Economic Change and Skill Obsolescence: Restructuring Education Policy to Facilitate Labor Market Integration

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Abstract: In this article, I identify the new risk of skill obsolescence as a key challenge for education policy-makers. Due to skill-biased technological change, trade, financial liberalization, and the growth of the knowledge economy, the potential for the education system to address the heightened risk of skill obsolescence has increased. However, some countries continue to invest little in education and fail to certify skills in a way that is transparent to all economic actors.

Drawing on the education policy literature, I construct two indices that aim at capturing the degree to which education systems in thirty countries meet the challenge of high skill obsolescence. The high correlation between the indices, on the one hand, and various education and labor market outcomes, on the other, presents some confirmation for the idea that expanding opportunities to learn and ensuring skill transparency improve individuals' ability to fare well in the new economy. The analysis also suggested that education policy plays a supporting role in the functioning of active labor market policy since countries with high scores on the two indices are related to more efficient types of active labor market policies.

Education systems hold the potential to address the heightened risk of skill obsolescence today by facilitating skill acquisition and skill transparency. The realization of this potential, however, remains contingent on political reforms, because contemporary education systems largely developed in a period of lower skill obsolescence when initial education proved sufficient to secure employment throughout the career. By facilitating skill acquisition and transparency, education systems stand to play a central role in bolstering labor market chances among marginalized workers as well as supporting government programs to reintegrate the unemployed.

The potential for education systems to alleviate skill obsolescence abides by the following logic. When faced with skill obsolescence, workers lose the capacity to fulfil the tasks required by their employment position. Depending on the source and degree of skill obsolescence, workers can reduce the ensuing labor market risk by bolstering their competitiveness in their current employment position or moving to a new employment position. All of these responses, however, require either learning new skills or providing evidence of existing skills to education institutions or potential new employers; these actions, in turn, depend largely on the structure of the education system.

Two aspects of education systems stand as particularly relevant to the mitigation of skill obsolescence, skill acquisition and skill transparency. Education systems influence skill acquisition by investing in individuals' cognitive capacity and creating opportunities to enter into formal education. The capacity and opportunity to learn skills reduce the risk of skill obsolescence by facilitating the replacement of obsolete skills with marketable skills. The second dimension, skill transparency, refers to the structure of the skill certification system, which governs the formal recognition of skills and the acknowledgement of shared skill sets between different academic degrees and professional occupations. Due to information problems that employers face in assessing job candidates and the extent to which previous coursework acts as a prerequisite for further study, the structure of the certification system influences hiring decisions and the range of training opportunities that workers' previous education qualifies them to pursue, respectively. Together these dimensions of skill acquisition and skill transparency express how education systems influence the ability of workers to

prevent and respond to skill obsolescence. To test the theoretical claim that education systems mitigate the risk of skill obsolescence, I create two indices for these aspects of educational systems.

The article proceeds as follows. The next section defines skill obsolescence and outlines the causes of its recent upward trend. The following section builds a model of how education systems mitigate skill obsolescence by first reviewing the existing literature on how education policy relates to economic and social outcomes and then developing an argument on the particular ways in which education systems can address the current risk of skill obsolescence. The analysis section outlines the measurement of the indices on skill acquisition and skill transparency, presents the results, and then validates the indices by correlating them with measures of observable implications of the theoretical argument. The discussion section then explains potential implications of the index for the integration of the unemployed and analyzes potential political explanations for the country rankings on both dimensions.

Defining Skill Obsolescence

While the intensity of skill obsolescence fluctuates over the course of history, recent trends prompt a new period of heightened skill obsolescence. To support this claim, it is first necessary to define skill obsolescence. In general, skill obsolescence means the loss of the value of skills that workers possess, though definitions of obsolescence vary according to how loss is calculated. Viewing obsolescence as a relational concept between workers suggests the following definition: "A person is obsolescent to the degree that, relative to other members of his profession, he is not familiar with, or is otherwise unfitted to apply, the knowledge, methods, and technologies that generally are considered to be important by members of his profession" (Shearer & Steger 1975, p. 265). From another perspective, obsolescence does not define the distance from the skills of the average worker, but rather the distance from the ideal skill set necessary to complete the task associated with a given job. With this understanding, one might consider the following definition: "Obsolescence is the degree to which organizational professionals lack up-to-date knowledge or skills necessary to maintain effective performance in either their current or future work roles" (Kaufman 1974, p. 23). For the purposes of the argument here, I rely on a broad understanding of skill obsolescence, where obsolescence refers to the deficiency of

skills necessary to fulfill the tasks associated with one's employment position or comparable employment positions.

Different general varieties of skill obsolescence can be identified: skill atrophy due to illness or nonuse; job-specific skill obsolescence through technological change; sector-specific skill obsolescence due to shifts in employment; and firm-specific skill obsolescence through displacement (de Grip 2004). These categories of skill obsolescence cluster into roughly two groups: technical obsolescence refers to changes that originate within the individual (e.g. nonuse) whereas economic obsolescence refers to decreases in the value of an individual's human capital due to external changes (e.g. technological change) (de Grip et al 2002; Rosen 1975). I focus here on economic obsolescence, which occurs through technological developments, trade, sectoral employment shifts, company restructuring, and shorter average job tenure.

The literature generally relies on three different ways of measuring skill obsolescence. The most direct way to assess obsolescence is through personal assessments (e.g. Allen & van der Velden 2002; Blechinger & Pfeiffer 2000; Karasek et al 1998; Kaufman 1989; van Loo et al 2001). Economic studies tend to focus most on wages (e.g. Jacobson et al 1993; Mincer & Ofek 1982; Neuman & Weiss 1995), which should decrease in response to high skill obsolescence. Other studies either look at flow from employment into unemployment (e.g. van Loo et al 2001) or non-participation (e.g. Allen & De Grip 2005; van Loo et al 2001) as an indicator of human capital obsolescence.

Quanitifying skill obsolescence is an illusive task. Measurement issues remain for three main reasons. First, both workers and employers' self-evident incentives to avoid obsolescence will lead them to update periodically existing skill sets to adapt to technological innovations or changes in the market. These practices will mask obsolescence by reducing skill-obsolescence-induced unemployment or non-participation. Declining investments in certain skill sets or increasing training efforts could provide additional measures of skill obsolescence, although cross-sectional time series data on college majors or in-firm training courses are not available.

Second, labor market regulations frustrate the reflection of skill obsolescence in labor market statistics. Sticky wages conceal skill obsolescence by failing to register reductions in productivity. In addition, employment protection potentially reduces the likelihood of unemployment of workers with obsolete skills, thereby underestimating true levels of skill obsolescence. On the other hand, unemployment rates may also overestimate skill obsolescence, because factors besides skill obsolescence lead to unemployment (see de Grip 2004).

Finally, personal assessments face the dilemma that obsolescence measures are subject to individual biases. For instance, managers may face problems in assessing the skills of their subordinates (Borghans et al 2000; de Grip 2004). At the same time, personal assessments hold the advantage that they capture potential skill obsolescence not yet reflected in wage levels due to wage rigidity.

Having defined skill obsolescence and the main methods of measuring of skill obsolescence, I now turn to the main causes of the heightened risk of skill obsolescence in the recent period. Doing so clarifies the ways in which skill obsolescence manifests itself by drawing out the ways in which demands for various skilled changed over time. The discussion calls on economic changes that alter the level and types of skills needed in advanced industrialized economies as well as the changed role of human capital in the production process.

Recent Causes of Skill Obsolescence

Over the last three decades or so, a number of economic changes generated a sustained period of high skill obsolescence. These changes include trade, financial liberalization, skill-based technological change, and the growth of the knowledge economy. Together, these changes alter firms' skill needs. In terms of skill level, trade, capital market liberalization, and skill-based technological change lead to a shift towards demand for higher skills. The types of skills that firms demand also changed. Firm displacement to foreign countries as well as shorter job tenure increases the obsolescence of firm-specific skills. The growth of the service sector and skill-based technological change also increase the

salience of various social skills, computer related skills, and cognitive skills. Below I elaborate on the logic behind and the evidence for these trends. I first review the support for the claim that the levels of skills has changed. Then I discuss ways in which the types of skills demanded by firms have changed. Finally, I discuss the growth of the knowledge economy and how technological innovation shortens the 'half-life' of workers' human capital investments and prompts the need to invest more often in training.

Demand for high-skilled workers arises predominantly from trade, financial liberalization and skill-based technological change. For the trade argument, the logic of factor price equalization suggests that prices for low-skilled labor in developed countries cannot remain above those in developing countries. Following Heckscher-Ohlin-Samuelson assumptions, trade with developing countries with abundant low-skilled workers should force down wages of less abundant low-skilled workers in developed countries; if labor market policy prevent adjustment, unemployment among low-skilled workers will rise in high wage countries. International specialization therefore drives up skill premia in economically developed nations (Wood 1994; Wood 1995). Increased levels of trade between advanced industrialized countries and less developed countries thereby either reduce the return to low-skill work or increase the risk of redundancy. Both lower wages and redundancy imply skill obsolescence, either because a worker's skills no longer suffice to earn the previously established wage or because high wage costs led firms of a certain skill-level to relocate in low-wage countries, thereby reducing labor demand for these skills in high-wage countries.

Financial liberalization allows for massive foreign direct investment (hereafter FDI) flows that, according to 'knowledge capital theory,' provide firms with incentives to reorganize production in ways that are sometimes anagolous to trade. According to Markusen and Maskus (2002; 2002), firms in traded industries face three options: they can either remain domestic, internationalize 'horizontally' by dividing similar production processes between different countries, or internationalize 'vertically' by dividing different production processes across countries. Firms follow these strategies depending on firm-level economies of scale and the costs of trade and FDI. Horizontal FDI aims to facilitate access

to foreign markets, and trade and horizontal FDI are therefore substitutes. Vertical FDI aims to take advantage of lower labor costs in countries with relatively abundant labor, and trade and vertical FDI are complements because component parts return to the home country for completion of the production process. Empirical evidence provides evidence for the link between firms incentives to pursue vertical FDI with the relative abudance of low-skilled labor in host countries (Hanson et al 2001). The pursuit of vertical FDI therefore increases the risk of skill obsolescence among low-skilled workers by shifting their low-skilled jobs to low-wage countries, similar to the trade argument.

Skill based technological change involves transformations in production technology that favor skilled labor over unskilled labor by increasing its relative productivity. Initial studies assumed that technological change was factor neutral and therefore influenced all workers equally (e.g. Solow 1957), but recent work finds evidence that technological change produces factor- and sector-specific effects (Chusseau et al 2008; Haskel & Slaughter 2002). On the basis of the different logics outlined above, scholars explain the clear trend towards increased demand for higher skills and waning demand for low skills (Autor et al 2006; Bresnahan et al 2002; Geishecker ; Nickell & Bell 1995). Skill based technological change therefore increases skill obsolescence by reducing the returns to low-level skills.

Beyond the increased obsolescence of low-level skills, broad types of skills also face obsolescence either because they have become redundant to the production process or because new skills become relatively more imporant. To begin, firm-specific skills face higher obsolescence in recent times. Firm displacement due to trade and financial liberalization as well as shorter terms of tenure increases the obsolescence of various firm-specific skills since workers who lose their position in a firm can no longer apply these skills to new jobs.

Sectoral employment shifts and skill based technological change also create new skill needs. An oft-cited skill requirement includes cognitive skills, which are mental skills used in gaining knowledge such as reasoning, perception and intuition. Furthermore, in contrast to product-specific skills dominant in the industrial period, the focus today is on problem solving, entrepreneurship,

communication, and social skills (Bengtsson 1993; Green et al 2000). Since service sector jobs typically involve face-to-face interaction, an ability to communicate and interact with a broad range of individuals greatly facilitates business. High rates of service sector growth thereby generate high demand for social skills.

Skill based technological change also calls for cognitive skills due to the need to work with and create new technologies. Frequently cited in the literature is the development of information and communication technologies, the impact of which is most often captured by the expansion of computer-based technologies. Demonstrating the salience of this technology for changing skill needs, studies indeed show that skill-upgrading occurs at highest rates in computer-intensive sectors (Autor et al 1998). Computers represent what Rosen (1975, pp. 199-200) labels a vintage effect, which occurs when "stocks of knowledge available to society change from time to time [and] capital losses are imposed on those embodying the earlier knowledge and skills." The capacity to function within a computer-based environment demands new competencies: "Effective use of computer systems calls for new cognitive skills, having a deep understanding of one's own organization and one's customers' needs. Even those managerial and professional workers who never touch computers are having their work transformed in this way, calling for more and more complex bodies of skill and knowledge" (Bresnahan et al 2002). The development of new technologies therefore calls for a new type of worker with the capacity to operate these technologies and apply them to existing work practices.

Additionally, business in a service-based technologically advanced society is more customer-orientated than was production in the industrial period. This tendency acquired the label mass customization, which stems from computer-based advancements that make the unification of low unit costs with mass production processes with the flexibility of custom-design possible (Pine 1999). Although the occurrence of long supply chains inhibits the development of mass customization, facilitating greater individualization on a mass scale defines a current shift in production strategies and management techniques.

In sum, the need to operate both with new technologies and more closely with customer needs increases demands for cognitive skills. In constrast to the skills required during the period of industrialization, the new period places more value on the ability to analyze and incorporate information quickly into the production process. Individuals who fail to adapt to these new skill needs face obsolescence, because their existing skill set does not suffice to compete effectively on the labor market.

The higher emphasis on cognitive skills in a postindustrial period belies a larger transformation in the nature of production. According to scholars of the 'knowledge economy,' the continued obsolescence of skills is a characteristic feature of the current era. The roots of the knowledge economy can be traced to innovations in scientific and information technology and can be defined as "production and services based on knowledge-intensive activities that contribute to an accelerated pace of technological and scientific advance as well as equally rapid obsolescence" (Powell & Snellman 2004, p.201). David and Foray continue this line of thought and, acknowledging the critical role of knowledge in economic growth, explain that "the crux of the issue lies in the accelerating (and unprecedented) speed at which knowledge is created, accumulated, and, most probably, depreciates in terms of economic relevance and value" (David & Foray 2003, p. 21). Though defining knowledge frustrates analysis, some describe the salience of knowledge as the heightened need of 'articulating and integrating' information into activities (Winch 2003) or the importance of 'know-why' (more theoretical knowledge), 'know-how' (skills), and 'know-who' (networks) as compared to 'know-what' (facts) (OECD 1996).

The breadth and depth of the knowledge economy remain controversial. Whereas some research views these changes as structural, influencing the whole economy (Bell 1973; Romer 1990), other research focuses more narrowly on productivity growth in certain industries (Brynjolfsson & Hitt 2003). Another strand of this literature looks at the capacity for knowledge transfer within the firm (Nonaka & Takeuchi 1995; Prusak 1997), which implicitly upholds a widespread view that the diffusion of new technologies depends on the development of complementary institutions and policies (Bengtsson

1993; David 1990). Beyond a handful of fields such as biotechnology where high levels of R&D and patents clearly demonstrate innovation, the extent to which the knowledge economy affects all workers is difficult to quantify.

Attemtps to gauge the development of the knowledge economy tend to focus either on stocks of knowledge including human, organizational, and intellectual capital or on activities including investment in training and information technology, R&D expenditure, and organizational reform (Powell & Snellman 2004). By far, however, the most commonly used measure of knowledge intensive production is patent data. High quality US patent data is publicly available (Hall et al), and demonstrate an upward trend since 1983 that takes off in the late 1990s, particularly in biotechnology and semiconductors. Finland provides a European example. Based predominantly on paper and forestry production in 1960, the growth in telecommunications and multiplex communications overtook these traditional industries in terms of patent size in 1994 (Powell & Snellman 2004). Additional support for the growth of knowledge intensive production shows an increase in the share of high tech patents in Finland, from 8.9 percent in 1990, to 30.3 percent in 1995, and 51.6 percent in 2000 (Powell & Snellman 2004; Zoppè 2002). The more salient role of knowledge in the production process increases the risk of skill obsolescence, because new 'vintages' are constantly developed, thereby reducing the relative value of existing skills. Since skills become obsolete quickly, individuals who fail to learn new technologies stand the risk of becoming obsolete as well.

To summarize, economic changes in the last few decades of the twentieth century altered the level and types of skills necessary to find stable employment. In some cases, jobs may simply no longer exist that use the workers' existing skills. This is the case where firms become insolvent or move abroad as well as in cases where workers' firm-specific skills lose value because they become redundant. Skill obsolescence also occurs when new skill needs reduce the relative value of workers' existing skills. This occurs due to new skill needs generated by both technological change and sectoral shifts in production.

These changing skill demands influence the capacity of individuals to retain their productivity in their current job or find similar employment positions. The degree of skill obsolescence inflicted by these economic changes varies by position, firm, sector and country. To minimize the effects of skill obsolescence, namely unemployment or job instability, it is necessary to anticipate obsolescence and adjust accordingly in terms of either gaining skills or changing employment. Participating in training holds the potential to reduce the negative consequences of skill obsolescence. Assessing the influence of lifelong learning on skill obsolescence, de Grip and van Loo find that training decreased the chance of unemployment or early labor market exit among workers (Allen & De Grip 2005). The study also showed proof that training occurs more often in jobs with high rates of obsolescence and that a decrease in training activity increases the probability of future job loss. Drawing on these insights, the next section explores how education can mitigate the negative consequences of skill obsolescence.

Education and Labor Market Risks of Low-Skilled Workers

Education policy represents an obvious policy area for addressing declining value in workers' human capital investment. For clarity, education systems include the rules, regulations and institutions that govern entry into new forms of education (prerequisites and costs), the content of education courses (curriculum), and the way in which skills are formally certified (categorization of skills, formal acknowledgement). Due to difficulties in collecting data and validating comparability, the issue of curricula is not addressed in detail here. The role of curricula differences in explaining responses to skill obsolescence is therefore only handled cursorily as part of the discussion on skill forecasting and state planning.

Highly relevant international organizations recognized the potential of education policy to address heightened labor market risk. In response to the increased incidence of labor market marginalization and the development of the knowledge economy, both the OECD and the World Bank developed agendas for education reform. The OECD's Schooling for Tomorrow Programme and the World Bank's report, Lifelong Learning for the Global Knowledge Economy, encapsulate the views of these organizations. Both institutions call for governments to address the salient role of knowledge in

today's economy by expanding opportunities to learn throughout the career as well as preparing young children to cope in a technologically advanced economy. However, while both agendas forward the idea of 'learning to learn,' the World Bank policy promotes a policy of competitive individualism whereas the OECD focuses more on institutional configurations that support the sharing of knowledge (Robertson 2005). The difference between these responses suggests the diversity of possible responses to economic change.

Scholarly literature on the role of education policy in addressing the issue of labor market integration of low-skilled workers in the knowledge economy is rarer. An EU-funded project at Uppsala University found that research on education reform rarely addressed aspects of social exclusion and inclusion (Popkewitz et al 1999). Perhaps also complicating the analysis of the effects of education policy, Arnesen and Lundahl (2006) also recognize that: "[i]n contrast to other parts of the welfare apparatus, e.g. health care and social services, education is supposed to serve several masters simultaneously. Not only should it provide the individual citizen with a certain safety and social connection, it must also contribute to economic growth by producing human capital" (286). It may indeed be imperative for education policy to address multiple concerns at the same time to be effective. Discussing the failure of neo-liberal policies in the UK to create a high-skills equilibrium, Lloyd and Payne (2003) contend that "[p]rogressive educational reform cannot be separated from the struggle for broader political, social and economic change" (102). Also, since education serves 'multiple masters,' there may be trade-offs in reforming education policy to address changed economic conditions. For instance, emphasizing science and technology may diminish the quality of arts and humanities education (Bullen et al 2004). In this way, addressing the risks facing low-skilled workers in the knowledge economy necessarily influences different issue areas simultaneously, such as cultural, social, and economic concerns, and the possibility exists that responding to changed economic conditions may neglect social and cultural aspects of education policy.

Despite the relative lack of comprehensive studies on the role of education reform in addressing new skill needs, fields such as political science, economics, sociology and comparative education

demonstrate a long history of assessing the diversity in educational institutions and their consequences for various micro and macro outcomes. Political science work shows that Social democratic parties tend to spend more than other parties on all levels of education (Busemeyer 2008; Iversen & Stephens 2008), right parties spend less than other parties (Busemeyer 2007), and Christian democrats spend relatively less on primary and tertiary education than their Scandinavian neighbors (Iversen & Stephens 2008). Economists recognize the role of education in economic growth (e.g. Barro 1997; Romer 1994). Working predominantly on the micro level, sociologists consider the stratifying effects of education policy (e.g. Kerckhoff 2001; Müller & Shavit 1998; Shavit 2007; Shavit et al 1998). Comparative education scholars explore education policy in different nations and investigate the social, economic, and political factors that explain the variation (e.g. Boli et al 1985; De Bruijn & Howieson 1995; Finlay & Niven 1996; Grollmann & Ruth 2006). The theory that I delineate below shares the sociological perspective on stratification, particularly among the low skilled, though the independent variable of interest remains the macro structure of educational institutions. The analysis tries to understand how these structures influence the labor market integration of marginalized workers. The richness of the economics, sociological and comparative education research helps to develop a model of how education systems influence reintegration efforts. Analyzing the politics of education reform, moreover, helps to address the question of why countries fail to invest highly in human capital and why some social groups face relatively higher labor market risk than others. Drawing on these various explanations of factors influencing educational spending, the structural of education institutions, and the social and economic ramifications of education policy, the following section builds upon this discussion to develop a model of how education institutions can mitigate the heightened risk of skill obsolescence.

Building a Theoretical Model for the Relationship between Education Policy and Labor Market Integration

In order to flesh out how education institutions can reduce the risk of skill obsolescence, I draw out two theoretical dimensions along which education policy varies. The unit of analysis is for both

dimensions is the skill set of an individual. I am interested in ways in which education institutions facilitate the adjustment mechanism of a (partially) obsolete skill set to a non-obsolete skill set. In my conceptualization, this can occur in two ways: either by acquiring new skills or by making existing skills more transparent to economic actors. First, education institutions can create the capacity or opportunity for individuals to acquire new skills. For example, in terms of cognitive ability, education systems can endow individuals with a strong initial education that makes it easier for them to acquire skills later in life. In terms of opportunities, education institutions can provide financial relief or mandate firms to provide training. Therefore, education policy can be understood as reducing the risk of skill obsolescence by investing in cognitive capacity and providing opportunities to gain new skills. For conceptual clarity, I will call this dimension the skill acquisition dimension.

Second, education institutions influence the transparency of individuals' skill sets, where transparency refers to the formal recognition of skills and the acknowledgement of shared skill sets between different academic degrees and professional occupations. Skills are typically learned as part of a broader group of similar or related skills. To the extent that educational degrees and job descriptions only acknowledge a skill as belonging to a specific academic degree or occupational profession, overlap between the skill sets of different educational degrees or professions does not receive acknowledgement. If authorities begin to recognize individually the various skills included as part of educational degrees or job descriptions, it becomes possible to measure the degree of overlap between of different degrees or professions. By extension, the coursework necessary to change professions can be developed. In education systems that facilitate skill acquisition and skill transparency, skills at the lower end of the distribution should be relatively higher and the incidence of employment precariousness should be relatively lower. I call this dimension the skill transparency dimension.

The two concepts underlying these two dimensions, skill acquisition and skill transparency, align closely with the concepts of vertical and horizontal organizational differentiation developed by Aage Sorensen (1970). Vertical differential refers to division of student cohorts into different ability groups, whereas horizontal differentiation implies division according to different types of curricula. This

comparison is useful because it provides an example of a study that links education structures to the distribution of skills within a given social group. However, whereas Sorensen was interested in the effect of school organization on student achievement, I am interested in the national structure of education policy more generally and the consequences for the skills, defined by level and transparency, of workers trained within that national structure.

To recapitulate, the theoretical argument developed above contends that education policy holds the potential to reduce the risk of skill obsolescence and does so by expanding opportunities either for individuals to acquire skills or by increasing the transparency of existing skills. Policies that expand opportunities to acquire skills constitute the skill acquisition dimension, and policies that improve skill transparency make up the skill transparency dimension. The observable implications of these two theoretical dimensions include expectations about skill levels and training behavior. In particular, high rankings on the skill acquisition and skill transparency dimension should be linked to higher average skill levels and training rates. Policies promoting skill acquisition will endow workers with strong cognitive skills that enable them to learn relatively efficiently and increase incentives to take up post-compulsory education due to higher expectations of success. These policies will also make opportunities to acquire skills relatively more affordable and abundant. The logic behind these observable implications in terms of skill transparency is a bit different. Where education policies increase skill transparency, workers will find it easier to enter new forms of training because their educational background, particularly initial and informal education, will qualify them for a relatively broader array of education opportunities.

Index Composition

Following from the theoretical discussion, I now develop empirical measures for the dimensions of skill acquisition and skill transparency. For each dimension, available measures of educational institutions, regulations or policies capture an aspect of skill acquisition or skill transparency, respectively. Please see the appendix for measurement of the variables included in this analysis.

For the analysis, the direction of the hypotheses is presumably consistent across all labor market groups, although the effect may be stronger for some than for others. The selection of these variables suffered from considerable data restrictions, because finding cross-nationally valid measures that are at once reliable across countries and simultaneously express much of the variation in countries' opportunities to enter new forms of education remains difficult.

To build the skill acquisition dimension, I measure nine variables that cluster into three groups. All nine variables express ways in which educational institutions facilitate or frustrate entry into further education. Making the link between education policies and training behavior follows two logics. Addressing how education policy influences the capacity to learn, the first four variables speak primary to the investment in future workers' cognitive capacity. The second set of variable speaks to the way in which education institutions restrict access to education before the end of compulsory education. The final set of variables focuses on post-compulsory education and captures the barriers to entering tertiary, continuing education, and active labor market policies. I will briefly elaborate on these variables below.

In order to capture the investment of education policy in individuals' cognitive capacity, the first group measures public investment in education. Whereas pre-primary and primary education provides workers with cognitive abilities to learn more efficiently (Esping-Andersen 2005), investment in secondary and tertiary education provides a base of reading, writing and reasoning skills that improve learning capacity. Following previous work measuring quality of education (Barro & Lee 1996; Dustmann et al 2003), I use education spending as a measure of school quality. Although many issues persist in assessing the relationship between school quality and education outcomes, the literature does demonstrate a link between school quality and both future earnings and educational attainment (Card & Krueger 1998).

The second group of variable constituting the skill acquisition index captures the degree to which the structure of educational institutions, on the secondary level, shapes the probability of entering further

forms of education. A central difference between education systems is in whether students follow different tracks and face an option of entering vocational education. These two institutional structures relate to each other, although they are not synonymous. On the one hand, vocational education historically receives positive acclaim for increasing students' employment chances. Vocational education facilitates both matching of skills to employers' needs (Scherer 2005), fulfils a safety net function (Arum & Shavit 1995; Shavit & Müller 2000), and has been shown to increase participation in continuing vocational training (Blog 2007). Although vocational systems appear to face challenges in recent periods, particularly with respect to firms' willingness to invest in apprenticeships, the merits of vocational training in providing students with useful occupational skills continues to be strong.

At the same time, such systems often carry with them reputational costs when students who follow vocational tracks are separated institutionally from the higher performing students. This separation signals to students and teachers alike the expected lower potential of this group, which may influence how these students perceive their future goals and, by extension, their ambitions in the labor market (see review by Arum & Shavit 1995). Therefore, I construct a variable for vocational training that codes countries that divide students according to ability before the end of compulsory education as '0' and all other countries according to the percentage of each student cohort that enters apprenticeship training. As such, this variable aims at capturing the labor market benefits of apprenticeship training while controlling for the disadvantages of such a system it terms of limiting students' perspective too early.

The third group of variables that I consider include measures of the ways in which the state reduces barriers to post-compulsory education. I consider the total commitment of countries to providing financial aid and, in light of the growing relevance of tertiary education for job security, I consider the cost barriers to entry into tertiary education. Low costs and available financial support improve chances for access to tertiary education (OECD 2000, 2002). With respect to continuing training, I include a variable for the regulation of continuing training. The regulation of continuing training increases worker participation in training (Billett & Smith 2005; Hall et al 2002; Smith & Billett

2006), and countries are coded according to the level at which training is mandated. Finally, I include a variable for the level of expenditure on active labor market policies divided by the unemployment rate with the expectation that spending effort on active labor market policies improves the employment prospects of program participants (Bradley & Stephens 2007; Kenworthy 2003).

Having discussed the variables that comprise the skill acquisition dimension, I turn now to skill transparency. Six variables that fall into three groups express how education policy can facilitate skill transparency. Skill transparency plays a large role in reducing the risk of skill obsolescence, but in order to clarify how it is necessary to explain what is being made transparent and to whom. First, skill forecasting plays a key role in illuminating general trends in skill demands, which, if taken seriously by policy-makers, can lead to updated curricula and modernized occupations (Neugart & Schömann 2002b). In this case, skill forecasts make new skill needs more transparent, which should help educational institutions adjust their curriculum and students match firms' needs with greater accuracy.

The next set of variables speaks to the degree to which qualifications are made transparent. First, the centralization of the qualification system increases transparency of earned qualifications across federal units (Blog 2007). Recognition of prior learning increases transparency by linking informal learning to formal educational classifications (Colardyn & Bjornavold 2005). Firms' use of external training institutions is first important because firm training is seen as central to a nation's skill profile (Lloyd & Payne 2002) and because the information about training from external institutions servicing many firms will be relatively more available.

The final set of variables goes one step further than the previously discussed by highlighting complementarities between different qualifications. A framework for linking different occupations illuminates shared skill sets between occupations and thereby facilitates occupational mobility (Blog 2007), and unitized qualifications, or modules, increase the pathways between vocational education and training and higher education (De Bruijn & Howieson 1995).

To construct each index, I conducted factor analysis. The results provided evidence for a single latent factor for each dimension based on the scree plot of the eigenvalues created with unrotated factor loadings. The first factor is therefore scored and used as the country values in the rest of the analysis.

Results

The tables below display the two indices of skill acquisition and skill transparency.[1] Given the recognition that political incumbency influences education spending, I will discuss the results using Esping-Andersen's (1990) concept of a welfare state regime: the Social Democratic regime includes countries where social democratic parties dominated the government; the Conservative or Christian Democratic regime includes those countries where Christian democratic parties were most prominent in government; and the Liberal regime refers to countries where right parties were dominant. The remaining countries in the study will be classified by geographical location (Mediterranean, East European), except for Japan, which will be referred to by name.

A brief glance over the two dimensions reveals the differences between the rankings and perhaps a surprising lack of clustering around groupings such as welfare state regimes or varieties of capitalism. One exception seems to be the Social Democratic countries, which receive high scores for both skill acquisition and skill transparency. The diversity in the Christian Democratic countries is evident on the skill acquisition dimension with Belgium, Italy, the Netherlands and Austria ranking quite high and Germany and Switzerland low. In terms of skill transparency, the Netherlands remains highly ranked, but Germany, Austria, Switzerland, and Italy receive low scores. Despite these shifts, however, Christian Democratic welfare states can be described as scoring about average on both dimensions.

The ranking of the Liberal welfare states demonstrate changes the most between the two dimensions. On the skill acquisition dimension, almost all Liberal states receive below average scores. On the skill transparency dimension, however, only the United States remains low on the ranking. All the other

[1] Appendix A and B explains the measurement and sources for the indices.

countries receive substantially higher scores, and New Zealand and Australia even receive the rank of 1 and 2, respectively.

Eastern European countries generally remain lower on the rankings of both dimensions with the exception of Slovenia, which scores high in terms of skill acquisition.

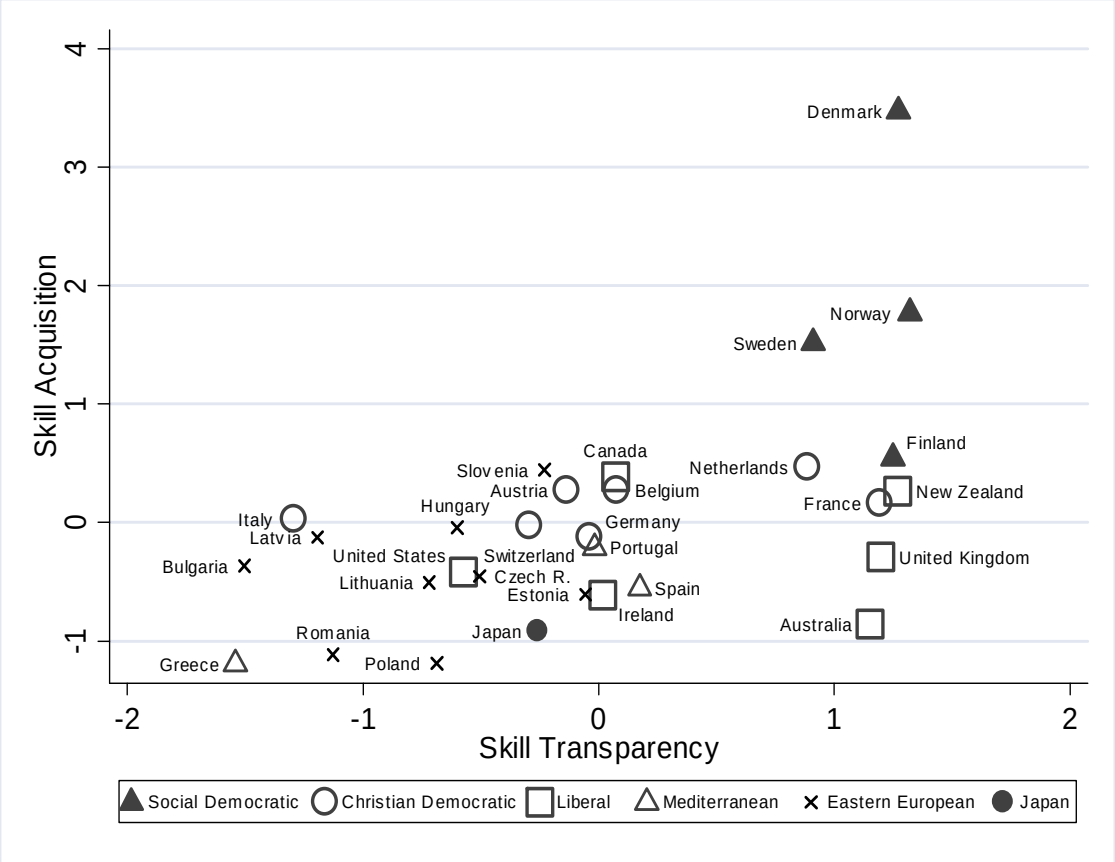
Table 1. Acquisition Dimension

Country	Access
Denmark	3.47
Norway	1.77
Sweden	1.52
Finland	0.55
Netherlands	0.47
Slovenia	0.44
Canada	0.39
Belgium	0.27
Austria	0.27
New Zealand	0.26
France	0.16
Italy	0.03
Switzerland	-0.03
Hungary	-0.04
Latvia	-0.13
Germany	-0.13
Portugal	-0.21
United Kingdom	-0.29
Bulgaria	-0.37
United States	-0.42
Czech Republic	-0.45
Lithuania	-0.51
Spain	-0.55
Estonia	-0.61
Ireland	-0.61
Australia	-0.86
Japan	-0.92
Romania	-1.12
Poland	-1.19
Greece	-1.19

Table 2. Transparency Dimension

Country	Transparency
Norway	1.32
Denmark	1.27
New Zealand	1.27
Finland	1.25
United Kingdom	1.20
France	1.19
Australia	1.15
Sweden	0.91
Netherlands	0.89
Spain	0.17
Belgium	0.08
Canada	0.07
Ireland	0.02
Portugal	-0.02
Germany	-0.04
Estonia	-0.06
Austria	-0.13
Slovenia	-0.23
Japan	-0.26
Switzerland	-0.29
Czech Republic	-0.51
United States	-0.58
Hungary	-0.60
Poland	-0.69
Lithuania	-0.72
Romania	-1.13
Latvia	-1.19
Italy	-1.29
Bulgaria	-1.50
Greece	-1.54

Figure 1. Dimensions of Education Systems: Skill Acquisition and Transparency



Validation

Having created an index that captures how educational institutions portend to reduce the risk of skill obsolescence, I now provide some evidence of the observable implications for the theory in order to validate the construction of the index. First, I will provide evidence that the skill acquisition dimension captures to a high degree the extent to which the education system develops cognitive capacity and provides opportunities to enter into new forms of education. Then, I will turn to the skill transparency dimension and provide some evidence that the index expresses how eduction systems provide formal recognition of individuals' skill as well as the degree of overlap between different professional skill requirements.[2]

The theory explained that different elements of the education system facilitate skill acquisition by developing cognitive skills and reducing barriers to pursuing further education. If the index for the

[2] Due to missing data, the countries that are included in the different correlations vary. Refer to the appendix for more information.

skill acquisition indeed promotes the attainment of new skills, the index should correlate highly with data for cognitive abilities and participation in various forms of education. As such, I correlate the index with measures of both low and information age literacy.[3] Cognitive ability, along with reduced barriers to education, should also increase training and overall labor market success after compulsory education. For these reasons, I also correlate the skill acquisition index with measures of training incidence, including percent of early school-leavers, tertiary education enrolment, participation in continuing education and recent participation in lifelong learning, as well as measures of unemployment among school-leavers with only a secondary degree.

All of the correlations receive the correct sign. As predicted, the index varies negatively with the measure of low literacy and positively with the measure for information age literacy, which suggests that investments in cognitive capacity improve skills on the low end of the distribution and at the high end. The following four variables provide evidence that the index capture the facility with which individuals enter education. The index correlates negatively with the percentage of individuals between 18 and 24 with only a secondary school degree and not currently in training; the index correlates positively with measures for tertiary education enrolment, continuing training among workers, and recent participation in lifelong learning among the working age population. Finally, looking at labor market outcomes among low-skilled workers, the results demonstrate that higher rankings lead to better employment prospects. I focus here on low-skilled workers, because the structure of the education system portends to have the largest effect on these workers. As case in point, unemployment among primary and secondary school leavers is lower for higher rankings. The gap in employment levels between those with a tertiary degree and those with a secondary degree narrows at higher rankings.

[3] The data for these variables comes from the Adult International Literacy Survey. "The IALS employed a sophisticated methodology developed and applied by the Educational Testing Service to measure literacy proficiency for each domain on a scale ranging from 0 to 500 points. Literacy ability in each domain is expressed by a score, defined as the point at which a person has an 80 per cent chance of successful performance from among the set of tasks of varying difficulty included in the assessment" Kahn LM. 2000. Wage Inequality, Collective Bargaining, and Relative Employment from 1985 to 1994: Evidence from Fifteen OECD Countries. *The Review of Economics and Statistics* 82:564-79.

Table 3. Validity Check: Skill Acquisition

	Coefficient		P-Value
Low Literacy[a]	-0.611	*	0.007
Information Age Literacy[a]	0.588	*	0.010
Percent Early School Leavers[b]	-0.275		0.183
Gross Tertiary Enrolment[c]	0.349		0.059
Participation in Continuing Education[a, b, c, d]	0.494	*	0.006
Percent in Recent Training Activity[b]	0.684	*	0.000
Unemployment - Primary School[b]	-0.363		0.074
Unemployment - Secondary School[b]	-0.547	*	0.005
Employment Gap - Tertiary – Secondary[b]	-0.573	*	0.003

Sources: [a] Adult Literacy Survey; [b] Eurostat; [c] UNESCO; [d] (Kurosawa 2001; Medvešek-Miloševič 2007).

A similar group of variables demonstrates the validity of the skill transparency dimension, insofar as skill transparency improves individuals' labor market chances. Since workers with high-level skills should face better chances of finding employment in any education system, I focus on the labor market prospects of low-skilled workers.

The results provide strong support for the relation between high-levels of skill transparency and the chances that low-skill workers avoid unemployment. As the theoretical discussion explained, the skill transparency dimensions facilitates training both by improving the chances that prerequisites are met as well as by revealing overlap between various skill sets.

Table 4. Validity Check: Skill Transparency

	Coefficient		P-Value
Low Literacy[a]	-0.499	*	0.031
Information Age Literacy[a]	0.585	*	0.011
Percent Early School Leavers[b]	-0.219		0.294
Gross Tertiary Enrolment[c]	0.430	*	0.018
Participation in Continuing Education[a, b, c, d]	0.714	*	0.000
Percent in Recent Training Activity[b]	0.716	*	0.000
Unemployment - Primary School[b]	-0.375		0.065
Unemployment - Secondary School[b]	-0.484	*	0.014
Employment Gap - Tertiary – Secondary[b]	-0.569	*	0.003

Sources: [a]Eurostat; [b] UNESCO; [c] (Kurosawa 2001; Medvešek-Miloševič 2007).

These calculations therefore provide evidence for the validity of the education system indices. Higher rankings on the skill acquisition and transparency dimensions lead to higher training activity and better labor market outcomes among low-skilled workers.

Implications for Integration

Given that education system influences the skills levels and training of workers, a further extension of this argument is that education systems improve the efficiency of programs that facilitate the reintegration of marginalized workers. In general, low-skilled workers face a much higher risk of unemployment. In countries with high rankings on the skill acquisition and transparency dimensions, however, the skills of these workers will be relatively strong and more visible to employers than in countries with low rankings. Since the original index for skill acquisition included a variable for active labor market policies, I have removed this variable for these correlations so that the indices do not correlate with the various measures of active labor market policies.

Table 5. Education and Integration through ALMP

	Skill Acquisition		Skill Transparency	
	Coefficient	P-Value	Coefficient	P-Value
Spending on Active Labor Market Policies	0.698 *	0.000	0.526 *	0.010
Subsets of ALMP: Training	0.793 *	0.001	0.498 *	0.013
Subsets of ALMP: Recruitment	0.712 *	0.000	0.219	0.303
Subsets of ALMP: Disabled	0.488 *	0.016	0.333	0.112
Subsets of ALMP: Direct Job Creation	-0.035	0.872	0.193	0.366

Source: OECD.

Indeed, the correlation of the two indices with an aggregate measure of active labor market spending (of GDP weighted by the unemployment rate) shows a strong relationship. Breaking down spending on active labor market policies shows that not all aspects of active labor market policies correlate highly with skill acquisition and transparency. High rankings on the educational system indices relate to high spending on training and, in the case of skill acquisition, on recruitment subsidies and support for the disabled. Neither index correlates highly with spending on direct job creation, nor are the results for the skill acquisition dimension actually negative. Given the relative success of training and recruitment subsidies and failure of direct job creation programs, a potential interpretation of these findings could be that high investment in education and transparent certification procedures improves the efficiency of active labor market policies.

Conclusion

In this article, I highlighted the new risk of skill obsolescence as a key challenge for education policy-makers. Due to skill-biased technological change, trade, financial liberalization, and the growth of the knowledge economy, the potential for the education system to address the heightened risk of skill obsolescence has increased. However, some countries continue to invest little in education and fail to certify skills in a way that is transparent to all economic actors.

Drawing on the education policy literature, I constructed two indices that aimed at capturing the degree to which education systems in thirty countries were prepared to meet the challenge of high skill obsolescence. The high correlation between the indices, on the one hand, and information age literacy

and recent training activity to name a few of the results presented, on the other, presents some confirmation for the idea that expanding opportunities to learn and ensuring skill transparency improve individuals' ability to fare well in the new economy. The analysis also suggested that education policy plays a supporting role in the functioning of active labor market policy by improving the skills of marginalized workers and making these skills more transparent.

Two main caveats are in order. First, the approach is admittedly extremely macro in nature. Therefore, additional research is necessary to test whether the education policies discussed in this article are indeed beneficial to all types of workers and the low skilled in particular. Second, given that education policy fulfills multiple goals, it remains to be seen whether some countries did not pursue policies related to high scores on the skill acquisition and skill transparency indices because of these policies conflicted with other social, political, or economic goals.

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Appendix: Codebook for Skill Acquisition and Skill Transparency Indices

Skill Acquisition Index: The first four measures consisted of average spending on education as a percent of GDP per pupil and distinguished between pre-primary, primary, secondary, and tertiary education between 1999 and 2006 (Source: UNESCO).

The next measure is constructed by first coding countries that separate students according to ability as '0' and then, for the remaining countries, calculating the percent of each student cohort that enters apprenticeships (Source: www.inca.org, http://www.eurydice.org, www.oecd.org/edu/eag2007).

The next four variables looked at post-compulsory education. The measure for tertiary financial aid was spending on financial aid as a percentage of government expenditure on tertiary education (Source: Education at a Glance 2007, Table B5.2.). The next variable for financial aid was spending on financial aid as a percentage of education expenditure (Source: Eurostat, Education at a Glance, OECD, 1998). The third variable for post-compulsory education included spending on active labour market policies as a percent of GDP (Source: OECD). The final measure captured the degree of regulation over continuing training. The coding scheme is the following: 0: training decisions predominantly made on firm level; 1: training decisions predominantly made through collective agreements; 2: training is regulated through legislation or controlled through an obligatory levy on firms. A report from Eiro-online supplied the data for Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Netherlands, New Zealand, Sweden, Switzerland, UK, and US. (Caprile & Llorens 1998). Data for the remaining countries came from the following sources: Australia (Cully 2002); Bulgaria (Neykov 2004); Canada (Betcherman et al 1998); Czech Republic (Hála & Kroupa 2005); Estonia (Karu M & K. 2007); Greece (Papadogamvros 1998); Hungary (Whitman 2003); Italy (D & V. 2002); Japan (Gasskov 1994); Latvia (Karnite 2004); Lithuania (Blaziene & Gruzevskis 2005); Norway (Nergaard 1999); Poland (Sroka 2005); Portugal (de Paz et al 2007); Romania (Preda 2004); Slovenia (Kanjuo Mrčela & Kajič 2005); Spain (Albarracín 2005).

Skill Transparency Index: The first measure captured the institutionalization of skill forecasting: countries with established practices dating back to before 1970 received a value of 2; countries that had conducted skill forecasts since around 1990 but did not do so with any regularity or use the results to inform policy received a value of 1; countries that had little to no history of skill forecasting received a score of 0. Specific sources for each country include: Australia (Isaac 1960; Kane & Stanton 1991); Austria (Lassnigg 2002); Belgium (ILO 2007); Bulgaria (2007); Canada (Ahamad & Blaug 1973; Boswell et al 2004); Czech Republic (Havlíèková 1999); Denmark (Lindskog 2004); Estonia (Zukersteinova & Strietska-Ilina 2007); Finland (Zukersteinova & Strietska-Ilina, p.73); France (Ahamad & Blaug 1973; Zukersteinova & Strietska-Ilina 2007, p.15); Germany (Boswell et al 2004, p. 25; Havlíèková 1999, p.18); Greece (Zukersteinova & Strietska-Ilina 2007, p.97); Hungary (Schmidt et al 2003); Ireland (Zukersteinova & Strietska-Ilina 2007, p. 18); Italy (Zukersteinova & Strietska-Ilina 2007); Japan (Neugart & Schömann 2002a); Latvia (Jakobsons 2006); Lithuania (Gruzevskis & Sventickaite 2006); Netherlands (Zukersteinova & Strietska-Ilina 2007, p.17); New Zealand (Papps 2001); Norway (Lindskog 2004); Poland (Havlíèková 1999, p. 155); Portugal (Sellin 2000, p. 129); Romania (Zukersteinova & Strietska-Ilina 2007); Slovenia (Havlíèková 1999); Spain (Neugart & Schömann 2002a); Sweden (Ahamad & Blaug 1973); Switzerland (Gilomen 2002); United Kingdom (Wilson 1994); United States (Boswell et al 2004, p. 32; Zukersteinova & Strietska-Ilina 2007, p.15).

The next set of variables looked at how qualifications were certified. The variable for centralized education policy captures the degree to which the qualifications system of a given country is unified throughout its regions and control lies with one main agency or with government. Possible responses include: 3. This is definitely true for my country; 2. This is only partially true for my country; 1. There is only limited experience of this in my country; and 0. This is not present in my country (Source: (Blog 2007)). The variable for the accreditation of prior learning captured the existence of a clear national programme or system for recognising non-formal or informal learning. The coding scheme is the same as for the centralization variable (Source: (Blog 2007)). The final variable measured the

percentage of training firms who used training institutions external to the firm. (Source: CVTS II, (Dawe 2003)).

The final set of variables captured the presence of policies that recognized complementarities between qualifications. The first variable assesses the degree to which countries have with an explicit framework linking qualifications from different educational and occupational sectors. The coding scheme is the same as for the centralization variable (Source: (Blog 2007)). The next variable measures the degree of modularization of the education system. The coding scheme is the same as for the centralization variable (Source: (Blog 2007)).