Chapter 8
The Benefits, Costs, and Financing of Technical and Vocational Education and Training

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Abstract The TVET is particularly an innovative application field of educational economic "Costs-Benefit-Quality"-research. This chapter gives an overview of the accumulating empirical evidence on the benefits, costs, and financing of selected TVET programs. Before examining the findings of individual studies, the author considers the context for studying TVET. The first step is to ask, what are the reasons for conducting researches on TVET's benefits, costs, and financing? Then he discusses frameworks for thinking about TVET and the methodologies for estimating TVET's costs and benefits. Finally, he turns to a review of studies of TVET costs and benefits from the perspectives of workers, employers, taxpayers, and the broader public. The research spans several countries and a variety of TVET systems and programs. The final sections summarize the findings and consider implications for policy.

8.1 Introduction

Human resources are central to the performance of every economy. Although reading, writing, and math skills are critical components of human capital, so too are competence and mastery in occupational skills and such noncognitive skills as listening, communication, problem-solving, and dealing well with superiors and peers. All advanced economies rely on universal primary education to teach verbal and math literacy. But, they differ in how they expect people to learn and use occupational and other workplace skills. Technical and Vocational Education and Training (TVET) plays a central role in occupational training in nearly all countries, but the governance, timing, delivery, location, and experience of TVET

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Z. Zhao and F. Rauner (eds.), *Areas of Vocational Education Research*, New Frontiers of Educational Research, DOI: 10.1007/978-3-642-54224-4_8,

varies widely across and often within countries (OECD 2009). In some countries, the government dominates TVET, while others involve private employers extensively. TVET begins by age 14 in some countries and not until a student's early 20s in other countries. Most TVET programs focus on initial vocational education (IVET), but some include continuing vocational education (CVET) for upgrading the skills of workers already in an occupation (Cedefop 2011). The duration of TVET programs ranges from less than 1 year to over 4 years. Training systems vary in their use of work-based relative to classroom-based learning. The range of occupations within the scope of TVET varies widely as well, especially in such white collar fields as computer networking, banking, and commerce. Finally, the scale of TVET varies widely as well, with some countries relying almost exclusively on academic subjects, leaving occupational and firm-based training entirely to employers.

Given the diversity of skill development systems, no one approach or set of estimates can fully capture the costs, benefits, and financing of TVET (Hoeckel 2008). However, an expanding literature is increasingly able to document the nature and financing of TVET systems and to assess the economic returns to TVET programs. The main purpose of this chapter is to review the accumulating empirical evidence on the costs, benefits, and financing of selected TVET programs.

Before examining the findings of individual studies, this chapter considers the context for studying TVET. The first step is to ask, why conduct this study? What goals can good information about TVET's benefits, costs, and financing help address? Next, we discuss the various frameworks for thinking about TVET and the methodologies for estimating TVET's costs and benefits. We then turn to a review of studies of TVET costs and benefits from the perspectives of workers, employers, taxpayers, and the broader public. The research spans several countries and a variety of TVET systems and programs. In general, the studies examine the impact of TVET by itself but not in comparison with alternative ways of financing and delivering occupational skills. The final sections summarize the findings and consider implications for policy.

8.2 Why Study the Net Benefits of TVET Systems?

Formal education and training for most occupations began to develop only in the late nineteenth and early twentieth centuries. Until then, individuals developed occupational skills by a process of learning by doing, sometimes informally and sometimes through structured apprenticeships. Today, the government plays a central role in skill development, not only by financing and delivering universal general education but also in providing resources for teaching occupational skills. In a free society, we count on employers and workers to decide on their investments in vocational training based on their own cost and benefit calculations. Firms may worry about the "poaching" problem, whereby one firm invests in

training a worker only to find that another firm hires the worker after the training and thereby prevents the training firm from recouping their investments. The potential losses represent risks to the firm that must be considered before making a training investment. Workers may have to bear the costs of lost earnings and/or tuition in return for higher wages in the future. Although workers may rationally expect earnings gains from various types of TVET investments, they also face risks that the specific TVET they received will yield few gains because, for example, of changing market conditions. Still, as in other areas of economic life, we rely on the judgments of the parties directly affected to make decisions in their best interests. Because those making the investments have the most at stake in considering costs and benefits, policymakers should attach a high weight to their calculations.

Yet, even though markets play a central role in determining the size and composition of human capital investments, there are several justifications for providing government support for education and training. A common rationale is externalities. When a firm trains workers in general or in occupational skills, the costs are borne by the workers and firms, but the training may yield positive externalities to nearly all firms that use workers with general skills and to selected industries that use workers with the same occupational training.

Another critical rationale for estimating TVET costs and benefits is incomplete information. The government is better positioned to conduct long-term research on the costs and benefits of education and training. Research findings on the net benefits of TVET by occupation are a public good that is likely to be undersupplied if left to the market. Individuals making judgments about careers and employers deciding about long-term training needs can benefit from good information but have no incentive to conduct the research on their own. In particular, lack of knowledge about education and training systems can cause workers, firms, and governments to choose inefficient approaches to human capital development.

Credit constraints and distributional concerns provide additional arguments for subsidizing vocational education. Some young people may be unable to afford to forego earnings or to take very low wages because of family obligations. Though they could raise their earnings through TVET, they may be unable to borrow to invest in their human capital. The distributional case for supporting TVET is that most countries heavily subsidize college and university education, despite the fact that college and university students are likely to experience the highest incomes in their cohorts. Without any significant support for TVET, government funding for human capital investments would become regressive.

Notwithstanding these and other reasons for government support for TVET, the scale and method of support should depend on the size of TVET's social costs and benefits. By social costs, I mean the resources used up in the delivery of vocational education, including the time of teachers, classroom space, and the time of workplace mentors. By social benefits, I mean the resources gained, which can be added production during the training period, but more importantly are the increased productivity and earnings induced by the TVET activities. Other potential benefits are more difficult to measure; these include a rise in innovation

and the profitability of enterprises, improvements in job matching and job satisfaction, improved health and citizen participation, and, as youth unemployment diminishes, reductions in crime and anti-social behavior. Reductions in social welfare payments to the unemployed are sometimes viewed as a benefit to taxpayers offset by the costs to individuals. However, the structure of social welfare benefits and the taxes required to pay for them generate economic costs by distorting the choices of recipients and taxpayers.

A major rationale for studying TVET costs and benefits concerns decisions about which type of TVET system to subsidize or whether to offer any subsidies at all. Some TVET systems emphasize a dual approach combining school-based and employer-based learning. At the upper secondary level, Switzerland, Germany, and Denmark involve the highest share of students in dual programs (OECD 2009). Others rely almost entirely on school-based TVET; over 50 % of upper secondary students in Belgium and Sweden are in school-based vocational and technical programs. Governments typically apply the highest subsidies to school-based vocational education, relying on employers to pay all or nearly all of the costs of on-the-job training.

Costs and benefits are relevant to the issue of funding any publicly sponsored TVET system. Taking issue with the TVET enterprise in general, some researchers and policymakers believe that public money should finance only general education and leave the development of occupational and firm-based skills to enterprises. The latest example comes from Hanushek et al. (2011b). They argue that:

> The EU perspective on VET is particularly interesting given the suggestion by Krueger and Kumar (2004) that the slower long-term growth of European economies compared to the US may, in fact, be the result of Europe's greater reliance on vocational education as opposed to more general education. Firms would be slower to adopt new technologies when it is more costly because their workers with more vocational education are less able to use them.

Given the contested role of TVET and the varying approaches to TVET, well-developed micro and macro analyses of TVET's net benefits are crucial and are likely to become increasingly influential in policymaking. More broadly, improved understanding of TVET's impacts is critical to the development of human capital, of rewarding careers, and of economic growth.

8.3 Complexities Arising in Estimating TVET Costs and Benefits

TVET represents an educational process that—in addition to general education—covers the study of technologies and related sciences and the acquisition of practical skills, attitudes, understanding, and knowledge relating to occupations in various sectors of economic life. From this perspective, TVET systems can encompass education and training in medicine, law, accounting, and architecture

as well as in machining, welding, plumbing, and electrical installation. While a broad definition makes sense, the concept of TVET held by employers, workers, policymakers, and the public is in fact specific to individual countries. Learning occupational skills takes place more or less formally, depending on the scope of each country's TVET system.

Given the diversity of TVET systems and programs, how can one develop accurate estimates of TVET costs and benefits? The estimates can answer narrow or broad questions. At the micro level, one can ask: what are the rates of return to participating in, and to completing various TVET programs? What are the costs and benefits to workers from taking and completing apprenticeship programs in specific occupations? What are the gains and losses for employers resulting from various types of TVET programs, including apprenticeship but also school-based programs? What costs and benefits do governments (taxpayers) bear in the context of various TVET programs?

The broader questions concern the macro economy. How does the scale and composition of TVET affect youth unemployment, wage inequality, economic opportunity and mobility, international competitiveness, innovation, and economic performance? From an economist's viewpoint, the micro issues involve marginal effects in single markets (or partial equilibrium) while the macro issues involve all markets taken together. Because of the importance of interactions among parties and markets and of expectations of workers and employers, answering the macro questions is quite difficult. One approach to determining system-wide effectiveness is to examine the experiences of countries with varying systems. For example, Germany and Switzerland—two countries with large dual TVET systems—have far lower youth unemployment rates than countries with small or school-based TVET systems. However, while we can observe both the dual systems and the low youth unemployment rates, it is far more difficult to prove causation, since other factors may be the real causes of low youth unemployment.

This chapter deals mainly with the micro studies of costs and benefits, with the marginal costs and the causal impacts of individual programs on workers, firms, and taxpayers. For school-based programs, the benefit estimates depend largely on what happens to students over their careers. Usually, analysts project how the lifetime earnings profile changes with additional education (in this case TVET) and then calculate the discounted present value of the differences in earnings over time. The costs of school-based programs are mainly the foregone earnings of students plus the outlays on teachers, classrooms, materials, and the annual use of equipment. Empirical studies of school-based TVET programs rarely examine the impacts on employers, despite frequent concerns expressed by employers about the availability of skilled workers, often even in recessions. For apprenticeships and other work-based TVET, studies examine both the impacts on workers as well as on employers. A major focus on employers is natural, given that employers bear most of the costs and make the decisions about the number and composition of apprenticeship opportunities.

Conceptual and practical issues arise in trying to estimate TVET costs and benefits. The first involves recognizing the wide variation in the structure and

breadth of TVET. The term encompasses school-based learning at the secondary and the postsecondary levels, varying amounts of work-based learning (from a few days or weeks to several years), and heterogeneity in general versus occupation-specific training and in the nature of career focus. In fact, the variety is so wide that many studies focus on a few types of TVET and/or a few occupations. This approach provides more refined estimates but makes generalizations difficult.

A second issue is defining the counterfactual, or what would have taken place in the absence of vocational education. Answering this question rigorously is difficult. In the absence of TVET, would the government have supplied purely academic education or would most TVET participants have entered the labor force with little or no vocational education or training? Comparing students or workers who go through a TVET program to those who do not is subject to the selection problem. Even if the comparisons are between TVET participants and nonparticipants with the same observed characteristics, there may be unobserved factors, such as the motivation to work or the desire to avoid an academic-only program, that affect entry into TVET and post-TVET earnings. One solution, used in evaluations of US job-training programs, is to use a social experiment in which applicants are randomly assigned to treatment groups with access to TVET or control groups with no access. Unfortunately experiments are expensive, take a long time, and typically provide no evidence on employer impacts. On the other hand, it is difficult to determine whether the outcomes for a comparison group accurately represent what would have happened to TVET participants had they not been exposed to TVET.

Another issue is that TVET programs, including apprenticeship, may work well for some occupations but not others. Generalizing in these contexts is difficult. A fundamental problem is the ex-post character of cost-benefit studies. They show the impact of past programs on past earnings and productivity gains. The results do not necessarily generalize for future time periods or different economic environments. A related issue involves the timing of studies. Learning about the effectiveness of TVET for today's cohort may require waiting 5, 10, or even 30 years. By that time, policymakers will often have made their decisions. Hanushek et al. (2011a, b) argue that the benefits of intensive TVET erode over time and that workers with TVET experience have lower employment levels after age 55 than workers with general education and similar test scores on reading and math. As Heise and Meyer (2004) put it, "…people belonging to different generations or birth cohorts are exposed to very disparate chances and risks regarding their education, training and working career and therefore receive a very different quantity and quality of education and training benefits."

Still another issue is risk and uncertainty. Typically, investments in TVET are at least somewhat irreversible, particularly in terms of foregone earnings and tuition and related expenses. (You cannot resell your time or your seat in the classroom last semester.) This irreversibility, combined with uncertainty about earnings outcomes from training, has implications for how to evaluate the returns to investing in TVET by the worker and by the employer (Jacobs 2007). In particular, the standard present value calculations do not necessarily serve as a

guide to the decision to invest in TVET. Instead, in an investment decision under uncertainty and irreversibility, you should take into account the option to postpone the TVET investment. As Jacobs notes, the ability to enter TVET at any point is similar to a financial call option. The student has the right but not the obligation to invest in human capital at some future date. When the student decides to enroll immediately, he exercises his option to buy the human capital asset and gives up the opportunity to wait and see when new information about the future investment returns become available. For potential TVET students, especially those in school-based programs, the option value approach makes individuals more reluctant to invest and thus raises the required expected returns. The reason is that the option to wait has value. By investing now, you give up something of value. Because the irreversible costs in foregone earnings and tuition are far less for those entering apprenticeships than for those entering school-based TVET, the option value and required returns are lower and thus more attractive.

Risk and uncertainty apply to the issue of general education versus vocational education. From one perspective, general education offers students more options by allowing occupational choices to take place later, after more information becomes available. On the other hand, students may be able to build on the skills acquired through TVET to reach higher levels in a wide range of occupations.

Real options are also relevant to evaluating investments by employers in training. Leuven and Oosterbeek (2001) consider firm-specific investments in on-the-job training. Given uncertainty about the productivity returns from irreversible investments in particular workers, the firm's investment creates a real option. When the training is completed, the firm has the option but not the obligation to hire the trained worker. This option value raises the firm's returns and increases the likelihood that they will invest in training.

Finally, several noneconomic outcomes are difficult to quantify but do show some association with VET. One analysis (CEDEFOP) found that TVET experience is linked to higher confidence and self-esteem, improved health, higher citizen participation, and higher job satisfaction. These relationships hold even after controlling for income. Other studies have indicated that TVET improves youth development (Halpern 2009) and vocational identity (Brown et al. 2007), but it is difficult to quantify the economic value of these social benefits.

8.4 Empirical Estimates of Costs and Benefits

Notwithstanding the difficulties in producing rigorous estimates, a vast literature has generated a range of estimates of components of benefits and costs of TVET. The findings cover both school-based and dual (school and work-based) TVET and deal mainly with impacts on students and impacts on employers in a number of countries. Sometimes, costs and benefits to the government are taken into account. The studies vary widely in the level of detail (a specific occupation, firm, industry, or country), the education level (secondary or post-secondary), and coverage

(inclusion of both costs and benefits to various groups). This review offers a selective review of estimates of impacts, with an emphasis on recent studies.

8.4.1 Costs and Benefits for Students and Workers

Several broad reviews of TVET have appeared in the last decade. The OECD's Learning for Jobs (2009) provides an overview of vocational education systems in 17 countries, but cites only a few studies dealing with benefits and costs of TVET. The OECD's Off to a Good Start: Jobs for Youth (2010) highlights the role of vocational education, especially apprenticeships, in smoothing the transition from school to work and in maintaining low youth unemployment. Research on rates of return to TVET programs in individual countries is common as well, such as in Australia, Austria, Germany, Switzerland, and the U.S. The recent contribution by Hanushek et al. (2011a) is an ambitious attempt to develop estimates of the returns to vocational education across 18 countries.

Most studies find that vocational education yields significant gains for young workers. In the U.S., the comprehensive National Assessment of Vocational Education (2004) reported that:

> Recent studies indicate a positive average effect of vocational education on annual earnings, measured just over a year or several years after high school graduation. Seven years after graduation, for example, students earned almost 2 percent (about $450) more for each additional high school vocational course they took, or just over $1,350 more for occupational concentrators. These benefits appear to extend to students who go to college, to those who have economic and educational disadvantages, to those with disabilities, and to both men and women; studies differ over whether there are earnings advantages for students who never attend college, an increasingly small group.

In another analysis, Meer (2007) finds that students choosing a technical vocational track in U.S. secondary schools earned significantly more than they would have earned had they chosen a general or academic track. On the other hand, students actually choosing academic tracks earned more than they would have had they chosen a vocational track. Thus, Meer shows that the diversity of tracks reflects the diversity of students: forcing a student choosing a technical vocational track into an academic track would worsen his or her outcomes in the job market. Other studies indicate that vocational education increases the rate at which students graduate from secondary school (Arum 1998; Bishop).

Another approach to TVET in the U.S. is Career Academies, or high schools organized around an occupational or industry focus, such as health care, finance, and tourism. They operate within regular high schools and try to weave related occupational or industrial themes into a college preparatory curriculum, using applied learning in academic courses as well as career-focused courses. The role of work-based learning varies, however, and long-term internships are not always a part of the student's experience. An experimental evaluation randomly assigned students applying for career academies into a treatment group with access to career

academies and a control group excluded from the academies. This approach yields highly reliable estimates of impacts. Career academies induced striking gains in earnings. In the period between 4 and 8 years after applying for the academies, young men in the treatment group were earning 17 % more than those in the control group (Kemple and Willner 2008). The gains were especially high among minority young men. Moreover, the longevity of the gains is by the fact that the treatment group reported a significantly higher likelihood of promotion than controls.

School-based postsecondary vocational education in the U.S. takes place mainly in public community colleges and private (often for-profit) 1- and 2-year colleges. A 2002 review by Grubb found an extensive set of estimates showing good returns to completing a vocational program within public, 2-year colleges. A recent study by Cellini and Chaudhary (2012) finds earnings gains of about 20 % from completing a 2-year degree in an occupational course, with similar impacts from public as well as from private, for-profit colleges.

One U.S. study examined the government costs as well as the worker and government benefits of three types of TVET—secondary vocational education, postsecondary vocational education (in community colleges), and apprenticeship programs—taking place in the State of Washington. Hollenbeck (2008) compared the earnings of secondary TVET students with earnings of all high school graduates. For workers with postsecondary TVET and apprenticeships, he used groups that entered employment offices and who had the same preprogram earnings. The earnings increase over the first 2.5 years after program exit exceeds the government and worker costs substantially for apprenticeships and secondary TVET. For postsecondary TVET, the results show costs approximately equaling benefits after 2.5 years but solid 7–9 % rates of return when net gains projected on a lifetime basis. Absolute and relative gains in earnings from apprenticeship are highest, reaching about $2,000 per month compared to only about $1,500 per month among those participating in occupational programs in 2-year colleges. When projected for a career, Hollenbeck's estimates of the benefits far outweigh the costs for all the TVET programs. By far the largest gains are for apprenticeship. Missing from the analysis is any assessment of employer costs. The implicit assumption is that employers gain sufficient benefits from sponsoring apprenticeships to offset their costs.

A broad study of apprenticeship in 10 U.S. states also documents large and statistically significant earnings gains from participating in apprenticeship (Reed 2011). It estimates how the length of participation in an apprenticeship affected earnings, holding constant for pre-enrollment earnings of apprenticeship participants. Using this "dosage" model, the author obtains estimates of what the level of earnings would be for comparable workers who did not participate in apprenticeship at all. The estimated impacts are consistently and highly positive. At 6 years after starting a program, earnings of the average apprenticeship participant (average duration in an apprenticeship) stood at 1.4 times the earnings of nonparticipants with the same pre-apprenticeship history. The gains were highly consistent across states although the earnings advantages narrowed between the

6th and 9th year after program entry. On the cost side, the study takes account only of government costs—both administrative and oversight costs as well as the costs of government-funded classroom instruction. Costs to employer and union-management sponsors of apprenticeship are not examined. Overall, the study finds that apprenticeship returns nearly $28 in benefits for every dollar of government and worker costs. The net dollar gains projected over a worker's career amounted to about $125,000.

Many studies have examined the earnings gains from apprenticeship training in European countries. They generally find high rates of returns to the workers, often in the range of 15 % (Krueger and Pischke 1995; Winkelmann 1996; and Fersterer and Winter-Ebner 2008). On the other hand, some cast doubt on high returns to apprenticeship training, arguing that German apprentices have similar wage profiles to U.S. high school graduates without occupational training. Unfortunately, few studies are able to isolate the net impact of apprenticeship rigorously. They are generally unable to account for a major concern of existing studies—the role of selection bias that results from the employer's selection of young workers who are more capable than their counterparts in ways that the analyst cannot observe. Unobserved heterogeneity can cause researchers to make comparisons between apprentices and nonapprentices that do not fully reflect the higher (or lower) capabilities of those entering apprenticeships.

One recent study of the returns to apprenticeship training in small Austria firms (Fersterer et al. 2008) overcomes much of the selection problem. The authors focus on the interaction between apprenticeship duration and failing firms. In the context of apprenticeship, a firm going out of business will generally cause a sudden and exogenous end to the apprenticeship training for apprentices in the firm. More generally, the timing of firm failure will affect the duration of apprenticeship training a particular worker experiences. By looking at apprentices who obtained training in failed firms, one can examine a large number of trained workers with varying durations in their apprenticeships. The sample covers small firms, where the closing of the firm is likely to occur most suddenly. The authors use an instrumental variables (IV) approach, in which the duration of a worker's apprenticeship is a function of the time between entering the firm and the firm's failure. Using this duration variable as an IV makes sense, since it is a good predictor of the duration of the worker's apprenticeship but does not predict long-term wages except through its indirect impact on apprenticeship. The results show a significant wage effect resulting from longer relative shorter durations of apprenticeship. Specifically, the estimates indicate that apprenticeship training raises wages by about 4 % per year of apprenticeship training. For a 3–4 year apprenticeship, post-apprenticeship wages end up 12–16 % higher than they otherwise would be. Since the worker's costs of participating in an apprenticeship are often minimal, the Austrian study indicates high overall benefits relative to modest costs.

A recent Canadian analysis indicates a high wage premium for apprenticeships for men but not for women (Boothby and Drewes 2010). Apprenticeship completion is the highest attainment for only about 7 % of Canadian men.

However, for this group, earnings are substantially higher than the earnings of those who have only completed secondary school and nearly as high as those who have completed college programs that are less than a university BA. Overall, the gains for men from apprenticeship training are in the range of 17–20 %. Even evaluated after 20 years of experience, apprenticeship training in most occupations yields continuing returns of 12–14 %.

Evidence from one Australian study shows very high rates of return to individuals undertaking TVET. Ryan (2002) finds that a male school leaver who completes a skilled vocational qualification while working part-time reaps a return of about 24 %. This gain far exceeds the 3.9 % return to a male who works part-time while obtaining an associates diploma (2-year college degree). Another analysis of the returns to skilled qualifications in Australia finds significant gains for those who did not complete 12 years of schooling.

A 2004 analysis of returns to apprenticeship in the United Kingdom yields much lower, but still positive rates of return for males (McIntosh 2004). The estimates suggest a respectable 7 % return to apprenticeships among men, though not for females. Not surprisingly, the gains from apprenticeship vary by occupation.

Although a number of researchers have highlighted the benefits of well-structured TVET systems (Steedman 1993; Acemoglu 2001; and Ryan 2002) and the OECD reports on youth comment favorable on the positive role of apprenticeship, some researchers argue that the evidence remains uncertain. In a recent review of European education and training policies, Wößmann argues that, "The debate on vocational versus academic qualifications and their payoffs is more heated in some European countries than others. But despite its prevalence in many European countries, there is a general lack of hard empirical evidence on which to base a sound analysis of efficiency and equity issues in vocational education." He indicates that TVET can be especially equitable, citing evidence that countries with well-structured TVET systems have fewer dropouts from secondary school and that French disadvantaged youth who go into apprenticeships have a higher likelihood of employment than those in school-based vocational education. Still, Wößmann concludes by viewing any efficiency or equity advantages of vocational education as tentative.

Wößmann's collaboration with Hanushek et al. (2011a, b) goes further in casting doubt on the benefits of TVET systems. This chapter deserves careful attention since it is an ambitious analysis likely to attract wide attention. The authors use data from the International Adult Literacy Survey (IALS), covering 18 countries in 1994 and 1998, to examine the impact of vocational education relative to general education on employment and earnings over the life cycle. The samples include 16–65 year-olds who completed at least secondary education and are not currently students. General education is defined as academic or college preparatory or a program leading to a BA or BS degree. Vocational education is a program in business, trade, or vocational that does not lead to BA/BS degree.

The estimates of general versus vocational education impacts rely on regression and matching techniques that essentially compare individuals who differ in terms

of type of education but have the same literacy scores, age, sex, years of schooling, adult training, and parents' educational attainment. Literacy scores (prose, document, and quantitative) are higher for general education individuals, but the overlap between the vocational and general education is substantial.

The authors argue that vocational education (including apprenticeships) improves employment and earnings outcomes of young people but the advantage erodes to a disadvantage at older ages. The gains at young ages are consistent with a variety of other studies highlighted by Wolter and Ryan (2011). Hanushek et al. (2011a) argue that the erosion of gains at older ages is clearest in countries that emphasize apprenticeship, such as Denmark, Germany, and Switzerland. Yet, according to several estimates in this chapter, the advantage in employment rates linked to vocational education in the apprenticeship countries remains through approximately age 60 (Table 6). Moreover, in the apprenticeship countries, the advantage in employment rates is sizable, providing men with vocational education a 9 %age point higher employment rate at age 40 and a 4 point advantage at age 50. Looking at the results using individual age categories instead of a linear age term, one again finds positive employment outcomes for the apprenticeship countries as a whole until ages 56–65, when the employment rates are equal for those with and without vocational education (Table 8). In the case of Germany, the same table indicates a large disadvantage for those with vocational education when men reach ages 56–65 and less of an advantage in the early ages.

While the employment results appear to vary across specifications and the employment advantage in apprenticeship countries is always highest at younger ages, many of the estimates show little or no disadvantage until workers are well over age 60. Such an employment shortfall might be due to higher benefits from early retirement for those with vocational education. Turning to differences in annual earnings, the authors find only insignificant effects of general versus academic education by age for most countries. Notwithstanding these insignificant effects, the final section includes estimates of differences in the present value of lifetime earnings within countries based largely on employment differences. The precise method and discount rate used are unclear, but the authors conclude that lifetime benefits from vocational education occur only in Switzerland and losses occur in Germany.

While the findings of the Hanushek, Woessman, and Zhang paper are interesting, they are subject to several limitations. First, the estimates cover a specific time period (1994 and 1998), using cross-sections of people at varying ages to generate life cycle patterns. Thus, the data do not follow individuals through their life cycle; instead, they capture employment and earnings of different birth cohorts only at one age. This problem may be particularly significant, given the specific years involved. Germany, in particular, went through an especially difficult period in the 1990s, having to absorb East Germany. At the time, German policies specifically tried to encourage early retirement and Germany's benefit system provided very high replacement rates for workers. In today's context, the situation for older workers with a vocational education background may be quite different from the period studied in the paper. Second, by including only those who completed at

least secondary school, the estimates ignore the potentially positive effects of vocational education on reducing high school dropout rates. Third, the results prove nothing about whether the apprenticeship countries would have achieved a better economic performance or improved outcomes for their workers if they deemphasized in-depth vocational education. Overall, the results of this chapter do not overturn the wide body of evidence showing significant benefits to vocational education.

8.4.2 Costs and Benefits for Employers

Since TVET in the form of publicly supported vocational schools relieve employers of classroom costs, the focus of studies of employer costs and benefits is on work-based TVET, such as apprenticeships. For employers, the net costs depend on the mix of classroom and work-based training, occupation, skill and wage progression, and the productivity of the apprentice while learning to master the required skill. The benefits depend on the extent to which apprenticeships save on subsequent hiring and training costs, lower turnover costs, and enhance productivity more than added wage costs. Also valuable is the employer's increased certainty that apprentice graduates know all relevant occupational and firm-specific skills and can work well alongside other skilled workers. In addition, having extra well-trained workers, such as apprentice graduates, provides firms with a valuable option of expanding production without reducing quality in response to uncertain demand shocks and covering for sudden absences of skilled workers.

Although few if any studies have been able to quantify all of these costs and benefits in a large sample of employers and countries, an increasing number have estimated the net costs and some of the benefits to employers of apprenticeship investments. The main direct costs include apprentice wages, the wages of trainer specialists for the time they oversee apprentices, materials, and the costs of additional space required for apprenticeship (Wolter and Ryan 2011). The benefits include the value of production generated by the apprentice, sometimes separated by whether the activities would otherwise have been performed by skill or unskilled workers. A common and realistic assumption is that, as the years in training take place, the apprentice's work contributions increasingly substitute for tasks undertaken by skilled workers.

The most extensive studies of net costs of apprenticeships deal with German and Swiss employers. One analysis compares results from surveys of 1,825 German firms and 1,471 Swiss firms. Looking only at the training period, the authors calculate the gross costs—outlays for worker wages, trainer wages, and materials—and the benefits to employers derived from the productive contributions of apprentices during the training period. On average, the gross costs per year amounted to 15,500 Euros for German firms and about 18,100 Euros for Swiss firms. Although Swiss firms spend more than German firms, they derive substantially higher benefits from the value added by apprentices. Swiss firms gain

over 19,000 Euros per year, more than double the 8,000 Euro benefits that German firms attribute to the value of production generated by apprentices. For a 3-year apprenticeship, Swiss firms are able to recoup the 54,400 Euro cost with benefits of 57,100 while German firms experience a 46,600 Euro cost but only 24,000 in benefits.

The reasons for these differences are instructive for apprenticeship programs as a whole. In Switzerland, the wages of management, skilled workers, and unskilled workers far exceed those in Germany. On the other hand, the wages paid to apprentices are far less in Switzerland than Germany. In addition, apprentices are at work for more days in Switzerland than in Germany (468 vs. 415 for a 3-year apprenticeship). Further, when at workplaces, Swiss apprentices devote 83 % of their time to productive tasks, compared to only 57 % among German apprentices. The differences in time spent on tasks with no direct value to the firm are larger as well. Again, the Swiss have the advantage, with apprentices devoting time to these tasks only 13–21 % of the time, while these tasks take up from 31–57 % of the time in Germany.

One striking feature of apprenticeships in both countries is how quickly apprentices ascend from taking on unskilled to skilled tasks. In Switzerland, the productivity of apprentices rises from 37 % of a skilled worker's level in the first year to 75 % in the final year; the increase in Germany is as rapid, increasing from 30 to 68 % of a skilled worker's productivity over the apprenticeship period. Still, the data suggest that nearly all German firms with apprenticeships (93 %) incur net costs while a majority of Swiss firms (60 %) more than recoup their costs.

Are the higher in-program net costs to German firms offset by any advantage after the apprenticeship period? The study indicates differences on one key outcome—retention of apprentices within the firm. In Switzerland, only about 36 % of apprentices remain with the firm that provided the apprenticeship training. The figure was 64 % for apprenticeships in the former West Germany, where employers receive less or no subsidy than in East Germany. Thus, while German firms bear much higher net costs than Swiss firms during the apprenticeship period, they are better able to reap higher returns during the post-apprenticeship period.

Evidence from the Germany surveys of employers offer some insight into post-program benefits (Beicht and Ulrich 2005). Recruitment and training cost savings average nearly 6,000 Euros for each skilled worker trained in an apprenticeship and taken on permanently. The report cites other benefits, including reduced errors in placing employees, avoiding excessive costs when the demand for skilled workers cannot be quickly, and performance advantages favoring internally trained workers who understand company processes over skilled workers recruited from the job market. Taking all of these benefits into account makes the apprenticeship investment into a net gain for employers.

Not all recent studies indicate high net costs of apprenticeships in Germany. For example, Mohrenweiser and Zwick (2008) find that for many occupations, the gains to the firm during the apprenticeship period more than offset the costs. They draw their conclusions by estimating the impact of apprenticeships on company profits. For apprenticeships in trade, commercial, craft, and construction

occupations, the estimates show a positive impact on profits. However, in manufacturing, the effect on current profits is negative, indicating a positive net cost.

In another careful study of German apprenticeships, Rauner et al. (2010) finds that the majority of the 100 firms in the sample recouped their investment in apprenticeships during the training period. This study used a tool called QEK (for quality, returns, costs) that allowed employers to make a detailed self-assessment of the costs and benefits of apprenticeship during the training period. In contrast to results reported by Dionisius et al. (2009) based on a larger sample, the Rauner et al. study finds that most firms experience low net costs or even net benefits from sponsoring apprenticeships. However, the net costs vary widely, with some firms gaining more than 10,000 Euro and other experiencing net costs. Somewhat surprisingly, net costs are inversely related to the quality of the apprenticeship. High quality apprenticeships have higher gross costs but are much more likely than low quality apprenticeships to help employers recoup their investment during the training period.

Although net cost studies of apprenticeship in other countries are less comprehensive that those conducted in Germany and Switzerland, they offer additional evidence on costs and benefits. An extensive study of Canadian employers sponsored by the Canadian Apprenticeship Forum (2006) estimated employer costs and benefits of apprenticeships in 15 occupations. The study drew on responses from 433 employers, with at least 16 per occupation. All were 4-year apprenticeships. The average gross costs ranged from about $78,000 for cooks to $275,000 for construction electrician. Average in-program benefits—measured as the revenue generated by the apprentices—varied widely as well, ranging from $120,000 for cooks to $338,000 for construction electricians. For all 15 occupations, employers earned a positive return to their apprenticeship investments even without taking account of any post-program benefits. In fact, the average benefit was 1.38 times the average cost.

A recent analysis of apprenticeships in the United Kingdom is based on eight employers in each of four industries—engineering, construction, retail, and business administration, including foundation and advanced levels (Hasluck and Hogarth 2010). The authors estimated that the average gross costs were higher than the average benefits during the apprenticeship period in all the four industries. However, the patterns varied by industry. In retail and business administration, the gross costs were only modestly higher than the benefits, which covered 80–90 % of gross costs. However, in engineering and construction, the productive contributions of apprentices covered less than 60 % of the substantially higher gross costs. Still, the authors estimate that employers at least break even during the early post-apprenticeship period, when the contributions to production of apprenticeship graduates are worth more than their wages.

In the United States, there are no rigorous studies with estimates of employer costs and benefits of apprenticeships. However, evidence from surveys of over 900 employer sponsors of apprenticeship indicates that the overwhelming majority of sponsors believe their programs are valuable and involve net gains (Lerman et al. 2009).

8.4.3 Government Costs and Benefits

Estimates of the government costs of TVET should take place in context, by determining TVET spending compared to what government spending would be in the absence of TVET. A common perspective is to estimate government costs of TVET compared to government costs of academic education. In general, government outlays per student are believed to be considerably higher for vocational education than for academic education (Psacharopoulos 1993; Middleton 1988; Gill et al. 1999; Klein 2001), especially in less developed countries. School-based vocational programs sometimes require special equipment, more expensive teachers with industry experience, and small classes. Notwithstanding these differences, there are strikingly few detailed studies of government spending on vocational education and in many countries the cost differences are modest. A detailed analysis of spending per student in Greece shows only modest gaps between academic and vocational education (Kostakis 1990). A graph prepared by Cedefop (2012) indicates virtually identical expenditures per student in a number of European countries, though it shows that outlays are substantially higher for vocational education than general education in France and Germany. In a study of the Geneva canton of Switzerland as of 1994, government costs per student were about 50 % higher in full-time vocational education than in general education but government costs per apprentice was only half the costs of general education (Hanhart and Bossio 1998).

Cost analyses rarely examine the way in which spending per student varies with the type of TVET (school-based or employer-based) and with the occupational field. In dual TVET systems, government costs are clearly lower than in school-based TVET for three reasons. First, government funding for schooling is lower because student's time in school declines from 5 days per week to 1 or 2 days per week. Second, government spending on equipment is less necessary for TVET dual-program students because students gain experience with the relevant equipment at their work site. Third, successful dual systems reduce the need for government spending on university education or on second-chance training programs.

A recent study in the U.S. Reed et al. (2012) estimates the government costs and benefits of registered apprenticeship in the 2000s. On balance, governments at all levels spent about $715 per apprenticeship participant, an amount only about 7 % of government spending per year on 2-year college programs. At the same time, public spending per student on 2-year postsecondary, school-based vocational education is about the same as academic 2-year programs; both are far less than academic programs in 4-year institutions. While Hollenbeck (2008) estimates a smaller but still substantial gap between school-based postsecondary TVET and apprenticeship (about $7,600 vs. $2,700) in Washington State. He projects an incremental cost for TVET at the secondary level of less than $1,000 per participant.

The long-term benefits of TVET accruing to governments are rarely estimated. The returns to taxpayers include how TVET-induced gains in earnings increase tax

revenues and decrease social benefit programs. If employers and other workers share in the TVET-induced increase in economic growth that might arise from increased innovation and reduced skill mismatches, then taxpayers would benefit from the associated added revenues. In the case of U.S. apprenticeship, Reed estimates that over the career of an apprentice, the tax returns are more than $27 and the total benefits are more than $35 per dollar invested. According to Hollenbeck (2008), the government obtains about 20 % of the overall net gains in earnings linked to various types of TVET. Projecting earnings gains that are sustained but phase out between the 2.5 year post-program observation period and age 65, Hollenbeck (2008) comes up with the long-term benefits from TVET. Using data on current costs and long-term benefits, he estimates implicit rates of return to the government for various TVET programs. They range from about 3 % for postsecondary, school-based TVET, to about 10 % for secondary, school-based TVET and 24 % for apprenticeships.

There are surprisingly few good studies of the government costs of TVET. While vocational programs vary widely on a whole range of dimensions, the evidence suggests that the costs per student in secondary education are higher in vocational than in academic programs, though the size of the differential depends significantly on whether the programs need specialized equipment. At the post-secondary level, the evidence is less clear and will be especially sensitive to the fields. Physics labs are part of academic programs, while business vocational programs require no special equipment. One clear conclusion is that apprenticeship programs are less costly to the government than is full-time schooling, whether vocational or academic. In most apprenticeship programs, the government pays only for part-time schooling, often only 20–25 % of a full academic schedule. Generally, the schooling component of apprenticeships does not require special equipment and if they do, employers often pay these extra costs.

8.5 Findings and Policy Implications

An overall assessment of the costs and benefits of TVET systems is methodologically challenging and requires common data that are not generally available (Hoeckel 2008). The analysts must recognize the heterogeneity of TVET, obtain data for specific types of TVET, and follow participants over a number of years after leaving TVET. A cost–benefit analysis of TVET must specify the relevant counterfactual, or what would have happened to TVET participants in the absence of TVET. Moreover, the analysis must consider potential external costs and/or benefits, such as reduced wage inequality and increased solidarity and innovation. Given these challenges, the scarcity of comprehensive cost–benefit analyses is not surprising.

The literature concentrates on the long-term net benefits to TVET participants and, in the case of apprenticeship or other employer-led training, on the net benefits to employers. The studies rarely deal with costs or external benefits.

For example, the study by Hanushek et al. (2011a) ignores the lower costs of apprenticeship versus other types of vocational education.

Still, the evidence suggests a number of conclusions about the costs and benefits of TVET. First, for the participant, TVET generally yields gains in wages, with gains especially high for participants in apprenticeship programs. Only one major study indicates that the long-term gains from TVET may fall short of the gains from general education, especially in TVET outcomes beyond age 55. On the other hand, even this study agrees with nearly every study in finding clear benefits in the early post-high school period. The net gains for participants are especially high for apprenticeship programs, partly because the skill development is highly suited to the needs of employers, partly because some valued learning can only take place in the context of the workplace, and partly because apprentices pay low or no costs. They often pay very little tuition and they do not generally forego earnings because they earn money from employers during the apprenticeship.

For employers, the patterns of costs and benefits vary widely. Under school-based, vocational education, employers pay little or no costs and may or may not reap clear benefits. Even when students are well-trained to enter the profession and be highly productive, the market for their services may raise their wage sufficiently to offset their added productivity. A focus of several studies is on the net costs to employers of providing apprenticeships. In well-structured, quality apprenticeships, the net costs depend on the wages of trainers and on the wages and productivity of apprentices. Careful analyses find that the majority of employers in Switzerland and possibly in Germany as well are able to recoup their investments in training within the training period itself. We do not know what would be the net costs of apprenticeships to those employers not currently sponsoring apprenticeships.

In estimating costs and benefits to the government, the counterfactual is often spending on academic programs. From this perspective, government outlays per student in school-based TVET are typically higher than outlays on general instruction but outlays on apprenticeships are generally lower than spending on general education.

Given the low public cost and high wage gains from dual work-based and school-based programs, the natural policy implication is for countries to de-emphasize school-based TVET and turn more to apprenticeship training. This policy shift would be significant in several countries, including the U.S., but not necessarily in other countries. No one policy can deal with high youth unemployment, low youth skills, the rise in inequality, and the decline of middle-skill jobs. But, TVET in general and apprenticeship in particular can help with these problems.

Finally, the weaknesses in the literature point to extensive shortcomings in research and data on TVET programs. Filling these gaps is critical for devising sound policies to prepare young people for careers in a cost-effective system.

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