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Vocational Education: An International Perspective

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Vocational Education: An International Perspective

Abstract

Vocational education is formal education about work, and vocational programs of study typically target a narrow subset of middle-income occupations. In this chapter, we trace vocational education from competing 20th century education philosophies to its varied structures throughout the 21st century world. We then review the body of economic research on labor market returns to vocational education. Three themes from this rapidly expanding literature are that (1) workers with a vocational education tend to have a flatter age-employment profile than workers with an academic education, (2) individuals who seek and gain access to more secondary vocational education tend to have better attainment and early-career outcomes, whereas the effects of large-scale changes to tracking in secondary grades are more ambiguous; and (3) vocational postsecondary education is associated with improved labor market outcomes relative to no or incomplete postsecondary education, particularly for multi-year programs. We close by highlighting areas where more empirical research is needed, which include a deeper understanding of the long-term and inter-generational effects of vocational education on stability and growth in earnings, and the effects of vocational education in the developing world.

JEL-Codes: I260, I230, J310.

Keywords: vocational education, earnings, employment.

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Introduction

For any society, its views of the philosophical and practical purpose of education inform how that society allocates responsibility for occupational training. Prevailing philosophies of education vary across time and location, and so do the forms and purposes of vocational education. Therefore, much of what we know about the economic effects of vocational education comes from the study of diverse programs and policies, and changes in how students or cohorts interact with vocational programs. Our understanding of the economic effects of vocational education is multiplying rapidly – but not yet coalescing – as data become more suited to the task of causal inference.

With this chapter, we take a snapshot of the evolving literature on vocational education and start to connect the constellation of results from a variety of international contexts. The dominant intent of today's vocational education is to improve economic opportunities for students after they leave formal schooling. The literature has focused on whether vocational education fulfills this purpose, and likewise, most of our review focuses on employment and wage returns to vocational education. Where possible, we reconcile the picture that emerges with some of the philosophies of education that led to such diversity in the mode and content of formal occupational learning in schools.

First, we develop a definition for vocational education that is grounded in the basic economics of education and labor and is flexible enough to describe the wide variety of vocational programs and structures available to students in practice.

What is vocational education? Three features

Vocational education is formal learning devoted to the development of occupational skills. The occupational focus of vocational education is its first defining feature, whether for the explicit purpose of developing workforce skills, for complementing general skills with hands-on or real-world applications, or for developing virtues such as citizenship and ethics.

Because any academic subject can conceivably relate and contribute to productivity outside of school, we wish to qualify this binary, jobs-focused feature of vocational education in order to differentiate it from general education. As a starting point, we can draw from Becker's (1962)

seminal model and think of vocational education as building up knowledge and skills that are specific to particular firms or occupations, rather than generally applicable across firms. The implication for education and training is that firms have a stake in providing firm-specific, but not general, education, obligating individuals to attain general skills on their own. Lazear (2009) enriches this model with the idea that firm-specific knowledge is more like a weighted combination of skills, some of which may be very general. A software firm providing tax optimization products, in Lazear's example, needs workers who know an idiosyncratic blend of accounting, economics, and computer science. The skill-weights concept extends from the firm to the occupation. A good communications specialist will draw from education, training, or experience in graphic arts, writing, marketing, as well as their firm's particular industry.

However, a typical firm does not place positive weight on *all* secondary and higher education subjects. Some subjects are inherently narrower than others. With this in mind, we propose a second feature of vocational education to be an abstract, continuous measure of broad to narrow applicability across jobs. Vocational education falls non-uniformly on this spectrum, tending to be (but not always) narrower. If we were to map vocational subjects to occupations, the alignment would be one-to-one or one-to-few more often than one-to-many or one-to-all.

A jobs-focused curriculum, typically relevant to a subset of jobs, is an inclusive conceptual framing for vocational education, but it also describes many subjects that are not thought of as vocational: theology, art, music, engineering, or law, to give a few examples. To tighten this framing further and bring it closer to vocational education as it appears in practice and research, we add a third (characteristic more so than defining) feature based on socioeconomic class or aptitude. Typically, programs of study in vocational subjects develop knowledge tailored to middle-skilled or middle-income occupations. Leading and popular examples include construction, manufacturing, office administration, and agricultural science. The class-based stratification of vocational and general studies is most apparent in countries where students enter secondary schooling on either a college preparatory track or a vocational track, and where the vocational track ends in a terminal diploma that cannot serve as a stepping stone to elite universities.[1] Even in more integrated school systems, educators, governments, and families tout vocational coursework as a pathway to financial security or upward mobility that does not need to involve college or university (although it can).

Of course, vocational education is not limited to secondary schooling. Much of the learning that

happens in colleges and universities is vocational in nature, both in terms of the specificity of skills and the socioeconomic class of jobs where those skills are needed. In short, the breadth and depth of vocational education varies across countries.

Our working definition of vocational education thus has three parts:

1. Students learn about work.
2. What students learn is usually relevant to a limited number of jobs.
3. What students learn is usually less relevant to the highest income jobs.

The strict intersection of these three features describes the plurality of vocational education programs today, and throughout recent history, but certainly not the complete set. Information technology programs are notable exceptions to item 2 since they develop general skills but are commonly situated within vocational programs. A prominent exception to item 3, the class-based characteristic feature of vocational education, is found in the current-day United States. There, a negative stigma was attached to vocational education throughout most of the 20th century, and by the late 1990s most state education agencies dropped the phrase "vocational education" in favor of "career and technical education" (CTE).[2] A typical CTE system in today's United States is organized around "career clusters" that encompass almost any occupation one could have, inclusive of those with the highest pay or highest degree requirements.[3]

Chapter overview and related reviews

We begin this chapter with a discussion of the historical trends and attitudes regarding vocational education, highlighting the tensions between general (or academic) and vocational education that have existed for over a century. Next, we present descriptive statistics on participation in vocational secondary and postsecondary education. Much of the available data are limited to nations in the Organization for Economic Cooperation and Development (OECD) or European Union (EU), although to the extent possible, we describe vocational participation rates in other countries around the world.

We then turn to the main focus of the chapter and review the research literature on estimated

effects of vocational education on attainment, employment, or earnings. We start with research on vocational secondary education, which has drawn inferences from regression-adjusted differences across individuals with a vocational versus academic background, cross-cohort comparisons of age-earning profiles, nationwide policy reforms to vocational tracking, and most recently, regression discontinuity designs that exploit cut-offs for admission to vocational education programs.

We then turn to postsecondary vocational education, starting with the U.S. research literature on returns to enrollment in community and technical colleges. Although these institutions provide the majority of postsecondary vocational education in the country, they also provide academic coursework that can be transferred to four-year colleges and universities. Early work in this area mainly used survey data sets, such as the National Longitudinal Survey of Youth (NLSY). More recent research relies on large administrate data sets of community college students, usually collected at the state level, linked with administrative earnings data collected for the Unemployment Insurance program.

Next, we summarize evidence on labor-market benefits from postsecondary vocational education outside the U.S. In many countries, vocational higher education institutions have limited crossover with academic colleges and universities. Some offer shorter vocational education programs comparable to the certificate programs in community colleges, whereas others provide much longer programs comparable to bachelor's degrees – in fact, some are called bachelor's degrees – but with a vocational focus. Recently, some countries such as Finland have started offering vocational master's degrees.

One important takeaway from research on vocational postsecondary education is that midcareer adults tend to realize significant labor market returns to completing a community or technical college program. And yet, the returns to *enrolling* in such a program are not as clear in the U.S., where completion rates at sub-baccalaureate institutions are very low. With this in mind, we turn away from our focus on labor market effects to highlight a selection of the large and growing research base on specific attributes of vocational postsecondary institutions and their effects on students. Specifically, we review some of the research on two-year college completion and how institutional inputs such as advising affect student attainment, as well as how financial aid affects student persistence, completion, and in some cases, labor market outcomes.

Our final two sections synthesize conclusions across these various arms of research on vocational education and then highlight areas and topics where future research is most in need.

Throughout our framework and review, we focus on formal classroom-based vocational programs, which can have components outside of the traditional classroom. We will say little about apprenticeships, and we refer readers to Wolter and Ryan (2011) for the necessary depth on that topic. Similarly, McCall, Smith and Wunsch (2016) review research and several case studies on public vocational training for adults in more detail than we do here. Cellini (this handbook) discusses for-profit postsecondary education, much of which is oriented toward specific occupations.

Previewing our synthesis of the literature, several studies have found that the age-employment profile of vocationally educated workers is flatter than that of workers with a more academic background. Looking across and within cohorts, vocational students may have higher employment and earnings than academic students early in their careers, but the ranking switches to favor general education later on. This life-cycle pattern is consistent with theoretical predictions (Lazear, 2009) and empirical evidence (Hanushek et al., 2017) that workers with more idiosyncratic skills are more vulnerable to market fluctuations and shifting technology. And yet, these patterns should not be taken as an unambiguous strike against vocational education. Traditional academic paradigms that focus on college readiness do not serve all students well (Cullen et al., 2013), and most national reforms to vocational tracking sequences have not yielded noticeable wage gains for the cohorts who spent more time in general education.

Furthermore, it is not clear from cross-cohort or survey evidence that *today's* vocational education students—who are navigating new waves of technology that have potentially dampened the relationship between education and wage inequality (Autor et al., 2020)—will exhibit the same pattern of early labor market success followed by flatter or more variable earnings growth. In some settings, postsecondary adults who attend vocational programs have better short-term outcomes than students who do not enroll, and there are significant returns to completing such programs. Studies that are able to isolate exogenous sources of variation in vocational education at the individual level, such as admission lotteries for over-subscribed vocational programs, are more apt to find positive, albeit short-term, effects on attainment or earnings.

An understanding of the long-term effects of modern vocational programs lies far in the future, although there is much to be learned today that can inform the economics of education and the practice of vocational learning. We highlight three areas that stand out as relatively thin strands of research in a rapidly growing volume of knowledge on vocational education. Foremost, more research is needed on the root causes of flatter age-employment and age-earnings profiles for vocationally educated individuals, and more generally, the potential risks inherent to a more targeted education. Second, we are primed to begin to learn more about the inter-generational effects of vocational education, and in particular, whether it fulfills its oft-touted promise of upward mobility. And third, estimated wage returns to vocational education in developing countries are widely varying across settings, and due to data constraints, causal inferences have relied largely on non-experimental variation in access to, or intensity of, vocational education. More efforts to reconcile these disparate results will have implications for the claim that vocational education is a key component of economic growth and development.

History and Philosophies of Vocational Education

The known history of vocational education and apprenticeship stretches back to ancient times, and has ebbed, flowed, and evolved under countless societal purposes and formal structures. In this section, we highlight themes from the global history and philosophies of education that are interwoven throughout the policies and programs examined by modern-day vocational education research.[4]

Vocational versus general education

One recurring theme from the history of formal education over the last 150 years is a tension between philosophies of education in work-oriented skills versus more general, academic skills. This tension over curriculum is rooted in a broader, longstanding debate about the aims of formal education, which asks: should students become conscientious and curious learners who can think and debate critically, or skilled workers capable of sustaining themselves and contributing to the economy? Or, are these complementary objectives? John Dewey held the complementary view, writing in 1915 that:

> I object to regarding as vocational education any training which does not have as its supreme regard the development of such intelligent initiative, ingenuity and

> executive capacity as shall make workers, as far as may be, the masters of their own industrial fate. (quoted in Larrabee, 2010)

Long before Dewey's prominence, the 19th century Swedish slöjd system (or sloyd, which remains a compulsory part of Swedish education) integrated paper, textile, and wood craftwork into general education in a complementary way, with the intent of developing a student's learning capacities more so than their technical skills. A contemporaneous system in Russia's Imperial Technical School of Moscow (today's Bauman University) provided students with tool instruction side by side with technical theory. Inspired by the Russian system, the president of the Massachusetts Institute of Technology paired the school's existing theoretical curriculum with new laboratories for engineering students to apply what they learned, in hopes that they would no longer need to complete an apprenticeship between graduation and work (Gordon, 2014).

Rivaling Dewey's and the slöjd's "executive capacity" view of vocational education was the idea that education's chief goal was to produce productive citizens. This economically-oriented aim of education was typically joined with the theory that curriculum content directly influenced knowledge, as opposed to the "faculty psychology" view that the mere act of learning new material enhanced a student's mental faculties for all sorts of purposes. The psychologist Edward Thorndike popularized the formal link between curriculum, knowledge, and skills in the early 20th century United States. Accompanying this link was an elevated purpose for teaching occupational skills through vocational education, preferably in strict separation from academic subjects (Larrabee, 2010). Thorndike's model of curricular learning is also responsible for introducing standardized testing as a scientific tool in the evaluation of students and their schools. Dewey's legacy as a philosopher is more revered, but Thorndike's practical view of education is far more prevalent among public school systems today (Lagemann, 1989; Tomlinson, 1997).

The arguments of the Thorndike-Dewey debates were not unique to the United States. Around the world in the first half of the 20th century, national efforts to grow or import vocational education were not always successful, in part because of this tension between vocational and academic education and the empirically well-founded belief that students who attain an academic education earn more over the course their careers. See case studies from Ghana (Foster, 1965) and China prior to World War II (Schulte, 2013). To this day, the question is rarely settled as to whether there is enough vocational education for students who want it, or too much for those who do not.

Tracked versus integrated vocational education

Even among those who share the view that formal education – including vocational education – serves economic purposes, there is disagreement as to the most productive way to teach about work. The oldest form of vocational education, apprenticeship, is not very different from work. An apprenticeship arrangement matches a student to a professional, typically under formal contract and sometimes lasting for many years. In many places, the traditional apprenticeship has been modified to include class instruction, such as in Germany's dual system where apprentices divide their time between work and school.

Other vocational education structures are entirely based in schools, but with a curriculum that is distinct and separate from what is offered to general education students. This form is common throughout the world today, where separate schools or tracks are offered for vocational and academic education, typically beginning in secondary grades.

The tracked model of vocational education aligned with the social efficiency doctrine, which in the U.S. was led in the early 1900s by David Snedden (Doolittle and Camp, 1999). Snedden was the first Commissioner of Education in Massachusetts, and, along with his deputy commissioner and former student Charles Prosser, was one of the more influential figures in the development of 20th century vocational education. Snedden held society and education systems liable for providing students with the tools to be economically self-sufficient, and in the spirit of Thorndike's vision of learning, advocated for vocational education programs that were separate from general education. His view was that some students were meant to be producers, and others the utilizers of what was produced, and that the two should ideally be educated in separate institutions and under separate curricula suited to their comparative advantage (Labaree, 2010).

Adherents to social efficiency claimed that most secondary students (many of whom would not have persisted into high school if they had been born in an earlier generation) would benefit from a fundamentally vocational education that prepared them for work. In response to Snedden's call to "closely correlate theoretical instruction to this practical work" (Snedden, 1977), Dewey contended that "a separation of trade education and general education of youth has the inevitable tendency to make both kinds of training narrower, less significant and less effective …" (Snedden and Dewey, 1977).

After apprenticeship and tracked systems, a third major form of vocational education integrates occupational learning with general education, within schools and even within courses or specific topics of study. Such an integrated education system is more aligned with Dewey's thinking, the slöjd system, and the early 20th-century US movement in "manual education," which viewed vocational and academic education as strongly complementary. Lauglo's (2009) description of "light dosage" vocational secondary education in sub-Saharan Africa fits this model as well.

Vocational education and upward mobility

Vocational education as a ticket to sustained or upward economic mobility amidst technological and cultural change is implicit in the social efficiency doctrine, its forbearing philosophies, and its legacy. The rhetoric of vocational education routinely connects work-focused learning to the idea that narrow skill development can do a better job than academic training at lifting an individual, race, or even a nation out of poverty.

Consider Booker T. Washington's 1895 "Atlanta Compromise" speech on the topic of Black economic progress in the U.S., addressed to a largely White audience at the Cotton States and International Exposition: "No race can prosper till it learns that there is as much dignity in tilling a field as in writing a poem. It is at the bottom of life we must begin, and not at the top" (Harlan, 1974). W. E. B. DuBois criticized Washington's philosophy of Black progress through "adjustment and submission" as paradoxical. He painted Washington's industrial education philosophy as "unnecessarily narrow," advocating instead for "[t]he education of youth according to ability," more resources for Black colleges and postsecondary training, and equality in civil and voting rights (DuBois, 1903).

More recently, a 2015 UNESCO publication reviews the state of vocational education in developing economies (Marope, Chakroun, and Holmes, 2015), and opens with the following:

> Technical and vocational education and training (TVET) is steadily emerging as a winner in the "race to the top" of global debates and government priorities for education and national development agendas.

Disruption: Demand for vocational education in the wake of shocks

A fourth theme evident from the global history of vocational education is the effect of economic or political shocks on the demand for and structure of vocational education.

Technological advancements that automate or economize labor tasks threaten workers with skills invested in fading technologies while simultaneously intensifying demand for expanded education in newer methods. The onset of the industrial revolution, in Europe and later the U.S., increased the need for low-skilled and medium-skilled production workers beyond what existing apprenticeship systems could supply. This shock coincided with the Morrill Acts in the U.S., which established land-grant universities and federally subsidized their development of agricultural and industrial postsecondary programs. Vocational education was introduced in U.S. public secondary schools somewhat later, in part as a response to industrial demands for workers adept in new technologies. These demands co-moved with Snedden's and Prosser's advocacy, World War I-era reductions in immigrant craftsmen, as well as the Smith-Hughes Act of 1917 that established a federal funding stream for vocational secondary education.

At various points in recent history, the outcome of war has shifted the importance of vocational education to favor the educational philosophy of the victors. Following World War I and the subsequent overthrow of the Ottoman state, the new Turkish Republic promoted a more economic purpose for formal education (as well as a more political one), secularized the education system, and grew the vocational education sector (Ozelli, 1974). China, following World War II and the civil war, expanded vocational education in a tracked, dual system under political and economic justifications (Bush and Haiyan, 2000). Also following World War II, West Germany redeveloped a tracked secondary system whereas Soviet-controlled East Germany adopted a general polytechnic model for all students.

Who Attends Vocational Education?

The 2019 edition of the OECD's report *Education at a Glance* provides an overview of current-day vocational education enrollment (OECD, 2019). Among OECD countries, approximately 40 percent of students ages 17 to 18 were in academic secondary schools, 30 percent were in vocational schools, and 30 percent were not in secondary school. However, overall averages mask substantial heterogeneity in attendance rates, with some countries such as Finland and Slovenia having more than two thirds of secondary school students in vocational education.

In systems without tracking, such as in U.S. primary and secondary schooling, it is not accurate to describe students as falling into mutually exclusive vocational or general education categories. Kreisman and Stange (2019) suggest that the best measure of vocational education (or CTE) participation in such a system is the number of credits taken rather than the number of students in dedicated vocational programs. The U.S. Department of Education (2013) reports that 77 percent of U.S. high school students earned at least one CTE credit as of 2013, and 37 percent earned at least two credits in a single career cluster.

The OECD report provides more detail on postsecondary education that is vocational in nature, particularly for what they term “short cycle” programs like U.S. community college certificate and associate’s degree programs. In most countries, enrollment in such programs peaks at ages 19 to 20, implying that students who enroll in short-cycle programs typically do so soon after completing secondary education. Figure 1 illustrates the enrollment rates for OECD countries with available data. Overall, five percent of 19-20 year-olds are enrolled in short cycle programs, but a few countries have enrollment of 15 percent or more: Chile, France, Korea, Turkey, and the United States. At the same time, several countries report no short cycle enrollment among this age group: Brazil, the Czech Republic, Germany, Iceland, Italy, the Netherlands, Poland, and Switzerland.

<FIGURE 1 HERE>

One challenge in comparing vocational education across countries, as noted by Ulicna, Messerer, and Auzinger (2016), is that the definition of vocational education programs varies from country to country. Examples of vocational education options in the European Union but not counted as short cycle programs are the vocational bachelor’s programs in Denmark and elsewhere. Instead, Ulicna et al. (2016) take a broader definition of vocational education at the postsecondary level that includes both short cycle and longer programs. Using that definition, Figure 2 illustrates the share of postsecondary students, by country, enrolled in vocational education programs.

<FIGURE 2 HERE>

The EU average is 20 percent, although there is great variation across nations. Fewer than five percent of postsecondary students attend vocational education in Italy, the Netherlands and Portugal, whereas 40 percent or more attend in Belgium, Denmark, and Slovenia.

In the U.S., Zhang and Oymak (2018) provide a detailed analysis of students pursuing an undergraduate degree of any type (including certificates, associate's degrees, or bachelor's degrees) using national survey data from the 2011-2012 National Postsecondary Student Aid Study (NPSAS).[5] They report that 38 percent of students pursue a vocational degree. Among these students, the most popular field of study by far is health sciences at 36 percent, with business and marketing second at 17 percent. No other field of study has more than 10 percent. Most U.S. students pursuing vocational degrees are women (60 percent), although there is wide variation in gender representation across fields.

Figure 3 illustrates the percentage of upper secondary school students who attend vocational (as opposed to general) education for developing and intermediately developed countries. The data for the figure come from United Nations Educational, Scientific, and Cultural Organization (UNESCO) UNEVOC country profiles from 2018 to 2020.[6] As the figure illustrates, there are substantial differences across countries in the rate of students attending vocational upper secondary education. Over 40 percent of students in Indonesia and China attend vocational education, contrasted with India and Myanmar, where fewer than five percent are enrolled in vocational education. In the Middle East, 28 percent attend vocational education in Lebanon, compared to 14 percent in Jordan, four percent in Kuwait, three percent in Saudi Arabia, and 1.5 percent in Qatar. Of the 18 countries surveyed, six have over 20 percent in vocational attendance, four have between 10 and 20 percent, and eight have under 10 percent.

<FIGURE 3 HERE>

The Labor Market Effects of Classroom-Based Vocational Education

Secondary vocational education

Table 1 summarizes a selection of the research literature on classroom-based secondary vocational education in the U.S. and Europe, listing several estimated returns to vocational education across diverse policies, reforms, and identification strategies.

<TABLE 1 HERE>

Secondary vocational education typically takes one of two forms. One form is the whole-school model, which can be found throughout Europe. A second form is the integrated model where vocational coursework is offered in sequence or as standalone courses on the same campus and at the same time as general academic and college preparatory courses. Most U.S. students participate in integrated vocational education at comprehensive high schools, although there are whole-school models that echo Snedden and Prosser's view of dedicated campuses for applied learning.

Part of the literature on the labor-market benefits of tracked, whole-school vocational education uses difference-in-difference models to study the tradeoff between vocational and general education, or the longer-term return to additional time spent in one track or the other. To arrive at credible causal inferences, some of these studies exploit national policy shifts that represent quasi-experiments in extending the number of years of required general education. Results from such studies are sketched in Panel A of Table 1.

Oosterbeek and Webbink (2007) study the effects of an increase in compulsory years of schooling for tracked vocational students in the Netherlands. Hall (2012, 2016) reports on the postsecondary and labor-market effects of a reform in Sweden that extended the amount of general education required for vocational upper secondary students. Malamud and Pop-Eleches (2010, 2011) and Zilic (2018) study reforms in Romania and Croatia, respectively, which increased the length of time spent in general education prior to tracking. Canaan (2020) studies the long-term labor market effects of a French reform that extended general education by two years, from primary into middle grades, alongside curricular reforms and ability grouping. Despite different time periods, policy shifts, and settings, the evidence from the Netherlands, Sweden, Romania, and Croatia are consistent in finding ambiguous and inconclusive effects of additional general education on subsequent labor-market outcomes.[7] The French reform, however, is associated with higher educational attainment and six percent higher wages by age 40-45. It is difficult to isolate the effect of later vocational tracking in France from the rest of a suite of reforms, but Canaan (2020) points to substitution of vocational diplomas for better-regarded technical degrees as one likely important mechanism.

Another approach common in his literature is to use survey data across countries to compare labor-market outcomes for individuals with vocational education versus those with general education. Note that these studies typically do not distinguish between upper secondary and

postsecondary students in either track, and so findings summarized in Panel B of Table 1 should be interpreted as encompassing both secondary and postsecondary vocational education. Regarding employment, multiple studies find that, compared to academic or general education, vocational education is associated with higher employment at younger ages, but equivalent if not lower employment rates at older ages (Hanushek et al., 2017; Brunello and Rocco, 2017a, 2017b; Hampf and Woessmann, 2017). For earnings, Golsteyn and Stenberg (2017) find a similar pattern for vocational upper secondary education in Sweden, in that vocational students experience higher initial earnings alongside a flatter age-earnings trajectory. Looking to the UK, Brunello and Rocco (2017b) likewise find evidence of a tradeoff of higher early-career wages for lower later-career wages among vocational students. This broad pattern of results holds for multi-country studies as well (Hanushek et al., 2017; Brunello and Rocco, 2017a).[8]

In addition to evaluating employment rates by age and form of education, Hanushek et al. (2017) uncover evidence of one theorized mechanism connecting vocational education to lower rates of employment later in one's career. Using administrative data from Austria, they show that following a plant closure, workers over age 50 who are classified as blue-collar (a proxy for having had a vocational education) were less likely to be re-employed. This finding aligns with the idea that a more specific education leaves a worker vulnerable to economic shocks later on, as articulated by Lazear's (2009) skill-weights model.

A third research design for understanding effects of vocational education takes advantage of admission rules that randomly sort secondary-school students into vocational programs. This kind of study, a selection of which is summarized in Table 1 Panel C, focuses on circumstances where the counterfactual to a more vocational secondary education is the outcome of students who were at least interested in a vocational program but were randomly or as good as randomly assigned to something else. Kemple and Willner (2008) use a randomized controlled trial to evaluate the effectiveness of Career Academies, a type of vocational program in the U.S. They find that being randomly assigned to a Career Academy raised annual earnings by 11 percent several years after high school, with the most pronounced effects for young men. More recently, Hemelt, Lenard, and Paeplow (2019) study an admissions lottery for one information technology Career Academy in the U.S., finding that quasi-experimental admission raises high school graduation rates by eight percentage points and also raises the likelihood of college enrollment for males. In a regression discontinuity analysis of oversubscribed technical schools in Massachusetts, Dougherty (2018)

reports that admission results in a significantly higher likelihood of high school graduation.[9] And in related emerging work, Brunner et al. (2019) show that males (but not females) who are admitted on the margin to 1 of 16 technical high schools in Connecticut are 10 percentage points more likely to graduate and 8 percentage points more likely to enroll in college.

In many countries, assignment to vocational versus general secondary school is based largely on admissions scores (usually grade point average, a standardized test score, or a combination of the two). Silliman and Virtanen (2019) use the discontinuity in assignment of students to secondary schools in Finland to study the relationship between vocational education and labor-market outcomes. They find that for students at the margin of acceptance into vocational education versus general education, vocational education is associated with a seven percent increase in earnings. Employment (measured in months) is similar between the two groups.

U.S. secondary school students access vocational education largely in schools that provide both general and vocational instruction. Panel D summarizes findings from Kreisman and Stange (2020), who use survey data to study the relationship between vocational course taking and labor-market outcomes in the U.S. They find that students positively select into vocational course work, in contrast to conventional wisdom that vocational education is primarily for low-achieving students. In addition, they find no relationship between basic vocational education and earnings, but they find that an additional year of advanced vocational coursework is associated with an increase in earnings of two percent.

There are two common threads in Panels C-D, reporting positive attainment or earnings effects of vocational education, that may help to reconcile these results with more ambiguous findings from Panels A-B of Table 1. First, causal identification from admission lotteries and thresholds are premised on student willingness or preference to attend particular vocational programs. Similarly, Kreisman and Stange (2020) rely on students' selection of more advanced CTE coursework to estimate later effects on earnings. Kreisman and Stange (2020) also report on the effects of earning more or fewer CTE credits by virtue of graduation requirements, finding no significant later effects. This echoes the experience of European cohorts affected by tracking reforms, who were likewise unaffected by policies that changed their exposure to vocational education (again, with the notable exception of the French reform). Student choice and preferences shape the counterfactual. Would a vocationally oriented student have experienced a steeper age-earnings profile if they had instead been routed to an academic track? This is the question Meer (2007)

poses for the U.S., and, using nationally representative survey data alongside a multinomial model of selection into tracks, finds evidence that "those most suited for a particular track are already on it, and, for the most part, would not benefit from shifting."

The second common thread is that newer studies finding positive effects of selection into vocational education are typically limited to reporting on early-career earnings, whereas Hanushek et al. (2017) do not find a general education advantage until roughly age 50. It remains to be seen if students who select into high-quality, oversubscribed vocational programs nonetheless experience the brunt of labor market shocks much later in their careers.

Although most of the literature on vocational secondary education focuses on North America or Europe, numerous studies look at other countries. Psacharopoulos (1994) provides a global review of returns to schooling in general, as well as to vocational versus general forms of schooling, finding a wide disparity in the rate of return to general (15.5%) versus vocational (10.6%) education. Due to data limitations, most studies use survey data and ordinary least squares (OLS) models to compare individuals with vocational education versus general education, regression-adjusting for other observable features and sometimes adjusting for selection into work. The results are very mixed. Table 2 outlines several studies of returns to vocational education in the developing world.

Estimated returns to vocational education in Asia are highly inconsistent across and even within settings. Olfindo (2018) finds similar labor-market outcomes between individuals with vocational secondary education and those with a general secondary education in the Philippines. In Singapore, vocational secondary education is associated with a sizably higher private rate of return for women, but for men, the reverse is true (Sakellariou, 2003). Newhouse and Suryadarma (2011) report mixed results when comparing academic to vocational high schools in Indonesia. Vocational high schools provide some benefits for women, but they are associated with an imprecise wage penalty for men. In contrast, Moenjak and Worswick (2003) and Tangtipongkul (2015) attribute higher earnings in Thailand to vocational versus general secondary education. For Vietnam, vocational education premia are smaller than they are for general education (both relative to primary attainment), but because it typically takes less time to complete a vocational track, private rates of return are around five percent for both (Moock, Patrinos, and Ventataraman, 2003). In a randomized evaluation in India for low-income women, Maitra and Mani (2017) find sizable employment and earnings effects from a vocational education program.

<TABLE 2 HERE>

Elsewhere in the world, research from sub-Saharan Africa and South America find that vocational education has lower returns than general education in Suriname (Horowitz and Schenzler, 1999), Rwanda (Lassibille and Tan, 2005); and Tanzania (Kahyarara and Teal, 2008). However, for Egypt, results have been mixed. El-Hamidi (2006) finds sizable earnings gains to vocational upper secondary education relative to no upper secondary or to general secondary education. Krafft (2018) likewise finds significant vocational wage premia with OLS identification, but she reports similar returns between the two secondary school sectors in preferred models that include family fixed effects. Krafft (2018) also finds large and significant returns to attaining advanced skills *outside* of formal schooling, e.g., by becoming a craftsman through apprenticeship.

In a study spanning Egypt, Iran, and Turkey, Salehi-Isfahani, Tunali, and Assaad (2009) report marginal effects of general upper secondary education versus vocational education for urban male workers at three points in time: 1988, 1998, and 2006. They find that general secondary education has higher marginal effects on earnings than vocational education at times and places where tracking was strictest (Egypt in all three years, and Iran in 2006). But in Turkey and in Iran prior to 2006, where students had more agency over their selection into one track or the other, vocationally educated workers had somewhat higher earnings than their counterparts who selected a more general education. This distinction between tightly regulated tracking versus individual selection into vocational education, and the resulting difference in estimated labor market returns, is found in the U.S. and European literature as well. We return to this theme in the synthesis below.

Postsecondary vocational education

Early work on the labor-market returns to community colleges, the main provider of postsecondary vocational education in the U.S., estimated OLS regression models on national surveys such as the National Longitudinal Study of 1972 (NLS72). Table 3 summarizes the results from these surveys, building on and updating summaries by Grubb (2002a) and Belfield and Bailey (2011). The reported estimates are log points.

For an associate's degree, the returns[10] for men are between 0.073 (Kane and Rouse, 1995) and 0.198 (Leigh and Gill, 1997). The returns for women are generally higher, ranging from 0.098 (Marcotte, 2019) to 0.339 (Marcotte et. al, 2005). Although the point estimates vary, the results from survey data consistently suggest positive returns to associate's degrees, with all but one study finding higher returns for women than for men.

<TABLE 3 HERE>

The temporal pattern in returns to certificates is unclear in the survey data. For high school graduates in the 1970s and 1980s, the returns are positive, although the range of estimates is substantial. In Grubb (1997) and Marcotte (2010), the returns are approximately six percent for men and 20 percent for women, whereas Marcotte et al. (2005) report returns of 18 percent for men and six percent for women.

Many studies report the returns to a year of full-time coursework, 30 credits, holding constant any sheepskin effects of completing an associate's degree or a certificate. Again, data from high school graduates in the 1970s and 1980s have consistent results: returns around five percent for men and slightly higher returns of 7-11 percent for women. ELS 2002 have high returns of over 40 percent for men but no evidence of higher returns for women (Marcotte, 2019).

Over the last 15 years, several research teams have estimated returns to postsecondary vocational credentials or enrollment using state administrative data sets linking community or technical college attendance data with state Unemployment Insurance (UI) earnings data.[11] The first, and one of the most comprehensive, studies using UI data is the work of Jacobson, LaLonde, and Sullivan (2005a). Using panel data on displaced workers in the state of Washington, they estimate person fixed effects models to account for time-invariant differences between displaced workers who attend community college and those who do not. In addition, they control for person-specific time trends to account for time-varying differences between students and non-students, and they allow for the returns to community college to vary with time since enrollment. Overall, they find that a year of community college attendance corresponds with higher earnings of nine percent for men and 13 percent for women, concentrated in more technically-oriented coursework. In follow up work, Jacobson, LaLonde, and Sullivan (2005b) show that the returns are about three percent lower for workers over age 35.

Since then, several studies have used administrative data from other states to study individual labor-market returns to community college programs. Table 4 provides a summary of recent results from administrative data, building on the summary in Belfield and Bailey (2017a).[12] In general, these studies control for person fixed effects and compare community college completers to non-completers, as (with some exceptions noted below) UI data contain essentially no covariates on which to build a comparison group of workers who did not attend community college. Because the fixed effects model uses pre-enrollment as well as post-enrollment earnings data, the studies focus on mature students who are at least 20 years old at the time of enrollment. The estimates in Table 4 are reported in log points for studies of log earnings and as percentages of mean earnings for studies reporting earnings levels.

<TABLE 4 HERE>

The table illustrates substantial heterogeneity in returns by award and gender. In most, but not all, studies, the returns are highest for associate's degrees, followed by long certificates (called diplomas in some states), and then by short certificates, consistent with higher returns for a longer duration of study. Most studies find higher returns for women than for men.

The returns for associate's degrees are between 0.063 and 1.222 for women, with roughly half the estimates between 0.20 and 0.36. For men, the range is 0.021 to 0.423, with most estimates between 0.10 and 0.25.

For certificates, most of the estimates for long certificates are statistically significant at the five percent level (two-sided test). At the same time, a couple of studies contain estimated returns near to or in excess of 0.40 for women, whereas only two studies have estimated returns above 0.20 for men. For short certificates, most of the estimates are not statistically significant from zero at five percent, with the exception of Turner's (2016) study of Colorado welfare recipients. That population realized higher returns to completing community college credentials than any other group represented in Table 4, suggesting that the benefits of postsecondary education may be especially pronounced for the neediest.

Thus, the results from administrative data suggest that, for mature students, associate's degrees are associated with substantial earnings gains, whereas the results for certificates are less clear. More often than not, studies report that the completion of a long certificate results in higher

earnings. These findings are broadly consistent with the findings from survey data, where most research likewise finds higher earnings for individuals completing vocational postsecondary awards.

Along with variation by state, the literature on returns to community colleges also contains substantial variation in methods. As mentioned previously, Jacobson, LaLonde, and Sullivan (2005a, b) allowed for the returns to community college to vary with time since enrollment. Much of the most recent work, including Jaggars and Xu (2016),[13] Minaya and Scott-Clayton (2017), Carruthers and Sanford (2018), and Bahr (2016) also allow for time-varying returns to community colleges, although each study uses a different functional form for the time-varying effect. For example, Minaya and Scott-Clayton (2017) assume that the time-varying return is linear, whereas Bahr (2016) assumes that it is quadratic.

Another contribution from Jacobson, LaLonde, and Sullivan (2005a, b) that has been adopted in more recent studies is the use of person-specific time trends to add flexibility to the fixed effects model. Following suit, the most recent research in this area likewise controls for individual time trends (Turner, 2016; Carruthers and Sanford, 2018; Stevens, Kurlaender, and Grosz, 2019). Dynarski, Jacob, and Kreisman (2018) discuss the advantages of controlling for person time trends, and they even show results from three different specifications of time-varying unobserved heterogeneity in individual earnings. They show that the earnings gains are sensitive to the inclusion of person time trends. In a sample of five community colleges in Michigan, the returns to associate's degrees are noticeably lower in the model that excludes person time trends.

Although fixed effects models have many benefits, Belfield and Bailey (2017b) note several limitations in the model. For example, the results will depend on the number of quarters included in the analysis, as well as whether observations with zero reported earnings are included or excluded from the results. With respect to the model specification, Belfield and Bailey (2017b) find that the results are sensitive to the way in which time trends are modeled. Jepsen, Mueser, and Jeon (2019) illustrate the bias in fixed effects models where the post-schooling measure does not vary with time since schooling.

In general, community college completers significantly out-earn non-completers after leaving school, but the inference that a sub-baccalaureate credential is worth the investment is incomplete without understanding the returns to enrolling and not necessarily completing. Community and

technical colleges in the U.S. have very low completion rates. Carruthers and Sanford (2018) extend the use of administrative data to include a matching analysis involving workers who are not students, allowing them to quantify the earnings gain from enrolling without necessarily completing a certificate program. Cellini and Turner (2019) also use this technique in their study of for-profit colleges, and Turner's (2016) study of welfare recipients in Colorado similarly evaluates the return to enrolling in community college at all alongside any additional premium from attaining a credential. These three studies come to notably different conclusions about three very different populations of students. Turner (2016) finds no significant return to college credits in the absence of attaining a credential for welfare recipients, Cellini and Turner (2019) likewise find that for-profit students do not outperform those who do not enroll at all, whereas Carruthers and Sanford (2018) find evidence of significant returns for non-completers in certificate programs at public technical colleges. One interpretation of these results is that the value of credits without a degree is heterogeneous, benefiting some students but not others.

Finally, recent developments in this literature are worth noting. For example, Carruthers and Sanford (2018) look at the relationship between vocational postsecondary education and industrial mobility, finding that postsecondary certificates facilitate entrée to new and growing industries, particularly health. Similar, ongoing work by Pan (2017) studies firm-specific pay premia in community colleges. Grosz (2020) reports 44 percent gains in earnings for nursing students who benefitted from randomized admission to oversubscribed nursing programs in California. Methodologically, Grosz (2020) finds quantitatively similar returns in models using individual fixed effects and time trends, in settings both with and without randomized admission.

Although Europe has institutions offering vocational education similar to certificate programs, little research has been done on these programs. Instead, the research typically focuses on one of two areas. As mentioned previously, one approach compares general education with vocational education, sometimes combining secondary and postsecondary education (Hanushek et al., 2017; Brunello and Rocco, 2017a, 2017b; Hampf and Woessmann, 2017). Focusing more on postsecondary vocational education, Dearden et al. (2002) use cross-sectional survey data for the UK. They point out that the higher wages for academic qualifications than for vocational ones can be explained by the longer duration of study for academic qualifications; the wage gain per year of study is similar in the two sectors. McIntosh (2006) looks at multiple cohorts and finds similar wage differentials. Backes-Gellner and Geel (2014) study employment and income differences between academic and vocational tertiary graduates in Switzerland. They find that

vocational graduates have higher initial incomes, but that this difference fades within five years as academic graduates catch up. Vocational graduates have lower unemployment rates at that point in time, however, and Backes-Gellner and Geel (2014) suggest that this pattern of results is consistent with a “less risky career path” that may compensate for the disadvantages of lower socio-economic backgrounds. Glocker and Storck (2014) use German Census data and a financial assets approach to compare earnings across fields of study. Although the highest returns are often for academic degrees, some vocational bachelor’s degrees also have high returns.

The second approach uses detailed, individual data to compare labor-market outcomes between individuals with vocational postsecondary education and individuals with less or no postsecondary education. In Finland, researchers exploited an education reform upgrading vocational postsecondary education into vocational bachelor’s degrees. Böckerman, Hämäläinen, and Uusitalo (2008) and Hämäläinen and Uusitalo (2008) generally find short- run improvements in employment and earnings for graduates of the new program relative to the old system, using a difference-in-difference model based on the timing of the reform.

Böckerman, Haapanen, and Jepsen (2018) apply matching and individual fixed effects models to show higher earnings of around 10 percent and employment of five percentage points for vocational bachelor’s degrees relative to no postsecondary education. Using similar techniques, Böckerman, Haapanen, and Jepsen (2019) find that attending a vocational master’s program in Finland is associated with an increase of earnings of seven percent for vocational bachelor’s degree recipients. For Germany, Rzepka (2018) finds increased annual earnings, but similar lifetime earnings, for individuals attending vocational college without vocational high school compared to vocational high school graduates. McGuinness et al. (2019) find that the pursuit of post-leaving certificates in Ireland is associated with a 16 percent increase in employment compared to not pursuing postsecondary education. Hallsten (2012) and Stenberg and Westerlund (2016) find earnings and employment gains for individuals attending postsecondary education (academic or vocational) later in life in Sweden,[14]

In Canada, several studies report differences in earnings by education level, typically using OLS regressions on Census data (Boothby and Drewes, 2006; Caponi and Plesca, 2009; Boudarbat, Lemieux, and Riddell, 2010; Foley and Green, 2016). The two main findings from this literature are: (1) the receipt of postsecondary certificates or diplomas below the bachelor’s level is associated with higher earnings of 10 to 15 percent compared to a high school degree, less than

half the returns to a bachelor's degree, and (2) the gains have grown by as much as one third since 1980. Ferrer and Riddell (2002) find positive returns to both years of schooling as well as postsecondary vocational credentials.

The labor-market returns for vocational postsecondary education in Australia are mixed. Using OLS, Coelli and Wilkins (2009) find higher earnings and employment for individuals who receive vocational postsecondary credentials compared to high school graduates.[15] Polidano and Ryan (2016) find small increases in earnings and more substantial gains in full-time employment. Lee and Coelli (2010) use matching estimators and show that the benefits of certificates and diplomas are generally concentrated among high school dropouts. Using panel data with individual fixed effects and instrumental variables, Coelli and Tabasso (2019) find little if any improvement in labor-market outcomes for mature students, although students report an increase in job satisfaction.

In contrast, the evidence for New Zealand is less promising. Using panel data and person fixed effects models (as in work with administrative data for Finland and the U.S.), Crichton and Dixon (2011) conclude that the receipt of certificates and diplomas below the bachelor's level do not lead to overall increases in employment or earnings. They find substantial heterogeneity by field of study and gender, with some fields associated with improved labor- market outcomes and others with declines. For individuals aged 15 to 21 who drop out of secondary school, Tumen, Dixon, and Crichton (2018) look at the relationship between labor- market outcomes and postsecondary education. Completing a certificate is associated with increases in employment, but earnings are not affected. Potential explanations for these findings are the high level of earnings for individuals without postsecondary education and the high percentage of individuals in postsecondary education relative to OECD countries (Norgrove and Scott, 2017).

The literature in Africa, Asia, and South America on returns to postsecondary vocational education is not very extensive. For Taiwan, van der Meulen Rodgers, Zveglich, and Wherry (2006) show that the earnings of community college graduates are 20 percent higher than high school graduates and 20 percent lower than university graduates. In Thailand, Tangtipongkul (2015) finds higher earnings for vocational certificates and diplomas relative to secondary education. For Singapore, Sakellariou (2003) reports high private rates of return for vocational postsecondary education relative to lower levels of education. Kanjilal-Bhaduri and Pastore (2018) find high returns to both vocational and technical education beyond the secondary level

relative to no postsecondary education in India.

Across many countries, time periods, and econometric techniques, vocational postsecondary education is often – but not always – associated with better labor-market outcomes relative to individuals without postsecondary education. The relationship is stronger in Canada and Europe, and it is weaker in New Zealand and Australia. One potential explanation for the relatively weaker labor-market benefits of certificates in New Zealand and Australia is that these two countries have high minimum wages and, until recently, extensive collective bargaining agreements that standardize wages and employment across employers.

Other Postsecondary Vocational Education Research Areas

Although the focus of this chapter has been on labor-market outcomes, there are substantial literatures on other aspects of vocational education. Here we highlight two related areas of research on (largely) postsecondary vocational education systems and how students navigate those systems. Each contributes to our understanding of the later returns to education by emphasizing that students face significant barriers to completing their studies well before they enter, or re-enter, the labor market. This is especially true of vocational students, who (recalling the class-based characteristic feature outlined in this chapter's introduction) tend to be more disadvantaged than peers who move through academic secondary and tertiary programs.

Financial and non-financial support for vocational postsecondary students

Deming and Dynarski (2010) and Page and Scott-Clayton (2016) provide an overview of the role of financial aid and information about aid in college access, although most of the studies reviewed are for academic rather than vocational institutions. Research on the effects of financial aid for vocational students and programs is more mixed. Older students who are more apt to favor vocationally focused programs appear to be less affected by financial aid than younger college students (Seftor and Turner, 2002; Barr, 2019; Gurantz, forthcoming). Utilizing geography-based variation in community college costs, Denning (2017) finds that lower cost is associated with increased enrollment.[16] Scott-Clayton and Schudde (forthcoming) highlight an understudied feature of aid programs, namely the requirement that, to continue receiving aid, students have to make adequate academic progress. They note that the short-run effects are heterogeneous, with some positive and some negative, but that in the longer-run, students are worse off from failing to

meet adequate progress and therefore losing access to aid.

Several studies focus on the effects of grants. Liu (2020) finds that extending Pell Grant eligibility is associated with increased summer enrollment as well as increased completion rates. Anderson and Goldrick-Rab (2018) find no increase in completion for community college students randomly assigned to a grant program. Similarly, Welch (2014) finds no relationship between merit aid and academic outcomes or earnings for community college students at the margin of receiving aid. On the other hand, Anderson (2020) finds a positive relationship between grant receipt and educational attainment for a first-come, first-served grant program in Wisconsin.

In the U.S., federal and institutional financial aid systems are complex and merely applying for aid can disproportionately burden the students who are meant to benefit (Dynarski, Scott-Clayton, and Wiederspan, 2013). In response, some programs have tried alternate ways to provide community college students with financial assistance. For example, Aid Like a Paycheck is a program that disbursed financial aid every two weeks rather than as lump sum payment to institutions. Although the program reduced short-term debt among students, long-run outcomes for debt and student achievement were similar to the control group (Weissman, Cerna, and Cullinan, 2019). Another series of randomized experiments across multiple U.S. settings provided performance-based scholarships directly to students (rather than through their institutional aid offices) of up to $1,500 per term, alongside advising or other services at some sites. These programs were shown to reduce student debt and modestly raise five-year completion rates (Mayer et al., 2015).

The recent rise of so-called “Promise” programs in the U.S. is also a response to the complexity inherent in college costs and financial aid, as well as to state and local efforts to retain and develop talented citizens. Promise programs differ widely in their intent, funding structure, benefits, and eligibility requirements, but the promise is typically for a free or tuition-free college education for students in a defined geographic area. Carruthers and Fox (2016) and Bartik, Hershbein, and Lachowska (forthcoming) show improvements in student enrollment in response to the decrease in costs resulting from the promise programs. As of 2020, there were 19 active statewide promise programs, and there are even more local programs.[17] Most statewide Promise programs limit their free-tuition guarantee to community or technical colleges, making public funding more feasible and sustainable.

Loans can supplement other forms of aid and support students through college, and in theory, publicly subsidized and administered loans overcome a private market failure where low-income, low-wealth students have no collateral to pledge in return for aid. Recent evidence suggests that the availability of additional loans for public or nonprofit college and university enrollment benefits students later on, in the form of higher educational attainment and earnings (Black, et al., 2020). Loans for for-profit students, however, appear to be more costly from an individual and societal perspective (Looney and Yannelis, 2015; Cellini, 2012). See Athreya et al. (forthcoming) elsewhere in this volume for a thorough review of research on student loans and repayment, and Cellini (forthcoming) for more on for-profit schools.

Factors influencing completion of vocational education programs

In the U.S., completion rates for community colleges are well under 50 percent. For students required to take remedial or developmental education, courses that do not count towards completion but merely prepare students to take college-level courses, the completion rates are much lower (Scrivener et al., 2015).

To better support occupationally-oriented college students, support structures have emerged that combine financial aid with advising, case management, logistical support such as bus passes, and other non-academic services. Several of these multi-faceted student support systems have been rigorously evaluated in random-assignment studies to ascertain whether their benefits (in terms of projected and measured earnings after college) exceed their substantial costs. One such program, the Accelerated Study in Associate Program (ASAP) showed that wraparound student support almost doubled the 2-3 year degree completion rate in both New York (Gupta, 2017) and Ohio (Sommo et al., 2018), although even the improved rate is only 40 percent in New York and 19 percent in Ohio. Likewise, a case management intervention in Texas increased associate's degree receipt for women by 7.4 percentage points, relative to a control group mean of 15.7 percent, whereas financial assistance alone did not significantly improve attainment relative to the control group (Evans et al., 2017).

Other programs improve student success in community colleges, albeit not as dramatically. MDRC (2018) summarizes several studies of programs to improve completion rates. For example, advising programs such as InsideTrack or Opening Doors appear to be most effective

when advisers are the ones initiating the contact with students as opposed to waiting for students to contact them. Another beneficial attribute of advising programs is when the students and the adviser form a cohort rather than having students work with different advisers. Encouraging students to take courses throughout the year, such as summer courses and, if available, the intersession between fall and spring terms, is associated with increased persistence and completion. The preliminary results from programs to change teaching practices, such as Dana Center's Mathematics Pathways and CUNY Start, are promising in terms of improving student outcomes. In contrast, providing students with computers has no discernable effect on earnings (Fairlie and Bahr, 2018).

A complementary body of research looks at specific elements of the education system as opposed to additional supports. For example, Xu and Jaggars (2013), Hart, Friedmann, and Hill (2018) and Kozakowski (2019) study the relationship between online course-taking and student achievement in community colleges, where they find similar if not worse outcomes for students taking courses on-line. Similarly, Bettinger et al. (2017) find no benefits to smaller classes in online courses. The relationship between remedial education and educational achievement is mixed. Martorell and McFarlin (2011) and Boatman and Long (2018) find no relationship between remedial education and either academic or labor-market outcomes for students at the margin of needing remediation. For lower achieving students, Boatman and Long (2018) find some evidence of a positive relationship between remediation and achievement, a finding similar to Bettinger and Long (2009) in an analysis using instrumental variables based on differences in remediation policy across colleges as well as proximity to college.

Outside the U.S., Colding (2006) studies determinants of dropout from vocational secondary schools in Denmark. The focus is on difference between natives and the children of immigrants. Family background variables and field of study do not explain the gap in dropout rates between the two groups. Also, Stratton et al. (2018) provide insights on the relationship between enrollment and completion in vocational education in Denmark and students' non-cognitive and cognitive skills. They report an inverse relationship between each measure of skill and enrollment into vocational education, alongside a positive relationship between math skills and completion of vocational tracks.

Finally, we note that the research literature is relatively quiet on how resources for vocational programs themselves affect students. Bonilla (2020) provides a recent exception, showing

evidence that districts who received a large grant to create aligned pathways between general and vocational education saw substantial declines in the high school dropout rate.

Synthesis

Is vocational education out of balance with general academic education? Is vocational education better as an integrated or segregated program? The answers are not obvious from our review, and likely differ by time and place. One common thread connecting several studies is the idea that endogenous take-up of vocational education benefits the students who select into it. The default model of economic choice holds that people generally make good choices, provided they have enough information about the alternatives and enough resources to access the alternatives. Although educational choices are rife with exceptions to these priors, our review of research on vocational education indicates that they may have merit in this context. Given the opportunity to deepen knowledge in a given CTE program, students who chose to do so appeared to benefit (Kreisman and Stange, 2020). Given the random or as-good-as-random opportunity to attend a vocational school, students who chose to do so likewise saw higher graduation rates and higher earnings early in their post-schooling careers (Kemple and Willner, 2008; Dougherty, 2018; Hemelt, Lenard, and Paeplow 2019; Silliman and Virtanen, 2019). Salehi-Isfahani et al. (2009) show find evidence of positive returns to vocational education in Middle Eastern systems where students have more control over selecting their track, versus negative returns in systems with more deterministic tracking. Nontraditional adults choosing to go back to college to pursue predominantly vocational certificates or degrees saw higher earnings than similar workers who did not re-enroll (Turner, 2016; Carruthers and Sanford, 2018).

Yet, students who attained more or less vocational education because of quasi-experimental changes in graduation requirements (Kreisman and Stange, 2020) or national policies that shifted time spent in vocational versus general education (Oosterbeek and Webbink, 2007; Malamud and Pop-Eleches, 2010, 2011; Hall, 2012, 2016; Zilic, 2018) saw earnings on par with the counterfactual, or worse (Hanushek et al, 2017). In that light, students may benefit from choosing what subjects they wish to study, whether they have the opportunity to do so within an integrated high school system or a dedicated vocational or academic school.

At the postsecondary level, most studies find a positive relationship between obtaining an award such as a certificate or degree relative to not obtaining degree or, in some cases, not attending

postsecondary education at all. The finding that longer programs have more benefits than shorter programs is consistent with the returns to program depth documented in secondary schools (Kreisman and Stange, 2020).

At the same time, completion rates in U.S. community colleges are quite low, and several studies investigate potential mechanisms to improve retention and completion. Comprehensive student support programs such as ASAP (Sommo et al., 2018) or the case management model described by Evans et al. (2017) show substantial improvements, whereas programs that target financial or other needs in isolation show more modest increases. Other factors, such as on-line course taking or providing computers to students, do not appear to increase completion rates. Thus, the research base implies that multi-faceted approaches are necessary to make dramatic improvements in vocational postsecondary completion rates.

Conclusions and Areas for Future Research

Despite the extensive and growing literature on vocational education, many fruitful areas for future research remain. We begin with three where the need for more research is most pressing, and then describe several other promising extensions to existing knowledge.

The returns to vocational knowledge and skills during technical change

First, data and empirical methods are better suited than ever to revisit early 20th century debates on the merits and modes of vocational education that have persisted to this day, and in particular, the root causes of flatter age-earnings and age-employment profiles for workers with a vocational education. One concern, now over a century old, is that an education in narrow skills leaves a student vulnerable to future technology (or other) shocks. In Lazear's (2009) model of skill-weighted human capital, more idiosyncratic skill mixes result in larger wage losses when the labor market thins. On this topic, Dewey (1915/1977) wrote that:

> The mobility of the laboring population in passing from one mode of machine work to another is important. Such facts cry aloud against any trade-training which is more than an incidental part of a more general plan of industrial education. They speak for the necessity of an education whose chief purpose is to develop initiative and personal resources of intelligence. The same forces

> which have broken down the apprenticeship system render futile a scholastic imitation of it.

These "forces" were, in part, technological advancements from the U.S. industrial revolution and increasingly specialized labor needs, alongside the need for employers to mobilize or turn over their workers to meet successive technologies. Today's disruptive technology – automation, in particular – resembles the disruption created by the industrial revolution, which contributed to the demand for vocational education in public schools as well as the expansion of high school enrollment.

Indeed, the intervening hundred years between Dewey's time and ours have been filled with several new waves of automation and technological efficiencies that required workers and schools to keep up in what has been called a "race between education and technology," which technology has dominated since the 1970s (Goldin and Katz, 2009; Autor et al., 2020). In response to a perceived "skills gap" between the supply of and demand for new technical skills, there are renewed calls for vocational education suited to today's technology and echoes of Snedden's social efficiency doctrine holding schools (and to a lesser extent, firms) responsible for producing workers who can dive right in and re-tool as needed (e.g., see Tyagarajan, 2019). Echoing Dewey's counterpoint to this urgency, however, are sentiments such as this:

> [T]here are no short cuts to cultivating the habits of the mind and heart that, over time, enable people to deepen their learning, develop resilience, transfer information into action, and creatively juggle and evaluate competing ideas and approaches. (Kuh, 2019)

The answerable research question at the heart of this debate is: Are short-term gains from learning a narrowly applicable mix of skills offset by longer-term losses and vulnerabilities to economic or technological shocks? Is this tradeoff more evident for some vocational programs than others? More research in the vein of Hanushek et al. (2017), who showed that older blue-collar workers were less likely to regain employment after a plant closure, would shed light on this critical issue and help to guide education and labor policy through the economic transitions to come.

The intergenerational effects of vocational education

For well over a century, prominent thinkers and institutions have touted vocational education as a foothold on the way to economic mobility, particularly for students who are not college-bound or who are not well served by a college preparatory secondary education. Much of the research we reviewed here has pointed to higher rates of secondary school completion and early-career earnings for vocational students, which supports this claim. And yet, lower employment rates later in life, and a potentially higher likelihood of displacement during economic downturns, could limit any intergenerational transfer of wealth and financial stability from a vocationally trained worker to their children. These ambiguous priors can be addressed, however, since data with intergenerational links are increasingly available to researchers and well-suited to the task of assessing the transfer of economic well-being from parents to children.

The individual and aggregate effects of vocational education in developing economies

Perhaps the most fruitful area for further research on vocational education is in developing countries, such as the recent study of vocational and firm-provided training in Uganda (Alfonsi et al., 2020). Data availability from developing settings lags behind that of the U.S. and Europe, but public and economic interest in vocational education is high. International organizations such as UNESCO lift up vocational education is a needed tool for economic growth and development, although the causal evidence base for this hypothesis is thin. There are great opportunities for new work on vocational education, attainment, and labor-market returns in a developing economy. The extent of research in the development economics literature more broadly has increased dramatically, due in part to an accelerated use of randomized control trials. Follow-up research on experiments in primary education could potentially be linked to data on secondary education, including the choice of vocational, general, or no secondary schooling. In other words, exogenous variation in secondary school choices could allow researchers to glean strong causal inferences about the effects of vocational secondary schooling in a developing economy context.

An alternative research design could study the later effects of policy-driven expansions in the availability of vocational education through construction of conversions of vocational secondary schools, akin to construction projects in Indonesia (Mazumder, Rosales-Rueda, and Triyana, 2019; Duflo, 2001, 2004; Newhouse and Suryadarma, 2011) and Burkina Faso (Kazianga et al., 2013). However, as noted in Filmer (2007), benefits of school construction are often small, particularly if the quality of the new school and of existing

schools is low. Another example is to utilize lotteries if vocational secondary schools are oversubscribed, although the data requirements for such a study are substantial.

Other promising extensions

Another debate with a long vintage is about the form rather than the volume of learning about work. How is vocational education most effective: as a complement to general education, or as a distinct program? How valuable, if at all, are non-course forms of vocational training such as industry-recognized certifications, or regulated licenses? At the secondary school level, many studies have exploited national or regional changes in years of compulsory schooling or the age at which tracking begins as a way to identify exogenous changes in dedicated vocational schooling. That literature shows that large-scale cuts to formal vocational learning in favor of more general education generally have weak if any effects on subsequent labor-market outcomes. It is not yet clear if these findings will generalize to less sweeping, more individual shifts between vocational education structures. New and promising insights on this question come from recent studies of plausibly exogenous circumstances where students are offered the chance to pursue vocational study in a dedicated environment (Kemple and Willner, 2008; Dougherty, 2018; Hemelt, Lenard, and Paeplow 2019; Silliman and Virtanen, 2019). This small and growing literature has generally found that students benefit from such an environment in the near term, although it bears repeating that – due to the methodology used – results are limited to students who indicated interest in vocational education by applying to specialized schools.

In systems where most students choose between general and vocational subjects in the same secondary school, more research is needed. Kreisman and Stange (2019, 2020) provide a valuable starting point with a careful analysis of individual transcripts, using extensive control variables and econometric techniques to compare selection on observables versus unobservables. Ideally, future work can continue to draw causal inferences from exogenous changes in vocational education, perhaps at the school or district level, to advance what we know about the effects of vocational education on educational and labor-market outcomes.

As we think about how to adopt vocational and general education in an ever-faster changing technological environment, policymakers will perpetually re-evaluate the purpose of vocational education. Is the primary goal for students to grow their intellect and capacity to meet new technologies *without* retraining, or with less need to return to school in the future? Or is that an

impractical aspiration? Would students be better served by learning specific skills for the current and projected job market? Future research, especially given recent advances in data quality and quantity, should be able to address which style of learning benefits which students more, in both the short term and over the course of their careers.

At the postsecondary level, we highlight at least two promising areas of future research. First, there is a need for more studies on the individual effect of vocationally-oriented postsecondary education outside of the U.S. We have reviewed a few studies using administrative data from Northern Europe, where the focus was on vocational bachelor's and master's degrees. Most countries also offer lower-level degrees analogous to community college certificates, yet little is known about the labor market returns to these programs, or their value for retraining displaced workers in the wake of technology shocks. More studies like Crichton and Dixon (2011) for New Zealand are needed.

A second, and related, area of future research, particularly in the U.S., is to understand better the determinants of completion for vocational postsecondary programs. Although, as mentioned previously, there are several high-quality studies, often using randomization, on areas such as advising, student support, and financial support, most of the participants are pursuing associate's degrees, often in academic subjects. Much less is known about ways to improve completion rates for certificates and vocational associate's degrees, despite low completion rates in these areas. For example, Carruthers and Sanford (2019) report a completion rate of 10 percent for certificates and 26 percent for diplomas (known as long-term certificates in some states), and completion rates for certificates and diplomas are even lower in Kentucky (Jepsen, Troske, and Coomes, 2014) and Michigan (Dynarski, Jacob, and Kreisman, 2018). Because completion rates are noticeably higher in other countries, the determinants of completion are rarely studied outside the U.S.

Finally, circling back to the economic and non-economic aims of education, more research is needed on the effect of vocational education on outcomes other than one's own attainment and earnings. Does vocational education affect engagement with school at the secondary level, for example, as measured by absences, grades in other subjects, discipline, peers, or extra-curricular activity? Does vocational education at any level affect financial and employment stability, family formation, entrepreneurship and business formation, health and disability, or the take-up of public benefits from the social safety net?

We are beginning to understand how a more targeted and technical education can affect individual employment and earnings, but there is much to learn about the long-term and heterogeneous effects of vocational education around the world, and how to best design a high-quality vocational program for a given context. Especially for students on the bottom rungs of the socioeconomic ladder, does a vocational education propel them and their children upward, or hold them in place?

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Table 1. Secondary Vocational Education Literature for U.S. and Europe

	Location	Identifying variation in vocational education	Sketch of major findings
A. National Reforms and Pilots			
Oosterbeek and Webbink (2007)	Netherlands	1 additional year of general education prior to tracking	No significant effects on log wages.
Hall (2012, 2016)	Sweden	1 year of additional, and more academic upper secondary study, in vocational programs	No significant effects on university attendance, earnings, or unemployment.
Malamud and Pop-Eleches (2010, 2014)	Romania	2 additional years of general education prior to tracking	No significant effects on university attendance, unemployment, or earnings.
Zilic (2018)	Croatia	2 additional years of general education prior to tracking	No significant effects on labor-market outcomes.
Canaan (2020)	France	2 additional years of general education prior to tracking, plus curricular reforms	Higher educational attainment and 6% higher wages at ages 40-45.
B. Vocational versus general education (tracked)			
Hanushek et al. (2017)	11 Countries	Intercohort age-earnings profiles by type of education; plant closures	For workers with vocational education, higher youth employment but lower employment later in working life.
Brunello and Rocco (2017a)	Europe	Cross sectional, regression adjusted	Higher probability of current employment and lower hourly earnings.
Brunello and Rocco (2017b)	UK	Intracohort age-earnings profile by type of education	Similar employment profile over the life cycle. Higher wages initially but lower wages later in working life.
Golsteyn and Stenberg (2017)	Sweden	Within-family differences in type of education across siblings	Higher wages initially but lower wages later in working life.
C. Admission to school-based CTE			
Kemple and Willner (2008)	United States	Lottery-based admission to 1 of 9 career academies	11% increase in earnings; 17% increase for young men.
Hemelt, Lenard, and Paeplow (2019)	North Carolina	Lottery-based admission to 1 career academy	Raises secondary school graduation and college enrollment by 8 percentage points
Dougherty (2018)	Massachusetts	Marginal admission to oversubscribed CTE secondary school	Raises secondary school graduation by at least 7-10 percentage points

Silliman and Virtanen (2019)	Finland	Discontinuity in secondary school admission	Earnings rise by 7%
D. Vocational versus general education (integrated systems)			
Kreisman and Stange (2020)	U.S. (NLSY97)	1 additional year in an advanced CTE program	Earnings rise by 2%.

Table 2. Secondary Vocational Education Literature on the Developing World

	Location	Identifying variation in vocational education	Sketch of major findings
Horowitz and Schenzler (1999)	Suriname	OLS, with Heckman (1979) model of selection into work	Log wage premium up to 0.314 lower for women with vocational/technical education as opposed to general education; 0.064 lower for men
Moenjak and Worswick (2003)	Thailand	OLS, with first-stage model of selection into vocational track	Log wage premium 0.494 higher for women with vocational education as opposed to general education; 0.639 higher for men
Moock, Patrinos, and Venkataraman (2003)	Vietnam	OLS	Log earnings premium 0.164 lower for women with vocational as opposed to general education; 0.029 lower for men
Sakellariou (2003)	Singapore	OLS	Private rates of return to vocational education are 5.7 points higher than returns to secondary formal education for women; 2.1 points lower for men
Lassibille and Tan (2005)	Rwanda	OLS, with Trost and Lee (1984) model of selection into employment sectors	Log wage premium 0.448 lower for workers with vocational education as opposed to general education
El-Hamidi (2006)	Egypt	OLS, with Heckman (1979) model of selection into work	Log wage premium 0.039 higher for women with vocational secondary education relative to a (typically non-terminal) general secondary education; 0.293 higher for men
Kahyarara and Teal (2008)	Tanzania	OLS, with two-stage control function	"While the return from vocational schooling can exceed that for the academic, *at the level at which entry occurs*, at no level does the return from vocational schooling remotely match that at the higher academic levels." (emphasis in original)
Salehi-Isfahani, Tunali, and Assaad (2009)	Egypt, Iran, Turkey	OLS	Log wage premium 0.088-0.144 lower in 2006 for workers with vocational versus general education in Egypt and Iran, with strict tracking; 0.097 higher in Turkey, without tracking
Newhouse and Suryadarma (2011)	Indonesia	OLS	Log wage premium 0.143 higher for women with public vocational versus public general education; not significantly different for men
Tangtipongkul (2015)	Thailand	OLS	8.9-11.3% rate of return to vocational education; 5.0-6.2% for general secondary education
Maitra and Mani (2017)	India	Field experiment for low-income women	96% gain in earnings over the control group 18 months after stitching and tailoring course
Olfindo (2018)	Philippines	OLS and propensity score matching	Statistically insignificant log wage premium of 0.00-0.055 for secondary vocational students over general education students.
Krafft (2018)	Egypt	OLS and family fixed effects	"Young men receive the same wages after 12 years of education, culminating in a vocational secondary degree, as they would have if they had not attended school at all."

Notes: Vocational and general secondary education premia are evaluated against earnings from lower attainment levels (no formal schooling, or primary grades only) unless noted otherwise.

Table 3: Returns to US Community Colleges, Survey Data, Log Annual Earnings

		Associate's Degree		Certificate		Credits Earned	
	Dataset	Women	Men	Women	Men	Women	Men
Kane and Rouse (1995)	NLS72	0.256	0.073			0.066	0.057
		(0.050)	(0.046)			(0.026)	(0.019)
Grubb (1997)	SIPP	0.205	0.166	0.219	0.063		
		(0.037)	(0.030)	(0.044)	(0.042)		
Leigh and Gill (1997)	NLSY79	0.253	0.198				
		(0.057)	(0.055)				
Marcotte et al. (2005)	NELS88	0.339	0.158	0.066	0.182	0.083	0.055
		(0.062)	(0.065)	(0.060)	(0.062)	(0.032)	(0.022)
Marcotte (2010)	NELS88	0.338	0.137	0.184	0.059	0.114	0.051
		(0.063)	(0.063)	(0.061)	(0.046)	(0.027)	(0.030)
Marcotte (2019)	ELS2002	0.098	0.157			-0.030	0.009
		(0.144)	(0.136)			(0.030)	(0.030)
Scott-Clayton and Wen (2019)	NLSY97	0.25		0.00		0.05	
		(0.05)		(0.08)		(0.04)	

Notes: For consistency, the reported results are for the preferred model specification in the first table of results. For credits earned, Marcotte (2010, 2019) report the returns for 1 credit, so we multiplied the coefficient and standard error by 30 to create the return to 30 credits to facilitate comparison with other studies. The results for ‘Some 2-year college (only)’ in Scott-Clayton and Wen (2019) is reported in the ‘30 Credits’ section. The results are as follows: Kane and Rouse (1995), Table 2, Column 6; Leigh and Gill (1997), Table 4, Column 4; Grubb (1997),
Table 3 for 1990 earnings; Marcotte et. al (2005), Table 3, Columns 5 and 7; Marcotte (2010), Table 3, Columns 5 and 7; Marcotte (2019), Table 4; Scott-Clayton and Wen (2019), Table 2, Column 4 (for the combined sample of men and women).

Table 4: Returns to US Community Colleges Using Administrative Data, Log / % Earnings

		Associate's		Long Certificate		Short Certificate	
Study	State	Women	Men	Women	Men	Women	Men
Belfield (2015)	AR	0.138	0.059	[a]	[a]	[a]	[a]
		(0.004)	(0.006)	[a]	[a]	[a]	[a]
Stevens, Kurlaender,	CA	0.351	0.198	0.321	0.128	0.118	0.126
and Grosz (2019)		(0.016)	(0.017)	(0.029)	(0.023)	(0.026)	(0.021)
Jepsen, Troske, and	KY	0.557	0.242	0.451	0.206	0.032	0.048
Coomes (2014)		(0.019)	(0.024)	(0.026)	(0.030)	(0.018)	(0.026)
Bahr et al. (2015)	MI	0.327	0.118	0.132	0.036	0.004	0.084
		(0.025)	(0.025)	(0.048)	(0.037)	(0.057)	(0.075)
Liu, Belfield, and	NC	0.339	0.159	0.278	0.079	0.028	0.067
Trimble (2015)		(0.005)	(0.006)	(0.005)	(0.012)	(0.006)	(0.008)
Zeidenberg, Scott, and	NC	0.167	0.423	0.014	0.386	0.006	-0.017
Belfield (2015)		(0.029)	(0.018)	(0.028)	(0.017)	(0.032)	(0.024)
Turner (2016)	CO	1.222 [c]		0.386		0.231	
		(0.164)		(0.124)		(0.074)	
Bettinger and Soliz	OH	0.264	0.212	0.217	0.180	0.055	0.411
(2016)		(0.020)	(0.024)	(0.069)	(0.107)	(0.087)	(0.213)
Minaya and Scott-	OH	0.481	0.267	0.329	0.179	0.021	0.028
Clayton (2017)		(0.013)	(0.019)	(0.021)	(0.048)	(0.031)	(0.025)
Pan (2017)	OH	0.208[b]					
		(0.010)					
Carruthers and Sanford	TN			0.173[b]		0.012[b]	
(2018)				(0.011)		(0.017)	
Dadgar and Trimble	WA	0.063	0.021	0.149	0.013	-0.028	-0.003
(2015)		(0.008)	(0.009)	(0.016)	(0.019)	(0.014)	(0.016)

[a]Belfield (2015) estimates returns for long and short certificates combined. The estimated returns are 0.013 (with a standard error of 0.003) for women and -0.031 (with a standard error of 0.004) for men.

[b]Results reported for combined sample of men and women.

[c]Results limited to women; specifically, single mothers entering Colorado's welfare system.

Notes: Standard errors are in parentheses. The results are as follows: Belfield (2015), Table 2 (full sample); Stevens, Kurlaender, and Grosz (2019), Table 5 (top panel), where short certificates are assumed to be 18-30 credits and long certificates are >30 credits; Jepsen, Troske, and Coomes (2014), Table 5 (columns 4 and 8); Bahr et al. (2015), Table 4; Liu, Belfield, and Trimble (2015), Table 6; Zeidenberg, Scott, and Belfield (2015), Table 2 (fixed effects); Bettinger and Soliz (2016), Table 3 (columns 1-2); Turner (2016), Table 2 (column 3) results converted to percentages using Table 1 means for pre-welfare earnings of mothers who enrolled in college; Minaya and Scott-

Clayton (2017), Table 2 (columns 3-4); Pan (2017), Table 3 (column 4); Carruthers and Sanford (2018), Table 2 (column 2); Dadgar and Trimble (2015), Table 2 (column d).

Bahr (2016) and Xu and Trimble (2016) are excluded because they do not report average earnings, so we cannot calculate returns as a percentage of average earnings.

Table 5. Selected Postsecondary Vocational Education Literature in Europe

	Location	Identifying variation in vocational education	Sketch of major findings
A. General education versus vocational education			
Dearden et al. (2020)	UK	OLS	Earnings increase of 6-10% per year of study; similar between vocational and academic programs.
McIntosh (2006)	UK	OLS	More pronounced age-earnings profile for academic education than for vocational education.
Glocker and Storck (2014)	Germany	financial assets model	Returns to academic fields are generally but not always higher than returns to vocational fields of study.
B. Vocational postsecondary education before / after reform			
Böckerman, Hämäläinen, and Uusitalo (2008)	Finland	Diff-in-diff and IV	Returns to new vocational bachelor's degree are higher than returns to older postsecondary vocational degree in business and administration but not other fields.
Hämäläinen, and Uusitalo (2008)	Finland	Diff-in-diff	Students have higher returns to vocational postsecondary education from newly created vocational bachelor's degrees compared to former vocational college degrees.
C. Vocational postsecondary education versus no postsecondary education			
Böckerman, Haapanen, and Jepsen (2018)	Finland	matching and FE	Vocational bachelor's degrees are associated with higher earnings of 13% and employment of two to six percentage points 10 years after entry.
Böckerman, Haapanen, and Jepsen (2019)	Finland	matching and FE	Vocational master's recipients have higher earnings of more than 7% compared to individuals with a vocational bachelor's degree.
Rzepka (2018)	Germany	matching	Individuals who attend vocational postsecondary education without the traditional vocational secondary education have higher annual earnings but similar lifetime earnings to vocational high school graduates with no postsecondary education.
McGuinness et al. (2019)	Ireland	matching	Receipt of vociational certificate is associated with 16% increase in employment.
D. Combined effect of vocational and academic postsecondary education for mature students			
Hallsten (2012)	Sweden	matching and FE	Individuals receiving postsecondary degrees (vocational or academic) in their 30s or later have higher earnings of 12% and employment of 18%.
Stenberg and Westerlund (2016)	Sweden	diff-in-diff and matching	Mature individuals attending higher education have higher gross earnings of 10% for females and 5.5% for males.

Table 6. Overview of Postsecondary Vocational Education Literature in Canada and Australia

	Data set	Identifying variation in vocational education	Sketch of major findings
A. Canada			
Ferrer and Riddell (2002)	1996 Census	OLS with sheepskin effects	Sheepskin effect of vocational postsecondary award is 6-7%.
Boothby and Drewes (2006)	1981 to 2001 Census	OLS with sheepskin effects	Returns to vocational postsecondary awards are less than half the returns of a bachelor's degree.
Caponi and Plesca (2009)	1994 General Social Survey	Matching and Heckman (1979) selection correction	Returns to college degrees are roughly 0.15 log points compared with 0.35 for bachelor's degree.
Boudarbat, Lemieux, and Riddell (2010)	1981 to 2006 Census	OLS	Returns to vocational postsecondary awards are between 10 and 15 percent and increase over the time period (particularly for men).
Foley and Green (2016)	Census and Labour Force Survey	OLS	Vocational postsecondary awards are associated with higher wages of 6-13% for men and 11-16% for women.
B. Australia			
Coelli and Wilkins (2009)	ABS and Census, 1982 to 2004*	OLS	The wage premium for vocational postsecondary awards in general has fallen over time.
Lee and Coelli (2010)	Survey of Education and Training, 1997-2005	Matching	Diplomas, and to a lesser extener, certificates lead to higher earnings and employment, particularly for high school dropouts.
Polidano and Ryan (2016)	HILDA	Fixed effects	Completion of vocational qualifications has larger earnings and employment benefits for women than for men.
Coelli and Tabasso (2019)	HILDA	Fixed effects and IV	For mature students, vocational qualifications are associated with higher hourly wages for men and higher hours of work for women.

Notes: The papers listed here are a subset of the literature for both countries. For more information, see Ferrer and Riddell (2002) for Canada and Polidano and Ryan (2016) for Australia.

* Coelli and Wilkins (2009) use data from 11 income-related surveys from the Australian Bureau of Statistics (ABS) as well as Australian Census data from 1981 to 2001.

[1] Some countries, such as Germany, offer "second chance" options for individuals to switch tracks in order to attend university (Biewen and Tapalaga, 2017). For more information on tracking, see Betts (2011).

[2] We use these terms interchangeably in this chapter.

[3] There are currently 16 career clusters recognized by Advance CTE, a consortium of state CTE leaders across the United States that dates back to 1920. These clusters include: Agriculture, Food, and Natural Resources; Architecture and Construction, Arts, Audio/Visual, & Communications; Business, Management, and Administration; Education and Training; Finance; Government and Public Administration; Health Science; Hospitality and Tourism; Human Services; Information Technology; Law, Public Safety, Corrections and Security; Manufacturing; Marketing, Sales, and Service; Science, Technology, Engineering, and Math; Transportation, Distribution, and Logistics.

[4] For a more detailed treatment of the history of vocational and general education, we refer the interested reader to Gordon (2014) for the United States development of what is now called career and technical education, Horner et al. (2015) and Berner and Gonon (2016) for reviews and comparative analyses of European systems, Cleverley (1992) for the evolution of Chinese education from traditional to modern models, as well as Johanson and Adams (2004) and Lauglo (2009) for reviews of vocational education in Sub-Saharan Africa.

[5] As mentioned in Jepsen, Mueser, and Jeon (2019) and elsewhere, survey and administrative data from the U.S. Department of Education, including the NPSAS, are limited to students attending schools that receive federal funding from the Title IV program. Nearly all public institutions receive such aid, but a nontrivial share of private schools, particularly for-profit schools, do not receive such aid.

[6] Unfortunately, country profiles prior to 2018 do not contain these data. Furthermore, several countries with profiles in 2018 to 2020, such as Kenya, Nigeria, and the Philippines, do not contain data on the percentage of upper secondary students attending vocational education.

[7] Several papers study how a compulsory general education reform in Finland affected achievement, intergenerational income mobility, and other outcomes (Pekkarinen, 2008; Pekkarinen, Uusitalo, and Kerr, 2009; Kerr, Pekkarinen, and Uusitalo, 2013; Böckerman et al., 2020).

[8] Similarly, Verhaest et al. (2018) look at the relationship between vocational versus general education (at both secondary and postsecondary levels) and educational and skill mismatches.

[9] Dougherty (2018) finds similar results for OLS models on a larger sample of career academies.

[10] For simplicity, we refer to the increase in earnings associated with a level of education as returns. However, Heckman, Lochner, and Todd (2008) point out that calculating the internal rate of return is a much more complicated endeavor.

[11] The Unemployment Insurance program requires states to collect individual-level quarterly earnings data for nearly all private sector employees.

[12] For a survey of previous results using administrative data, see Grubb (2002b).

[13] Because Jaggars and Xu (2016) use a piecewise linear function, they do not report an overall or average returns and therefore are not included in Table 2.

[14] In each study, the author does not distinguish between academic and vocational postsecondary education. Although Hallsten (2012) provides separate analyses for academic versus vocational *secondary* schooling, students often attend vocational postsecondary after attending academic secondary schooling.

[15] For brevity, we limit the results on Australia to recent academic studies. See Polidano and Ryan (2016) for a review of earlier OLS results concerning vocational postsecondary education and labor-market outcomes in Australia.

[16] In ongoing work, McFarlin, Martorell, and McCall (2017) and McFarlin, McCall, and Martorell (2018) also find

increased college attendance and attainment when students face lower costs.

[17] We identified 19 active or approved statewide Promise, or Promise-like, programs using the Education Commission of the States State Policy Tracker (https://www.ecs.org/state-education-policy-tracking/) and Jones and Berger (2018). These include programs in Arkansas, California, Delaware, Hawaii, Iowa, Indiana, Kentucky, Louisiana, Maryland, Missouri, Montana, Nevada, New Jersey, New York, Oklahoma, Oregon, Rhode Island, Tennessee, and Washington. Eligibility requirements and program benefits vary widely across states.