



**European Expert Network on  
Economics of Education (EENEE)**

**Effects of Vocational and General Education  
for Labor-Market Outcomes over the Life-Cycle**

EENEE Analytical Report No. 37  
Prepared for the European Commission

Ludger Woessmann  
December 2018

**37**



**Erasmus+**



***Europe Direct is a service to help you find answers  
to your questions about the European Union.***

**Freephone number (\*):  
00 800 6 7 8 9 10 11**

(\* The information given is free, as are most calls (though some operators, phone boxes or hotels may charge you).

More information on the European Union is available on the Internet (<http://europa.eu>).

Luxembourg: Publications Office of the European Union, 2018

ISBN: 978-92-79-91288-7

doi: 10.2766/566869

© European Union, 2018  
All rights reserved.

This document has been prepared for the European Commission. However, it reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein

# **Effects of Vocational and General Education for Labor-Market Outcomes over the Life-Cycle\***

Ludger Woessmann (University of Munich and ifo Institute)

---

\* Analytical Report of the European Expert Network on Economics of Education (EENEE) prepared for the European Commission, Directorate-General for Education, Youth, Sport and Culture. I would like to thank Rossella Cravetto, Sandra McNally, and George Psacharopoulos for constructive comments.

## Table of Contents

<b>Executive Summary .....</b>	<b>3</b>
<b>Résumé .....</b>	<b>5</b>
<b>Kurzversion.....</b>	<b>7</b>
<b>1. Introduction .....</b>	<b>9</b>
<b>2. General and Job-Specific Skills: The Basic Trade-off over the Life-Cycle .....</b>	<b>11</b>
<b>3. Evidence on the Effects of General vs. Vocational Education over the Life-Cycle... 15</b>	
3.1 Initial Evidence from IALS.....	15
3.2 New Evidence from PIAAC.....	18
3.3 Further Country-Specific Evidence.....	21
3.4 Evidence from Variation in Job Specificity across Apprenticeship Programs .....	23
<b>4. Policy Implications for Future-Oriented Education Programs .....</b>	<b>24</b>
4.1 Some Overall Policy Implications .....	24
4.2 Securing a Basis for Adaptability .....	25
4.3 Providing the Institutional Frameworks Required in Apprenticeship Systems .....	26
4.4 “Generalizing” Vocationally Oriented Education Programs .....	27
4.5 Relating Skills to Real-World Tasks in General Education Programs .....	28
4.6 Strengthening Lifelong Learning .....	29
<b>References .....</b>	<b>30</b>

## Executive Summary

Vocational skills are job-specific skills that prepare for work in specific occupations. By contrast, the usage of general skills transcends specific occupations. In dynamically changing economies, this difference implies a basic trade-off between vocational and general education programs for labor-market experiences over the life-cycle.

Vocational education programs have the advantage of helping young people master the transition from school to work because job-specific skills directly prepare students for the tasks demanded by firms. As a consequence, they may result in reduced youth unemployment.

But there is another side to the same coin: Job-specific skills will be subject to increasing risk of becoming obsolete when the structure of occupations changes. In addition, if the acquired general skill base is limited, vocationally educated people may find it hard to learn different job-specific skills. By contrast, the skills generated by general education programs may provide workers with greater adaptability to changing environments. As a consequence, they may result in higher employment opportunities at older ages.

An increasing body of empirical evidence confirms this basic trade-off between vocational and general education programs over the life-cycle. While vocationally educated individuals initially have better employment opportunities than generally educated individuals, this pattern turns around at older ages. Results are particularly strong in countries that have extensive apprenticeship systems. The trade-off between education types over the life-cycle is also visible in earnings and in participation in adult career-related education.

The consistent evidence on a life-cycle trade-off of focusing education programs on job-specific skills provides the basis for policy implications about how education systems can prepare students for lifetime work. At the most basic level, the findings indicate that in dynamic economies, policy needs to consider the full working life-cycle, which also implies that they must convey the ability to adapt to changing economic conditions.

Each country should aim to find the right balance between conveying general and work-specific skills to its population. Successful apprenticeship systems require institutional and regulatory frameworks defining the tasks of stakeholders, financial structures, and certification requirements. To make graduates fit for employment over their full life-cycles, apprenticeship programs could reduce the early specialization of apprentices by lowering the number of specific apprenticeships, expanding the share of general educational content, and modularizing apprenticeship components. General education programs could implement measures to relate

the conveyed skills to tasks that are relevant in the real world as currently demanded on the labor market. Finally, countries should establish strong systems of lifelong learning.

## Résumé

Les compétences professionnelles sont des compétences propres à un travail, qui préparent à remplir des postes spécifiques. En revanche, l'utilisation des compétences générales transcende les postes de travail. Dans des économies à évolution dynamique, cette différence implique un compromis de base entre les formations professionnelle et générale pour les expériences sur le marché du travail tout au long du cycle de vie.

Les programmes de formation professionnelle présentent l'avantage d'aider les jeunes à maîtriser la transition entre les études et le monde du travail, car les compétences propres à un métier préparent directement les étudiants aux tâches demandées par les entreprises. Par conséquent, ils peuvent contribuer à la réduction du chômage parmi les jeunes.

Mais la médaille a également son revers : les compétences propres à un métier sont sujettes au risque croissant de devenir obsolètes lorsque la structure des postes de travail change. En outre, si la base de compétences générales acquises s'avère limitée, les personnes ayant suivi une formation professionnelle pourraient avoir du mal à acquérir de nouvelles compétences professionnelles. En revanche, les compétences générées par les programmes de formation générale peuvent apporter aux travailleurs une plus grande adaptabilité face à des environnements changeants. Ainsi, ils peuvent donner lieu à davantage d'opportunités d'emploi pour les personnes les plus âgées.

Un ensemble croissant de preuves empiriques confirme l'existence de ce compromis de base entre les programmes de formation professionnelle et générale tout au long du cycle de vie. Alors que les personnes ayant suivi une formation professionnelle ont, au départ, plus de chances de trouver un travail que les personnes ayant suivi une formation générale, ce modèle s'inverse au fil du temps. Les résultats s'avèrent particulièrement significatifs dans les pays qui disposent de systèmes extensifs de formation d'apprentis. Ce compromis entre les types de formation tout au long du cycle de vie est également visible dans les revenus et la participation à la formation professionnelle des adultes.

Les preuves cohérentes d'un compromis axé tout au long du cycle de vie sur les programmes de formation en compétences professionnelles fournit une base aux implications politiques sur la façon dont les systèmes éducatifs peuvent préparer les étudiants au travail toute leur vie durant. Au niveau le plus basique, les conclusions indiquent que dans les économies dynamiques, les politiques doivent tenir compte de la totalité du cycle de vie, ce qui implique aussi qu'elles doivent apporter la capacité de s'adapter face à des conditions économiques changeantes.

Chaque pays devrait se donner pour objectif de trouver le bon équilibre dans la transmission des compétences générales et professionnelles à sa population. La réussite des systèmes de formation d'apprentis passe par la mise en place de cadres institutionnels et de régulation définissant les tâches des parties prenantes, les structures financières et les exigences en matière de certification. Pour faire en sorte que les diplômés demeurent aptes à l'emploi toute leur vie durant, les programmes de formation des apprentis pourraient réduire la spécialisation précoce des apprentis, en diminuant le nombre d'apprentissages professionnels spécifiques, en élargissant la part des contenus de formation générale, et en modularisant les composantes professionnelles. Les programmes de formation générale pourraient mettre en œuvre des mesures visant à faire le lien entre les compétences enseignées et les tâches pertinentes dans le monde réel, actuellement requises sur le marché du travail. Enfin, les pays devaient instaurer des systèmes solides de formation tout au long de la vie.

## Kurzversion

Fachkompetenzen sind berufliche Fähigkeiten, die zur Arbeit in bestimmten Berufen befähigen. Der Nutzen allgemeiner Kompetenzen geht dagegen über konkrete Berufe hinaus. In einer sich dynamisch verändernden Wirtschaft führt dieser Unterschied zu einem grundlegenden Zielkonflikt zwischen beruflichen und allgemeinen Bildungswegen, was die Erfahrungen auf dem Arbeitsmarkt während des gesamten Berufslebens angeht.

Angebote der beruflichen Bildung haben den Vorteil, dass sie jungen Menschen den Übergang von der Schule in die Arbeitswelt erleichtern, weil berufliche Fähigkeiten die Schüler direkt auf die im Unternehmen geforderten Aufgaben vorbereiten. Dadurch könnte die Jugendarbeitslosigkeit gesenkt werden.

Das Ganze hat aber auch eine negative Seite: Wenn sich die jeweiligen Berufe strukturell wandeln, besteht zunehmend die Gefahr, dass berufliche Fähigkeiten obsolet werden. Wenn dann noch der allgemeine Bildungsgrad gering ist, fällt es Menschen mit einer Berufsausbildung möglicherweise schwer, neue berufliche Fähigkeiten zu erlernen. Durch allgemeine Bildung erworbene Kompetenzen könnten dagegen die Fähigkeit von Arbeitnehmern verbessern, sich an neue Umstände anzupassen. Dadurch steigt möglicherweise ihre Beschäftigungsfähigkeit in späteren Lebensphasen.

Immer mehr empirische Untersuchungen bestätigen diesen grundlegenden Zielkonflikt zwischen beruflichen und allgemeinen Bildungswegen im Verlauf des Lebens. Zwar haben Menschen mit einer Berufsausbildung anfänglich bessere Jobchancen als Menschen mit einem allgemeinen Bildungsabschluss, dieses Muster kehrt sich jedoch in späteren Lebensphasen um. Dies zeigt sich besonders deutlich in Ländern mit einer umfassenden Lehrlingsausbildung. Der Zielkonflikt zwischen diesen beiden Bildungsmodellen über die gesamte Berufskarriere ist auch beim Einkommen und bei der berufsbezogenen Fortbildung sichtbar.

Es gibt klare Belege dafür, dass die Konzentration auf Bildungsprogramme, die berufliche Fähigkeiten vermitteln, im Verlauf des Lebens zu Abstrichen führt; dies hat auch politische Implikationen für die Frage, wie Bildungssysteme Schülerinnen und Schüler auf ein langes Berufsleben vorbereiten können. Grundsätzlich zeigen die Ergebnisse, dass die Politik in dynamischen Wirtschaften das gesamte Berufsleben berücksichtigen muss, d. h. sie muss auch die Fähigkeit vermitteln, sich an neue wirtschaftliche Bedingungen anzupassen.

Jedes Land sollte versuchen, für seine Bevölkerung das richtige Gleichgewicht zwischen allgemeinen und berufsbezogenen Fähigkeiten zu finden. Eine erfolgreiche Lehrlingsausbildung braucht institutionelle und gesetzliche Rahmenbedingungen, mit denen

die Aufgaben der Beteiligten, die finanziellen Strukturen und die Zulassungsanforderungen definiert werden. Um Absolventen langfristig beschäftigungsfähig zu machen, sollte die Lehrlingsausbildung den Anteil der praktischen Berufsausbildung senken und diese modular anbieten, den Anteil der allgemeinen Bildung dagegen erhöhen und so einer frühen Spezialisierung der Lehrlinge entgegenwirken. Angebote der allgemeinen Bildung könnten versuchen, die vermittelten Fähigkeiten mit Aufgaben im echten Leben in Zusammenhang zu bringen, die aktuell auf dem Arbeitsmarkt nachgefragt werden. Nicht zuletzt sollten die Länder umfassende Systeme für lebenslanges Lernen aufbauen.

## 1. Introduction

A recurrent theme in educational debates is the extent to which education systems should convey general skills or rather vocational skills that prepare for work in a specific job. In line with these debates, the economics literature distinguishes between general and vocational skills. The defining criterion of vocational skills is that they are job-specific, that is, they are required only in specific occupations. By contrast, the defining criterion of general skills is that their usage transcends specific occupations. In this sense, general skills include any skills and competences that prove useful over a broad range of occupations, such as basic literacy, numeracy, and science skills, but also social and personal skills and transversal skills such as creativity, problem solving, and critical thinking in general.

This distinction is similar to the one adopted by the European Commission in its 2012 Communication “Rethinking Education: Investing in Skills for Better Socio-economic Outcomes,” which – in discussing the need to build skills for the 21<sup>st</sup> century – distinguishes between transversal and basic skills on the one hand and vocational skills on the other hand (European Commission 2012, pp. 3-7). Transversal and basic skills are both examples of general skills as used in the economics literature. Similarly, the whole range of key competences described by the European Commission (2018), being applicable in a wide range of contexts, would fall in the domain of general skills as specified in the economics literature to the extent that they are relevant on the labor market.

Vocational education programs such as apprenticeship systems are particularly strong at conveying vocational skills and have therefore attracted interest in many countries in recent years. Advocates praise apprenticeship systems that are common in German-speaking countries for the way they facilitate the youth’s transition from school to work, thereby apparently combating youth unemployment. Other countries have school-based vocational programs that also prepare for a specific occupation, but without the close link to work experience within firms. Still other countries have mostly abandoned vocational programs, relying on general education programs in the hope that they can convey general skills that provide the basis for later learning on the job.

Of course, the focus of education policies in different countries and of different programs within countries have been constantly evolving over time, adapting to actual or perceived requirements from the labor market and elsewhere. It is beyond the scope of this report to describe the evolutions occurring in different countries and in different types of education programs in greater detail, or to assess the specific differences in the quality of general and of

vocational programs that exist in different countries. Instead, the report focuses on a more stylized discussion of the relative merits of education programs that focus on conveying vocational or general skills, respectively, for participants' prospects on modern labor markets. At the same time, it is important to note that in practice, many vocational and general programs impart both types of skills in different proportions, with some vocational programs also conveying a good amount of general skills and some general programs having a high level of job-specific content.

Recent evidence suggests that in a dynamic knowledge-based economy, early employment gains of programs that are focused on conveying vocational skills may lead to later problems when specific skills become obsolete and workers lack the ability to adjust to a changed economic environment. There may thus be a trade-off between short-term benefits and long-term costs of a focus on conveying job-specific skills. The skills generated by vocationally oriented programs appear to facilitate the transition into the labor market but later on become obsolete at a faster rate. By contrast, the skills generated by general education programs may not prepare as well for direct entry into the labor market but may help workers to adapt more easily to changing environments later on. This report describes the underlying conceptual framework, summarizes the evidence, and draws conclusions for education policy in the European Union.<sup>1</sup>

The next section outlines the basic idea that, compared to general education, vocational education facilitates entry into the labor market but may hurt employment opportunities later in life because of limited adaptability to changing economic environments. Section 3 summarizes existing evidence on the changing effects of general and vocational education over the life-cycle, covering findings from the international adult achievement tests IALS and PIAAC as well as additional country-specific evidence, with a particular focus on European countries. Because individuals who enter vocational education programs may on average have quite different basic skill profiles than individuals who enter general education programs in many countries, the underlying research among others ensures that results cannot be driven by such underlying differences between people in the two types of programs. On the basis of the presented evidence, section 4 draws policy conclusions on ways to find the right balance

---

<sup>1</sup> Beyond the differing effects over the life-cycle in changing economic environments, the effects of vocational and general education may also differ by individuals' characteristics such as abilities, school experiences, and motivations for specific tasks, by countries' characteristics such as qualities and aspects of different education programs, industry structures, and traditions, and by other matters of specific contexts that are not the focus of this report.

between conveying general and work-related skills in different educational programs of the member states of the European Union.

## **2. General and Job-Specific Skills: The Basic Trade-off over the Life-Cycle**

An aspect that is of particular relevance to understand the relative merits of vocational and general education programs is economic change.<sup>2</sup> In a static economy, the occupation-specific skills obtained in vocational education programs will be just as relevant towards the end of one's working life as they were at the beginning of one's career. But in reality, our economies are constantly changing.

There are many aspects to economic change, and for the analyses in this report, it is not important where the impetus of change comes from. But as general examples, two major trends that have led to substantial change in European Union countries over the past decades are globalization and technological change. First, the integration of the former Eastern Bloc and China into the world economy has meant that many sectors of Western economies have been relocated to Eastern Europe and East Asia. This process of globalization has been further facilitated by technological developments in global communication and logistics. Second, technological progress has been particularly pronounced in information and communication technologies. Broadly speaking, computerization, automation, industrial robots, and digitalization have led to skill-biased and routine-biased technological change, replacing many tasks that specific occupations used to perform by machines, robots, and computer networks (e.g., Katz and Autor (1999); Autor, Levy, and Murnane (2003); Akerman, Gaarder, and Mogstad (2015)). While these developments do not affect all sectors of an economy and all economies in the same way, they reflect general trends that brought fundamental changes to all countries of the European Union.

In a constantly changing knowledge-based economy, the facilitated labor-market entry due to vocational skills may have to be weighed against reduced later employability when specific skills become obsolete and workers lack the ability to adjust to the changed economic environment. Much of the recent discussion about the disappearance of formerly middle-class jobs in many Western societies due to technological advance is related exactly to the theme of adapting to changed conditions. Therefore, conveying skills that allow workers to adapt to changing environments must be a central aspect in evaluating the extent to which vocational

---

<sup>2</sup> The following exposition draws directly from Woessmann (2017).

and general education programs prepare students for lifetime opportunities on modern labor markets.

To highlight the trade-offs involved in different types of education programs, it helps to distinguish two types of skills. On the one hand, there are *general* skills such as broad knowledge and basic skills in language, communication, math, science, and any other cognitive, social, or personal skills that are valuable on the labor market in many different occupations. These skills serve as the foundation for further learning on the job. They can thus be used to enter different jobs. Moreover, at a later age, general skills that facilitate continuous learning such as basic cognitive skills, transversal skills, adaptability, creativity, problem solving, and critical thinking skills may provide a useful basis to adapt to changing labor-market requirements and facilitate the learning of a different set of job-related skills.

On the other hand, there are *job-specific* skills that are required only in a specific occupation. Learning these job-related skills prepares students well to work in the specific occupation, but they are less relevant in other occupations. Being equipped with the relevant job-specific skills makes students productive right when they enter the labor market, as they have the skills that employers require now. But if demand for these skills dissipates on the labor market, these skills become mostly obsolete.

Of course, the distinction between general and job-specific skills is somewhat blurred. While one could argue that all basic skills are transversal, the extent to which more advanced skills are specific to a job, a company, or an industry can vary considerably.<sup>3</sup> Therefore, beyond basic skills, many skills will have an element of job specificity, depending on their level. For example, some basic ICT skills are required and similar over many types of jobs, but many ICT skills will also be specific to the respective occupation, sector, or even firm. Similarly, while basic levels of literacy are highly transversal, some jobs such as being an editor require very high levels of literacy that are not as relevant in a majority of other occupations. Also, skills such as creativity that are generally used as prime examples of transversal skills will be more heavily employed in some occupations than in others, entering an element of job specificity in their usage.

As a stylized depiction, we can distinguish two types of education programs: general education programs and vocational education programs (see Table 1). For the argument here, the assessment of particular education programs depends on the extent to which the education

---

<sup>3</sup> The seminal analysis of investment in human capital by Gary Becker (1962) emphasizes the aspect of generality or specificity of training to a particular firm.

program conveys general and/or job-specific skills. We will refer to programs that mostly convey general skills as general education programs and to programs that mostly convey job-specific skills as vocational education programs.<sup>4</sup>

**Table 1: Stylized Depiction of Types of Education Programs**

	<b>General education</b>	<b>Vocational education</b>	
		<b>School-based</b>	<b>Apprenticeship-type</b>
<b>Focus on skill type</b>	General skills (language, communication, math, science, ...)	Occupation-/industry-specific skills, with possible elements of basic skills	Occupation-/firm-specific skills
<b>Entry into labor market</b>	Not directly prepared, needs substantial learning on the job	Job-specific skills facilitate labor-market entry, but limits due to missing experience	Easy entry as education included direct labor-market experience
<b>Labor market at later age</b>	General skill base facilitates adaptation to changing economy	Job-specific skills may become obsolete in changing economy; adaptability depends on size of general skill base	Job-specific skills may become obsolete in changing economy; low adaptability due to focus on firm and limited general skill base

Among the vocational education programs, there are two main stylized sub-types. On the one hand, there are school-based vocational programs that focus on skills that prepare for work in a specific occupation. On the other hand, there are apprenticeship-type vocational programs that partly take place within firms so that industry is directly involved in the educational process.<sup>5</sup> These combined school and work-based apprenticeship programs tend to provide a

---

<sup>4</sup> In reality, there is a significant variability in terms of occupational specificity both within programs generally referred to as general and within programs generally referred to as vocational. For example, some university programs may convey mostly skills that are relevant in many occupations, while other university programs may to a large extent convey skills that are mostly required in a limited number of jobs. Similarly, while some programs that are advertised as vocational education and training are indeed very much oriented to one particular occupation, in particular when they have a significant work-based learning component linked to a particular firm, other vocational programs can be rather broad covering a number of occupational groups. This variation in job specificity across vocational programs is analyzed by the studies discussed in section 3.4 below.

<sup>5</sup> While sometimes linked in practice, conceptually the question of whether education programs have a general or vocational focus is quite distinct from that of the age of tracking, i.e., the age at which students are placed into different school types that are hierarchically structured by (apparent) performance. Both early and late tracking in the school system can involve differently paced general curricula or differentiation between

high intensity of industry-based vocational experience (cf. Wolter and Ryan (2011)). In addition, while some of the skills acquired during work experience will be transferable across firms and possibly occupations, part of the skills acquired will be specific to the particular firm in which they are obtained, rather than to the occupation or industry in general.

A particular advantage of apprenticeship systems over school-based systems is that they usually do not educate too many youths in areas without demand in the economy. Because apprenticeship places have to be offered by employers, there are limits to the extent to which youth are educated in occupations for which there is not enough demand on the labor market – limits that may be much less strict in school-based vocational systems.<sup>6</sup>

The characteristics of the two types of skills indicated above imply that a basic trade-off exists between general and vocational education programs when it comes to their implications for labor markets over the life-cycle. Vocational education programs have the particular advantage of helping young people master the transition from school to work because the job-specific skills directly prepare students for the tasks that firms require them to perform (e.g., Shavit and Müller (1998); Ryan (2001); Zimmermann et al. (2013)). As a consequence, they may result in reduced youth unemployment.

But there is another side to the same coin: If the skills conveyed by vocational programs are particularly useful in a specific occupation, they will be subject to increasing risk of becoming obsolete when the structure of the economy – and hence the specific occupation – changes. Furthermore, if the acquired general skill base is limited, vocationally educated people may find it hard to learn different job-specific skills. That is, over the life-cycle, vocational programs may lead to lower adaptability to technological and structural change (cf. Krueger and Kumar (2004)). As a consequence, they may come with the disadvantage of reduced employment opportunities at older ages.

The main point is that there is a basic trade-off between vocational and general education programs in that any relative labor-market advantage of vocational over general education programs decreases with age, potentially becoming a disadvantage at one point. Within the vocational education programs, the fact that some of the skills conveyed in apprenticeship-type

---

general and vocational curricula. In fact, truly vocational curricula will usually not be introduced before grades 10 or 11, so the curricular focus is quite independent of whether the lower secondary school system is tracked between grades 4 and 10 or not. The focus of this report is just on general vs. vocational program orientation; for evidence on the effects of early tracking see, e.g., Woessmann (2009) and Pekkarinen (2014).

<sup>6</sup> Other potential benefits of apprenticeship systems include effects of the integration of theoretical with practical learning on motivation and cognition and a closer correspondence of skill content and production requirements (see, e.g., Wolter and Ryan (2011)).

vocational programs will have a firm-specific component may further facilitate the school-to-work transition compared to purely school-based vocational programs, but may also lead to additional skill obsolescence when the worker is required to change firm.

### **3. Evidence on the Effects of General vs. Vocational Education over the Life-Cycle**

In recent years, an increasing body of empirical evidence has confirmed the described basic trade-off between vocational and general education programs over the life-cycle. This section surveys the recent evidence on the topic, with a particular focus on European countries.

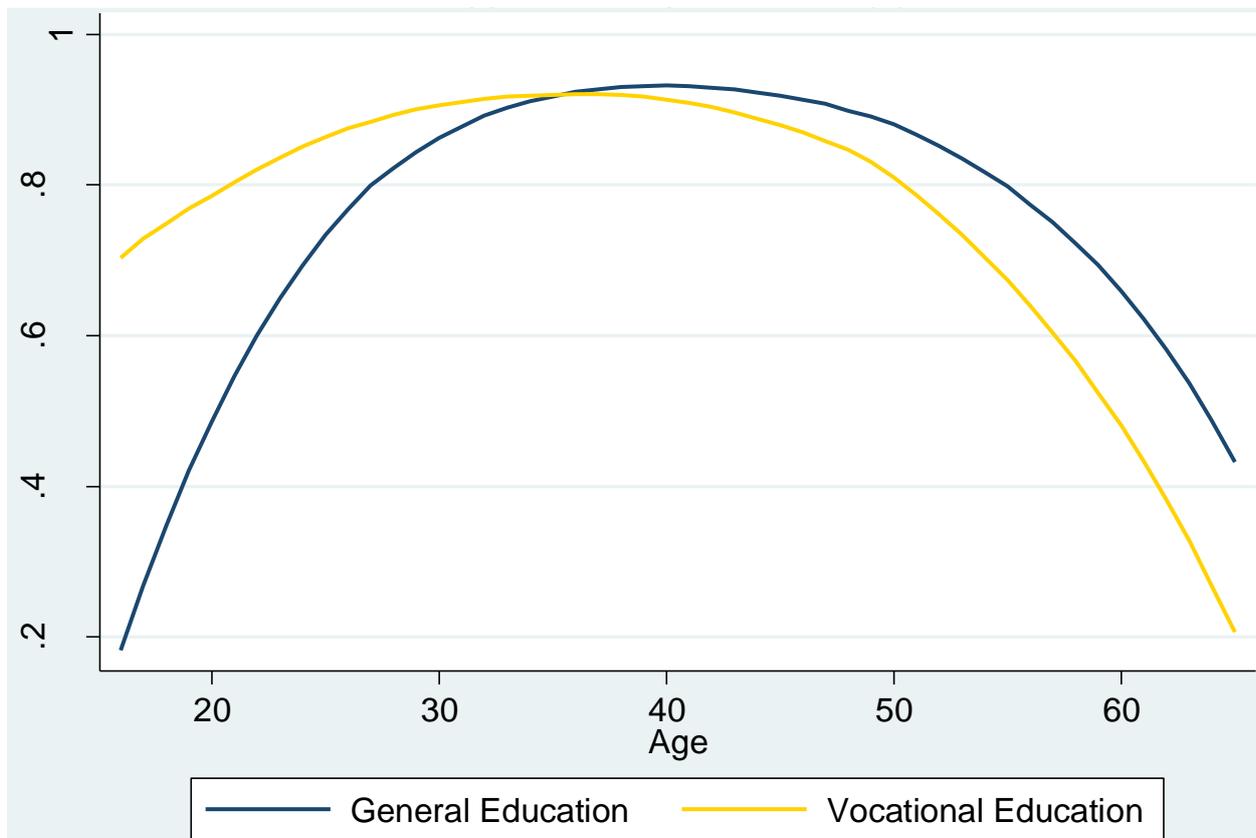
#### *3.1 Initial Evidence from IALS*

To test the labor-market effects of vocational and general education programs over the life-cycle, Hanushek et al. (2017b) use the data of the International Adult Literacy Survey (IALS). Coordinated by the Organisation for Economic Co-operation and Development (OECD) in the mid-1990s, IALS provides data for 15,000 individuals aged 16 to 65 years in 18 countries. The basic analysis compares the labor-market experience of people who attended vocational and general education programs at different ages.<sup>7</sup> In the “prime age” (roughly age 30 to 45), people with the different types of education have very similar (and high) employment rates, indicating that there are no fundamental differences in labor-market attachment between these two groups (see Figure 1). However, there are strong differences both at labor-market entry and at older ages.

---

<sup>7</sup> The analysis is restricted to males who historically show stable aggregate labor-force participation patterns during prime age. Cohort-specific selection into work by females raises concerns for this type of analysis.

**Figure 1: Employment over the Life-Cycle with Vocational and General Education in IALS**



Notes: Sample includes males who completed at least secondary education and are currently not students in the three “apprenticeship countries” (Denmark, Germany, and Switzerland). Smoothed scatterplot using locally weighted regressions (Stata lowess). Source: Hanushek et al. (2017b).

The key finding is the following trade-off in employment patterns over the life-cycle: At the beginning, individuals with a job-specific vocational education have better employment chances than those who completed general education. At older ages, it is the other way around, with individuals with a general education having better employment chances. This age-employment pattern is consistent with vocational education improving the transition from school to work but reducing adaptability of older workers to economic change. On the one hand, the skills generated by vocational education appear to facilitate the start into the labor market. On the other hand, vocationally educated people are at a higher risk of losing their jobs later in life if demand for their occupation-specific skills fades over time due to technological and structural change. The initial advantage of vocational education compared to general education thus seems to turn into a disadvantage over the life-cycle. Short-term benefits have to be traded off against long-term costs.

The life-cycle employment pattern – both the initial advantage and the later disadvantage – is particularly pronounced in those countries with extensive apprenticeship programs that combine school and work-based training – Denmark, Germany, and Switzerland in the IALS data. In these countries, the emphasis on industry-based education seems to provide the strongest treatment intensity of vocationalization. However, the general life-cycle employment pattern is also visible in the broader group of countries with noteworthy vocational programs, which additionally includes Belgium, the Czech Republic, Finland, Hungary, the Netherlands, Norway, Poland, and Slovenia.

The empirical approach effectively compares two differences in the employment rates: the first difference is between vocational and general education, the second difference is between young and old workers (therefore, it is called a “difference-in-differences” approach). For the validity of this approach, it is important to ascertain that today’s older workers provide a good approximation for what we can expect today’s younger workers to look like a few decades from now. To test this, Hanushek et al. (2017b) provide deepened analyses that make use of specific aspects of the IALS data, in particular the literacy and numeracy test produced by IALS. Among others, they match individuals within each country so that each individual with a vocational education is compared to an individual with a general education who is very similar in terms of skill scores as well as age, years of schooling, and parental education levels. This way, the analysis ensures that results cannot just reflect underlying differences in the basic skill profile of individuals who select into the different types of education programs. Results are very similar in this sample of individuals who are observationally comparable to each other in terms of skills and other background factors. This finding indicates that results are not driven by differences in these characteristics between vocationally and generally educated individuals.

In their regression analyses, the authors can also hold constant any change in the overall shares of individuals entering vocational or general programs in a country over time. Furthermore, they show that while both literacy scores and parental education are predictive of whether an individual has chosen a vocational or general education program, these predictions do not change significantly with the age of the individual. In other words, older people with a specific education type seem to be a good approximation for future expectations of younger people with the same education type.

The trade-off between education types over the life-cycle is visible not only in employment patterns, but also in income. Furthermore, at least in apprenticeship countries, there is some indication that as people get older, generally-educated individuals become increasingly likely to participate in adult career-related education. This increasing participation in adult education

may be one mechanism by which generally-educated individuals maintain their employability given their updated knowledge and skills. The initial general education may decrease the costs of subsequent educational investments, and the updated skills may raise adaptability to technological change.

It is hard to come up with a full assessment of how life-time earnings compare between vocational and general education, which would allow for a judgement of whether the advantage of early employment is sufficient to make up for the later period of less employment for those with vocational education. However, the authors provide back-of-the-envelope calculations of the present value of lifetime earnings for workers with different schooling types, considering average employment and earnings for each age cohort by schooling type and using a discount rate of 3 percent to discount future earnings back to age 16. They perform these calculations for the three apprenticeship countries (Denmark, Germany, and Switzerland) which showed the clearest evidence of the age-employment pattern. The calculations suggest that the present values of lifetime earnings is larger for the group of vocationally educated workers in Switzerland, but larger for the group of generally educated workers in Denmark and Germany. Interestingly, Denmark and Germany had noticeably higher growth rates of their economies over the relevant period than Switzerland, and thus presumably experienced more pronounced economic change. Therefore, the pattern across these three apprenticeship countries is consistent with the basic idea that individuals with general education are more capable to adapt to changing economic demands.<sup>8</sup>

### *3.2 New Evidence from PIAAC*

A significant drawback of the IALS analysis is that the results relate to the period of the mid-1990s. Across countries, labor markets have seen substantial transformations since then. As indicated above, globalization and technological change such as automation and digitalization have led to significant structural changes in Western economies (e.g., Autor, Dorn, and Hanson (2015)). These changes may have made the obsolescence of occupation-specific skills over the life-cycle even more pronounced in recent decades. However, there are also trends that may have weakened the differences in life-cycle implications across education types. In particular, reforms of the social security systems such as reduced options of generous

---

<sup>8</sup> Beyond these back-of-the-envelope calculations of lifetime earnings, there are many cost-benefit studies of vocational and general education, in particular from developing countries; see Psacharopoulos (1987) and Hoeckel (2008) for literature reviews. Hoeckel (2008) comes to the conclusion that for substantive and methodological reasons, an aggregate analysis or general conclusions that would apply to all OECD countries are hardly feasible.

early retirement schemes may have dampened the incidence of reduced employment at older ages,<sup>9</sup> thereby lowering the scope for differential employment patterns by education type at older ages. Furthermore, education programs may have changed over time, with an altered extent to which the curricula of general programs contain job-specific material and the curricula of vocational programs contain general material.

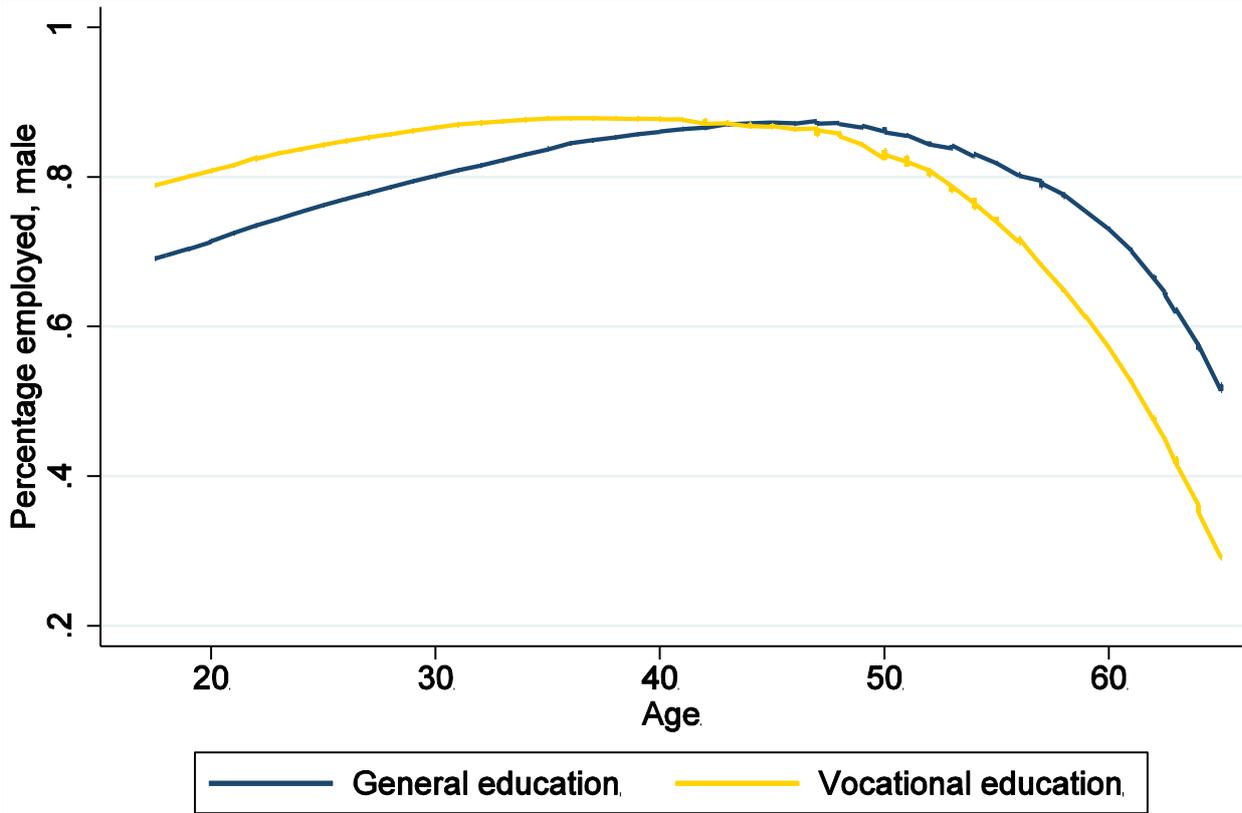
To revisit the differential effects of general and vocational education in a more recent economic environment, Hampf and Woessmann (2017) use the data of the Programme for the International Assessment of Adult Competencies (PIAAC), conducted by the OECD in 2011/12. The dataset covers 29,000 adults in 16 countries. Apart from the larger sample size, the PIAAC data also provide a much richer testing of skills than IALS and further measures of family background, allowing for richer analyses to confirm that results are not driven by individual differences in literacy and numeracy skills and in family environments during youth.

As is apparent from Figure 2, they find the same basic employment pattern of vocational and general education over the life-cycle: While vocationally educated individuals initially have better employment opportunities than generally educated individuals, this pattern turns around at older ages. Again, results are particularly strong in countries that have extensive apprenticeship systems – Austria, Denmark, and Germany in the case of the PIAAC data. But again, the overall pattern is also visible in the broader set of countries with notable vocational systems, including the Czech Republic, Finland, France, the Netherlands, Norway, and Sweden.

---

<sup>9</sup> For example, in Germany the share of those retiring before age 61 among all retirees has declined from 56 percent in 1995 to 25 percent in 2012 after reforms made the terms of early retirement less generous and raised the entitlement age for early retirement after a one-year unemployment spell from 60 to 63 years.

**Figure 2: Employment over the Life-Cycle with Vocational and General Education in PIAAC**



Notes: Sample includes males who completed at least secondary education and are currently not students in the three “apprenticeship countries” (Austria, Denmark, and Germany), based on a matched sample that uses propensity-score matching to ensure common support between persons with a vocational and a general education in each country. Smoothed scatterplot using locally weighted regressions (Stata lowess). Source: Hampf and Woessmann (2017).

The estimates for the early 2010s are surprisingly similar in size to the prior estimates for the mid-1990s. If anything, they tend to indicate a slightly earlier cross-over age by which individuals with a general education have higher employment probability than individuals with a vocational education. While the estimation of cross-over ages is quite imprecise and varies across specifications, the regression analyses of the older data suggested a cross-over age of around 50. In the recent data, the cross-over age is also around 50 in the broad sample of countries, but somewhat earlier around 45 in the apprenticeship countries.<sup>10</sup> Thus, also after the

<sup>10</sup> Given that the employment patterns are rather flat during the prime-age phase, the exact estimation of cross-over ages should not be over-emphasized. In addition, while the lower employment of generally educated workers below age 20 appears much more pronounced in Figure 1 than in Figure 2, this pattern should not be over-emphasized as it draws on a potentially rather selective group of individuals. In particular, Hanushek et al. (2017b) note that two-thirds of those aged 16 to 19 are still in school (and are thus not considered in the analysis), and this may vary with type of education. The young people included in the analysis may thus not be

significant transformation of labor markets due to globalization, digitalization, and pension reforms, vocational education seems to facilitate the school-to-work transition, but at the same time reduce the adaptability of older workers to changing environments.

### *3.3 Further Country-Specific Evidence*

Several complementary country-specific investigations reinforce the general finding of a trade-off of general vs. vocational education over the employment life-cycle. To begin with, Hanushek et al. (2017b) provide two additional sets of analyses that strengthen the interpretation that the distinct age pattern reflects depreciated skills rather than other forces inducing people to leave employment.

Using the much larger sample of the German Microcensus data, they show that the differential age-employment pattern by education type also holds when restricting the analysis to variation within tightly defined occupation groups and when excluding occupations in which brawn is important. This finding indicates that the differential movement out of employment is not simply a matter of physical wear and tear of people in specific vocationally intensive occupations.

Analyzing job losses due to plant closures in Austrian Social Security data, they additionally show that the relative employment rates of displaced blue-collar workers (with more vocational education) are above those of white-collar workers at younger ages, but below them at ages above 50. The exogenous nature of the employment shock removes concerns about unobserved retirement preferences that could affect the general results.

A number of additional recent country-specific studies show a similar age pattern of labor-market outcomes by education type over the life-cycle.<sup>11</sup> Cörvers et al. (2011) provide life-cycle earnings patterns in vocational and general education for Germany, the Netherlands, and Great Britain. Consistent with the pattern described above, they show that earnings of vocationally educated individuals are higher at labor-market entry, but are overtaken by those

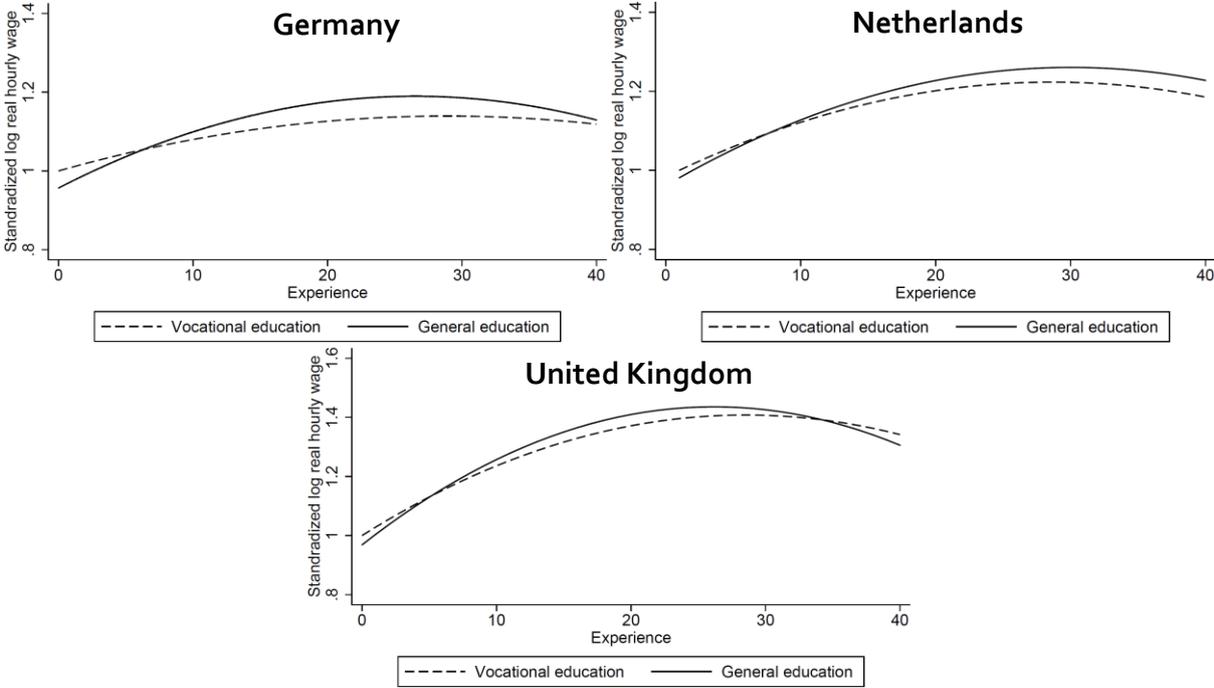
---

representative of the youth who eventually finish school and start the school-to-work transition. For this reason, Hampf and Woessmann (2017) restrict the depiction in Figure 2 to a matched sample of generally and vocationally educated persons in each country who are similar in terms of background characteristics, something that is not done in Figure 1. Furthermore, to make sure that results do not depend on the young age group, Hanushek et al. (2017b) and Hampf and Woessmann (2017) show that results in both IALS and PIAAC are robust to restricting the analysis to the age groups above age 20, and even above age 30.

<sup>11</sup> In a contemporaneous study similar to Hampf and Woessmann (2017), Forster, Bol, and van de Werfhorst (2016) also find similar patterns with the PIAAC data. Brunello and Rocco (2015) use the PIAAC data to look at the effects of vocational education on adult skills and wages.

of generally educated individuals with increasing age. The pattern is particularly pronounced in Germany, the country with a widespread apprenticeship system (see Figure 3).

**Figure 3: Earnings after Different Years of Experience with Vocational and General Education in Germany, the Netherlands, and the United Kingdom**



Notes: Experience-earnings profiles. See Cörvers et al. (2011) for data sources and specifics of estimation method. Source: Cörvers et al. (2011).

Relatedly, Weber (2014) estimates human capital depreciation rates for Switzerland and finds that depreciation rates are higher for vocational education than for general education.

Analyzing training programs for the unemployed in Sweden, Stenberg and Westerlund (2015) find that in the short run, specific training is related to higher earnings, but that the earnings of those who attended general training converge after a few years. By contrast, Hall (2016) is an exception that does not find a significant pattern based on the pilot of a Swedish reform in 1988-1993 that extended upper-secondary vocational programs by one year and increased their general content.

Two additional studies are of particular interest because they have longitudinal data to observe individual labor-market outcomes by education type over the life-cycle. Focusing on two-year programs at the upper secondary school level in Sweden, Golsteyn and Stenberg

(2017) show that vocational education is related to higher short-term earnings whereas general education is related to higher long-term earnings.

Similarly, using British data, Brunello and Rocco (2017) find evidence of a trade-off between short-term advantages and long-term disadvantages of vocational education over the life-cycle in particular for wages of individuals with lower secondary vocational education. However, their results also indicate differences in the effects of vocational vs. general education across lower vs. higher levels of education, across cohorts, and across employment and wage effects.

The fact that the Swedish and British studies confirm a trade-off of labor-market outcomes by education type over the life-cycle with longitudinal data indicates that the age differences analyzed by the studies above reflect actual age effects rather than cohort effects that are specific to different education types.<sup>12</sup>

### *3.4 Evidence from Variation in Job Specificity across Apprenticeship Programs*

Most of the studies reviewed so far employ a simple dichotomous distinction of education programs into vocational and general types. In reality, however, there is variation in the extent to which vocational programs also convey general skills, as well as the extent to which general programs also convey job-specific skills. By emphasizing variation in job specificity within vocational programs, two additional analyses – both using data from Switzerland – provide further insights and address some of the limitations in distinguishing vocational and general education programs in the international and national datasets.

Using evidence from the mobility of apprenticeship graduates between firms and occupations, Mueller and Schweri (2015) study the extent to which skills obtained in Swiss apprenticeship programs are firm-specific or occupation-specific. They find that one year after graduation, there is substantial mobility between firms, but little mobility between occupations, indicating that the programs convey occupation-specific skills that are transferable within an occupational field.

Eggenberger, Rinawi, and Backes-Gellner (2018) go deeper into the measurement of differences in the occupational specificity of different apprenticeship programs in Switzerland by analyzing the content of the different training curricula and linking them to demands on the

---

<sup>12</sup> Analyzing the Romanian labor market during the transition to a market economy, Malamud and Pop-Eleches (2010) do not find effects of vocational vs. general education on labor-market participation and earnings. Their analysis does not focus on differential effects over the life-cycle, however. In fact, for methodological reasons their analysis is restricted to prime-aged individuals (ages 31 to 46), so the absence of significant labor-market differences is quite consistent with the analyses reported here.

labor market. In particular, their specificity measure compares the skills conveyed in a specific training curriculum on a task basis to the overall demand for these tasks on the labor market, revealing that there is substantial variation in the occupational specificity of different vocational education programs.

Their analysis shows that more specific training curricula, while being associated with higher returns if graduates are able to continue work in the given job, are related to significantly lower occupational mobility, reducing the probability of occupational changes and increasing search times for new jobs when individuals become unemployed. That is, focusing more on the actual skills conveyed rather than the overall orientation of an education program, the study shows that skills that are highly specific to a limited set of occupations run the risk of limiting adaptability when demands on the labor market change.

## **4. Policy Implications for Future-Oriented Education Programs**

The consistent evidence on a life-cycle trade-off of focusing education programs on job-specific skills provides the basis for a number of policy implications about how education systems can prepare students for lifetime work. Each country, including the countries of the European Union, should aim to find the right balance between conveying general and work-specific skills to its population.

### *4.1 Some Overall Policy Implications*

At the most basic level, the findings indicate that in dynamic economies, policy needs to consider the full working life-cycle. They raise caution about policies that focus just on the current employment situation and ignore the dynamics of growing economies. Focusing just on the labor-market entry phase and youth unemployment is too narrow, as it ignores important countervailing effects later in life.

The crucial point is that no-one knows which specific skills will be demanded in the economy in, say, 30 years from now. The only thing that we can be sure of is that the economy will look very different from today's due to continuous technological and structural change. But today's secondary-school graduates will not even be 50 years old at that time, and they will want to strive on the labor market for at least another 15 years. This requires a strong educational foundation that provides workers with the ability to adapt as demands change.

As a consequence, neither vocational education programs nor general education programs are uniformly "good" or "bad." There are pros and cons of both types of education programs. Therefore, countries have to find the right balance between vocational and general programs,

and each type of program has to find a proper balance between conveying general and job-specific skills.

An advantage of education programs that focus on job-specific skills is that they may facilitate the transition from school to work. But focusing on job-specific skills also entails the risk of reducing the adaptability of workers to changing economic conditions. By contrast, education programs that focus on general skills may make it harder for graduates to find their way into the labor market, but may foster their capability to adapt to change later in life. This insight implicates a number of further conclusions for the design of future-oriented education systems.

#### *4.2 Securing a Basis for Adaptability*

A key factor for education policy is to recognize the importance of the ability to adapt to changing economic conditions (cf. Nelson and Phelps (1966); Welch (1970); Schultz (1975) for early contributions). Education systems need to promote the kind of general skills that pay off in dealing with new economic processes. Recent cross-country evidence based on the PIAAC data suggests that labor markets strongly reward cognitive skills, and that these returns are particularly high in countries that have grown rapidly (see Hanushek et al. (2015, 2017a)). General skills are important to be able to cope with dynamic economic change.

This insight points to the importance of a high-quality school system. Many general skills that form the basis for further learning and adaptation are basic skills that are learned during childhood and adolescence. It is very hard to compensate failures of the primary and secondary school system later on. In particular, the lack of basic general skills cannot simply be replaced by learning job-specific skills in an apprenticeship. It is the strong general skill base that is required to thrive on the labor market when things change.

One of the most significant labor-market problems facing many Western societies today is the number of workers whose middle-class jobs are slipping away and who are not prepared to adjust to a rapidly moving labor market. Societies are struggling to find ways of dealing with this problem. But expanding programs that focus on job-specific skills cannot substitute for the failure of the school system to provide the required general skill base. Failing to provide basic skills to the next generation would lock in the current middle-class malaise for the future and would likely make the long-run skill problems worse, as it would reproduce the current skill mismatch for future generations.

### *4.3 Providing the Institutional Frameworks Required in Apprenticeship Systems*

Beyond securing the general skill base, the hope of a smoothed school-to-work transition and ensuing reduced youth unemployment has enticed many countries, including several Southern European countries hit most severely by the economic crises of the past decade, to consider emulating the type of apprenticeship systems most common in German-speaking countries that combine learning at school and in the workplace. It is important to be aware, however, that the implementation of a functioning apprenticeship system requires many specific details of a strong institutional and regulatory framework that supports its success.

A key element is that these labor markets put a strong emphasis on certification. For this, the degrees obtained from an apprenticeship need to send credible signals about students' acquired skills to potential employers. This requires not only a broad prevalence and publicity of the apprenticeship programs, but also clear certification requirements. An employer who considers hiring an applicant who received the apprenticeship training in another firm needs to be sure that the apprenticeship degree credibly certifies that the applicant has obtained the most important skills that will be required for performing the job. This is usually achieved by a strong involvement of employers' associations in curriculum development and, in particular, final examinations.

More generally, successful apprenticeship systems tend to require strong involvement of both social partners – employers' associations and employees' unions – as well as the state. Apart from employers, the unions usually contribute to defining the apprenticeship curriculum and training requirements for firms and enforce restrictions and regulations on the labor market that facilitate the implementation of apprenticeships. There is also strong government involvement, as the state tends to coordinate the apprenticeship regulations with the social partners. Even more, the state tends to run and pay for the schools that apprentices have to attend for usually 1-2 days per week – the second part of the “dual” vocational system apart from the work-based training. In that sense, the financing of apprenticeship education is split between employers (who pay apprentice wages), apprentices (who accept lower wages during apprenticeship), and the state (which pays for schools).

Cost-benefit analyses of the German and Swiss apprenticeship systems indicate that the willingness of firms to train apprentices also depends on the extent to which they entail net benefits (production motive) or net costs (investment motive) during the apprenticeship phase (Muehlemann et al. (2010)). That is, the more likely it is that firms can recoup their training costs already during the apprenticeship phase and the more likely they are to retain apprentices

in whom they have invested, the more likely it is that apprenticeship positions are in fact offered by the firms. Simulations of different scenarios of implementing apprenticeship programs in Spain based on the Swiss experience suggest that the expected net costs of offering apprenticeships for Spanish firms strongly differ by the specific occupation, training scenario, and firm size (Muehleemann and Wolter (2017)). For any country that considers emulating an apprenticeship system, this suggests that finding a particular balance between benefits and costs for each stakeholder – employers, apprentices, and the state – is an intricate part of a successful apprenticeship system.

The consideration of stakeholder tasks, financial structures, and certification requirements indicates that apprenticeship systems require institutional and regulatory frameworks that often took decades to emerge and consolidate. The German-speaking countries can build on a specific tradition that allows for the functioning of their apprenticeship systems. Emulating these systems requires the implementation of institutions and regulations that similarly make the apprenticeship system worthwhile both for school graduates and for employers.

#### *4.4 “Generalizing” Vocationally Oriented Education Programs*

For countries that have vocational education programs in place or are considering implementing one, it is important to take into consideration what is required to make graduates fit for employment over their full life-cycles. The presented evidence suggests that reducing the early specialization of students on specific occupational skills may be conducive to their long-run prospects on the labor market. Based on observations of the German apprenticeship system, it may be worthwhile to consider designs and reforms that reduce the early specialization of apprentices. This could entail initiatives to lower the number of specific apprenticeships, expand the share of general educational content, and modularize apprenticeship components.

Countries with extensive apprenticeship systems differ substantially in the number of specific apprenticeships offered. While Germany has substantially more than 300 specific apprenticeship occupations, Switzerland gets by with much fewer specific apprenticeships, despite an otherwise quite similar system. For example, Germany has more than 30 specific apprenticeships in the commercial area, from special programs for commercial apprentices working in the courier and mail business to special programs for commercial apprentices working in the logistics business. By contrast, Switzerland has moved away from such an especially fine-grained system and offers one apprenticeship for all commercial trainees. They follow the same school curriculum for the first two years of their apprenticeship and specialize in their specific sector only during the third year. From the point of view of adaptability to

changing economic environments, the latter system seems more likely to equip apprentices with skills that make them employable over their full life-cycle which often requires changing sectors. More generally, lowering the number of specific apprenticeships is likely to raise the chances that graduates obtain skills that are demanded in broader sections of the labor market.

Another means to ensure that graduates of vocationally oriented programs also obtain general skills that facilitate adaptability to change is to ascertain that the curriculum of the vocational schools contains a sufficient share of general educational content. Apart from teaching job-specific skills, these schools should also convey a basis of general skills that go beyond narrow occupational areas and facilitate later learning. Such skills may help graduates also later on when the requirements of the economy have changed. The “generalization” of skills obtained during an apprenticeship might also entail the modularization of apprenticeship components, so that apprentices in different occupations in part take the same training modules. Such a setup could facilitate the movement of graduates into different occupations later on.

Thus, there are a number of options to reduce the early specialization of participants in vocationally oriented programs. When implementing or reforming vocational programs in a future-oriented way, countries should make sure that participants increase their general skills to make them fit for the changing future.

#### *4.5 Relating Skills to Real-World Tasks in General Education Programs*

At the same time, the presented evidence suggests that countries with a strong focus on general education programs may want to implement measures to relate the conveyed skills to tasks that are relevant in the real world as currently demanded on the labor market. Given the difficulties of general education programs in preparing their graduates for the transition into the labor market, these programs could emulate successful components from vocational programs that facilitate the move from the education system into the labor market.

For example, general education programs could extend the provision of job-specific skills by including requirements for internships and other work experiences in their programs. This way, graduates may find it easier to apply their general skills to real-world tasks.

A particular form of providing skills directly geared to the labor market are entrepreneurship education programs that are sometimes added to general education programs. While it has proved not to be easy to successfully instill entrepreneurial skills (e.g., Oosterbeek, van Praag, and Ijsselstein (2010)), in principle such elements could help general programs to convey a good mix of general and work-related skills that balance the demands of labor-market entry and long-term employability.

#### *4.6 Strengthening Lifelong Learning*

Finally, an important aspect for the long-term employability of workers is a strong focus on lifelong learning. Considering the specificity of the skills obtained in vocational programs, their graduates are in particular need to retrain when the economy changes. Unfortunately, quite to the contrary, data from several countries suggest that graduates from vocational education programs are much less likely to participate in adult education than graduates from general education programs. Such differences in participation in adult education and training may emerge from several sources, including workers' interests and preferences, firms' willingness to undertake or finance further training, and specificities of different occupations.<sup>13</sup> But the differences may also partly be due to the fact that general education programs develop skills that facilitate later learning throughout one's career.

In addition, as long as an employee stays with the same company, the company is likely to offer the kind of job-specific courses that update the worker's skills in the particular profession. However, companies obviously do not have an incentive to provide the kind of training courses that would prepare their employees to work in a different profession for a different firm, something that is increasingly needed in changing economies.

As a consequence, it may be worth considering the establishment of a system for lifelong learning that does not only update workers' skills within their occupation but also conveys skills that facilitate their flexibility if changing labor-market conditions require occupational change. That is, it is important to strengthen lifelong learning for graduates of vocational education programs on a broader scale. These requirements will become increasingly severe as European Union countries move more into being knowledge economies and as digitalization and automation of routinized job tasks require adaptability to change.

---

<sup>13</sup> Evidence from an adult education voucher program in Switzerland indicates, though, that even when the adult education is offered free of charge through the provision of a voucher, people with a vocational training degree are less likely to participate in adult education, even though they might profit in particular (see Schwerdt et al. (2012)).

## References

- Akerman, Anders, Ingvil Gaarder, Magne Mogstad (2015). The skill complementarity of broadband internet. *Quarterly Journal of Economics* 130 (4): 1781-1824.
- Autor, David H., David Dorn, Gordon H. Hanson (2015). Untangling trade and technology: Evidence from local labour markets. *Economic Journal* 125 (584): 621-646.
- Autor, David H., Frank Levy, Richard J. Murnane (2003). The skill content of recent technological change: An empirical exploration. *Quarterly Journal of Economics* 118 (4): 1279-1333.
- Becker, Gary S. (1962). Investment in human capital: A theoretical analysis. *Journal of Political Economy* 70 (5, Part 2): 9-49.
- Brunello, Giorgio, Lorenzo Rocco (2015). The effects of vocational education on adult skills and wages: What can we learn from PIAAC? OECD Social, Employment and Migration Working Papers 168. Paris: OECD.
- Brunello, Giorgio, Lorenzo Rocco (2017). The labor market effects of academic and vocational education over the life cycle: Evidence from two British cohorts. *Journal of Human Capital* 11 (1): 106-166.
- Cörvers, Frank, Hans Heijke, Ben Kriechel, Harald Pfeifer (2011). High and steady or low and rising? Life-cycle earnings patterns in vocational and general education. ROA Research Memorandum ROA-RM-2011/7. Maastricht: Research Centre for Education and the Labour Market.
- Eggenberger, Christian, Miriam Rinawi, Uschi Backes-Gellner (2018). Occupational specificity: A new measurement based on training curricula and its effect on labor market outcomes. *Labour Economics* 51: 97-107.
- European Commission (2012). Rethinking Education: Investing in Skills for Better Socio-economic Outcomes. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. COM(2012) 669 final. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52012DC0669&from=EN>.
- European Commission (2018). Key Competences for Lifelong Learning: A European Reference Framework. Annex to the Proposal for a Council Recommendation on Key Competences for Lifelong Learning. COM(2018) 24 final. <https://ec.europa.eu/education/sites/education/files/annex-recommendation-key-competences-lifelong-learning.pdf>.
- Forster, Andrea G., Thijs Bol, Herman G. van de Werfhorst (2016). Vocational education and employment over the life cycle. *Sociological Science* 3: 473-494.
- Golsteyn, Bart H.H., Anders Stenberg (2017). Earnings over the life course: General versus vocational education. *Journal of Human Capital* 11 (2): 167-212.
- Hall, Caroline (2016). Does more general education reduce the risk of future unemployment? Evidence from an expansion of vocational upper secondary education. *Economics of Education Review* 52: 251-271.
- Hampf, Franziska, Ludger Woessmann (2017). Vocational vs. general education and employment over the life cycle: New evidence from PIAAC. *CESifo Economic Studies* 63 (3): 255-269.

- Hanushek, Eric A., Guido Schwerdt, Simon Wiederhold, Ludger Woessmann (2015). Returns to skills around the world: Evidence from PIAAC. *European Economic Review* 73: 103-130.
- Hanushek, Eric A., Guido Schwerdt, Simon Wiederhold, Ludger Woessmann (2017a). Coping with change: International differences in the returns to skills. *Economic Letters* 153: 15-19.
- Hanushek, Eric A., Guido Schwerdt, Ludger Woessmann, Lei Zhang (2017b). General education, vocational education, and labor-market outcomes over the life-cycle. *Journal of Human Resources* 52 (1): 48-87.
- Hoeckel, Kathrin (2008). Costs and benefits in vocational education and training. Paris: OECD. <http://www.oecd.org/education/innovation-education/41538706.pdf>.
- Katz, Lawrence F., David H. Autor (1999). Changes in the wage structure and earnings inequality. In *Handbook of Labor Economics*, edited by Orley Ashenfelter, David Card. Amsterdam: Elsevier: 1463-1558.
- Krueger, Dirk, Krishna B. Kumar (2004). Skill-specific rather than general education: A reason for US-Europe growth differences? *Journal of Economic Growth* 9 (2): 167-207.
- Malamud, Ofer, Cristian Pop-Eleches (2010). General education versus vocational training: Evidence from an economy in transition. *Review of Economics and Statistics* 92 (1): 43-60.
- Muehlemann, Samuel, Harald Pfeifer, Günter Walden, Felix Wenzelmann, Stefan C. Wolter (2010). The financing of apprenticeship training in the light of labor market regulations. *Labour Economics* 17 (5): 799-809.
- Muehlemann, Samuel, Stefan C. Wolter (2017). Can Spanish firms offer dual apprenticeships without making a net investment? Empirical evidence based on ex ante simulations of different training scenarios. *Evidence-based HRM* 5 (1): 107-118.
- Mueller, Barbara, Jürg Schweri (2015). How specific is apprenticeship training? Evidence from inter-firm and occupational mobility after graduation. *Oxford Economic Papers* 67 (4): 1057-1077.
- Nelson, Richard R., Edmund Phelps (1966). Investment in humans, technology diffusion and economic growth. *American Economic Review* 56 (2): 69-75.
- Oosterbeek, Hessel, Mirjam van Praag, Auke Ijsselstein (2010). The impact of entrepreneurship education on entrepreneurship skills and motivation. *European Economic Review* 54 (3): 442-454.
- Pekkarinen, Tuomas (2014). School tracking and intergenerational social mobility. *IZA World of Labor* 214: 56.
- Psacharopoulos, George (1987). To vocationalise or not to vocationalise: That is the curriculum question. *International Review of Education* 33 (2): 187-211.
- Ryan, Paul (2001). The school-to-work transition: A cross-national perspective. *Journal of Economic Literature* 39 (1): 34-92.
- Schwerdt, Guido, Dolores Messer, Ludger Woessmann, Stefan C. Wolter (2012). The impact of an adult education voucher program: Evidence from a randomized field experiment. *Journal of Public Economics* 96 (7-8): 569-583.
- Schultz, Theodore W. (1975). The value of the ability to deal with disequilibria. *Journal of Economic Literature* 13 (3): 827-846.

- Shavit, Yossi, Walter Müller, eds. (1998). *From school to work: A comparative study of educational qualifications and occupational destinations*. Oxford: Clarendon Press.
- Stenberg, Anders, Olle Westerlund (2015). The long-term earnings consequences of general vs. specific training of the unemployed. *IZA Journal of European Labor Studies* 4 (1): 1-26.
- Weber, Sylvain (2014). Human capital depreciation and education level. *International Journal of Manpower* 35 (5): 613-642.
- Welch, Finis (1970). Education in production. *Journal of Political Economy* 78 (1): 35-59.
- Woessmann, Ludger (2009). International evidence on school tracking: A review. *CESifo DICE Report - Journal for Institutional Comparisons* 7 (1): 26-34.
- Woessmann, Ludger (2017). Vocational education in apprenticeship systems: Facing the life-cycle trade-offs. Background Report for Finland's Economic Policy Council.
- Wolter, Stefan C., Paul Ryan (2011). Apprenticeship. In *Handbook of the Economics of Education, Vol. 3*, edited by Eric A. Hanushek, Stephen Machin, Ludger Woessmann. Amsterdam: North Holland: 521-576.
- Zimmermann, Klaus F., Costanza Biavaschi, Werner Eichhorst, Corrado Giulietti, Michael J. Kendzia, Alexander Muravyev, Janneke Pieters, Núria Rodríguez-Planas, Ricarda Schmidl (2013). Youth unemployment and vocational training. *Foundation and Trends in Microeconomics* 9 (1-2): 1-157.

## EENEE Analytical Reports

- |    |  |   |
|----|--|---|
| 37 | Ludger Woessmann   | Effects of Vocational and General Education for Labor-Market Outcomes over the Life-Cycle |
| 36 | Daniela Craciun<br>Kata Orosz                                | Benefits and costs of transnational collaborative partnerships in higher education        |
| 35 | George Psacharopoulos  | Education for a better citizen: An assessment   |
| 34 | Daniel Münich<br>George Psacharopoulos                       | Education externalities – What they are and what we know                                  |
| 33 | Edwin Leuven<br>Hessel Oosterbeek                            | Class size and student outcomes in Europe   |
| 32 | Michel Vandenbroeck<br>Karolien Lenaerts<br>Miroslav Beblavý | Benefits of early childhood education and care and the conditions for obtaining them      |
| 31 | Holger Bonin   | The Potential Economic Benefits of Education of Migrants in the EU                        |
| 30 | Giorgio Brunello<br>Maria De Paola                           | School Segregation of Immigrants and its Effects on Educational Outcomes in Europe        |
| 29 | Mette Trier Damgaard<br>Helena Skyt Nielsen                  | The use of nudges and other behavioural approaches in education                           |
| 28 | Marius Busemeyer<br>Philipp Lergetporer<br>Ludger Woessmann  | Public Opinion and the Acceptance and Feasibility of Educational Reforms                  |
| 27 | Maria de Paola<br>Giorgio Brunello                           | Education as a tool for the economic integration of migrants                              |
| 26 | Daniel Münich<br>Steven Rivkin                               | Analysis of incentives to raise the quality of instruction                                |
| 25 | Elena Del Rey<br>Ioana Schiopu                               | Student Debt in Selected Countries  |
| 24 | Maria Knoth<br>Humlum<br>Nina Smith                          | The impact of school size and school consolidations on quality and equity in education    |

23	Torberg Falch Constantin Mang	Innovations in education for better skills and higher employability
22	Francis Kramarz Martina Viarengo	Using Education and Training to Prevent and Combat Youth Unemployment
21	Jo Blanden Sandra McNally	Reducing Inequality in Education and Skills: Implications for Economic Growth
20	Ludger Woessmann	The Economic Case for Education
19	Daniel Münich George Psacharopoulos	Mechanisms and methods for cost-benefit / cost-effectiveness analysis of specific education programmes
18	Reinhilde Veugelers Elena Del Rey	The contribution of universities to innovation, (regional) growth and employment
17	Giorgio Brunello Maria de Paola	The costs of early school leaving in Europe
16	Samuel Muehleemann Stefan C. Wolter	Return on investment of apprenticeship systems for enterprises: Evidence from cost-benefit analyses
15	Hessel Oosterbeek	The Financing of Adult Learning
14	Susanne Link	Developing key skills: What can we learn from various national approaches?
13	Marc Piopiunik Paul Ryan	Improving the transition between education/training and the labour market: What can we learn from various national approaches?
12	Daniel Münich Erik Plug George Psacharopoulos Martin Schlotter	Equity in and through Education and Training: Indicators and Priorities
11	Adrien Bouguen Marc Gurgand	Randomized Controlled Experiments in Education
10	Torberg Falch Hessel Oosterbeek	Financing lifelong learning: Funding mechanisms in education and training
9	Reinhilde Veugelers	A Policy Agenda for Improving Access to Higher Education in the EU
8	Giorgio Brunello Martin Schlotter	Non Cognitive Skills and Personality Traits: Labour Market Relevance and their Development in E&T Systems
7	Eric A. Hanushek Ludger Woessmann	The Cost of Low Educational Achievement in the European Union
6	George Psacharopoulos Martin Schlotter	Skills for Employability, Economic Growth and Innovation: Monitoring the Relevance of Education and Training Systems

- 5 Martin Schlotter  
Guido Schwerdt  
Ludger Woessmann
  - 4 Martin Schlotter
  - 3 Martin Schlotter  
Guido Schwerdt  
Ludger Woessmann
  - 2 George  
Psacharopoulos
  - 1 Ludger Woessmann  
Gabriela Schuetz
- Methods for Causal Evaluation of Education Policies and Practices: An Econometric Toolbox
- Origins and Consequences of Changes in Labour Market Skill Needs
- The Future of European Education and Training Systems: Key Challenges and their Implications
- The Costs of School Failure – A Feasibility Study
- Efficiency and Equity in European Education and Training Systems



Publications Office

doi: 10.2766/566869  
ISBN: 978-92-79-91288-7