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ABSTRACT

Skill Development in Middle Level Occupations: The Role of Apprenticeship Training

Concerns about the polarization of the labor market are widespread. However, countries vary widely in strategies for strengthening jobs at intermediate levels of skill. This paper examines the diversity of approaches to apprenticeship and related training for middle-level occupations. We begin by defining and describing middle-skills occupations, largely in terms of education and experience. The next step is to describe skill requirements and alternative approaches to preparing and upgrading the skills of individuals for these occupations. Programs of academic education and apprenticeship programs emphasizing work-based learning have often competed for the same space but the full picture reveals significant numbers of complementarities. Third, we consider the evidence on the costs and effectiveness of apprenticeship training in several countries. The final section highlights empirical and policy research results concerning the advantages of apprenticeship training for intermediate level skills, jobs, and careers.

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Human resources are central to the performance of every economy. In the short-run, the framing of the skills issue is how best to reduce unemployment. Skill mismatches may hinder the return to full employment and slow economic recovery (Puri 2012). The case of Marlin Steel Wire Products in Baltimore is an example (Weitzman and Harding 2011). In 2011, when the U.S. unemployment rate was over 8 percent, the company of 30 employees reported that it could not find sufficient qualified workers to maintain high levels of growth. It is hard to blame wages, since Marlin offered a compensation package of more than \$80,000 per year. Data from a 2011 Manpower Group survey indicated that more than half of employers had difficulty filling jobs and nearly half blame the lack of hard, technical job skills. Moreover, the hardest jobs to fill in 2011 were for workers qualified in skilled trades, including machinists and machine operators.

Jobs are the short-run focus, but in the long run, the central issue is whether a country's human resources are of sufficient quality to promote or even accommodate high rates of economic growth. Several countries rely heavily on schooling, secondary and postsecondary degrees, and academic test scores to measure their human resources. Although reading, writing, and math skills and degrees are critical indicators of human capital, so too are competence and mastery in occupational skills and such behavioral skills as listening, communication, problem-solving, and dealing well with superiors and peers (Lerman 2008, Heckman, Stixrud, and Urzua 2006; Heckman and Rubinstein 2002; Almlund *et al.* 2007). All advanced economies rely on universal primary education to teach verbal and math literacy. But they differ in how they expect people to learn and use occupational and other workplace skills, especially for intermediate or middle-level occupations.

In nearly all countries, Technical and Vocational Education and Training (TVET) systems play a central role in occupational training. But the governance, timing, delivery, location, and experience of TVET vary widely across and often within countries (OECD 2009). In some countries, the government dominates TVET, while others involve private employers extensively. Serious TVET begins by age 14 in some countries and not until a student's late teens and early 20s in other countries. Most TVET programs focus on initial vocational education but some

include continuing vocational education to upgrade the skills of workers already in an occupation (Cedefop 2008). The duration of TVET programs ranges from less than a year to over four years. Training systems vary in their use of work-based vs. classroom-based learning. Some countries rely almost exclusively on academic subjects, leaving occupational and firm-based training entirely to employers. The range of occupations within the scope of TVET varies widely as well.

Apprenticeship training is common in many countries, with varying duration and degrees of involvement in the production process. Apprenticeship arrangements involve employees who have formal agreements with employers to carry out a recognized program of work-based and classroom learning. Apprentices participate in the production process, work with a trainer who is often a mentor as well, and ultimately gain sufficient occupational mastery to become certified by an external body. The scale of apprenticeship programs varies widely across countries, reaching up to 4 percent of the workforce in Germany and Australia but only 0.3 percent in the United States.

A critical distinction between apprenticeship and other TVET is the way training positions are created. Vocational schools provide openings based on administrative decisions concerning available teachers, budgets, and potential enrollment. Although administrators take some account of market demands, the schools are largely insulated from the job market. In contrast, apprenticeship slots only arise when employers create them. Because employers invest their own money when providing apprenticeship opportunities, their perception of the composition of demand is generally better informed than that of school administrators. On the other hand, training positions are pro-cyclical, with too many openings in boom periods and far too few during trough periods.

This paper examines the diversity of approaches to apprenticeship and related training for intermediate or middle-level occupations. We begin by defining and describing middle-skills occupations, largely in terms of education and experience. The next step is to describe skill requirements and alternative approaches to preparing and upgrading the skills of individuals for these occupations. Programs of academic education and apprenticeship programs emphasizing work-based learning have often competed for the same space but the full picture reveals

significant numbers of complementarities. Third, we consider the evidence on the costs and effectiveness of apprenticeship training in several countries. The final section highlights empirical and policy research results concerning the advantages of apprenticeship training for intermediate level skills jobs and careers.

What are middle-level occupations?

Classifying occupations or jobs by skill is complicated because of the multi-dimensional character of skills. The middle of a single distribution (say, by educational attainment or by a score on a cognitive test) fails to capture the wide variety of skills required to master and be productive on specific jobs or occupations. Should the skills required to play professional baseball be considered “middle-skill” positions even if education beyond high school is not necessary for the position? Are the skills required for a master carpenter in some sense *lower* than those required of elementary school teachers with BA degrees?

One solution is to use the wage as a proxy for skill in the particular job or occupation. Wages may be viewed as incorporating the skill levels along various dimensions together with the market valuation of those skills. Just as the prices of homes reflect the combination of housing characteristics along with “hedonic prices,” one might argue that the wage captures the diverse mix and value of skills required for jobs. However, several problems arise if we are interested in classifying jobs and occupations by skills. First, wages reflect not only skill but also the riskiness, job satisfaction, responsibility, status, and flexibility of jobs and occupations. Second, skill requirements and expertise required in an occupation may not change but the wage return to the occupation may. Third, wages sometimes are a reward for tenure on the job; seniority often matters. Fourth, wage differences can come about from differences in bargaining power of workers in various fields. For example, the pay of a longshoreman can depend on the ability of his representatives to gain high returns because of the high costs of strikes relative to wage increases. Fifth, wages for the same occupation often differ widely across geographic areas, partly because of rent differentials. Sixth, classifying occupations by mean wages can miss the substantial variation in wages within detailed occupations.

The approach used by Autor (2010), a major proponent of the hollowing out thesis, is to rank detailed occupations by their average wages in a base period. Middle-skill jobs are in occupations in the middle segment of the average wage distribution in that period. Using his approach, Autor finds that middle-skill occupations are declining rapidly relative to high- and low-skill positions. One of the main reasons is the increased power of computers to automate routine tasks that many middle-skill positions have long undertaken. Expanding international trade, declining unionization, and the erosion of the minimum wage are other factors that Autor sees leading to the “hollowing out” phenomenon. Moreover, similar trends are apparently occurring in other countries. Autor cites a recent paper by Maarten Goos, Alan Manning, and Anna Salomons (2009) that finds middle-wage occupations have been declining as a share of employment in all 16 countries they studied, mostly offset by a rising share of high wage occupations.

The Autor approach is useful but subject to several limitations. It does not capture the wide distribution of wages within detailed occupations.¹ For all employees and across all occupations, hourly earnings at the 75th percentile of jobs were 2.48 times hourly earnings at 25th percentile. But, the weighted 75-25 ratio *within* occupations was nearly 1.61, or 65% of the overall ratio. Moreover, there are clearly overlaps in wages across occupations that do and not require a BA degree. The level of average annual earnings at the 25th percentile of college occupations (defined as having over half of workers with a BA or higher degree) was about \$53,500. For occupations where only 15-50% of workers have a BA or higher degree, average annual earnings at the 75th percentile of those occupations was nearly as high at about \$52,000.²

Many high level occupational positions not requiring a BA involves a considerable amount of work-based learning and experience as well as other specialized talents (e.g.,

¹ The figures in this paragraph and the following paragraph come data drawn from the occupational employment survey. See http://www.bls.gov/oes/current/oes_nat.htm.

² These figures involved merging tables published on the Bureau of Labor Statistics website. The occupation and earnings data come from employer-based surveys under the Occupational Employment Statistics (OES) program while the occupation and education data come from the American Community Survey (ACS) conducted by the U.S. Bureau of the Census. See http://www.bls.gov/emp/ep_table_111.htm and the cross industry employment figures on occupations, http://www.bls.gov/oes/oes_dl.htm

salesmanship, responsibility, creativity, and detailed expertise). This suggests that sub-BA occupations can generate high wages at the top levels of quality and productivity. For example, there is a vast difference in wage levels, skill, and status between the occupations “cook at a restaurant” and “chefs and head cooks”. Cooks average only about half the hourly earnings level of chefs. If cooks and lower level chefs upgraded to high quality and productivity, earnings for a non-college occupation could compete with earnings of many college occupations. Occupations with above average earnings and with a majority of workers without a BA cover many fields. Among them are construction managers, buyers and purchasing agents, lodging managers, appraisers, court reporters, various types of technicians, aircraft mechanics, police officers, supervisors of police, and operators of gas plants.

Classification schemes for occupations into low, middle, and high skills categories sometimes rely on the educational attainment and training of people in the respective jobs. For example, Holzer and Lerman (2009) use BLS estimates of education and training requirements to classify middle skill broad occupational categories. This definition is certainly imperfect, since many professional/technical and service jobs are clearly middle-skill while some jobs in the clerical, sales and other categories are not. For purposes of describing trends, Holzer and Lerman saw these discrepancies as generally canceling out.

According to this classification, past and future trends do not herald a polarized or hollowed-out economy. Middle-skill jobs still make up roughly half of all employment today, even though they decreased their share of total employment from about 55 percent to 48 percent between 1986 and 2006. Professional and related occupations rose from 17 percent in 1986 to more than 20 percent in 2006 and managerial positions increased from about 12 to 15 percent of total employment. Low-skill (service) jobs barely increased their share from 15 to 16 percent of total employment. Jobs in sales and office occupations fell from about 28 to 25 percent of all jobs. Production positions dropped as well, from 9 to 6.5 percent. But several intermediate level occupations with good wages have increased substantially since 1986, including medical therapists (such as respiratory, recreational, and radiation therapists) increasing by 30 percent, carpenters (by 20 percent), heavy vehicle maintenance specialists (25 percent), and heating and air conditioning positions (21 percent).

In summary, definitions of intermediate level jobs vary, depending on whether they use wage, occupation, and educational criteria. Generally, intermediate level jobs are positions between jobs that require very little training and jobs that require a university degree. They are declining modestly as a share of total jobs, but still represent a large segment of the labor market.

Skills Required for Intermediate Level Occupations

Whether “middle-skill” occupations are modestly expanding or contracting, the key questions should be: 1) what are the skills required to perform well in these occupations? And 2) what are the best approaches to educating and training workers to generate high productivity and high wages in these fields? We begin by discussing skill requirements and then turn to ways workers can learn these skills.

In determining the skill requirements for intermediate-level occupations, one must consider the appropriate mix of generic academic skills, specific occupational skills, and generic, non-academic skills, such as communication, motivation, and responsibility. Mounier’s (2001) classification is similar, distinguishing between cognitive, technical, and behavioral skills. Some of all three types of skills are required for nearly all jobs, but the levels of each type of skill vary across occupations.

In the U.S., education reformers have boldly claimed that “...*all* students — those attending a four-year college, those planning to earn a two-year degree or get some postsecondary training, and those seeking to enter the job market right away — need to have comparable preparation in high school.” (Achieve 2005). Despite strong evidence against this proposition (Lerman 2008), the common core idea is taken seriously and has led to the creation of the “common core” standards at the high school level.

The evidence strongly suggests that occupational and behavioral skills are far more significant from the employer perspective than is exposure to upper level academic courses. For example, data from a survey asking a representative sample of U.S. workers what skills they use on the job (Handel 2007) indicate that only 19 percent use the skills developed in Algebra I, only 9 percent use the skills for Algebra II and less than 15 of workers ever write anything five

pages or more. This is not meant to imply that jobs not requiring certain academic courses are unskilled. As Rose (2004) points out, many occupations viewed as low- or middle-skill require a complex mix of cognitive and social skills. Upper blue collar and even lower blue collar workers must know how to read and create visuals, such as maps, diagrams, floor plans, graphs, or blueprints, skills typically learned in occupation-specific courses. Workers also report the importance of behavioral skills, including problem-solving and communication, teaching and training other workers, dealing with people in tense situations, supervising other workers, and working well with customers. Mastering these skills is cognitively challenging.

The 1991 Secretary's Commission on Achieving Necessary Skills (SCANS) in the U.S. confirmed the importance of behavioral skills, including the ability to allocate resources (time, money, facilities), interpersonal skills (such as teamwork, teaching others, leadership), the ability to acquire and use information, understanding systems, and working well with technology. Other qualities demanded by employers include responsibility, self-esteem, being sociable, self-management, and integrity and honesty. In one large survey undertaken in the mid-1990s of 3,300 businesses (the National Employer Survey), employers ranked attitude, communication skills, previous work experience, employer recommendations, and industry-based credentials above years of schooling, grades, and test scores administered as part of the interview (Zemsky 1997). More recent surveys in the UK and Washington State find similar results (Washington Workforce Training Board 2008, Hillage et al. 2002).

Evidence confirming the importance of behavioral skills has been accumulating in academic literature as well. Heckman, Stixrud, and Urzua (2006) find that except for college graduates, non-cognitive skills (as measured by indices of locus of control and self-esteem) exert at least as high and probably higher impact on job market outcomes than do cognitive skills (word knowledge, paragraph comprehension, arithmetic reasoning, mathematical knowledge, and coding speed as measured by the Armed Forces Vocational Aptitude Battery). In a recent study, Lindqvist and Vestman (2011) document the differential impacts of cognitive and what they term as non-cognitive skills on the earnings of Swedish men. They used special data on a representative sample of the Swedish male population matched with education, earnings, and information on cognitive and non-cognitive skills obtained in the military

enlistment process through interviews with psychologists. Persistence, social skills and emotional stability are the non-cognitive/behavior skills measured and coded from the interview. The study finds that in low to mid ranges of skills, non-cognitive skills exert a higher impact on wages than do cognitive skills.

The sociocultural approach provides some revealing examples of how skills are used in context and how non-academic skills are often developed and used as part of a “community of practice” (Stasz 2001). Nelsen (1997) points out that workplaces not only require formal knowledge—facts, principles, theories, math and writing skills—but also informal knowledge—embodied in heuristics, work styles, and contextualized understanding of tools and techniques.

What about occupational skills? Often, firms, labor representatives, and government reach agreement on what is required for a qualification that will allow employers to have confidence in the capabilities of their young workers. In several countries, skill requirements for occupations develop through the operation of apprenticeship programs and other training programs. Sometimes, the occupational qualifications fit within a broad framework of national vocational qualifications running from basic to intermediate to advanced levels.³

In the United Kingdom, the National Vocational Qualification (NVQ) system specifies requirements for proficiency that vary widely across types of occupations and over levels within occupations.⁴ The ultimate goal is that employers place a value on attaining a qualification level, giving workers an incentive to learn on the job. Although the system has not worked out very well (see e.g., Eraut 2001), NVQs have led to some added training in certain sectors (Cox 2007). In the U.S., the National Skill Standards Board (NSSB) failed to develop relevant, rigorous, portable, and well-recognized skill standards to guide training and provide reliable signals to worker and employers. However, occupation-specific skills standards exist in the U.S. through state level licensing and certification. Today, about one in five workers requires a state license to practice their occupation, up from less than 5 percent in the early 1950s (Kleiner

³ For a review of national qualification frameworks in Europe, see CEDEFOP (2012).

⁴ For an overview on NVQ and other qualification systems in the United Kingdom, see material provided by the Qualifications and Learning Authority, <http://www.qca.org.uk>.

2006). Licensing rules vary widely across states, with many states regulating occupations as varied as alarm contractor, auctioneer, manicurist, and massage therapists.

School-based and dual work-based/school-based systems try to insure that occupational qualifications are widely accepted by employers. In primarily school-based programs, decisions about what is necessary to prepare young people for particular careers are often the faculty of post-secondary institutions. Often, training colleges—such as U.S. community colleges and for-profit schools—decide themselves (sometimes in consultation with potential employers) about what constitutes qualifications in quite detailed occupations, such as domestic air conditioner and furnace installer, medical receptionist, and medical coder.⁵ Other standards directly involve employers and government entities.

Occupational standards are prerequisites for the functioning of apprenticeship programs, which involve work-based and school-based learning leading to a credential documenting the individual's occupational qualifications. Australia has developed the national Training Package (collections of competency standards gathered into qualifications) for all industry areas, while previously qualifications were only available in a limited range of occupations and industries (Smith 2012). In a thoughtful critique of this system, Wheelehan and Moodie (2011) argue against a system of task competencies, favouring instead an approach that stresses the worker's general capabilities.

In Canada, the Interprovincial Standards Red Seal Program helps develop occupational standards that allow for effective harmonization of apprenticeship training and assessment in each province and territory (Miller 2012). The Red Seal program's standards incorporate essential skills (reading, document use, writing, numeracy, oral communication, thinking, digital technology, and lifelong learning), common occupational skills (that apply to a small range of occupations), and specific occupational skills.⁶

In England, the Sector Skills Councils and their employers design the content of each apprentice using the design principles of a national Apprenticeship Blueprint (Miller 2012). The

⁵ Curricula for certificates in these occupations appear in the catalogue for the Kentucky technical college system, http://kctcs.edu/en/students/programs_and_catalog.aspx.

⁶ See the documents linked with <http://www.red-seal.ca/tr.1d.2@-eng.jsp?tid=51> for examples.

Secretary of State appoints and Sector Skills Councils commission an Issuing Authority to promulgate standards for specific apprenticeships. As of 2012, there were 200 operating apprenticeship frameworks and another 118 under development. At the same time, employers have considerable flexibility in implementing their apprenticeship programs. France uses Apprenticeship Training Centers (CFA) to help design and deliver the classroom-based components of apprenticeship, with skill standards often developed by Professional Consultative Committees (Dif 2012). They operate under frameworks established by the National Commission for Vocational Qualifications.

In Switzerland, the Federal Office for Professional Education and Technology, together with cantons, employers, trade associations and unions, participate in framing the occupational standards for about 250 occupations (Hoeckel, Field and Grubb 2009). The canton vocational education programs implement and supervise the vocational schools, career guidance, and inspection of participating companies and industry training centers. Professional organizations develop qualifications and exams and help develop apprenticeship places. In Germany the “social partners”, including government, employer, and employee representatives determine occupational standards (Hoeckel and Schwartz 2009). The chambers of commerce advise participating companies, register apprenticeship contracts, examine the suitability of training firms and trainers, and set up and grade final exams.

The content of skill requirements in apprenticeships includes academic courses and structured work-based training. In each field, the requirements are to complete the coursework in a satisfactory manner and to demonstrate the apprentice’s ability to master a range of tasks. In some systems, there are a set of general tasks that apply to a family of occupations (say, metalworking) and tasks that apply to a specific occupation (say, tool mechanics or metal construction and shipbuilding). While the tasks vary widely across occupations, all involve the application of concepts and academic competencies.

The coverage of occupational standards for apprenticeship extends well beyond the traditional construction crafts. In the UK, for example, specific apprenticeships are available within such broad categories as business, administration and law; arts, media, and publishing; in health and public services; retail and commercial enterprise, and information technology and

communication. Common apprenticeships in Switzerland include information technology specialists, commercial employees, pharmacy assistants, and doctor's assistants. German standards cover over 300 occupations, including lawyer's assistant, bank staff worker, industrial mechanic, industrial manager, retail workers, commercial sales, and computer networking. While much of the training is specific to the occupation, nearly all fields learn skills in closely related occupations. For example, apprentices in industrial management learn accounting, procurement, production planning, staffing, and logistics.

Some apprenticeship programs rely on an overall narrow approach to learning. Fuller and Unwin (2006) draw attention to the differences at the firm level between the more narrow "restrictive" skill development and the broader approach used in "expansive" work environments.

Apprenticeship and School-Based Approaches to Preparing Workers for Middle-Skill Jobs

Countries have developed a variety of approaches to dealing with training workers to become effective in intermediate level occupations, those that require considerable skill but not a BA degree. Systems vary with respect to the level and duration of general education, the timing of occupation-specific education and training, and the split between classroom-based and work-based learning.

These differences can have important consequences for productivity and student outcomes. In a series of articles comparing British and German companies in the same industries, Wagner and colleagues cited the substantially higher vocational qualifications of German workers as playing a key role in the productivity advantage of German firms (see, for example, Steedman and Wagner (1987); also see Prais (1995)). Waiting too long to incorporate occupation-focused education and training runs the risk of high levels of disengaged students and forcing a highly academic approach on many students who would do better in a more concrete setting that emphasizes applications. This argument is especially strong to the extent that school requirements are poorly matched to the job market opportunities facing most young people. On the other hand, beginning an occupation-focused program too early might trap youth in unrewarding fields and limit their adaptability and upward mobility.

Although discussions of skill preparation systems generally focus on the work-based vs. school-based distinction, the quality, depth, and portability of what students or apprentices learn are at least as important. The portability of the skills learned in occupation-specific programs is a common concern about apprenticeships or any occupation-specific training. How skill portability varies with the mode of learning and the curricula is unclear, a priori. As Geel and Gelner (2009) point out, learning even a highly specific skill can yield benefits outside the narrow occupation.

For example, an adolescent who wants to become a clockmaker should not necessarily be considered poorly equipped for future labor market requirements, even though his industry is small and shrinking. Rather, he is well equipped because his skill combination is very similar to skill combinations of other occupations in a large and growing skill cluster, which includes, for example, medical technicians or tool makers. Despite a seemingly very narrow and inflexible skill combination in his original occupation, he is nonetheless very flexible and well prepared for future labor market changes due to the sustainability of his acquired skills and his current skill cluster.

To operationalize the concept of skill specificity, Geel and Gelner (2009) and Geel, Mure, and Gellner (2011) begin with an insight borrowed from Lazear (2009) that all skills are general in some sense and occupation-specific skills are various mixes of skills. The authors compile the key skills and their importance for nearly 80 occupations. They then use cluster analysis to estimate how skills are grouped within narrow occupations. This approach recognizes that skills developed ostensibly for one occupation can be useful in other occupations. It identifies occupational clusters that possess similar skill combinations within a given cluster and different skill combinations between clusters. Next, indices for each narrow occupation measure the extent to which the occupation is relatively portable between occupations within the same cluster and/or relatively portable between the initial occupation and all other occupations. The authors use these indices to determine how portability affects mobility, the wage gains and losses in moving between occupations, and the likelihood that employers will invest in training.

The authors test their hypotheses on the basis of empirical analyses of German apprentices. One finding is that while only 42% of apprentices stay in their initial occupation, nearly two-thirds remain with either the occupation they learned as an apprentice or another occupation in the cluster using a similar mix of skills. Second, those trained in occupations with

more specific skill sets are most likely to remain in their initial occupation or move to occupations within the same cluster. Third, apprentices actually increase their wages when moving to another occupation within the same cluster but lose somewhat when moving to another cluster. Fourth, as Geel, Mure, and Gellner (2011) show, employers are especially likely to invest in apprenticeships with the most specific skill sets.

Other strong evidence of the high returns and transferability of German apprenticeship training comes from Clark and Fahr (2001). They examine the returns to apprenticeship for those who remain in the original apprentice occupation as well as losses that do occur or would occur from transferring to another occupation. The overall rates of return to each year of apprenticeship range from 8-12% for training in firms of 50 workers or more and from about 5.5-6.5% for firms of 2-49 workers. Although transferring to another occupation can offset these gains, the reduction is zero for those who quit and only about 1.7% for those who are displaced from their job and shift to another occupation. As found by Geel and Gellner (2009), the wage penalty varies with the distance away from the original occupation. There is no penalty at all from displacement into a somewhat related occupation. Göggel and Zwick (2012) show the net gains or losses from switching employers and occupations differ by the original training occupation, with apprentices in industrial occupations actually experiencing wage advantages while those in commerce, trading, and construction see modest losses. Finally, Clark and Fahr (2001) present workers' own views on their use of skills learned in apprenticeship training on their current jobs. Not surprisingly, 85% of workers remaining within their training occupation use many or very many of the skills they learned through apprenticeship. This group constitutes 55% of the sample. But, even among the remaining 45%, about two of five workers reported using many or very many of the skills from their apprenticeship and another 20% used some of the skills. Overall, only 18% of all former apprentices stated they used few or no skills learned in their apprenticeships.

The findings show that the skills taught in German apprenticeship training are often general. Even when bundled for a specific occupation, the skills are portable across a cluster of occupations. Moreover, apprentices are quite likely to remain in occupations that use the skills they learned in their initial occupation. Apprenticeships skills do vary in terms of specificity and

portability. But, when the skills are less portable, firms are more likely to make the necessary investments and workers are less likely to change occupations significantly.

A key issue is whether the general components of training, usually financed by the government and/or students, are higher in school-based programs. Some favor school-based systems on grounds that firm-based apprenticeship training limits mobility and adaptability (Hanushek, Wößmann's, and Zhang 2011). Yet, these programs, especially the purely academic tracks in U.S. secondary schools and U.S. community colleges, may have no advantage for mobility. First, a high percentage of students drop out of both academic secondary and community college programs. Second, many community college programs are at least as specific as apprenticeship programs. Many certificate programs within community colleges are almost entirely devoted to learning a narrow occupational skill, such as courses to become a phlebotomist, child care assistant, and plastics processing worker. Some U.S. school-based programs in for-profit colleges also offer narrow programs, such as truck driving, medical assistant, and medical insurance billing and coding. Third, skills often erode when they go unused. To the extent students learn general skills but rarely apply and forget them, their training is unlikely to offer upward mobility.

While community college and private for-profit students often take highly specific occupational courses, apprentices all take some general, classroom courses. Thus, apprentice electricians learn the principles of science, especially those related to electricity. In most countries, collaboration takes place between vocational schools and apprenticeship programs. In the U.S., apprentices often take their required "related instruction" in classes at community colleges or for-profit colleges (Lerman 2010). From this perspective, U.S. apprenticeship programs should be viewed as "dual" programs that combine work-based and school-based learning.

In the case of other OECD countries, the mix of school-based vs. employer-based programs used to prepare young people for careers varies widely. Secondary school students in Belgium and Sweden participate at high rates in vocational education but have very low rates of participation in work-based programs. In contrast, most of the vocational education in

Germany, Austria, Switzerland and Denmark revolves around work-based learning, including apprenticeships.

Apprenticeship training limits the gaps between what is learned at school and how to apply these and other skills at the workplace. An extensive body of research documents the high economic returns to workers resulting from employer-led training (Bishop 1997). Transmitting skills to the workplace works well with supervisory support, interactive training, coaching, opportunities to perform what was learned in training, and keeping the training relevant to jobs (Pelligrino and Hilton 2012). These are common characteristics of apprenticeships. Employer-based training like apprenticeship often bears fruit in the form of higher levels of innovation (Bauernschuster, Falck, and Heblich 2009), net gains to firms that train during and soon after the training, and externalities, such as benefits for other employers and for the public when workers are well-trained to avoid the consequences of natural or man-made disasters. Under apprenticeships and other forms of employer-based training, the government generally gains by paying little for the training while reaping tax benefits from the increased earnings of workers.

Methodological Issues in Estimating the Costs and Benefits of Apprenticeship Training

Conceptual and practical issues arise in trying to estimate the costs and benefits of apprenticeship training. One is the variation in the structure and breadth of apprenticeship. The term encompasses a variety of occupations with varying levels of school-based learning at the secondary and the postsecondary levels, varying amounts of work-based learning, and heterogeneity in general vs. occupation-specific training. A second issue is defining the counterfactual, or what would have taken place in the absence of apprenticeship. Even when comparing outcomes of apprenticeship participants and those of non-participants with the same observed characteristics, unobserved differences between groups, such as the motivation to work or the mode of learning, may affect both entry into apprenticeship and post-program earnings. Another issue is that apprenticeship programs may work well for some occupations but not others. Generalizing in these contexts is difficult.

Uncertainty adds another twist to estimating benefits and costs. Given uncertainty about the productivity returns from irreversible investments in particular workers, the firm's

investment creates a real option. When the training is completed, the firm has the option but not the obligation to hire the trained worker. This option value raises the firm's returns and increases the likelihood that they will invest in training.

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

Estimates of Costs and Benefits for Workers

Notwithstanding the difficulties, a large literature has generated estimates of apprenticeship benefits and costs. The OECD's *Learning for Jobs* (2009) provides an overview of vocational education systems in 17 countries, but cites only a few studies dealing with benefits and costs. The OECD's *Off to a Good Start: Jobs for Youth* (2010) highlights the role of apprenticeships in smoothing the transition from school to work and in maintaining low youth unemployment. Research on rates of return to apprenticeship and other vocational training programs in individual countries is common as well, such as in Australia, Austria, Germany, Switzerland, and the U.S.

One U.S. study examined the government costs as well as the worker and government benefits of three types of technical vocational education and training (TVET)—secondary vocational education, postsecondary vocational education (in community colleges) and apprenticeship programs. Using data on individuals in the State of Washington, Hollenbeck (2008) used groups with different program experience that entered employment offices and who had the same preprogram earnings. The earnings increases over the first 2.5 years after program exit exceeded the government and worker costs substantially for apprenticeships and secondary TVET. For postsecondary TVET, the results show costs approximately equaling

benefits after 2.5 years but solid 7-9 percent rates of return when net gains projected on a lifetime basis. Absolute and relative gains in earnings from apprenticeship are highest, reaching about \$2,000 per month compared to only about \$1,500 per month among those participating in occupational programs in two-year colleges.

A broad study of apprenticeship in 10 U.S. states also documents large and statistically significant earnings gains from participating in apprenticeship (Reed 2012). It estimates how the length of participation in an apprenticeship affected earnings, holding constant for pre-enrollment earnings of apprenticeship participants. Using this “dosage” model, the author obtains estimates of what the level of earnings would be for comparable workers who did not participate in apprenticeship at all. The estimated impacts are consistently and highly positive. At six years after starting a program, earnings of the average apprenticeship participant (average duration in an apprenticeship) stood at 1.4 times the earnings of non-participants with the same pre-apprenticeship history. The gains were highly consistent across states although the earnings advantages narrowed between the 6th and 9th year after program entry. Overall, the study finds that apprenticeship returns nearly \$28 in benefits for every dollar of government and worker costs. The net dollar gains projected over a worker’s career amounted to about \$125,000.

Many studies have examined the earnings gains from apprenticeship training in European countries. They generally find high rates of returns to the workers, often in the range of 15 percent (Clark and Fahr 2001; Fersterer, Pischke, and Winter-Ebner 2008; Geel and Gellner 2009). As noted above, Clark and Fahr (2001) estimate wage gains in this range (about 6-8% per apprenticeship year with duration of slightly less than 3 years), with gains made only modestly lower by shifts from the training occupation to another occupation. Unfortunately, few studies are able to isolate the net impact of apprenticeship rigorously. They are generally unable to account for a major concern of existing studies—the role of selection bias that results from the employer’s selection of young workers who are more capable than their counterparts in ways that the analyst cannot observe.

One recent study of the returns to apprenticeship training in small Austria firms (Fersterer, Pischke, and Winter-Ebmer 2008) overcomes much of the selection problem. The

authors focus on the interaction between apprenticeship duration and failing firms. In the context of apprenticeship, a firm going out of business will generally cause a sudden and exogenous end to the apprenticeship training for apprentices in the firm. More generally, the timing of firm failure will affect the duration of apprenticeship training a particular worker experiences. By looking at apprentices who obtained training in failed firms, one can examine a large number of trained workers with varying durations in their apprenticeships. The sample covers small firms, where the closing of the firm is likely to occur most suddenly. The results show a significant wage effect from longer durations of apprenticeship. For a 3-4 year apprenticeship, post-apprenticeship wages end up 12-16 percent higher than they otherwise would be. Since the worker's costs of participating in an apprenticeship are often minimal, the Austrian study indicates high overall benefits relative to modest costs.

A recent Canadian analysis indicates a high wage premium for apprenticeships for men but not for women (Boothby and Drewes 2010). Apprenticeship completion is the highest educational attainment for only about 7 percent of Canadian men. However, for this group, earnings are substantially higher than the earnings of those who have only completed secondary school and nearly as high as those who have completed college programs that are less than a university BA. Overall, the gains for men from apprenticeship training are in the range of 17-20 percent. Even evaluated after 20 years of experience, apprenticeship training in most occupations yields continuing returns of 12-14 percent.

Evidence from one Australian study shows very high rates of return to individuals undertaking TVET. Ryan (2002) finds that a male school leaver who completes a skilled vocational qualification while working part-time reaps a return of about 24 percent. This gain far exceeds the 3.9 percent return to a male who works part-time while obtaining an associates diploma (2 year college degree). Other researchers have highlighted the benefits of well-structured vocational and apprenticeship systems (Steedman 1993; Acemoglu and Pischke 1999; OECD 2010; and Ryan 2001).

A skeptical view of returns to apprenticeship emerges in Hanushek, Wößmann and Zhang (2011). They argue that vocational education (including apprenticeships) improves employment and earnings outcomes of young people but the advantage erodes to a

disadvantage at older ages. The gains at young ages are consistent with a variety of other studies highlighted by Wolter and Ryan (2011). Hanushek, *et al.* (2011) argue that the erosion of gains at older ages is clearest in countries that emphasize apprenticeship, such as Denmark, Germany, and Switzerland. Yet, according to several estimates in the paper, the advantage in employment rates linked to vocational education in the apprenticeship countries remains through approximately age 60 (Table 6 in Hanushek et al. 2011). Moreover, in the apprenticeship countries, the advantage in employment rates is sizable, providing men with vocational education a 9 percentage point higher employment rate at age 40 and a 4 point advantage at age 50.

Costs and Benefits for Employers

For employers, the net costs depend on the mix of classroom and work-based training, occupation, skill and wage progression, and the productivity of the apprentice while learning to master the required skill. Direct costs include apprentice wages, the wages of trainer specialists for the time they oversee apprentices, materials, and the costs of additional space required for apprenticeship (Wolter and Ryan 2011). The benefits depend on the extent to which apprenticeships save on subsequent hiring and training costs, lower turnover costs, and enhance productivity more than added wage costs. Also valuable is the employer's increased certainty that apprentice graduates know all relevant occupational and firm-specific skills and can work well alongside other skilled workers. In addition, having extra well-trained workers, such as apprentice graduates, provides firms with a valuable option of expanding production without reducing quality in response to uncertain demand shocks and covering for sudden absences of skilled workers.

The most extensive studies of net costs of apprenticeships deal with German and Swiss employers. One analysis compares results from surveys of 1,825 German firms and 1,471 Swiss firms that refer to the year 2000 (Muehlemann et al. 2010). The study does not include the costs of school-based learning linked to apprenticeships. The firms' main gross costs are the wages of trainers and the wages of apprentices. The authors calculate gross costs and the benefits to employers derived from the productive contributions of apprentices only during the

training period. On average, the gross costs per year amounted to 15,500 Euros for German firms and about 18,000 Euros for Swiss firms. Although Swiss firms spend more than German firms, they derive substantially higher benefits from the value added by apprentices. Swiss firms gain over 19,000 Euros per year, more than double the 8,000 Euro benefits that German firms attribute to the value of production generated by apprentices. For a three year apprenticeship, Swiss firms recoup the 54,400 Euro cost with benefits of 57,100 while German firms experience a 46,600 Euro gross cost but only 24,000 in benefits. While the wages paid to apprentices are higher in Switzerland than in Germany, apprentices are at work for more days in Switzerland than in Germany (468 vs. 415 for a three year apprenticeship). Further, when at workplaces, Swiss apprentices devote 83 percent of their time to productive tasks, compared to only 57 percent among German apprentices.

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

Are the higher in-program net costs to German firms offset by any advantage after the apprenticeship period? The study indicates retention of apprentices within the firm is much higher in Germany than in Switzerland. Thus, while German firms bear much higher net costs than Swiss firms during the apprenticeship period, they reap higher returns during the post-apprenticeship period.

Evidence from the Germany surveys of employers offers some insight into post-program benefits (Beicht and Ulrich 2009). Recruitment and training cost savings average nearly 6,000 Euros for each skilled worker trained in an apprenticeship and taken on permanently. The report cites other benefits, including reduced errors in placing employees, avoiding excessive costs when the demand for skilled workers cannot be quickly, and performance advantages favoring internally trained workers who understand company processes over skilled workers

recruited from the job market. Taking all of these benefits into account makes the apprenticeship investment into a net gain for employers.

Not all recent studies indicate high net costs of apprenticeships in Germany. For example, Mohrenweiser and Zwick (2009) find that for many occupations, the gains to the firm during the apprenticeship period more than offset the costs. They draw their conclusions by estimating the impact of apprenticeships on company profits. For apprenticeships in trade, commercial, craft, and construction occupations, the estimates show a positive impact on profits. Moreover, the gains come from the higher productivity of apprentices (relative to unskilled or semi-skilled workers) and not from lower wages. Only in manufacturing is the effect on current profits negative, indicating a net cost during the apprenticeship period that is presumably offset by post-program benefits. In another careful study of German apprenticeships, Rauner et al. (2010) finds that the majority of the 100 firms in the sample recouped their investment in apprenticeships during the training period. The Rauner *et al.* study finds that most firms experience low net costs or even net benefits from sponsoring apprenticeships. However, the net costs vary widely, with some firms gaining more than 10,000 Euro and others experiencing net costs. High quality apprenticeships have higher gross costs but are much more likely than low quality apprenticeships to help employers recoup their investment during the training period.

An extensive study of Canadian employers sponsored by the Canadian Apprenticeship Forum (2006) estimated employer costs and benefits of four year apprenticeships in 15 occupations. The study drew on responses from 433 employers. The average gross costs varied widely, ranging from about \$78,000 for cooks to \$275,000 for construction electrician. Average in-program benefits—measured as the revenue generated by the apprentices--varied widely as well, ranging from \$120,000 for cooks to \$338,000 for construction electricians. For all 15 occupations, employers earned a positive return to their apprenticeship investments even without taking account of any post-program benefits.

In a recent analysis of apprenticeships in the United Kingdom based on eight employers, Hasluck and Hogarth (2010) estimated that the average gross costs were higher than the average benefits during the apprenticeship period in all four industries. The gross costs were

only modestly higher than the in-program benefits in retail and business administration, but much higher in engineering and construction. Still, the authors estimate that employers at least break even during the early post-apprenticeship period, when the contributions to production of apprenticeship graduates are worth more than their wages.

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

Government Costs and Benefits of Apprenticeship and Other Vocational Education

Government outlays per student are believed to be considerably higher for school-based vocational education than for academic education (Psacharopoulos 1993; Middleton 1998; Gill et al. 1999; Klein 2001). Yet, there are strikingly few detailed studies of government spending on vocational education and in many countries the cost differences are modest. A graph prepared by Cedefop (2012) indicates virtually identical expenditures per student in a number of European countries, though it shows that outlays are substantially higher for vocational education than general education in France and Germany. In a study of the Geneva canton of Switzerland as of 1994, government costs per student were about 50 percent higher in full-time vocational education than in general education but government costs per apprentice was only half the costs of general education (Hanhart and Bossio 1998).

Government costs are clearly lower in apprenticeship programs than in school-based TVET. One reason is that students in apprenticeship frameworks are in school far less time. Second, government spending on equipment is less necessary for TVET dual-program students because they gain experience with the relevant equipment at their work site. Third, successful dual systems reduce the need for government spending on university education or on second-chance training programs.

In the U.S., Reed (2012) estimates that governments at all levels spent only about \$715 per apprenticeship participant, or only about 7 percent of the amount governments spend per

year on two-year college programs. Hollenbeck (2008) finds a substantial gap between school-based postsecondary TVET and apprenticeship (about \$7,600 vs. \$2,700) in Washington State.

The long-term benefits of apprenticeship accruing to governments are rarely estimated. Reed projects that over the career of an apprentice, the tax returns are more than \$27 for each dollar invested. According to Hollenbeck (2008), the government obtains about 20 percent of the overall net gains in earnings linked to apprenticeship earnings gains.

Investments in apprenticeship training are substantially larger in countries with large systems, such as Austria, Denmark, Germany and Switzerland. Their governments are generally convinced that these investments bear fruit in the form of low youth unemployment, improving the school-to-work transition, insuring effective skills options for people who learn best by doing, increasing the share of people with a skill qualification, and improving the climate for manufacturing.

Conclusions

Skilled jobs and careers that do not require a BA or higher degree make up a significant share of employment in modern economies. The jobs range from construction crafts and construction management to skill manufacturing positions, including machinists and laser welders, to police officers and fire fighters, to sales and purchasing positions, to health technicians and licensed practical nurses, to chefs and floral designers, and to legal secretaries. Although the current number and trend of intermediate level jobs is subject to debate, new jobs plus replacement openings in these fields will continue to make up 40% or more of all jobs in Advanced Capitalist Countries (ACCs) like the USA, UK, Australia and the EU. The wages and skill levels vary widely within each of these occupations.

Apprenticeships to train workers for intermediate level careers work well. Skill development through apprenticeships is closely suited to the needs of employers and the job market, reinforces classroom learning with applications at the workplace, involves trainees in the production process, makes for a seamless transition from school to a career, provides trainees with a natural mentoring process, allows trainees to earn wages while gaining occupational mastery, applies to a wide range of occupation, requires less government spending than other education and training strategies, and generally raises the quality of the

work force. Countries with robust and well-structured apprenticeship programs appear to outperform other countries in achieving low youth unemployment, raising the status of skilled and semi-skilled occupations, and maintaining more good-paying manufacturing jobs.

Notwithstanding these advantages, the apprenticeship strategy is subject to two common critiques: 1) employers have little or no incentive to make investments in apprenticeship because they bear the costs and workers and other employers reap many of the benefits and 2) the training is too specific to a particular occupation. Since workers often change employers and occupations, much of the enhancement to human capital will go unused and offers workers fewer options to shift to other fields without losing their earnings power.

An expanding literature suggests that both critiques lack strong empirical support, at least for a class of apprenticeship programs. For many employers in several countries, the investments in apprenticeship training are recouped during the training period itself. The majority of employers in Switzerland and many in Germany experience zero or very low net costs (training, material costs, and wages minus the value of the apprentice's production). Reduced turnover and training costs and the certainty that the regular worker will meet skill standards are simply added benefits.

For workers, the skills learned in apprenticeship are generally quite portable. Changing occupations within the same cluster of occupations actually raises wages. Those who leave their training occupations report they frequently use the skills learned in their apprenticeships. The transferability of apprenticeship skills should not be surprising, given that apprenticeships teach a wide range of tasks and include classroom training in theory as well as practical applications. Overall, most studies find healthy and often high rates of return to participating in apprenticeship programs.

The main alternatives to apprenticeship training are entering the job market and added schooling, especially university education. Although researchers have not been able to offer definitive estimates of the relative returns to entering college vs. entering apprenticeships for different groups of young people, countries that place exclusive emphasis on college for all end up with weaker human capital development than countries that provide a mixed strategy of college and apprenticeships. Given the low public cost and high wage gains from dual work-

based and school-based programs, the natural policy implication is for countries to deemphasize the “academic only” approach as well as school-based TVET and to move toward more apprenticeship training. This policy shift would be significant in several countries, including the U.S., but not all. No one policy can deal with high youth unemployment, low youth skills, the rise in inequality, and the decline of middle-skill jobs. But, expanding apprenticeship can help with these problems.

After extensive research, the OECD concluded that apprenticeship training should play a much larger role in the many countries with small programs. Several countries—notably Australia, England, and even France, are already pursuing major efforts to expand apprenticeship. Apprenticeship is taking hold and able to succeed both in relatively regulated and unregulated labor markets (Muehlemann, et al., 2010). It will be important to learn how these initiatives proceed because a major concern is the transferability of aspects of the model to countries without a long tradition of apprenticeship.

Given these policy developments, expanding the research base about apprenticeship is critically important. Ideally, an experimental approach could be mounted. The emerging research on and syntheses of existing programs can help ensure that expanding apprenticeship leads to a better trained, productive, well-compensated, satisfied, and adaptable work force.

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