria	0.25	-	0.13	0.05
Canada	0.17	0.19	-	0.11
Czech Republic	0.29	0.15	-	0.07
Estonia	0.42	0.40	0.27	0.14
Finland	0.27	0.12	0.09	0.05
France	-	-	-	-
United Kingdom	0.18	0.16	0.13	0.04
Germany	0.22	-	0.13	0.06
Ireland	0.33	0.35	0.16	0.10
Japan	0.47	0.48	0.33	0.16
Korea	0.31	0.38	0.12	0.08
Netherlands	0.08	0.09	0.04	0.04
Norway	0.17	0.13	0.08	0.06
Poland	0.68	0.45	-	0.25
Spain	-	-	-	-
United States	0.12	0.22	0.06	0.05

Source: our elaboration on PIAAC data. -: data not available

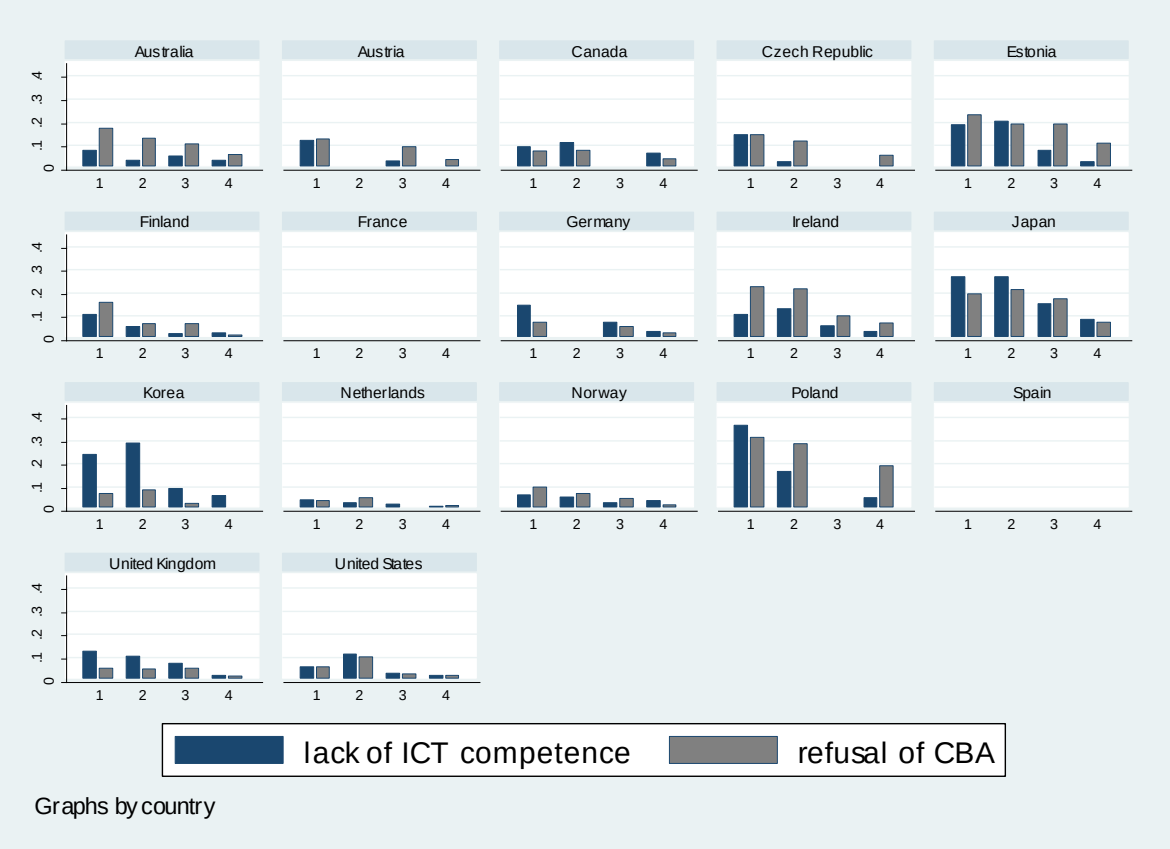
95. There are also important differences between cohorts, as missing values are more frequent among individuals aged 45 or older. In Japan and Norway they are two times as large, in Finland four times as large as in the sub-group of individuals aged 25 to 44 years.

96. Missing values are due both to lack of ICT competences (including lack of experience and failure in core ICT tests) and to the refusal to undertake a computer-based assessment. In Figure 11 we report the percentage of missing values for each cause, separately by country and education career. Refusal of CBA is more frequent than lack of ICT competences in many countries, but the relative importance of each explanation does not depend on the educational career.[33] For this reason and given that the lack of ICT competence is likely to induce refusal of CBA, in the following analysis we will treat PSTRE proficiency as a single outcome, without distinguishing between the two sources.

97. Turning to the large majority of individuals who undertook the test and for whom proficiency has been estimated, gaps between individuals with vocational education and individuals with academic education are narrower compared to those observed for literacy and numeracy. Looking at males with vocational education at ISCED 3-4 (Figure 12), relative proficiency in problem solving ranges between 85 percent in the United Kingdom and 94 percent in Austria. Among females with the same level of vocational education, relative proficiency is 85 percent in the United Kingdom and 95 percent in Canada. Much more limited are the gaps in problem solving proficiency among individuals with vocational education at ISCED 5 (Figure 13). Among males, relative performance is always above 93 percent (United Kingdom) and peeks in Japan (98 percent). Among females the range is between 91 percent in Finland and 97 percent in Germany and Korea.

33. We have defined a dummy taking the value 1 if missing PSTRE proficiency is due to lack of ICT competence and to 0 if it is due to refusal of CBA. We have regressed this dummy on an indicator of vocational education and other exogenous controls, separately by ISCED level. Estimates indicate that the type of education is unrelated to the sources of missing PSTRE proficiency.

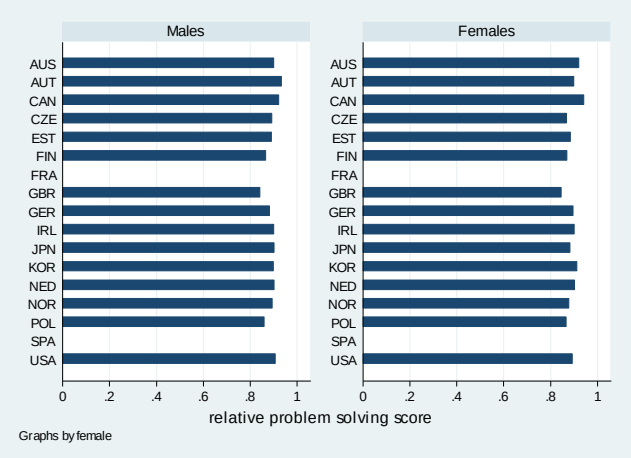
Figure 11. **Missing rates in PSTRA proficiency data due to lack of ICT competences and to refusal of take computer based assessment (CBA). By educational career and country. Both genders.**



Note: Educational careers on the horizontal axis: following the convention of Section 2, 1 stands for vocational education at ISCED 3-4, 2 for academic education at ISCED 3-4, 3 for vocational education at ISCED 5, and 4 is for academic education at ISCED 5. The category denoted as lack of ICT competence includes both individuals not tested in PSTRA because they report having no experience with ICT and those who failed ICT core tests in PIAAC. PSTRE not assessed in France and Spain.

Source: Calculation based on PIAAC (2012)

Figure 12. **Average proficiency in problem solving of individuals with vocational ISCED 3-4 education relative to individuals with academic ISCED 5 education. By country and gender. Raw data**

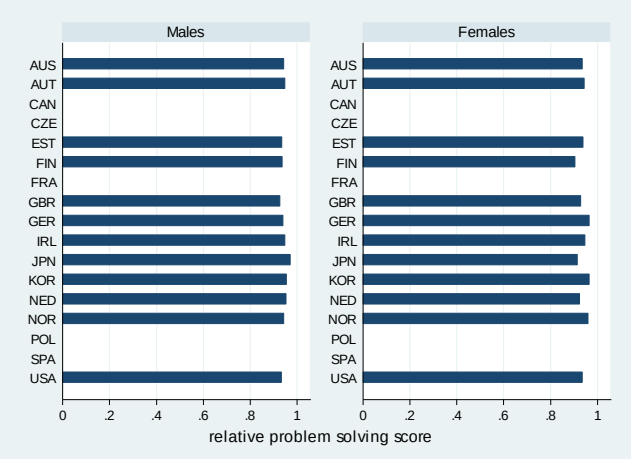


Note: France and Spain do not assess problem solving.

Source: calculation based on PIAAC (2012)

98. Since the comparison of raw means combines the effect of education on proficiency with the effect due to pre-treatment differences (selection bias), we turn to the IPWRA methodology described in Section 2. We consider four alternative treatments: vocational education at ISCED 3-4, academic education at ISCED 3-4; vocational education at ISCED 5 and academic education at ISCED 5, thereby excluding those with ISCED 2 or lower education, and evaluate the ATEs generated by administering to the population vocational rather than academic education. We report our results below separately for each foundation skill, starting with literacy.

Figure 13. **Average proficiency in problem solving of individuals with vocational ISCED 5 education relative to individuals with academic ISCED 5 education. By country and gender. Raw data**



Note: we drop Canada and Poland because vocational ISCED 5 is not available, and the Czech Republic because vocational ISCED 5 education has few observations in our data. France and Spain do not assess problem solving.

Source: calculation based on PIAAC (2012)

3.1.1 Literacy

99. We average country – specific ATEs - defined as differences between population means of potential outcomes – over our sample of countries and report these mean differential effects in Table 10. When averaging, each country – specific ATE is weighted by the inverse of its variance, so that more precisely estimated ATEs weight more. We report ATEs separately by gender and for the entire sample

(individuals aged between 25 and 64), for the subsample of those aged between 25 and 44 and the difference in ATEs between individuals aged 45 to 64 and individuals aged 25 to 44.

100. For both genders, we observe that vocational education is not as effective as academic education in promoting literacy proficiency. The differences in ATEs between younger and senior individuals are small and generally non-statistically significant.[34] Considering education at ISCED 3-4 (column 1), we find that literacy proficiency is about 2 percent lower among individuals who completed a vocational track (2.2 percent lower among males and 2.0 percent lower among females). Turning to ISCED 5, literacy proficiency is about 5.9 percent lower for males (resp. 5.7 percent lower for females) with vocational education (column 2).

Table 10. **Aggregated Average Treatment Effects. Dependent variable: log literacy score**

	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Males		
Age 25-64	-0.022***	-0.059***
	(0.003)	(0.003)
Age 25-44	-0.032***	-0.059***
	(0.004)	(0.004)
Gap between age 45-64 and age 25-44	0.008*	-0.001
	(0.005)	(0.006)
Females		
Age 25-64	-0.020***	-0.057***
	(0.003)	(0.002)
Age 25-44	-0.019***	-0.058***
	(0.004)	(0.003)
Gap between age 45-64 and age 25-44	-0.001	0.006**
	(0.005)	(0.005)

Note: one, two, three stars for statistical significance at the 10, 5 and 1 percent level of confidence

Source: calculation based on PIAAC (2012)

101. Tables 11 and 12 report estimated ATEs by country and separately for males and females. There is substantial heterogeneity, although with no evident outliers. At ISCED 3-4, the differential effect of vocational education on literacy test scores (column 1) is small or absent in Canada, Ireland, Japan, and Korea for both genders. For females, the effect is also not significantly different from zero in Australia, Estonia, Spain and the United States. When the effect is statistically significant, it shows the superiority of academic education and ranges between 3.3 percent in the UK and 10.4 percent in the Czech Republic for males, and between 1.7 percent (in Korea) and 8.8 percent (in the Netherlands) for females.

102. Turning to tertiary education (column 2 in each table), academic education yields a clear advantage in all countries. Only in Norway and for females the ATE follows the academic pattern but is not statistically significant. Among males, vocational education at ISCED 5 reduces proficiency in literacy between 3 percent (Finland) and 8.4 percent (Spain) compared to academic curricula. Among females, the negative gap in proficiency is between 2.9 percent (France) and 8.1 percent (Spain).

34. There is a significant (at 95 percent) difference in ATEs between the two age groups only for females and when we compare individuals with vocational education at ISCED 5 with those with academic education at the same ISCED level.

3.1.2 Numeracy and Problem Solving

103. We present our estimates of the ATEs involving vocational and academic education at different ISCED levels in Tables 13 to 15 for numeracy and in Tables 16 to 18 for problem solving. Unsurprisingly, the patterns described for literacy fit remarkably well with those of both these skills. The size of the effects is largely comparable, especially at the secondary and post-secondary non-tertiary level (column 1 of Tables 13 and 16). Also, the distribution of the effects across countries and genders almost perfectly mirrors that observed for literacy.

Table 11. **Average treatment effects, by country. Males. Dependent variable log literacy score**

Males	**Vocational ISCED 3-4 versus academic ISCED 3-4**	**Vocational ISCED 5 versus academic ISCED 5**
Australia	-0.058***	-0.059***
Austria	-	-0.054***
Canada	0.005	-
Czech Republic	-0.104***	-
Estonia	-0.030***	-0.082***
Finland	-0.063**	-0.030***
France	-0.073***	-0.033***
United Kingdom	-0.033***	-0.068***
Germany	-	-0.080***
Ireland	-0.015	-0.068***
Japan	0.004	-0.045***
Korea	-0.003	-0.046***
Netherlands	-0.060***	-0.056***
Norway	-0.058***	-0.066***
Poland	-0.045**	-
Spain	-0.095***	-0.084***
United States	0.046***	-0.072***

Note: see Table 10

Source: calculation based on PIAAC (2012)

Table 12. **Average treatment effects, by country. Females. Dependent variable log literacy score**

Females	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Australia	-0.014	-0.061***
Austria	-	-0.056***
Canada	0.009	-
Czech Republic	-0.056***	-
Estonia	-0.010	-0.067***
Finland	-0.058***	-0.073***
France	-0.071***	-0.029***
United Kingdom	-0.033***	-0.058***
Germany	-	-0.053***
Ireland	-0.010	-0.065***
Japan	-0.003	-0.066***
Korea	0.017**	-0.041***
Netherlands	-0.088***	-0.035***
Norway	-0.064***	-0.011
Poland	-0.023**	-
Spain	-0.030	-0.081***
United States	0.014	-0.063***

Note: see Table 10

Source: calculation based on PIAAC (2012)

104. Especially among females, there is a moderate gradient across domains in the effects. The estimated ATEs on problem solving are the smallest in absolute value, followed by those on literacy and finally by those on numeracy. Consequently, the difference between ATEs is relatively large if we contrast numeracy and problem solving. Indeed, the relative effect of vocational education at the tertiary level (compared to academic education at the same level) is that of reducing proficiency in problem solving by 4.4 percent among males and 4.7 percent among females. The corresponding effect on numeracy proficiency is larger and equal to 6.7 percent and 7.0 percent respectively (column 2 in Tables 16 and 13).

Table 13. **Aggregated Average Treatment Effects. Dependent variable: log numeracy score**

	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Males		
Age 25-64	-0.019***	-0.067***
	(0.003)	(0.003)
Age 25-44	-0.030***	-0.066***
	(0.004)	(0.004)
Gap between age 45-64 and age 25-44	0.008	-0.003
	(0.006)	(0.006)
Females		
Age 25-64	-0.029***	-0.070***
	(0.003)	(0.003)
Age 25-44	-0.028***	-0.070***
	(0.004)	(0.003)
Gap between age 45-64 and age 25-44	-0.004	0.002
	(0.005)	(0.005)

Note: See Table 10

Source: calculation based on PIAAC (2012)

Table 14. **Average treatment effects, by country. Males. Dependent variable log numeracy score**

Males	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus a ISCED 5
Australia	-0.061***	-0.082***
Austria	-	-0.060***
Canada	0.021***	-
Czech Republic	-0.081***	-
Estonia	-0.031***	-0.097***
Finland	-0.063**	-0.034***
France	-0.103***	-0.029**
United Kingdom	-0.040***	-0.074***
Germany	-	-0.080***
Ireland	-0.015	-0.065***
Japan	0.013	-0.069***
Korea	-0.001	-0.062***
Netherlands	-0.044**	-0.057***
Norway	-0.048***	-0.057**
Poland	-0.039	-
Spain	-0.092***	-0.078***
United States	0.066***	-0.074***

Note: See Table 10

Source: calculation based on PIAAC (2012)

Table 15. **Average treatment effects, by country. Females. Dependent variable log numeracy score**

Females	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Australia	-0.021	-0.084***
Austria	-	-0.072***
Canada	0.004	-
Czech Republic	-0.069***	-
Estonia	-0.017**	-0.072***
Finland	-0.069***	-0.076***
France	-0.100***	-0.049***
United Kingdom	-0.050***	-0.080***
Germany	-	-0.065***
Ireland	-0.014	-0.072***
Japan	-0.002	-0.088***
Korea	0.014	-0.052***
Netherlands	-0.099***	-0.029*
Norway	-0.065***	0.001
Poland	-0.032***	-
Spain	-0.018	-0.076***
United States	0.024*	-0.094***

Note: see Table 10

Source: calculation based on PIAAC (2012)

Table 16. **Aggregated Average Treatment Effects. Dependent variable: log problem solving score**

	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Males		
Age 25-64	-0.018***	-0.044***
	(0.003)	(0.003)
Age 25-44	-0.025***	-0.043***
	(0.004)	(0.003)
Gap between age 45-64 and age 25-44	0.000	-0.003
	(0.006)	(0.005)
Females		
Age 25-64	-0.023***	-0.047***
	(0.003)	(0.002)
Age 25-44	-0.021***	-0.049***
	(0.004)	(0.003)
Gap between age 45-64 and age 25-44	-0.005	0.009***
	(0.006)	(0.005)

Note: see Table 10

Source: calculation based on PIAAC (2012)

Table 17. **Average treatment effects, by country. Males. Dependent variable log problem solving score**

Males	**Vocational ISCED 3-4 versus academic ISCED 3-4**	**Vocational ISCED 5 versus academic ISCED 5**
Australia	-0.037***	-0.050***
Austria	-	-0.020*
Canada	-0.004	-
Czech Republic	-0.117	-
Estonia	-0.039***	-0.075***
Finland	-0.054**	-0.027***
France	-	-
United Kingdom	-0.046***	-0.058***
Germany	-	-0.045***
Ireland	-0.004	-0.040***
Japan	0.004	-0.017*
Korea	-0.007	-0.042***
Netherlands	-0.044***	-0.038**
Norway	-0.027**	-0.052***
Poland	-0.040*	-
Spain	-	-
United States	0.037**	-0.065***

Note: see Table 10

Source: calculation based on PIAAC (2012)

Table 18. **Average treatment effects, by country. Females. Dependent variable log problem solving score**

Females	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Australia	-0.011	-0.054***
Austria	-	-0.045***
Canada	-0.003	-
Czech Republic	-0.047***	-
Estonia	-0.36***	-0.048***
Finland	-0.058***	-0.054***
France	-	-
United Kingdom	-0.050***	-0.061***
Germany	-	-0.032***
Ireland	-0.019**	-0.039***
Japan	-0.022	-0.068***
Korea	0.015	-0.021***
Netherlands	-0.050***	-0.041***
Norway	-0.060***	-0.001
Poland	-0.025	-
Spain	-	-
United States	0.011	-0.064***

Note: See Table 10

Source: calculation based on PIAAC (2012)

105. Estimates of the effects of VET on problem solving should be interpreted with care for countries such as Poland, Japan, Estonia, Ireland and Korea, where the proportion of missing data on PSTRE proficiency is relatively high. To account for the role of missing data, we report in the Appendix the estimates obtained when the outcome variable is an indicator of missing PSTRE assessment (a dummy which takes the value 1 if the individual either lacks basic ICT skills or he/she refuses to take computer-based assessment and 0 otherwise). This outcome can also be viewed as an indicator of ICT illiteracy. At ISCED 3-4, we observe that vocational education has no significant effect on the probability of being an ICT illiterate at ISCED 3-4 for both genders (see column 1 of Table 22). We detect no significant difference in ATEs among both individuals aged between 25 and 44 and individuals aged 45 or older.

106. When we consider higher education – ISCED 5 – the evidence suggests that vocational education increases the probability of ICT illiteracy by 5.1 percentage points among males and by 4.9 percentage points among females. We also observe that the gap is much narrower among individuals aged between 25 and 44 (1.6 and 2.4 percentage points for males and females respectively). Turning to the estimates by country, for males (Table 23) only in Canada and the U.S. does vocational education significantly reduce the probability of ICT illiteracy relative to academic education at ISCED 3-4 (column 1) while it increases such probability by 13.5 percent in Australia. At ISCED 5 (column 2), no significant gap results in the Netherlands, Norway, Finland and Ireland; in the remaining countries, vocational education generates an increase in the likelihood of ICT illiteracy by about 5-6 percentage points, with a spike in Japan (10.3 percentage points) and Estonia (16.1 percentage points).

107. Among females (Table 24) the picture is much more nuanced. When education at ISCED 3-4 level is considered (column 1), in Ireland, Korea and the U.S., vocational education reduces ICT illiteracy relative to academic education, but increases it in Finland, Czech Republic and Poland by about 10 percentage points. When higher education – ISCED 5 – is considered (column 2), there is no statistically significant effect of vocational education on illiteracy in Austria, Finland, Norway, Netherlands and the United States. Among the remaining countries, vocational education increases the probability of ICT illiteracy by 4 to 7 percentage points with, again, a spike in Japan (15.3 percentage points) and Estonia (9.8 percentage points). Overall, these results suggest that the gap in problem solving proficiency associated to vocational education (reported in Tables from 16 to 18) could be underestimated for tertiary education (ISCED 5) and slightly overestimated for upper secondary and post-secondary education (ISCED 3-4).

3.1.3 Patterns in the ATEs

108. In this section we analyse more systematically the heterogeneity of ATEs across countries by regressing ATEs on a set of country specific characteristics, including indicators of the size and characteristics of vocational education in each country, labour market indicators and per-capita real GDP. In these estimates, we pool ISCED levels and types of skill. Since the regressors of interest vary at the country level, standard errors are clustered by country. In the regressions, each ATE is weighted by the inverse of its variance. Results are reported in Table 19 for males, females and for both genders combined.[35]

109. The estimates indicate that the negative gap in proficiency associated to vocational education is larger at ISCED 5 than at ISCED 3-4 by about 3 percentage points, slightly larger for numeracy and slightly smaller for problem solving (compared to the other two domains). There is little difference across genders. While the negative gap increases with the proportion of students attending a vocational track, it is invariant with respect to country differences in the presence of combined schooling and work VET programs. There is evidence (especially among males) that higher per capita income contributes to reduce the gap. Finally, neither the unemployment rate nor the degree of employment protection are significantly associated with ATEs.[36]

Table 19. **Partial correlations between estimated ATEs and country specific effects**

VARIABLES	(1) Males	(2) Females	(3) All
ISCED 5 dummy	-0.035***	-0.030**	-0.032***
	(0.010)	(0.013)	(0.009)
female dummy			0.000
			(0.004)
share with vocational education	-0.009***	-0.011**	-0.010***
	(0.002)	(0.004)	(0.002)
vocational programs combining school and work	0.001	0.003	0.003
	(0.014)	(0.010)	(0.009)
unemployment rate	-0.000	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
employment protection legislation	-0.006**	0.003	-0.003
	(0.003)	(0.005)	(0.003)
log real GDP per-capita	0.013***	0.001	0.006***
	(0.002)	(0.004)	(0.002)
Domain			
Reference: Literacy			
numeracy	-0.002	-0.009***	-0.006***
	(0.002)	(0.003)	(0.004)
problem solving	0.014***	0.009***	0.011***
	(0.005)	(0.003)	(0.004)
differential missing rate in problem solving	-0.112*	-0.111***	-0.116***
	(0.063)	(0.046)	(0.041)
Constant	-0.021	-0.000	-0.009
	(0.012)	(0.014)	(0.010)
Observations	75	75	150
R-squared	0.600	0.447	0.490

Note: standard errors clustered by country. *** p<0.01, ** p<0.05, * p<0.1. ATE for proficiency in literacy, numeracy and problem solving are pooled in the dataset. The variable "differential missing rate in problem solving" is obtained as the difference between the proportion of individuals with vocational education who failed to be tested for PSTRE and the corresponding proportion among individuals with academic education, by level of education, country and gender.

Source: calculation based on PIAAC (2012)

35. We also control for differences in missing values in the PSTRE evaluation.

36. We observe only significant but very small effect of EPL among males.

3.2 Effect of vocational education on skill use.

110. A distinctive feature of the PIAAC survey is that it contains information not only on proficiency in basic skills, but also on twelve indices of skill use at work and at home. These indices have been derived by combining information on the frequency of skill use in a variety of situations. For instance, regarding the use of reading skills at work, individuals are asked how often they read: 1) directions or instructions; 2) letters or e-mails; 3) newspapers; 4) professional journals; 5) books; 6) manuals; 7) invoices or bank statements; 8) diagrams or maps. Four of these indices refer to skill use at home (writing, reading, numeracy and ITC skills), seven refer to skill use at work (the previous four plus task discretion, planning skills, influencing skills, learning at work) and one refer to personal attitudes towards learning (readiness to learn).[37] The unit of measurement of these indices is their standard deviation. Since the proportion of missing data in Spain is large, especially among individuals with a vocational education at ISCED 3-4, we have preferred to leave this country out of the current analysis.

111. Tables 20 and 21 report average ATEs for males and females for each index of skill use. As above, aggregation is obtained by weighting each ATE estimated at the country level by its inverse variance. For each possible educational choice – vocational or academic - estimated ATEs should be interpreted as the distance, measured in standard deviations, between the average index prevailing if the entire population were assigned to the former track and the average index under the latter track. For instance, when we consider vocational and academic education at ISCED 3-4 level, and focus on males, the use of writing skills at home is less frequent with vocational than with academic education. The gap is estimated at 0.116 standard deviations (Table 20, first cell in column 1).

112. Generally, vocational education reduces in the frequency of skill use relatively to academic education at the same level. The gap is particularly significant in the case of ICT skills and especially evident at higher education levels (column 2 in the tables). More in detail, in the case of males the use of ICT skills both at home and at work is respectively 0.26 and 0.33 standard deviations lower under vocational than under academic tertiary education. Among females, this gap is equal to 0.19 standard deviations for the use of ICT skills at home and to 0.27 standard deviations for their use at work.

113. We provide country by country estimates of skill usage for the four potential treatments in the Appendix. There is some heterogeneity across countries, and, notably, one exception to the academic finding from aggregate results: in Norway, the use of numeracy and ICT skills is higher for females with vocational tertiary education than for those with aa academic tertiary curriculum.

114. It is often said that one of the limits of vocational education is that it does not foster attitudes to learn new skills and adapt to an ever changing economy and society. Tables 20 and 21 provide some support to this view by comparing readiness to learn by level and type of education. Interestingly, at the ISCED 3-4 level, there is no statistically significant gap in the readiness to learn between vocational and academic tracks. When we turn to higher education, however, the gap is negative and statistically significant, and ranges from 0.17 to 0.20 standard deviations, depending on gender.

37. The index of readiness to learn is derived from the answers to six items. Respondents are required to specify "To what extent do the following statements apply to you?": 1) When I hear or read about new ideas, I try to relate them to real life situations to which they might apply; 2) I like learning new things; 3) When I come across something new, I try to relate it to what I already know; 4) I like to get to the bottom of difficult things; 5) I like to figure out how different ideas fit together; 6) If I don't understand something, I look for additional information to make it clearer.

Table 20. **Aggregated Average Treatment Effects. Dependent variable: indices of skill use. Males.**

Males	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Use writing skills at home	-0.116***	-0.218***
	(0.022)	(0.023)
Use reading skills at home	-0.045**	-0.156***
	(0.018)	(0.018)
Use of numeracy skills at home	-0.061***	-0.185***
	(0.020)	(0.021)
Use if ICT skills at home	-0.110***	-0.264***
	(0.023)	(0.022)
Use of writing skills at work	0.014	-0.179***
	(0.027)	(0.026)
Use of reading skills at work	-0.022	-0.248***
	(0.022)	(0.021)
Use of numeracy skills at work	-0.040	-0.223***
	(0.027)	(0.028)
Use of ICT skills at work	-0.124***	-0.331***
	(0.030)	(0.022)
Use of task discretion at work	-0.018***	-0.087***
	(0.025)	(0.023)
Use of planning skills at work	-0.009	0.017
	(0.025)	(0.025)
Use of influencing skills at work	-0.041*	-0.216***
	(0.024)	(0.025)
Learning at work	0.017	-0.097***
	(0.024)	(0.023)
Readiness to learn	-0.029	-0.202***
	(0.019)	(0.021)

Note: one, two, three stars for statistical significance at the 10, 5 and 1 percent level of confidence

Source: calculation based on PIAAC (2012)

3.3 Summary

115. The analysis of proficiency in basic skills and of skill use reveals that vocational education is generally not as effective as academic education. This is true for both genders and, in spite of some heterogeneity, for all countries. The gap is larger for tertiary education (ISCED 5) in countries where the share of vocational students is higher.

116. The relative dominance of academic curricula is a source of concern especially when the use of ICT skills are concerned, given that computer - related technologies are spreading to all provinces of economic and social activities. It is also a matter of concern that those with vocational education appear to be not as ready to learn than those with a more academic curriculum, especially at higher levels of education. For a policy perspective, however, one might ask to what extent these attitudes are the outcome of the type of education (vocational or academic), or rather a factor explaining why individuals choose vocational rather than academic tracks. If readiness to learn develops early on in the life of individuals and persists over time, failure to control for individual differences in this attitude may violate our "conditional independence assumption and bias our estimated ATEs. Our defence to this objection is that, as long as readiness to learn depends on parental education and on the availability of books at home, our ability to control for these differences ensures that assignment to treatment remains as good as random. We stress that only in this case we are entitled to interpret our findings on readiness to learn as reflecting the type of skills learnt in vocational and academic curricula.

Table 21. **Aggregated Average Treatment Effects. Dependent variable: indices of skill use. Females.**

Females	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Use of writing skills at home	-0.030*	-0.175***
	(0.018)	(0.018)
Use of reading skills at home	-0.008	-0.178***
	(0.016)	(0.015)
Use of numeracy skills at home	-0.036**	-0.112***
	(0.016)	(0.018)
Use if ICT skills at home	-0.048**	-0.189***
	(0.019)	(0.017)
Use of writing skills at work	-0.002	-0.177***
	(0.028)	(0.023)
Use of reading skills at work	-0.011	-0.354***
	(0.021)	(0.019)
Use of numeracy skills at work	-0.134***	-0.157***
	(0.027)	(0.025)
Use of ICT skills at work	-0.138***	-0.272***
	(0.028)	(0.021)
Use of task discretion at work	0.037	-0.090***
	(0.026)	(0.022)
Use of planning skills at work	-0.017	-0.134***
	(0.025)	(0.022)
Use of influencing skills at work	-0.009	-0.282***
	(0.025)	(0.023)
Learning at work	-0.010	-0.076***
	(0.026)	(0.022)
Readiness to learn	-0.006	-0.168***
	(0.017)	(0.018)

Note: one, two, three stars for statistical significance at the 10, 5 and 1 percent level of confidence

Source: calculation based on PIAAC (2012)

117. The result that VET does not perform as well as academic education in literacy, numeracy and skill use may also be the natural consequence of the fact that these skills are to a large extent "academic" skills. If vocational education excels in the production of "practical" or "occupation-specific" skills, the fact that these skills are not measured by PIAAC should warn the reader against rushing to easy conclusions. This concern is at the basis of recent efforts to measure at least some of these skills (see Baethge and Arends, 2009), although this is clearly a difficult task.

APPENDIX TO SECTION 3

Table 22. **Aggregated average treatment effect of vocational education relative to academic education. Dependent variable: missing PSTRE evaluation**

	ATE Vocational ISCED 3-4 versus academic ISCED 3-4	ATE Vocational ISCED 5 versus academic ISCED 5
Males		
Age 25-64	-0.002	0.051***
	(0.009)	(0.007)
Age 25-44	-0.014	0.016***
	(0.010)	(0.007)
Gap between age 45-64 and age 25-44	-0.026*	0.064***
	(0.015)	(0.014)
Females		
Age 25-64	0.004	0.049***
	(0.007)	(0.007)
Age 25-44	0.001	0.024***
	(0.009)	(0.007)
Gap between age 45-64 and age 25-44	0.007	0.049***
	(0.015)	(0.013)

Note: one, two, three stars for statistical significance at the 10, 5 and 1 percent level of confidence. The dependent variable is a dummy which takes value 1 if the individual either lacks basic ICT skills or he/she refuses of undertaking the computer-based assessment, and value 0 if proficiency in problem solving is evaluated.

Source: calculation based on PIAAC (2012)

Table 23. **ATE of vocational education relative to academic education. Males. By country. Dependent variable: missing PSTRE evaluation**

Males	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Australia	0.135***	0.084*
Austria	-	0.055*
Canada	-0.050***	-
Czech Republic	-0.010	-
Estonia	0.036	0.161***
Finland	-0.011	0.036
France	-	-
United Kingdom	0.018	0.066***
Germany	-	0.056***
Ireland	0.005	0.031
Japan	-0.009	0.103***
Korea	-0.025	0.065***
Netherlands	-0.019	-0.002
Norway	0.020	0.015
Poland	0.036	-
Spain	-	-
United States	-0.070*	0.054*

Note: see Table 22

Source: calculation based on PIAAC (2012)

Table 24. **ATE of vocational education relative to academic education. Females. By country. Dependent variable: missing PSTRE evaluation**

Females	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Australia	0.051	0.060***
Austria	-	0.054
Canada	0.005	-
Czech Republic	0.148***	-
Estonia	-0.029	0.098***
Finland	0.094**	0.027
France	-	-
United Kingdom	0.029	0.043**
Germany	-	0.068**
Ireland	-0.082**	0.057**
Japan	0.019	0.153***
Korea	-0.044*	0.058**
Netherlands	0.027	-0.022
Norway	0.021	0.042
Poland	0.115***	-
Spain	-	-
United States	-0.085***	0.033

Note: see Table 22

Source: calculation based on PIAAC (2012)

Table 25. **ATE of vocational education at ISCED 3-4 relative to academic education at ISCED 3-4. Males. By country.**

Males	Use of writing skills at home	use of reading skills at home	use of numeracy skills at home	use if ICT skills at home	use of writing skills at work	use of reading skills at work	use of numeracy skills at work	use of ICT skills at work	use of task discretion at work	use of planning skills at work	use of influencing skills at work	readiness to learn	learning at work
Australia	-0.039***	-0.156**	-0.135*	-0.321***	0.011	0.079	-0.021	-0.022***	0.067	0.092	0.070	-0.065	-0.045
Austria	-	-	-	-	-	-	-	-	-	-	-	-	-
Canada	-0.045	0.007	0.045	0.008	0.120**	0.077	0.037	-0.087	-0.028	-0.031	0.047	-0.018	0.127**
Czech Republic	-0.496***	-0.433***	-0.269*	-0.428***	-0.202	-0.196	-0.271	-0.322	-0.143	0.046	-0.179	-0.467**	-0.097
Estonia	-0.195***	-0.057	-0.126***	-0.157***	-0.151***	-0.085	-0.073	-0.026	0.004	-0.007	-0.075	-0.070*	0.026
Finland	-0.077	-0.002	-0.098	-0.220*	0.093	-0.035	-0.016	-0.077	-0.054	0.169	0.100	-0.225*	-0.129
France	-0.359***	-0.230***	-0.374***	-0.338***	-0.234**	-0.294***	-0.086	-0.276**	-0.285**	-0.360**	-0.252**	-0.111**	-0.082
United Kingdom	-0.183*	-0.035	-0.135	-0.138	-0.065	-0.092	-0.110	-0.433***	0.022	0.068	0.042	-0.010	0.033
Germany	-	-	-	-	-	-	-	-	-	-	-	-	-
Ireland	0.092	0.246***	0.221***	0.138	0.060	0.139*	0.004	-0.262*	0.064	-0.019	-0.086	0.184***	0.103
Japan	-0.265**	-0.061	-0.087	-0.033	-0.102	-0.067	0.075	0.066	-0.259**	-0.176**	-0.137*	-0.004	-0.144*
Korea	-0.082	0.040	-0.059	0.084	0.161*	0.018	-0.019	-0.062	-0.178*	0.020	0.020	-0.027	0.060
Netherlands	-0.029	-0.009	-0.190*	-0.111	0.011	-0.090	-0.234	-0.328***	-0.115	0.154	-0.115	-0.317***	0.110
Norway	-0.370***	-0.175***	-0.291***	-0.346***	-0.110	-0.102*	-0.323***	-0.380***	-0.203*	0.019	-0.173**	-0.033	-0.096
Poland	-0.269	-0.139	-0.070	-0.202	-0.239	0.091	-0.060	-0.378	-0.208	-0.002	-0.061	0.136	-0.021
Spain	-	-	-	-	-	-	-	-	-	-	-	-	-
United States	0.120	0.249**	0.039	0.240**	0.333***	0.173**	0.040	0.168	-0.034	0.048	0.136	0.384***	0.193

Note: one, two, three stars for statistical significance at the 10, 5 and 1 percent level of confidence. For each index, the unit of measurement is its standard deviation.

Source: calculation based on PIAAC (2012)

Table 26. **ATE of vocational education at ISCED 3-4 relative to academic education at ISCED 3-4. Females. By country.**

Females	use of writing skills at home	use of reading skills at home	use of numeracy skills at home	use if ICT skills at home	use of writing skills at work	use of reading skills at work	use of numeracy skills at work	use of ICT skills at work	use of task discretion at work	use of planning skills at work	use of influencing skills at work	readiness to learn	learning at work
Australia	-0.057	0.016	0.028	-0.016	0.037	0.126	-0.186	-0.201	-0.207*	0.070	0.101	0.056	0.083
Austria	-	-	-	-	-	-	-	-	-	-	-	-	-
Canada	0.073**	0.016	0.038	0.016	0.125**	0.075*	0.024	-0.034	0.046	0.052	0.089*	0.010	-0.018
Czech Republic	-0.104	-0.278***	-0.134**	-0.207***	-0.098	-0.228**	0.019	-0.028	0.108	-0.020	-0.126	-0.097	0.044
Estonia	-0.127**	0.080*	-0.069	0.042	-0.058	0.084	-0.077	-0.111	-0.099	0.061	0.079	0.039	0.045
Finland	-0.147	-0.073	-0.059	-0.207***	0.018	-0.061	-0.368***	-0.123	0.135	0.044	-0.014	-0.105	-0.105
France	-0.242*	-0.210***	-0.269**	-0.262**	-0.463***	-0.498***	-0.335**	-0.643***	-0.308***	-0.522***	-0.293***	-0.044	-0.073
United Kingdom	-0.114	-0.075	0.003	-0.147	0.104	-0.140	-0.112	-0.215	-0.149	-0.074	-0.065	-0.014	0.119
Germany	-	-	-	-	-	-	-	-	-	-	-	-	-
Ireland	0.117*	0.201***	0.076	0.134**	0.070	0.191***	0.056	-0.059	0.178*	0.208*	-0.053	0.158***	-0.005
Japan	0.047	0.034	-0.100	-0.138	0.073	-0.019	0.114	-0.016	0.009	-0.047	-0.092	-0.038	-0.059
Korea	0.097	0.099	0.066	0.142	0.038	0.095	-0.063	-0.029	-0.006	-0.132*	0.073	0.118	-0.062
Netherlands	-0.069	0.005	-0.137	-0.093*	0.061	-0.048	-0.467***	-0.244***	-0.130	-0.107	0.044	-0.058	0.133
Norway	-0.255***	-0.067	-0.152*	-0.216***	-0.194**	-0.015	-0.321***	-0.377***	-0.210**	-0.048	0.005	-0.105*	-0.061
Poland	-0.280***	-0.115	-0.066	-0.278***	-0.331**	-0.061	0.051	-0.280**	-0.032	-0.046	-0.136	-0.063	-0.003
Spain	-	-	-	-	-	-	-	-	-	-	-	-	-
United States	0.046	0.162**	0.046	0.091	-0.173	0.050	-0.155	-0.184*	0.219**	0.077	0.022	0.008	-0.018

Note: See Table 25

Source: calculation based on PIAAC (2012)

Table 27. **ATE of vocational education at ISCED 5 relative to academic education at ISCED 5. Males. By country.**

Male	use of writing skills at home	use of reading skills at home	use of numeracy skills at home	use if ICT skills at home	use of writing skills at work	use of reading skills at work	use of numeracy skills at work	use of ICT skills at work	use of task discretion at work	use of planning skills at work	use of influencing skills at work	readiness to learn	learning at work
Australia	-0.375***	-0.219***	-0.352***	-0.264***	-0.183***	-0.212***	-0.194***	-0.259***	-0.167**	0.080	-0.190**	-0.233***	-0.130*
Austria	-0.303***	-0.284***	-0.137	-0.405***	-0.335***	-0.228***	-0.333***	-0.459***	-0.093	0.271**	-0.041	-0.403***	-0.245***
Canada	-	-	-	-	-	-	-	-	-	-	-	-	-
Czech Republic	-	-	-	-	-	-	-	-	-	-	-	-	-
Estonia	-0.402***	-0.213***	-0.286***	-0.347***	-0.574***	-0.521***	-0.517***	-0.536***	-0.359***	0.201**	-0.506***	-0.297***	-0.183**
Finland	-0.177**	-0.181***	-0.074	-0.330***	-0.089	-0.148***	-0.069	-0.292***	0.092	-0.043	-0.038	-0.206***	-0.019
France	-0.368***	-0.162***	-0.203	-0.370***	-0.164	-0.140*	-0.043	-0.349***	-0.201*	0.057	-0.117	-0.083**	0.049
United Kingdom	-0.144**	-0.194***	-0.118*	-0.287***	-0.147*	-0.213***	-0.156*	-0.274***	-0.051	0.077	-0.184**	-0.201***	-0.043
Germany	-0.225***	-0.174***	-0.184***	-0.282***	-0.008	-0.153**	-0.022	-0.200***	0.105	0.241***	-0.066	-0.145**	-0.156**
Ireland	-0.254***	-0.064	-0.223***	-0.067	-0.248***	-0.313***	-0.265***	-0.368***	-0.105	-0.089	-0.246***	-0.035	-0.048
Japan	0.007	-0.050	-0.243***	-0.103	0.017	-0.148**	-0.154**	-0.186**	0.025	0.105	-0.203***	-0.056	-0.016
Korea	-0.200**	-0.181***	-0.186***	-0.348***	-0.283***	-0.310***	-0.271***	-0.508***	-0.102	-0.073	-0.164***	-0.364***	-0.134**
Netherlands	-0.019	-0.066	0.008	-0.087	-0.093	-0.156*	0.053	-0.056	-0.022	0.184	0.008	0.023	0.065
Norway	-0.018	-0.035	-0.069	0.059	-0.007	-0.025	0.098	0.005	0.083	0.040	-0.103	-0.111	-0.011
Poland	-	-	-	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	-	-	-	-	-	-
United States	-0.227**	-0.047	-0.110	-0.388***	-0.055	-0.078	-0.245**	-0.399***	-0.165	-0.165	-0.339***	-0.290***	-0.025

Note: see Table 25

Source: calculation based on PIAAC (2012)

Table 28. **ATE of vocational education at ISCED 5 relative to academic education at ISCED 5. Females. By country.**

Female	use of writing skills at home	use of reading skills at home	use of numeracy skills at home	use if ICT skills at home	use of writing skills at work	use of reading skills at work	use of numeracy skills at work	use of ICT skills at work	use of task discretion at work	use of planning skills at work	use of influencing skills at work	readiness to learn	learning at work
Australia	-0.147***	-0.178***	-0.122***	-0.157***	-0.217***	-0.264***	-0.130*	-0.153**	-0.156**	-0.216***	-0.174***	-0.092	-0.089
Austria	-0.033	-0.258***	-0.103	-0.346***	-0.173	-0.289***	-0.240**	-0.337***	-0.249**	0.212	0.179	-0.287***	-0.188**
Canada	-	-	-	-	-	-	-	-	-	-	-	-	-
Czech Republic	-	-	-	-	-	-	-	-	-	-	-	-	-
Estonia	-0.267***	-0.258***	-0.084*	-0.246***	-0.385***	-0.586***	-0.251**	-0.302***	-0.144***	-0.194***	-0.414***	-0.211***	-0.100
Finland	-0.271***	-0.264***	-0.186***	-0.266***	-0.178***	-0.233***	-0.109*	-0.314***	0.025	-0.213***	-0.363***	-0.234***	-0.015
France	-0.460***	-0.165***	-0.200*	-0.154**	-0.140	-0.360***	-0.020	-0.228***	-0.148*	-0.386***	-0.363***	-0.097***	-0.100
United Kingdom	-0.138***	-0.111***	-0.123**	-0.149***	-0.047	-0.149***	-0.058	-0.216***	0.004	-0.032	-0.164**	-0.163***	0.097
Germany	-0.069	-0.030	-0.208***	-0.253***	-0.088	-0.276***	-0.254***	-0.400***	-0.103	-0.119*	-0.301***	-0.156**	-0.082
Ireland	-0.190***	-0.152***	-0.089	-0.214***	-0.210***	-0.291***	-0.164*	-0.162**	-0.129*	-0.304***	-0.434***	-0.124**	-0.079
Japan	-0.017	-0.102**	-0.106	-0.066	0.028	-0.162*	-0.164*	-0.350***	-0.201**	0.052	-0.054	-0.219***	0.019
Korea	-0.198**	-0.087	-0.049	-0.242***	-0.139	-0.076	-0.153	-0.286***	-0.171*	0.039	-0.068	-0.133*	-0.094
Netherlands	0.168	-0.113	0.070	0.053	0.018	-0.032	-0.006	-0.052	-0.139	-0.057	-0.072	-0.177	0.023
Norway	-0.222	-0.063	-0.071	-0.038	-0.217**	-0.076	0.257**	0.287**	0.197	-0.219***	-0.352***	0.063	-0.231*
Poland	-	-	-	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	-	-	-	-	-	-	-
United States	-0.143*	-0.120*	-0.017	-0.232***	-0.225**	-0.329***	-0.111	-0.341***	-0.023	-0.213**	-0.395***	-0.126	-0.022

Note: see Table 25

Source: calculation based on PIAAC (2012)

SECTION 4. The effects of vocational education on monetary and non-monetary outcomes

118. In this section we examine the effects of vocational education on monetary and non-monetary outcomes. We compare four treatments, vocational and academic education at ISCED level 3-4 (upper secondary or post-secondary education), and vocational and academic education at ISCED 5 (tertiary education). Monetary outcomes include the hourly wage, current employment status, the probability of being not in employment, education or training and the number of years spent in paid jobs during a completed working life. Non-monetary outcomes include self-reported health and two measures of civic behaviour, participation in voluntary activities and trust in others. Our sample consists of the seventeen countries for which we have public data and where vocational education can be clearly identified.

119. Our measure of earnings is hourly earnings including bonuses for wage and salary earners. PIAAC data include also broader measures of earnings, which encompass the earnings of the self-employed. Given their low reliability, however, we ignore these measures in the current report.[38] Employment – inclusive of self-employment - is one among alternative current labour market statuses at the time of the survey, which include also unemployment and out of the labour force. Since employment refers to the time of the survey, it does not provide a complete description of employability over the lifetime. To integrate this measure, we also use the total number of years of work experience that the respondent has acquired in his or her completed working life, divided by age minus 14.

4.1 Earnings

120. Hourly earnings are not available in the public data for five of the seventeen countries in our sample (Australia, Austria, Canada, Germany and the US). The public data cover all the countries in our sample if we are prepared to consider the wage deciles, which are computed in PIAAC by dividing the original data into ten equally sized groups per country, based on the position in the earnings distribution. Using this rougher measure for descriptive purposes, we compute for each country and gender the ratio between the average wage decile for individuals with vocational education – both at ISCED level 3 or 4 and at ISCED 5 – and the decile for individuals with academic ISCED 5 education.

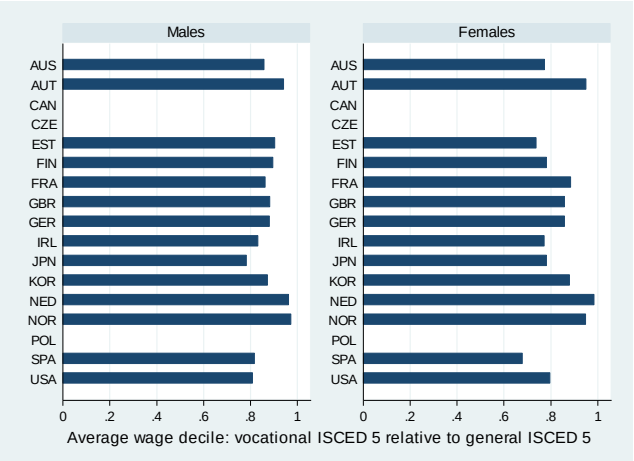
121. We restrict our sample to individuals aged 25 to 59, who are likely to have completed their education and to be only marginally affected by retirement. Figures 14 and 15 plot the wage decile ratios for the seventeen countries in our sample and show that the hourly earnings of individuals with vocational education – independently of ISCED – typically belong to lower deciles of the gender-specific distribution than the earnings of college graduates with academic education.

38. According to the PIAAC technical report, "… a thorough validation of earnings of the self-employed was not really feasible due to idiosyncrasies inherent in earnings from business (for example, many respondents reported zero earnings)...". (OECD, 2013, Section 3, page 35).

Figure 14. **Average wage decile of individuals with vocational ISCED 3-4 education relative to individuals with academic ISCED 5 education. By country and gender. Raw data.**

Source: calculation based on PIAAC (2012)

Figure 15. **Average wage decile of individuals with vocational ISCED 5 education relative to individuals with academic ISCED 5 education. By country and gender. Raw data.**



Note: In Canada and Poland vocational ISCED 5 is not available. We drop the Czech Republic because vocational ISCED 5 education has few observations in our data.

Source: calculation based on PIAAC (2012)

122. When we consider males and ISCED 3-4 education, the earnings gap is largest in Spain (ratio: 60.7) and lowest in Canada (ratio: 86.4). When we consider instead females with the same level of education, the gap is largest in Great Britain (ratio: 54.2) and smallest in Canada (ratio: 76.5). Turning to ISCED 5 vocational education, we find that for males the gap is highest in Japan (ratio: 78.9) and lowest in Norway (ratio: 97.8). For females, the gap is highest in Spain (ratio: 68.4) and lowest in the Netherlands (ratio: 99).

123. We use the IPWRA method discussed in Section 2 to estimate average treatment effects for the four relevant treatments (vocational ISCED 3-4, academic ISCED 3-4, vocational ISCED 5 and academic ISCED 5). For most countries in our sample we use the publicly available hourly data on hourly wages. For the five countries where hourly wages are not publicly available, the relevant estimates are provided by the OECD.

124. Table 29 presents the estimated effects of education type and level on log hourly earnings, separately for males and females. The table shows average relative effects across countries, obtained by weighting each estimated country specific effect with the reciprocal of its variance, so that more precise estimates weigh more. Consider first education at ISCED level 3 or 4. Estimates in column (1) suggest that vocational education does not perform as well as academic education but the differences are small. The negative gap is smaller for men – less than 2 percentage points and not statistically significant - than for women, who suffer a 4.8 percent negative and statistically significant gap. [39]

125. At the tertiary level the negative gap widens, ranging from 19 percent for men to 21.7 percent for women results (see column (2) in the Table). The second row in the table reports for both genders the differences in average treatment effects of vocational with respect to academic education for the sub-group of individuals aged 25 to 44. The third row reports instead the estimated differential ATE between the group aged 45 to 59 and the younger age group.

126. By adding the numbers in the second row to the numbers in the third row one can get the estimated differences in average treatment effects for the older age group. The table shows that the negative effect of vocational education is stronger among older males and females. To illustrate, the earnings of older male workers with vocational education at ISCED 3-4 are 5.5 percent lower than with academic education at ISCED 3-4. This negative gap is equal to 6.7 percent for older females.

39. Including controls for numeracy proficiency does not change greatly the results (see footnote 7 for an explanation of why these controls are omitted in the main tables). The average treatment effect of vocational education relative to academic education increases slightly (i.e. the difference is less negative).

Table 29. **Average treatment effects of vocational education relative to academic education. Dependent variable: log hourly earnings.**

	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Males		
Age 25-59	-0.013	-0.190***
	(0.012)	(0.012)
Age 25-44	-0.003	-0.182***
	(0.014)	(0.013)
Gap between age 45-59 and age 25-44	-0.052***	-0.031***
	(0.012)	(0.012)
Females		
Age 25-59	-0.048***	-0.217***
	(0.011)	(0.010)
Age 25-44	-0.043**	-0.204***
	(0.013)	(0.012)
Gap between age 45-59 and age 25-44	-0.024**	-0.063***
	(0.011)	(0.010)

Note: one, two and three stars for statistical significance at the 10, 5 and 1 percent level of confidence.

Source: calculation based on PIAAC (2012)

127. The finding that the negative gap is generally larger for the older than for the younger age group does not necessarily imply that this gap widens with age, as we are comparing different cohorts rather than individuals at different points of their age profiles. Since it is impossible with the cross section data at hand to distinguish between age and cohort effects, the effects of age on estimated returns by education type cannot be discussed here.

128. We report the country by country average treatment effects between vocational and academic education in Tables 30 and 31. As in the previous section, each table presents the estimated average treatment effects of vocational education at a given ISCED level compared to academic education at the corresponding ISCED level. As before, we cannot estimate these effects at ISCED 3-4 for Germany and Austria, because of the very few available observations in these two countries. For Canada, the Czech Republic and Poland, we cannot estimate differences at ISCED 5 either because this treatment is missing or because of the very few available observations.

Table 30. **Average treatment effects of vocational education relative to academic ISCED education. By country. Males. Dependent variable: log hourly earnings.**

Males	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Australia	-0.004	-0.215***
Austria	-	-0.110**
Canada	0.083***	-
Germany	-	-0.129***
USA	0.230***	-0.232***
Czech Republic	-0.158	-
Estonia	0.018	-0.253***
Finland	-0.012	-0.203***
France	-0.068**	-0.171***
UK	-0.000	-0.248***
Ireland	-0.033	-0.260***
Japan	-0.015	-0.223***
Korea	-0.032	-0.134***
Netherlands	-0.147**	-0.126
Norway	-0.063**	-0.072*
Poland	-0.017	-
Spain	-0.180**	-0.240***

Note: see Table 29

Source: calculation based on PIAAC (2012)

129. The tables show that there is substantial heterogeneity in the estimated effects across countries. Consider first vocational education versus academic education at ISCED 3-4 (column (1) in the tables). For both genders, the estimated gap is positive and sizeable in the U.S., where it ranges between 16 and 23 percent, and in Canada, where is ranges between 5.9 and 8.3 percent. The estimated gap is negative instead in France, the Netherlands and Norway for both genders and negative for British females. When compared to academic education at the same ISCED level, however, higher vocational education at ISCED 5 does not fare as well (see column (2)).[40]

130. We plot in Figure 16 the country specific difference in estimated returns between vocational and academic education by ISCED level against the relative supply of individuals having vocational education. For both ISCED levels we detect the presence of a negative correlation, suggesting that a relative supply effect may be present – the earnings premium to vocational education is higher when the supply of individuals with this type of education is smaller. We also plot in Figure 17 the differences in estimated returns by type of education and ISCED level against the difference in the average years of education. The figure shows that there is some evidence of a positive correlation between returns and years of schooling for ISCED 3-4, but no such evidence for ISCED 5.

40. As for the aggregate regressions, including controls for numeracy proficiency reduced the (negative) difference in earnings between vocational and academic education. As a result of this inclusion, the difference is no longer statistically significant in a number of countries, particularly among males.

Table 31. **Average treatment effects of vocational education relative to academic education. By country. Females. Dependent variable: log hourly earnings.**

Females	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Australia	-0.111***	-0.208**
Austria	-	-0.163**
Canada	0.059*	-
Germany	-	-0.247***
USA	0.160*	-0.296***
Czech Republic	-0.066	-
Estonia	-0.042	-0.276**
Finland	-0.079*	-0.213***
France	-0.145***	-0.126***
UK	-0.185***	-0.193***
Ireland	0.033	-0.334***
Japan	-0.024	-0.329***
Korea	0.121*	-0.216***
Netherlands	-0.020	-0.108**
Norway	-0.046*	-0.023
Poland	-0.012	-
Spain	-0.053	-0.359***

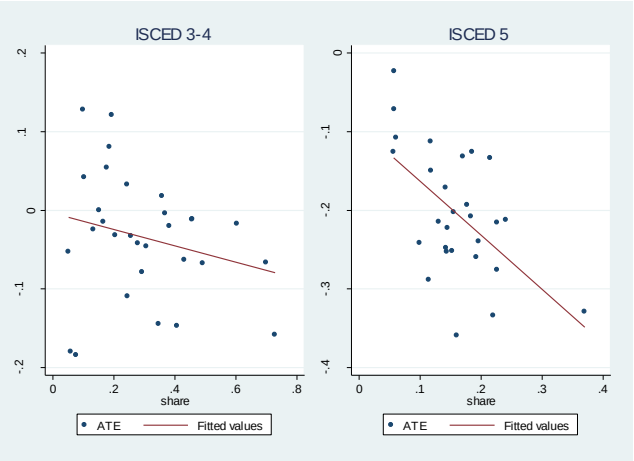
Note: see Table 29

Source: calculation based on PIAAC (2012)

131. We pool the estimated differences in returns for each ISCED level across genders and regress them on relative supply, the difference in the average years of education and a dummy indicating whether the vocational system in the country has programs that combine school and work, using as weights the reciprocal of the variance of estimated returns, so that more precise estimates receive a higher weight[41].

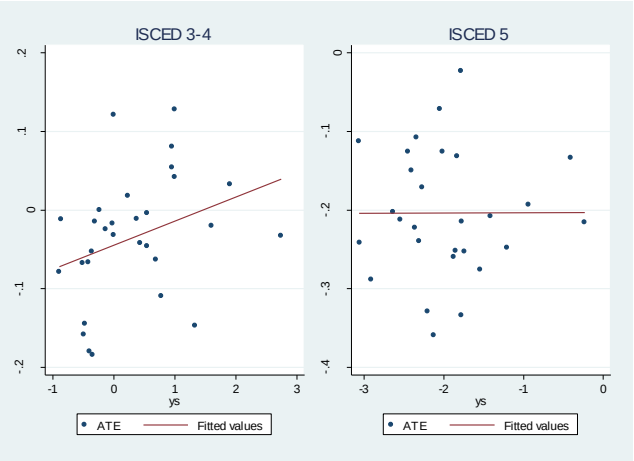
41. Standard errors are clustered by country, because the explanatory variables vary at this level. However, we warn the reader that with a relatively small number of clusters (15 in our case) standard error estimates could be downward biased (see Cameron and Miller, 2015).

Figure 16. **Correlation between the estimated difference in log earnings between vocational and academic education and the relative supply of individuals with vocational education. Both genders.**



Source: calculation based on PIAAC (2012). Share: share of individuals with vocational education.

Figure 17. **Correlation between the estimated difference in log earnings between vocational and academic education and the relative length of education programs. Both genders.**



Source: calculation based on PIAAC (2012). Ys: years of education.

132. As shown in the first column of Table 32, there is some evidence that differences in returns correlate negatively with relative supply – as documented in Figure 16 - and positively with differences in the average length of education programs. There is also some evidence that wage returns associated to vocational education are relatively higher in countries with programs that combine school and work, although all these estimated effects are not statistically significant at conventional levels. We hasten to stress that this exercise does not uncover causal relationships and should therefore be interpreted with caution.

Table 32. **Partial correlations between estimated differences in log hourly earnings and country specific effects. Both genders and ISCED levels. Dependent variable: estimated differences in log hourly earnings and in employment**

	Relative hourly wage	Relative employment
ISCED 5 dummy	-0.153***	-0.034*
	(0.037)	(0.017)
female dummy	-0.029**	-0.008
	(0.010)	(0.011)
share with vocational education	-0.210	-0.080
	(0.121)	(0.052)
vocational programs combining school and work	0.048	-0.010
	(0.028)	(0.010)
average years of education	0.020*	0.006
	(0.010)	(0.006)
Constant	0.037	0.043**
	(0.044)	(0.017)
Observations	58	58
R-squared	0.697	0.250

Note: see Table 29

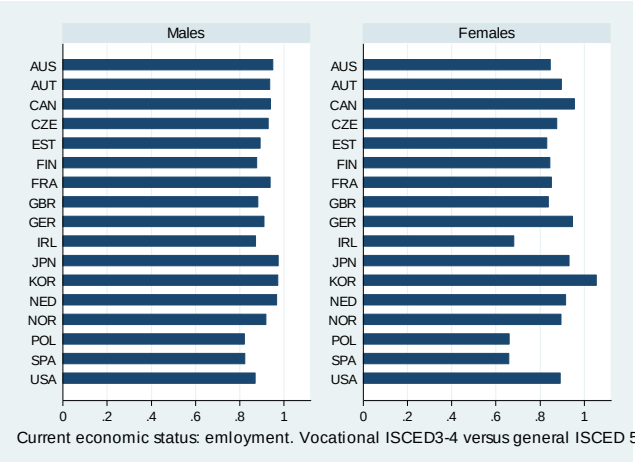
Source: calculation based on PIAAC (2012)

4.2 Employment

133. We have documented so far that vocational education – both at ISCED 3-4 and at ISCED 5 levels – makes a difference with respect to hourly earnings, and that this difference can be sizeable. Next, we document the effects that this type of education has on current employment status, on the probability of being not employed and not engaged in education or training in the past 12 months, and on the number of years spent on a paid job during a completed working life.

134. Figures 18 and 19 show the relative probability of being currently employed for those who have attained vocational education – either at ISCED 3-4 or at ISCED 5 – relative to those who have completed tertiary academic education, using the raw data. For the less educated, this probability is always lower than for the more educated with academic education, with the sole exception of Korean females. The negative gap is largest in Spain and Poland, where it is close to 20 percentage points for males and to 40 percentage points for females, and smallest in Korea, Japan and Canada. For the better educated (ISCED 5), we find that those with vocational education fare better in terms of employment than those with academic education at the same ISCED level in Japan, France, the Czech Republic and Norway among males and in Germany, Korea and the Netherlands among females.

Figure 18. **Employment probability. Individuals with vocational ISCED 3-4 education relative to individuals with academic ISCED 5 education. By country and gender. Raw data.**

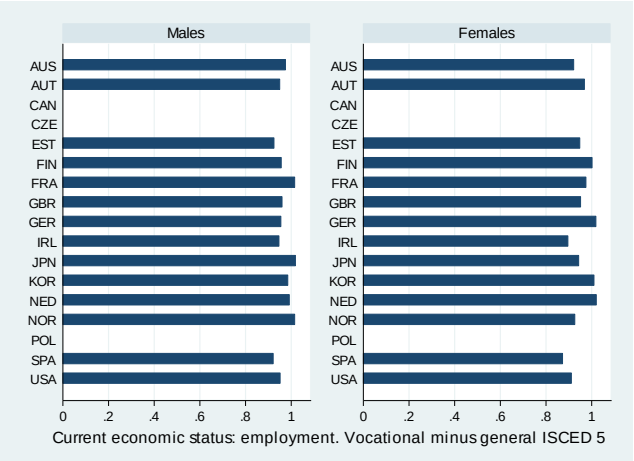


Source: calculation based on PIAAC (2012)

135. As in the case of earnings, we estimate average treatment effects for each of the four available treatments and compute average differences in employment probabilities between vocational and academic education at both ISCED levels. Our estimates are reported in Table 33, which is organised as Table 29 above. The numbers reported in the table should be interpreted as percentage differences between employment probabilities. We find that vocational education at ISCED 3-4 level increases employment probability compared to academic education at the same ISCED level. When compared to tertiary academic education, however, the advantage of vocational education (at the same ISCED level) disappears and turns into a disadvantage that is especially large among females (-2.7 percentage points).

136. Our estimates also reveal that almost any employment advantage for those with vocational education tends to disappear in the older age group. If one adds the second and the third row of the table – for each gender - the percentage gap in employment probabilities turns negative in all cases with the single exception of the comparison between vocational and academic ISCED 3-4 education for females.

Figure 19. **Employment probability. Individuals with vocational ISCED 5 education relative to individuals with academic ISCED 5 education. By country and gender. Raw data.**



Note: In Canada and Poland vocational ISCED 5 is not available. We drop the Czech Republic because higher ISCED 5 vocational education has few observations in our data.

Source: calculation based on PIAAC (2012

Table 33. **Average treatment effects of vocational education relative to academic education. Dependent variable: current employment status.**

	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Males		
Age 25-59	0.022***	-0.014**
	(0.008)	(0.006)
Age 25-44	0.026***	-0.004
	(0.009)	(0.008)
Gap between age 45-59 and age 25-44	-0.025***	-0.034***
	(0.008)	(0.006)
Females		
Age 25-59	0.019*	-0.027***
	(0.010)	(0.008)
Age 25-44	0.014	-0.014
	(0.013)	(0.009)
Gap between age 45-59 and age 25-44	0.006	-0.018***
	(0.010)	(0.008)

Note: see Table 29

Source: calculation based on PIAAC (2012)

137. Tables 34 and 35 present the country – specific estimated average treatment effects for individuals aged 25 to 59, separately for males and females. We find that the positive effect of vocational education at ISCED 3-4 on current employment, relative to academic education at the same level, is highest in Canada for males and in Australia, Canada, Korea and Spain for females. In Poland, the gap is negative for females, relatively large and statistically significant at the 10 percent level of confidence.

Table 34. **Average treatment effects of vocational education relative to academic education. Dependent variable: current employment status. My country. Males**

Males	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Australia	-0.001	-0.011
Austria	-	-0.022
Canada	0.057***	-
Germany	-0.071	-
USA	-0.011	-0.045
Czech Republic	-0.007	-0.003
Estonia	0.054**	-0.111***
Finland	-0.033	-0.059**
France		-0.029
UK	0.002	-0.044
Ireland	0.019	0.019
Japan	0.031	-0.003
Korea	0.042	-0.013
Netherlands	0.010	0.047*
Norway	-0.033	-
Poland	-0.131	-0.043
Spain	-0.013	-0.039

Note: see Table 29

Source: calculation based on PIAAC (2012)

138. Turning to ISCED 5, we find that the employment gap associated to vocational education (relative to academic education) is negative in most countries, with the exception of the Netherlands, where it is positive and statistically significant. For females, the gap is negative and largest in the Netherlands, Poland and the US, and positive and statistically significant in Korea. We regress the estimated differences in employment probabilities on relative supply, the differences in years of education and a dummy for the presence of combined school and work VET programs. Our results are reported in the second column of Table 32. There is evidence that estimated differences in employment probabilities decline with relative supply and increase with the average length of education programs, albeit both effects are not statistically significant at the conventional level.

Table 35. **Average treatment effects of vocational education relative to academic education. Dependent variable: current employment status. My country. Females**

Females	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Australia	0.083*	-0.037
Austria	-	-0.018
Canada	0.049**	-
Germany	-0.083	-
USA	0.051	-0.009
Czech Republic	-0.020	-0.009
Estonia	0.038	-0.008
Finland	-0.075	-0.060***
France	-	-0.021
UK	-0.011	-0.068**
Ireland	-0.035	-0.045
Japan	0.057	0.002
Korea	0.117***	0.049*
Netherlands	0.001	-0.089**
Norway	-0.066	-
Poland	-0.181*	-0.075*
Spain	0.081**	-0.080**

Note: see Table 29

Source: calculation based on PIAAC (2012)

139. Among those not currently employed, we can distinguish in these data between those who have been in education and training in the past 12 months and those who haven't (NET).[42] Table 36 shows the percentage of NET among those not currently employed by gender, age group and type of education. We find that, for each level of education, vocational education is associated to a higher probability of being NET. This probability increases with age for all education types, possibly because of early retirement patterns and other labour force exits.

140. Current employment status only partly captures employability associated to the level and type of education, because individuals who are currently employed may have experienced previous periods of joblessness. We therefore supplement the existing evidence with information on the total number of years of work experience acquired during a completed working life, which is available in PIAAC only for thirteen countries in our sample (missing for Austria, Germany, Canada and the US). We divide years by age minus 14, assuming that most labour market history starts after that age. Table 37 presents our estimates for the full sample and for the two sub-samples of younger and older individuals. Focusing on all age groups, our results clearly suggest that vocational education increases the amount of time spent at work relative to academic education. When we consider vocational and academic education at the same ISCED level, involving similar numbers of years spent at school, we find that the gap between vocational and academic education is 5.7 and 12.2 percentage points for males and 0.8 and 7.3 percentage points for females.

42. We use the acronym NET to distinguish this group from the much discussed group of NEET, which typically refer to young individuals.

Table 36. **Probability of being NET by gender, age and education type. Raw data.**

	Males	Females	age group 25-44	age group 45-59
Vocational ISCED 3-4	0.72	0.75	0.67	0.81
Academic ISCED 3-4	0.63	0.73	0.62	0.8
Vocational ISCED 5	0.53	0.61	0.57	0.64
Academic ISCED 5	0.42	0.5	0.41	0.59

Source: our computations using PIAAC data

Table 37. **Average treatment effects of vocational education relative to academic education. Dependent variable: years of work / (age-14).**

	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Males		
Age 25-59	0.057***	0.122***
	(0.010)	(0.010)
Age 25-44	0.069***	0.169***
	(0.013)	(0.013)
Gap between age 45-59 and age 25-44	-0.042***	-0.107***
	(0.010)	(0.010)
Females		
Age 25-59	0.008	0.073***
	(0.014)	(0.010)
Age 25-44	0.010	0.126***
	(0.018)	(0.014)
Gap between age 45-59 and age 25-44	-0.010	-0.136***
	(0.014)	(0.010)

Note: see Table 29

Source: calculation based on PIAAC (2012)

141. To some extent, these positive gaps may depend on the fact that, even controlling for ISCED level, those in academic school tend to stay longer in school, and therefore have less time to spend in the labour market. To check this, we have depurated county-specific ATEs from the effect due to the differential numbers of years of schooling between each treatment and counterfactual in the aggregation procedure. As shown in Table 38, the estimated gaps decline in most cases, especially among females. The positive premium associated to vocational education, however, remains, especially among males.

Table 38. **Average treatment effects of vocational education relative to academic education, depurated from the effect due to different years of school between treatment and counterfactual. Dependent variable: log years of work. With additional controls for years of schooling.**

	Vocational ISCED 3-4 versus academic ISCED 3-4	**Vocational ISCED 5 versus academic ISCED 5**
Males		
Age 25-59	0.033***	0.069***
	(0.004)	(0.004)
Females		
Age 25-59	0.006	0.037***
	(0.006)	(0.004)

Note: see Table 29

Source: calculation based on PIAAC (2012)

4.3 Non – monetary outcomes

142. The PIAAC survey contains information that can be used to investigate whether vocational education affects important non-monetary outcomes, such as health, civic behaviour – that we capture both with the willingness to participate to voluntary activities and with trust in others.[43] Health in PIAAC is self-reported into five broad categories, as it is by now standard in many surveys. We define poor health P as a dummy equal to 1 if the individual views her health as fair or poor, and 0 otherwise; trust T as a dummy variable taking value 1 if the individual disagrees or strongly disagrees with the view that somebody should only trust a few persons, and 0 otherwise; and voluntary activities V as a dummy equal to 1 if the individual has been involved in these activities, and 0 otherwise. As in the case of foundation skills, we retain information on the broader sample of individuals aged 25 to 64.[44]

43. Oreopoulos and Salvanes, 20011, review the empirical literature on the non-pecuniary returns to education.

44. Contrary to the case of earnings, the observability of health or skills is unlikely to be affected by retirement decisions.

143. Table 39 reports our estimates when the dependent variable is poor health. When we compare vocational with academic education by keeping constant the ISCED level, we find that vocational education unambiguously rises the likelihood of reporting poor health. The gap is particularly large among men, who report a 6.5 percentage points gap at ISCED 3-4 and a 3.1 percentage points gap at ISCED 5.

Table 39. **Average treatment effects of vocational education relative to academic education. Dependent variable: poor health.**

	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Males		
Age 25-59	0.065***	0.031***
	(0.007)	(0.007)
Age 25-44	0.028***	0.028***
	(0.006)	(0.008)
Gap between age 45-59 and age 25-44	0.089***	0.006
	(0.007)	(0.007)
Females		
Age 25-59	0.015*	0.034***
	(0.009)	(0.007)
Age 25-44	0.024**	0.019**
	(0.010)	(0.008)
Gap between age 45-59 and age 25-44	-0.020*	0.024***
	(0.009)	(0.007)

Note: see Table 29

Source: calculation based on PIAAC (2012)

144. Table 40 reports instead the estimated average treatment effects when the outcome variable is individual trust. Considering vocational and academic education at the same ISCED level, we find that vocational education lowers trust. For males, the negative gap ranges from -0.8 to 8 percentage points, and for females it ranges between -2.1 and -7.6 points.

145. Finally, we report in Table 41 the average treatment effects when the outcome of interest is the participation to voluntary activities in non-profit organisations. Focusing again on comparisons for the same ISCED level, we find no statistically significant effect at ISCED 3-4 and evidence that higher vocational education reduces the propensity to participate in voluntary activities. In the latter case, the estimated negative gap is between 4.9 and 6 percentage points.

Table 40. **Average treatment effects of vocational education relative to academic education. Dependent variable: trust.**

	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Males		
Age 25-59	-0.008	-0.080***
	(0.008)	(0.009)
Age 25-44	-0.008	-0.077***
	(0.010)	(0.012)
Gap between age 45-59 and age 25-44	-0.014*	-0.000
	(0.008)	(0.009)
Females		
Age 25-59	-0.021***	-0.076***
	(0.008)	(0.008)
Age 25-44	-0.023**	-0.080***
	(0.010)	(0.011)
Gap between age 45-59 and age 25-44	0.002	0.014*
	(0.007)	(0.008)

Note: see Table 29

Source: calculation based on PIAAC (2012)

Summary

146. Our investigation of the labour market payoffs to vocational and academic education at ISCED 3-4 (upper secondary and post-secondary education) suggests that individuals with vocational education earn slightly lower hourly earnings and enjoy a mildly higher probability of being currently employed than their more academically oriented counterparts. The higher probability of current employment of the vocationally trained is reinforced by their higher share of completed working life spent in paid employment, even after controlling for the length of education programs.

147. When we consider vocational and academic education at the tertiary level (ISCED 5), we find evidence that individuals with the former type of education have significantly lower hourly earnings and a slightly lower probability of being current employed than those with a more academic education. Independently of the ISCED level, we find that vocational graduates who are not currently employed are more likely to be NET. When we consider the time spent in a paid job since leaving school, individuals with tertiary vocational education retain a clear advantage with respect to those with a more academic education.

148. Turning to non-monetary outcomes, we find that vocational education increases the likelihood of poor health and poor civic behaviour. There is also evidence that older cohorts with vocational education have relatively poorer labour market returns than younger cohorts. Whether these differences simply

reflect cohort effects or also indicate the presence of age effects is impossible to tell with the data at hand, and must be left to further research.

149. Our results on the relative employability of individuals with vocational education clearly reflect the current economic situation, and the current balance of demand and supply of skills. But what about future demand developments? Is the number of jobs requiring vocational skills expected to decline or to increase in the future? Statistics Norway (2013), has produced projections up to 2030 on the expected labour demand by type of education. These projections show that the relative number of jobs requiring upper secondary vocational education are likely to grow faster than supply in the near future, especially in the health care industry – because of the progressive ageing of the population, with potentially positive developments for the earnings and employability of those having the required skills. Of course, if the demand for jobs requiring academic tertiary education grows even faster, thereby offering better earnings and employment prospects, enrolment in vocational education may decline even in the presence of favourable demand developments.

Table 41. **Average treatment effects of vocational education relative to academic education. Dependent variable: participation in voluntary activities (non-profit organisations).**

	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Males		
Age 25-59	0.005	-0.049***
	(0.010)	(0.011)
Age 25-44	-0.005	-0.040***
	(0.013)	(0.014)
Gap between age 45-59 and age 25-44	0.024**	-0.007
	(0.010)	(0.011)
Females		
Age 25-59	0.007	-0.060***
	(0.009)	(0.010)
Age 25-44	0.006	-0.054***
	(0.012)	(0.012)
Gap between age 45-59 and age 25-44	0.014	-0.008
	(0.009)	(0.010)

Note: see Table 29

Source: calculation based on PIAAC (2012)

SECTION 5. IVET and CVET. Complements or substitutes?

150. Continuous technological progress, the availability of new tools, machineries and materials, tend to increase the rate at which the skills and competencies of workers depreciates. Much emphasis has been put on continuous learning to increase productivity and reduce the risk of unemployment and early retirement, as documented for instance by the EU 2020 agenda, which calls for an increased participation of the population aged 25-64 in lifelong learning by 2020. An important component of lifelong learning is continuing vocational education and training (CVET), which can be either provided by the employer or acquired by the employee from public or private providers.

151. PIAAC provides information on two measures of CVET: incidence and intensity. Incidence is defined as the participation to any training or education activity in the twelve months before the interview. Intensity is the total number of days spent in these activities. We include in CVET both formal adult education and the participation to on – the – job and off – the – job training, which includes e-learning, seminars and other courses or private lessons. As in Section 4, we attenuate the problems associated to selection into retirement and exclude most of the standard education done before labour market entry by focusing on individuals aged 25 to 59. For the sake of brevity, we shall use the word “training” to indicate all CVET activities.

152. As shown in Table 42, training incidence as measured by PIAAC is quite common among individuals aged 25-59: in most countries more than 50 percent of the respondents report to have undertaken at least a training activity in the twelve months prior to the interview, with France (42 percent) and Poland (37 percent) being the exceptions. In Scandinavian countries such as Norway and Finland training incidence is close to 70 percent and reaches its highest in the Netherlands, where it exceeds 74 percent among males.

153. It is important to notice that the concept of training incidence as measured in PIAAC is rather vague and imprecise: an individual is treated as having had training independently of whether she has spent one day or three months in any training activities. It is therefore important to supplement incidence with a measure of training intensity, or the average number of full training days spent in the past twelve months by those who have had any training. Intensity by country and gender is shown in Table 43. The average number of training days for those with any training is highest in Korea and Spain and lowest in France and the Czech Republic.

Table 42. . **Training incidence in PIAAC. By country and gender.**

Country	Male	Female
Australia	0.62	0.61
Austria	0.56	0.55
Canada	0.64	0.62
Czech Republic	0.56	0.51
Estonia	0.52	0.61
Finland	0.67	0.73
France	0.42	0.42
Germany	0.58	0.55
Ireland	0.59	0.53
Japan	0.53	0.39
Korea	0.60	0.53
Netherlands	0.74	0.70
Norway	0.67	0.67
Poland	0.37	0.37
Spain	0.61	0.59
United Kingdom	0.61	0.57
United States	0.62	0.60

Source: our computations using PIAAC data

Table 43. **Training intensity (number of days of training in the past twelve months for those with any training) in PIAAC. By country and gender**

Country	Male	Female
Australia	11.35	13.64
Austria	12.71	14.08
Canada	14.67	15.54
Czech Republic	8.02	11.57
Estonia	10.32	11.78
Finland	10.13	10.68
France	8.65	10.80
United Kingdom	12.44	13.65
Germany	12.64	13.61
Ireland	13.37	16.52
Japan	17.11	18.45
Korea	25.61	41.27
Netherlands	12.24	13.99
Norway	12.29	11.72
Poland	13.61	19.32
Spain	26.63	29.86
United States	18.07	19.28

Source: our computations using PIAAC data

154. In this section we analyse the relationship between initial and continuing vocational education and particularly we ask whether attaining IVET encourages acquiring more CVET after labour market entry. The answer is not clear a priori. On the one hand, adults with initial vocational education may require less training at labour market entry because their skills are already adequate for the job at hand. On the other hand, these skills may be exposed to faster obsolescence (as shown by Hanushek, Woesmann and Zhang, 2011) and therefore require additional training.

155. Assessing the impact of IVET on the propensity to engage in CVET is challenging because individuals who attended vocational and academic education differ in their abilities, preferences and attitudes even before attending school. Such differences are likely to affect not only the choice of initial education but also the propensity to undertake training after labour market entry. Our approach to this problem is the same as the one adopted in the previous two sections and consist of applying the IPWRA method described in Section 2 in a context of multiple treatments. These treatments are: ISCED 3-4 vocational curriculum, ISCED 3-4 academic curriculum, ISCED 5 vocational and ISCED 5 academic.

5.1 Descriptive Analysis

156. The sample used in this section is described in Section 4 and consists of individuals aged between 25 and 59 with at least ISCED 3 education who reside in one of the seventeen countries for which we have adequate data. Large differences in the propensity to undertake training show up in the raw data when we compare individuals with vocational education (either at upper or post-secondary or at the tertiary level) and individuals with academic education at the tertiary level, our selected benchmark. We find that in the case of males with vocational education at level ISCED 3-4 (Figure 20), the negative gap in the probability of attending any kind of training in the year prior to the interview with respect to the benchmark is highest in Poland (40 percentage points) and lowest in Canada (13 percentage points). Similar results hold for females. When we compare individuals with different curricula and the same ISCED level - tertiary education - (see Figure 21), the negative gap in training incidence for those with vocational education declines but remains significant, at around 10 percentage points for most countries in our sample. Exceptions are Norway for males, where this gap is positive and equal to one percentage point, and Austria for females, where the gap is also positive and close to 8 percentage points.[45]

157. Turning to the average number of training days per year, we compute this average for all individuals in the sample by assigning zero days to those who have had no training during the previous 12 months.[46] We find that individuals with vocational education generally spend less time in training. As shown in Figure 22, for individuals with ISCED 3-4 vocational education average training intensity in Korea and Spain is about 15 days shorter among men and either 20 or 12 days shorter among females than for comparable individuals with academic education. The picture is more nuanced when we compare individuals with tertiary education (Figure 23). For males, in six countries (Australia, U.S., Ireland, Norway, Netherlands, Germany) out of the fourteen for which data is available adults with a vocational background spend slightly more days on training than adults with a more academic training.[47] In Australia, U.S. and Germany, this happens also for females.

158. An important factor affecting the demand for training is the type of occupation. Compared to routine jobs, more advanced and creative occupations require additional training to preserve skills and competences. The type of occupation is influenced by initial education: typically, individuals with tertiary education are over-represented in high-skilled jobs and individuals with lower education concentrate in low-skilled occupations. Table 44 reports the distribution of males and females in high-skilled, medium skilled and elementary occupations by type of initial education in the PIAAC sample. While the distribution across jobs is alike for individuals with upper-secondary or post-secondary education (ISCED 3-4), regardless of it being vocational or academic, more marked differences result when comparing individuals with vocational and academic ISCED 5 education: about three quarters of those with an academic tertiary degree have a skilled occupation (managers, legislators, professionals, technicians or associate professionals) in contrast with only half of those with a higher vocational degree.

45. The Netherlands also performs better than average for both genders: the gap in training incidence for those with vocational education is less than 5 percent for males and almost zero for females.

46. Data on this variable are missing for Canada.

47. Qualitatively, the same pattern results when we exclude from the computation individuals who did not train in the past year.

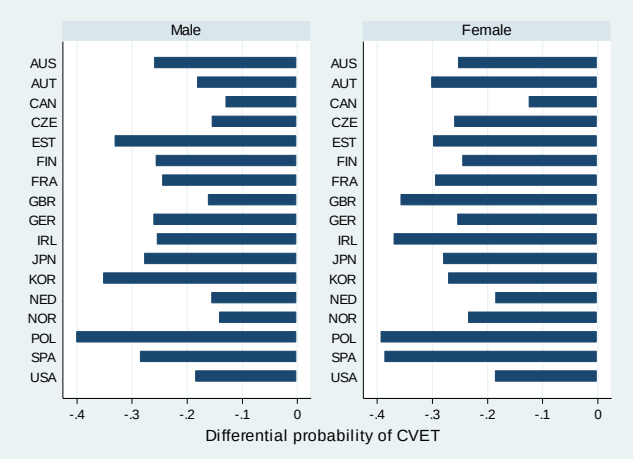
Table 44. **Individuals in the labour force, by occupation and education.**

	Type of occupation	Vocational ISCED 3-4	Academic ISCED 3-4	Vocational ISCED 5	Academic ISCED 5	Total
Males	Skilled occupations	27.3	32.5	51.8	77.1	50.1
	Semi-skilled white-collar	16.2	22.1	19.2	11.5	15.7
	Semi-skilled blue-collar	50.5	35.8	25.9	9.6	29.5
	Elementary occupations	6.0	9.7	3.2	1.8	4.7
Females	Skilled occupations	29.9	30.9	52.7	78.8	54.4
	Semi-skilled white-collar	50.4	51.9	39.7	18.2	35.2
	Semi-skilled blue-collar	10.1	7.5	4.0	1.6	5.2
	Elementary occupations	9.5	7	3.6	1.4	5.3

Note: the classification of occupation is based on ISCO. Skilled occupations include ISCO codes from 1 to 3 (legislators, senior officials and managers; professionals; technicians and associate professionals). Semi-skilled white-collar occupations include ISCO codes 4 and 5 (clerks; service workers and shop and market sales workers). Semi-skilled blue-collar ISCO includes codes from 6 to 8 (skilled agricultural and fishery workers; Craft and related trades workers; plant and machine operators and assemblers). Elementary occupation coincides with ISCO code 10 that has the same label. Individuals with ISCED 2 or lower are excluded from the sample.

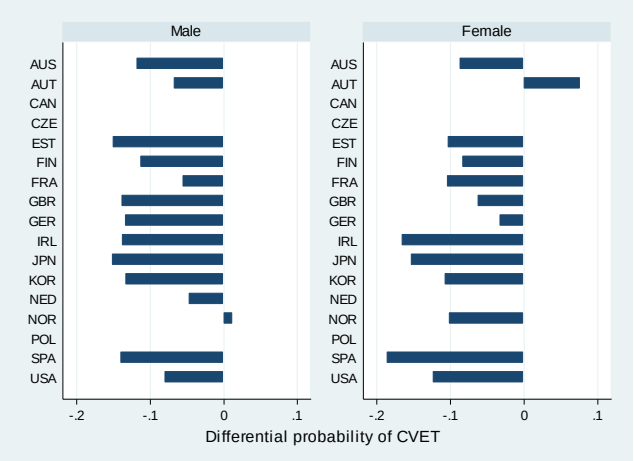
Source: our computations using PIAAC data

Figure 20. **Differences in average training incidence between individuals with ISCED 3-4 vocational education and individuals with ISCED 5 academic education. By country and gender.**



Source: calculation based on PIAAC (2012)

Figure 21. **Differences in average training incidence between individuals with ISCED 5 vocational education and individuals with ISCED 5 academic education. By country and gender.**



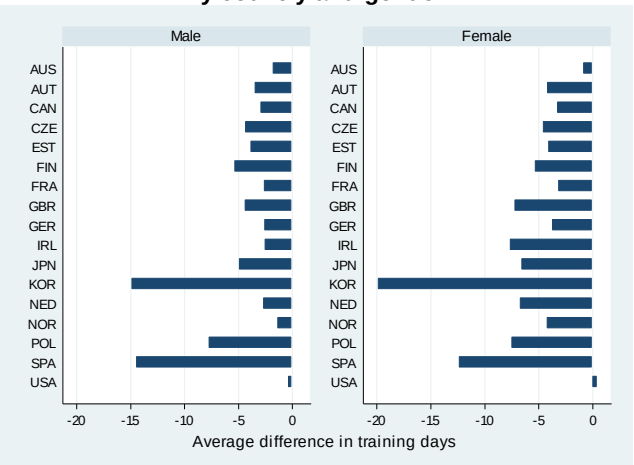
Note: In Canada and Poland vocational ISCED 5 is not available. We drop the Czech Republic because higher ISCED 5 vocational education has few observations in our data.

Source: calculation based on PIAAC (2012)

5.2. Treatment effects on training (CVET)

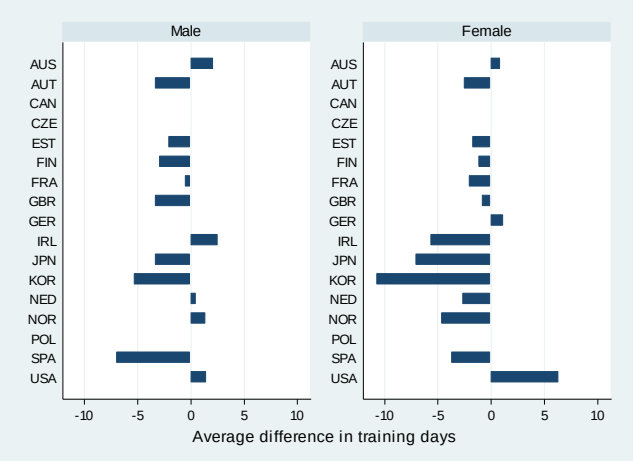
159. In this section we analyse average treatment effects (ATEs) when there are four potential treatments and the outcome variable is training incidence. We first pool together all types of CVET activities, including on-the-job and off-the-job training episodes, training courses, seminars, learning for a degree and practical training. As in previous sections, estimated ATEs measure the average effect that we would observe if the entire population were assigned a certain treatment in place of a counterfactual treatment.

Figure 22. **Differences in average training intensity (number of training days per year) between individuals with ISCED 3-4 vocational education and individuals with ISCED 5 academic education. By country and gender.**



Source: calculation based on PIAAC (2012)

Figure 23. **Differences in average training intensity (number of training days per year) between individuals with ISCED 5 vocational education and individuals with ISCED 5 academic education. By country and gender.**



Note: In Canada and Poland vocational ISCED 5 is not available. We drop the Czech Republic because higher ISCED 5 vocational education has few observations in our data.

Source: calculation based on PIAAC (2012)

160. Table 45 reports the aggregate effects computed by averaging country-level ATEs and by assigning to each ATE a weight inverse to its variance. Column 1 reports the aggregate ATEs for training incidence in the event that the population is assigned to initial vocational education at ISCED 3-4 rather than to academic education at the same ISCED level. Assignment to vocational education increases training incidence by 4.0 percentage points for males and by 2.4 percentage points for females, without significant differences between younger and older cohorts. This positive effect is in sharp contrast with the negative and much larger effect resulting from assignment to vocational education when tertiary level education is considered (column 2 of the Table). We estimate that average training incidence is 10.7 and 9.9 percentage points lower for males and females with vocational tertiary education than for those with more academic skills.

Table 45. **Aggregate ATEs on training incidence. By education, cohort and gender.**

	ATE Vocational ISCED 3-4 versus academic ISCED 3-4	ATE Vocational ISCED 5 versus academic ISCED 5
Males		
Age 25-59	0.040***	-0.107***
	(0.011)	(0.011)
Age 25-44	0.037***	-0.105***
	(0.014)	(0.014)
Gap between age 45-59 and age 25-44	-0.011	-0.007
	(0.019)	(0.022)
Females		
Age 25-59	0.024**	-0.099***
	(0.011)	(0.010)
Age 25-44	0.015	-0.098***
	(0.014)	(0.012)
Gap between age 45-59 and age 25-44	0.001	-0.022
	(0.019)	(0.019)

Note: one, two, three stars for statistical significance at the 10, 5 and 1 percent level of confidence

Source: calculation based on PIAAC (2012)

161. We believe that the observed pattern partly reflects the fact that those with academic tertiary education tend to concentrate in skilled occupations, where there are more training opportunities than in semi-skilled and unskilled occupations. We also notice that close to 10 percent of males with academic ISCED 3-4 education are employed in elementary occupations, where there are virtually no training opportunities, compared to only 6 percent of males with vocational ISCED 3-4 education. This might explain why the positive gap in training incidence is especially pronounced among males with less than tertiary education.

162. The estimated ATEs at the country level reveal heterogeneous patterns both across countries and genders (Tables 46 and 47). For males, in the US, Canada and Poland vocational education at the upper secondary and post-secondary level relative to academic education at the same ISCED level significantly increases training incidence. In all other countries the ATEs are imprecisely estimated, with signs that can be either positive or negative (column 1 in the tables). For females, we observe a positive significant effect on training incidence in Australia, Canada, Korea and the US and a negative and statistically significant effect in France and Spain (in these two countries the estimated ATEs are also negative for males, although not precisely estimated).

Table 46. **Country-level ATEs on training incidence. Males.**

Males	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Australia	0.032	-0.140***
Austria	-	-0.034
Canada	0.099***	-
Czech Republic	-0.179	-
Estonia	-0.014	-0.202***
Finland	0.015	-0.133***
France	-0.052	-0.055
United Kingdom	0.054	-0.090**
Germany	-	-0.116***
Ireland	0.064	-0.082**
Japan	-0.021	-0.134***
Korea	-0.016	-0.127***
Netherlands	0.009	-0.153*
Norway	0.027	0.049
Poland	0.095**	-
Spain	-0.096	-0.135***
United States	0.164***	-0.059

Note: see Table 45

Source: calculation based on PIAAC (2012)

Table 47. **Country-level ATEs on training incidence. Females.**

Females	Vocational ISCED 3-4 versus academic ISCED 3-4	Vocational ISCED 5 versus academic ISCED 5
Australia	0.129***	-0.084***
Austria	-	0.063
Canada	0.072***	-
Czech Republic	-0.095	-
Estonia	0.014	-0.122***
Finland	0.031	-0.088**
France	-0.158***	-0.125***
United Kingdom	-0.071	-0.078**
Germany	-	-0.014
Ireland	0.021	-0.146***
Japan	0.039	-0.152***
Korea	0.077**	-0.093**
Netherlands	0.065	-0.035
Norway	-0.021	-0.163**
Poland	-0.034	-
Spain	-0.240***	-0.184***
United States	0.167***	-0.117***

Note: see Table 45

Source: calculation based on PIAAC (2012)

163. When we consider tertiary education (column 2), we find that country-specific ATEs are generally negative and statistically significant, with a magnitude comparable to that of the mean ATEs. Exceptions are Austria, France, Norway and the US for males and Austria, Germany and Netherlands for females (where estimated ATEs are not significantly different from zero).

164. As a measure of training intensity, we consider the probability of training for longer than 5 days during the past 12 months. In our sample, close to 58 percent report any training incidence, but only 23 percent report at least five days of training during the reference period. Table 48, which shows average ATEs, documents that there are no statistically significant differences in average ATEs when ISCED 3-4 education is considered (see column 1). Conversely, at the tertiary level (column 2), training intensity is significant lower for both males and females with vocational education (7.3 percentage points among males and 8.7 percentage points among females).

Table 48. **Aggregate ATEs on training intensity (more than 5 days of training in the past 12 months). By cohort and gender.**

	ATE Vocational ISCED 3-4 versus academic ISCED 3-4	ATE Vocational ISCED 5 versus academic ISCED 5
Males		
Age 25-59	-0.005	-0.080***
	(0.009)	(0.011)
Age 25-44	-0.013	-0.091***
	(0.012)	(0.014)
Gap between age 45-59 and age 25-44	0.024	0.028
	(0.016)	(0.021)
Females		
Age 25-59	-0.005	-0.095***
	(0.010)	(0.010)
Age 25-44	-0.006	-0.101***
	(0.012)	(0.012)
Gap between age 45-59 and age 25-44	0.011	0.002
	(0.017)	(0.019)

Note: see Table 45

Source: calculation based on PIAAC (2012)

165. We explore cross-country heterogeneity in the association of VET with training incidence and intensity by regressing the estimated country-specific ATEs at both ISCED 3-4 and ISCED 5 and for both genders on several country-specific variables. As usual, these ATEs are weighted by their inverse variances. Moreover, we cluster estimates at the country level because our regressors vary only by country.

166. Table 49 reports the estimates of our preferred specification, which includes among the regressors the relative supply of individuals with vocational education, a dummy for the presence of combined school and work programs, the unemployment rate, an index of employment protection and real per-capita GDP. Our estimates suggest that the negative gap in training incidence associated to vocational education is larger in countries where employment protection is stronger. One might expect that stronger

employment protection laws, by reducing the probability of dismissal, increase the incentives that workers have to train. However, it is not clear why this effect ought to be weaker when workers have had vocational rather than academic education.

Table 49. **Association between estimated ATEs and country characteristics.**

VARIABLES	CVET	Intensive CVET
ISCED 5 dummy	-0.130***	-0.077***
	(0.020)	(0.018)
female dummy	-0.008	-0.010
	(0.019)	(0.014)
share with vocational education	0.007	0.006
	(0.007)	(0.006)
vocational programs combining school and work	0.072*	0.025
	(0.038)	(0.036)
unemployment rate	-0.004	-0.003
	(0.003)	(0.003)
employment protection legislation	-0.037***	-0.042***
	(0.010)	(0.007)
log real GDP per-capita	0.002	-0.012
	(0.009)	(0.007)
Constant	0.106***	0.108***
	(0.030)	(0.036)
Observations	*58*	*56*
R-squared	0.581	0.490

Note: see Table 43

Source: calculation based on PIAAC (2012)

167. Finally, we distinguish between on-the-job and off-the-job training, the former being defined in PIAAC as training usually organised by the employer and involving supervisors or co-workers, the latter including seminars, workshops, learning towards a degree and e-learning. These two types of training are not mutually exclusive: in our sample, about half of the respondents who reported any training in the past 12 months did both on-the-job and off-the-job training.

168. The effect of vocational education at ISCED 3-4 (relative to academic education at the same level) is an increase of about 2.4 and 2.1 percentage points in the propensity to on-the-job training among males and females respectively. No significant effect of vocational education at ISCED 3-4 is observed as regards off-the-job training (see column 1 in Tables 50 and 51). Notable differences emerge instead when considering the effects of vocational education at the tertiary level (column 2 in the tables). In this case, the negative training incidence gap associated to vocational education is about twice as large for off-the-job training (14.8 percentage points for males and 12.6 percentage points for females) than for on-the-job training (6.2 percentage points for males and 7.6 for females).

Table 50. **Aggregate ATEs on the propensity to on-the-job training. By cohort and gender.**

	ATE Vocational ISCED 3-4 versus academic ISCED 3-4	ATE Vocational ISCED 5 versus academic ISCED 5
Males		
Age 25-59	0.024**	-0.062***
	(0.010)	(0.012)
Age 25-44	0.028**	-0.061***
	(0.012)	(0.015)
Gap between age 45-59 and age 25-44	-0.022	0.000
	(0.019)	(0.023)
Females		
Age 25-59	0.021**	-0.076***
	(0.010)	(0.011)
Age 25-44	0.020	-0.069***
	(0.013)	(0.013)
Gap between age 45-59 and age 25-44	-0.002	-0.005
	(0.018)	(0.021)

Note: see Table 43

Source: calculation based on PIAAC (2012)

169. One might expect that job satisfaction, turnover and the feeling of being under-qualified are three outcomes which might be linked to training incidence and intensity. Surprisingly, however, our estimates do not generally support this expectation. Only at the tertiary level is vocational education associated with lower job satisfaction, but only for males (Table 52, column 2). No effect on job satisfaction is found at upper secondary or post - secondary education (see column 1).

Table 51. **Aggregate ATEs on the propensity to off-the-job training. By cohort and gender.**

	ATE Vocational ISCED 3-4 versus academic ISCED 3-4	ATE Vocational ISCED 5 versus academic ISCED 5
Males		
Age 25-59	0.015	-0.148***
	(0.010)	(0.012)
Age 25-44	0.008	-0.149***
	(0.013)	(0.015)
Gap between age 45-59 and age 25-44	0.000	-0.010
	(0.018)	(0.023)
Females		
Age 25-59	0.004	-0.126***
	(0.010)	(0.011)
Age 25-44	-0.007	-0.120***
	(0.013)	(0.013)
Gap between age 45-59 and age 25-44	0.022	-0.032
	(0.018)	(0.021)

Note: see Table 43

Source: calculation based on PIAAC (2012)

Table 52. **Aggregate ATEs on job satisfaction. By cohort and gender.**

	ATE Vocational ISCED 3-4 versus academic ISCED 3-4	ATE Vocational ISCED 5 versus academic ISCED 5
Males		
Age 25-59	0.006	-0.035***
	(0.010)	(0.010)
Age 25-44	0.017	-0.040**
	(0.012)	(0.013)
Gap between age 45-59 and age 25-44	-0.034*	0.001
	(0.018)	(0.018)
Females		
Age 25-59	0.009	-0.003
	(0.010)	(0.019)
Age 25-44	0.007	0.001
	(0.014)	(0.012)
Gap between age 45-59 and age 25-44	0.003	-0.002
	(0.019)	(0.017)

Note: Job satisfaction is coded as a dummy, based on the reported level of satisfaction in the job. The dummy is equal to 1 for individuals extremely satisfied or satisfied and 0 for those who report to be neither satisfied nor dissatisfied, dissatisfied, or extremely dissatisfied. One, two, three stars for statistical significance at the 10, 5 and 1 percent level of confidence.

Source: calculation based on PIAAC (2012)

5.3. Other outcomes related to training (CVET)

170. When tertiary education is considered, VET reduces the probability of feeling under-qualified only for women, and by about 4.7 percentage points. No significant effect is observed for men with tertiary education and for both genders at lower levels of education.[48] There is also no effect of vocational education on turnover in the past 5 years, excepting for males at ISCED 5, who experience a marginally lower turnover compared to individuals with academic education at the same level. [49]

Table 53. **Aggregate ATEs on the feeling of being under-qualified. By cohort and gender.**

	ATE Vocational ISCED 3-4 versus academic ISCED 3-4	ATE Vocational ISCED 5 versus academic ISCED 5
Males		
Age 25-59	0.008	-0.004
	(0.012)	(0.012)
Age 25-44	0.010	0.003
	(0.014)	(0.014)
Gap between age 45-59 and age 25-44	0.004	-0.005
	(0.020)	(0.022)
Females		
Age 25-59	-0.018*	-0.047***
	(0.011)	(0.011)
Age 25-44	-0.019	-0.057***
	(0.015)	(0.013)
Gap between age 45-59 and age 25-44	-0.001	0.029
	(0.020)	(0.021)

Note: The feeling of being under-qualification is coded as a dummy (1 underqualified; 0 otherwise). One, two, three stars for statistical significance at the 10, 5 and 1 percent level of confidence

Source: calculation based on PIAAC (2012)

5.5 Summary

171. We have found that initial vocational education (IVET) and training and subsequent vocational education and training (CVET) are linked is a rather peculiar way. While IVET at lower levels of education (ISCED 3-4) is positively associated to training incidence, when compared to academic education at the same level, the opposite is true for IVET at the tertiary level of education (ISCED 5). In this case, and for both genders, training incidence, either on-the-job or off-the-job, is lower for those with a vocational curriculum. The negative effect of IVET is more pronounced on off-the-job training.

48. The effect is only marginally significant at 10 percent among women with secondary or post-secondary education.

49. Turnover is defined as the number of different employers in the past 5 years. In our sample 56 percent report only 1 employer and the remaining 44 percent between 2 (22.8 percent) and 7 or more (1.6 percent). The estimates are available from the authors upon request.

We also find that the negative effect of IVET on training is larger in countries characterised by higher employment protection.

172. We have further investigated whether the type of curriculum influences job-satisfaction, the feeling of being underqualified, and turnover intensity, but found little evidence that this is the case. We have argued that the significant differences in training incidence and intensity found at the tertiary level of education may be related to the type of job and to occupational status, as those with a more academic curriculum are much more likely to fill jobs with higher skill requirements, where training plays a more important role.

SECTION 6. Labour market outcomes and skill levels for those with ISCED 2 and ISCED 3-4 education

173. In the previous sections we have documented that vocational education at the upper secondary or post-secondary level is associated to lower labour market returns than tertiary education. In this final section, we extend our analysis to include those who have only completed at most lower secondary education (ISCED 2), that in most countries is compulsory. The focus of our comparison is this level of education and upper secondary or post – secondary education (ISCED 3-4).

174. The percentage of individuals with at most ISCED 2 in PIAAC is about 15 percent, with a peak in Spain (46 percent) and a minimum in the Czech Republic (7.8 percent). Females are slightly more likely to belong to this group than males, although the weighted difference in our sample of countries is minimal (15.2 versus 14.8 percent). As expected, this percentage is higher for the older cohorts aged 40 to 64 than for those aged 25 to 40 (16 percent versus 11 percent).

175. In some OECD countries, vocational education starts at ISCED level 2. The eventual difference in curricula at this level of education, however, is not registered by PIAAC, which only considers vocational education at upper secondary education or higher. We therefore treat education before the upper secondary level as a single unit, independently of the actual curricula being followed. Average length of schooling for those with at most ISCED 2 education is about 8 years, which compares to about 12 years for those with at most ISCED 3 and 15.7 years for those with higher education.

176. We adapt our methodology which estimates ATEs by adding to the set of potential treatments the additional treatment "at most lower secondary education", and compute average treatment effects as mean differences between vocational or academic education at ISCED 3-4 and ISCED 2 education. We consider the following outcomes: (hourly) wages, the probability of employment, the probability of being in a NET condition, the percentage of time spent at work during the lifetime and numeracy test scores.

177. Starting with wages, Our estimates are reported in Column 1 of Table 54 for those aged 25 to 59, separately for males and females. We find that there is a clear monetary payoff to having completed upper secondary or post-secondary vocational education, and that this payoff is as high as 10.3 percent for males and 8.5 percent for females.

178. We report in the second column of Table 54 the estimated ATEs of vocational education at ISCED 3-4 relative to ISCED 2 when the relevant outcome is the probability of being currently employed. The relative payoff of higher education is large, ranging from 11.9 to 17.6 percentage points. Similarly, when we consider the probability of being NET (not in employment and not in education or training in the past twelve months), we find that this probability is much lower if upper secondary or post-secondary education is attained (see Table 54 – column 1).

Table 54. **Hourly earnings and employment. Vocational and academic education at ISCED 3-4 versus ISCED 2 education**

	ATE Vocational ISCED 3-4 versus ISCED 2 - wages	ATE Vocational ISCED 3-4 versus ISCED 2 – employment
Males		
Age 25-59	0.103***	0.119***
	(0.012)	(0.009)
Females		
Age 25-59	0.085***	0.176***
	(0.012)	(0.011)

Note: One, two, three stars for statistical significance at the 10, 5 and 1 percent level of confidence

Source: calculation based on PIAAC (2012)

179. Next, we estimate ATEs when the outcome is the percentage of time since age 14 spent in a paid job. As shown in the second column of Table 55, we find an interesting contrast between males and females. For males, having completed vocational education in high school or in post-secondary education increases by 3 percentage points the time spent at work relative to having completed at most ISCED 2 education. The positive gap in favour of higher education is much larger in the case of females, where it reaches 7 percentage points. Since individuals who have attained ISCED 3-4 education have spent on average about four more years in school than those who have attained at most ISCED 2, and therefore have had less time to spend in the labour market, these estimates indicate that, especially for females, completing vocational upper secondary school is a ticket to substantially higher employability.

Table 55. **NET probability, time in a paid job and proficiency in numeracy. Vocational and academic education at ISCED 3-4 versus ISCED 2 education**

	ATE Vocational ISCED 3-4 versus ISCED 2 - NET	ATE Vocational ISCED 3-4 versus ISCED 2 – time in a paid job	ATE Vocational ISCED 3-4 versus ISCED 2 – numeracy skills
Males			
Age 25-59	-0.104***	0.030***	0.117***
	(0.008)	(0.005)	(0.004)
Females			
Age 25-59	-0.162***	0.070***	0.112***
	(0.011)	(0.007)	(0.004)

Note: see Table 54.

Source: calculation based on PIAAC (2012)

180. Finally, the last column of Table 55 presents the estimated ATEs when the output variable is the numeracy test score. As in the case of wages and employment, it is clear that attaining vocational upper secondary or post-secondary education increases numeracy skills for both males and females relatively to attaining at most ISCED 2. We estimate that having completed ISCED 3-4 vocational education increases numeracy skills – as measured by test scores – by 11.7 percent for males and by 11.2 percent for females.

CONCLUSIONS

181. We have shown that vocational education does not perform as well as academic education both in labour market outcomes and in the level of basic skills, including literacy and numeracy. This is especially true for higher education. Only at the upper secondary or post-secondary level does vocational education perform slightly better than academic education in the probability of being currently employed as well as in the time spent in paid employment, although the differences we find are small.

182. Should then vocational education be reduced in favour of more academic curricula? One might say that the answer is partially provided by the recent evolution of vocational curricula in many countries, which are characterised by increasing emphasis on more academic education. Our own view is more nuanced.

183. First of all, this report provides substantial information on the benefits of vocational and academic education, but has very little to say on costs. Yet, individual decisions to undertake vocational or academic education depend both on benefits and on costs. Although academic education provides higher earnings, higher skills proficiency and better non-monetary outcomes, it could also have higher costs for some individuals, who may find that a vocational curriculum, if available, is privately optimum.

184. Beside direct and opportunity costs, an important component of the private cost of education is the disutility of the effort required to complete it, which depends on several factors, including the composition of the ability portfolio an individual is endowed with. On the one hand, individuals with higher cognitive ability, who often come from better educated families and environments, are advantaged in acquiring academic education and are likely to have a lower cost of effort when engaging in this type of education. On the other hand, individuals with a higher propensity to perform manual activities and with higher dexterity, possibly coming from a less privileged environment, may find it less costly to complete a vocational curriculum. When both benefits and costs are taken into account, vocational education can be for many the education choice that provides the highest net expected benefit. The availability of this track is also an opportunity that keeps some individuals in school, and reduces the risk of early school leaving.

185. There is scope for public intervention when the assignment of individuals to different ability levels is determined at least in part by parental background, especially when this background operates as a constraint that precludes choices. Carneiro and Heckman (2002) propose the distinction between short-term and long-term constraints to educational choice, with the former due to lack of economic resources and the latter induced by disadvantaged parental education. When the choice between vocational and academic education is affected by the presence of long – term constraints, public intervention may be desirable early on in an individual life, so as to compensate differences in the environment that affect the development of cognitive and non - cognitive abilities.

186. There may also be externalities at work. Our own evidence in Section 4 suggests that individuals with a more academic education are more likely to engage in voluntary activities and to trust others. These activities spill-over positively on others and on society at large, but the associated benefits are often ignored by singles when deciding which type of educational curriculum to pursue. The presence of these positive externalities suggests that the degree of investment in academic education could be “too low”.

187. Although the presence of long term liquidity constraints and of positive externalities associated to academic education may suggest that the degree of investment in this type of education is lower than the social optimum, we do not recommend that vocational education should be drastically reduced or even eliminated from upper secondary curricula. This is because individuals may differ in their portfolio of skills (practical versus academic) even after the differences in long term constraints have been taken care of. If this is the case, the availability of the vocational option may reduce early school leaving by keeping more practically oriented individuals in school.[50]

188. Rather the cutting back on vocational studies, perhaps a more promising policy avenue is that of making vocational education as effective as possible, by increasing its expected benefits. Will the recent evolution of education policy promoted by the EU, which includes the emphasis on facilitating transitions between vocational and academic tracks, a higher flexibility in the design of curricula and the promotion of a better integration between vocational education at school and training at work, help in this direction? In our empirical research we have asked whether the labour market outcomes associated to vocational education are more favourable in the countries where the combination of school and work programs is more advanced. However, we have found no systematic evidence that this is the case.

189. While we think that the empirical evidence based on PIAAC is interesting, there are drawbacks that should be mentioned: because of the nature of the data and of the comparative perspective, our empirical strategy relies on selection-on-observables. This strategy is based on assumptions that cannot be tested, and that can be rightly questioned. Perhaps a more promising empirical strategy would be that of exploiting natural experiments. When this is done, results are less negative for vocational education than the ones we find. Notice however that the results using natural experiments do not necessarily contradict what we have found in this report, as they refer to particular sub-samples of the population (LATE effects) rather than to average treatment effects applicable to the entire population, as our results do. Needless to say, further research is required to provide firmer conclusions.

190. While the evaluation of the relative benefits of vocational and academic education that can inform the policy maker and the public is certainly valuable, further research is also needed to assess what policy interventions are more effective at improving the market value of vocational education. A great help to evaluation would be that when new policies are implemented they are also accompanied by pilot experiments designed to provide data for subsequent evaluations.

50. The fact that in some countries vocational education accounts for the large majority of students in upper secondary education is prima facie evidence that this type of curriculum is not clearly dominated by more academic education.

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ANNEX A.1: COMPLEMENTARY NOTES

Notes regarding Cyprus

Readers should note the following information provided by Turkey and by the European Union Member States of the OECD and the European Union regarding the status of Cyprus:

Note by Turkey

The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue".

Note by all the European Union Member States of the OECD and the European Union

The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

Throughout this report, including the main body, boxes and annexes, Cyprus is accompanied by a (*) symbol pointing to these notes.

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