

# Skill change and skill matching in the labor market: A cross-national overview

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Reward attainment in the labor market is dependent on how well worker skills are matched with job requirements. Two aspects of skill matching are particularly important from a welfare point of view. First, the psychological payoff of having a high-skill job depends positively on the skills of the worker (up to the point where the job demands cease to be challenging). At low levels of worker skills, the psychological payoff of job complexity may be zero or negative. Second, both economically and psychologically, the payoff to worker skills (such as education) depends positively on the skill requirements of the job. At an aggregate level, changes in the distribution of wages are commonly believed to be closely tied to changes in the balance between skill demand and skill supply.

It is well-known that the average level of education has risen significantly in advanced industrial nations in recent decades. There is also a wide-spread but contested view that the average skill level among jobs has risen even faster, due mainly to two developments: technological change and globalization. The supposed excess demand for skills is widely used as an explanation for the observed increase in wage dispersion in several (but not all) countries. The relationship between skill and wage movements is assumed to be especially tight in labor markets with relatively uncoordinated ("flexible") systems of wage determination. In more coordinated ("rigid") labor markets, an increase in skill demand is sometimes supposed to instead raise unemployment among the low-skilled. Krugman (1994) was one of the first to formulate this trade-off between wage inequality and unemployment (i.e., between price and quantity effects of skill demand shifts).

This paper reviews contemporary research on skill change and skill matching in the labor market. Aside from giving an overview of published work, I assemble aggregate data for a number of countries to assess trends in the market for skills. Four distinct but related topics are covered: (a) how the skill requirements of jobs have changed in recent decades, (b) how worker skills, especially education, have changed during the same period, (c) how the quality of job-worker matches with respect to skills has evolved, and (d) how the distribution of wages, especially the returns to schooling, has changed. In addition, I indicate how the evolution of unemployment is related to shifts in skill demand and supply, and how country-specific labor market institutions might conceivably modify the impact of market change.

## **Changes in the skill requirements of jobs**

### Assessing skill demand

The literature on skills and wages has to a large extent avoided explicit measurement of the demand side. Instead, skill demand is often inferred from data on skill supply (usually education) and wages. This implicit strategy has been especially common in labour economics, although exceptions have recently emerged (Autor et al. 2003, Goos and Manning 2006). By contrast, in sociology and in the skill matching tradition in economics that studies overeducation, attempts are made to measure the skill requirements of jobs more directly. There are three main approaches: (a) job classification based on some kind of external judgment, (b) self-reported (by the job holder) requirements, and (c) the average or typical education among job incumbents. We focus on (a) and (b) below, since (c) conflates the supply and demand sides of skill (i.e., workers and jobs). Nonetheless, many empirical descriptions revert to (c) for lack of available alternatives.

The most common version of (a) is occupational schemas, such as the American DOT or the Swedish SEI which is very close operationally (if not theoretically) to the Erikson-Goldthorpe (or EGP) class model (see further below). Among employees, the most discriminating criterion across classes is the typical educational requirements of the occupation. (See Tåhlin 2006a for a recent theoretical and empirical analysis of the connection between social class and the skill requirements of jobs.) Large

representative data sets containing occupational information are available for many countries and several time-points.

In contrast, self-reports of skill requirements have rarely been available in nationally representative data sets, at least not to an extent sufficient to establish trends and/or allow cross-national comparisons. In Sweden, the Level of living surveys (LNU) contain self-reported educational requirements comparable across four time-points from 1974 to 2000. Similar measures are available for some other countries for some time-points. The Swedish survey question is phrased: "How many years of education beyond compulsory school are required in your job?" A similar question is used in the second wave of the European Social Survey (ESS), carried out in 2004. We make extensive use of these European data later in this chapter. The correlation between this survey item and occupational class (measured by a set of EGP dummies) is high (.72 in LNU 1991).

Apart from measuring how much (formal) education is required to get a particular job, it is essential to measure how much training on the job is required after the point of hiring. In the Swedish LNU, the question on this dimension of skill requirements reads: "Apart from the competence needed to get a job such as yours, how long does it take to learn to do the job reasonably well?" Again, a similar item is used in ESS 2004. The correlation with class (EGP) is not as high as the educational requirements indicator, but still substantial (.40 in LNU 1991).

Together, the self-reported measures of educational requirements and on-the-job training predict wage rates roughly as well as class does. In a Mincer model (ln hourly wage regressed on education in years plus experience in years and its square) including a sex dummy,  $R^2$  increases from .355 to .422 when adding educational requirements and to .446 when additionally including the OJT requirements measure. By comparison, adding class (EGP) to the Mincer model raises  $R^2$  from .355 to .465, i.e. by more but not much more than the skill requirements measures. Predictions of the residual from the Mincer model (i.e., wages net of differentials by human capital and sex) based on skill requirements (the two self-report measures) and on EGP, respectively, correlate .67.

Despite these powerful correlations, it should be noted that the measures of skill requirements are of course far from perfect. In particular, self-reported levels of educational requirements are likely to be affected not only by real job demands but also by, *inter alia*, characteristics of the national schooling system and business cycles (general labour demand relative to supply). It is therefore essential that additional indicators of the skill level of the job are used for validation purposes.

A basic distinction when assessing the evolution of skill requirements of jobs is between (1) changes in the occupational and industrial *structure* of a nation's labor market and (2) changes that occur *within* occupational and industrial categories. There is evidence from at least two countries, the United States and Sweden, that structural change is the clearly dominant of these two components. For the US case, Spenner (1983) shows that skill requirement changes within detailed occupations do occur but tend to go in both directions so that net effects are typically small. An early study by Horowitz and Hernstadt (1966) came to the same conclusion. For Sweden, le Grand, Szulkin and Tåhlin (2001a) show that shifts in the distribution of employment across broad occupational and industrial categories account for close to all the change in the average skill content of jobs between 1974 and 2000.

On the other hand, there is recent evidence from two other countries – Britain and Germany – that there is significant upgrading of skill requirements within occupational categories. Unpublished analyses for Britain (Zhou 2005), based on data from the Social Change and Economic Life Initiative (SCELI) survey 1986, the Employment in Britain survey 1992, and the Skills Surveys from 1997 and 2001, show that close to half of the rise in required qualifications in Britain during the 1990s was due to upgrading net of structural change. For the earlier period (1986-1992) the within-group share was even larger. Similarly, Spitz-Oener (2006) shows that the dominant fraction of skill upgrading in Germany between 1979 and 1999 was due to within-occupation changes in the task set of different jobs. The measures of skill requirements in the German study are rather crude, however, in that they exclusively are based on dichotomous items rather than continuous scales. In view of the conflicting results in the studies described above, an important issue for future research is to analyze different countries on the basis of more comparable data.

A broad survey of recent evidence of skill requirement change in the United States (National Research Council 1999; see also the overview in Handel 2003) questions the relevance of using traditional classification boundaries in capturing the effects of technological and organizational change. Such concerns are also reflected in the recent modification of the ISCO (occupations) and ISIC (industries) systems in the EU countries and elsewhere from the mid-1990s (see the overview in Elias and McKnight 2001). While intermittent updates of classification systems for the labor market are of course needed, they do not make structural analyses of change irrelevant or impossible. On the contrary: data on structural transformations are widely available for all advanced countries over long periods of time and may be used to achieve reliable estimates of the evolution of skill requirements. Breaks in the time series can be handled reasonably well by short periods of overlapping measurement. Other sources of information, in particular repeated surveys containing detailed questions to individuals on the skill content of their jobs, are obviously important to use continuously as corrective instruments. To repeat, however: existing evidence strongly suggests that the picture exclusively provided by analyses of structural change is likely to be sufficiently sharp for many purposes.

### Pattern of findings

Studies of several countries: A comprehensive review of cross-national variations in the evolution of skill requirements is possible to do, at least in principle, based on data on structural change. A very useful source in this regard is a collection of surveys including occupational distributions for several countries over a long period of time (Breen and Luijkx 2004: 74-75). Data for seven nations from the 1970s, 1980s and 1990s are available in the form of social class distributions among men. The applied class model is the well-known EGP schema (Erikson and Goldthorpe 1992; see also Erikson and Goldthorpe 2002), which divides employees into workers holding production and service occupations and further divides these two categories according to the typical skill requirements of their occupation. By comparing class distributions among employees in several countries over time, we get a fairly sharp picture of the international variation in trends in skill demand. As far as I know, the pattern shown in table 1 is the most detailed cross-national assessment available in the literature. A measure of average educational requirements for three time-points in each country has been estimated by assigning a skill demand value to each of four classes of

occupations: high-skill service, low-skill service, high-skill production and low-skill production. The assigned values are taken from the Level of Living Surveys (LNU) in Sweden that contain information both on the (self-reported) educational requirements of jobs and information on EGP class (based on self-reported occupation). The values are 5.1 years of required post-compulsory education in high-skill service occupations, 1.6 years in low-skill service occupations, 2.0 years in high-skill production occupations, and 0.5 years in low-skill production occupations. (Since skill values from one country are assigned to classes in other countries, no attempt will be made at making absolute skill demand comparisons across countries. I am only concerned with cross-national comparisons of within-country change.)

Table 1. Trends in skill demand in seven countries, 1970s to 1990s. Average educational requirements (years of post-compulsory schooling) in jobs held by male employees, and relative change across decades (1970s=100). Source: Own computations based on data from Breen and Luijkx (2004).

	1970s	1980s	1990s	70s-80s	80s-90s	70s-90s
France	2.19	2.45	2.56	115	105	120
Germany	2.87	2.99	3.10	106	104	109
Ireland	1.87	2.16	2.31	111	110	122
Netherlands	2.98	3.08	3.36	104	109	114
Sweden	2.54	2.67	2.84	107	107	114
UK	2.70	2.99	3.20	113	110	125
USA	2.64	2.89	3.00	109	105	115
Average	2.54	2.74	2.91	109	107	116

According to these estimates, skill demand grew considerably in all countries between the 1970s and the 1990s, but with some notable cross-national variation. The average pace of change was roughly similar in the first and the second half of the period, but only the Netherlands had a larger growth from the 1980s to the 1990s than in the earlier decade. Across the two decades, the rise in demand was especially strong in France, Ireland and the UK and comparatively slow in Germany, while Sweden, the US and the Netherlands form an intermediate group. I return to these trends below when examining international variations in the evolution of skill supply (education).

Other cross-national studies: Machin and Van Reenen (1998) and Berman, Bound and Machin (1998) are interesting studies in that they analyze several different

countries (seven and twelve OECD nations, respectively). As proxies for the skill requirements of jobs they use either the simple dichotomy between production and non-production workers or worker skills (education). These proxies are too blunt to produce much new knowledge on the evolution of skill demand.

International data sets: (1) The European Surveys on Working Conditions (European Foundation, Dublin), conducted in 1990, 1995 and 2000, and (2) The European System of Social Indicators (ZUMA, Mannheim). These data sets are attractive in that they contain reasonably comparable information for many countries. Their drawbacks are (a) that the time periods covered are still fairly short, and (b) that the information on the skill requirements of jobs is very limited, such as whether survey respondents view their job as "interesting" (there is much more on other work-life dimensions). The probably most useful information with regard to skill demand shifts consists of data on changes in occupational and industrial distributions. On a cross-sectional basis, internationally comparable data on the skill requirements of jobs are available from the second round of the European Social Survey (ESS; see further above and [www.europeansocialsurvey.org](http://www.europeansocialsurvey.org), where data can be downloaded).

Britain: Gallie, White, Cheng and Tomlinson (1998) give a broad account of changes in work content – including skill requirements – in Great Britain from 1986 to 1992. Felstead, Gallie and Green (2002) provide additional analyses for Britain, with data up to 2001. The information used comes from the Social Change and Economic Life Initiative (SCELI) 1986, the Employment in Britain survey 1992, and the Skills Surveys from 1997 and 2001. Findings from these surveys are also reported in Penn et al. (1994), Felstead et al. (1999) and Green et al. (2000). There is no systematic attempt in the analyses to distinguish between changes brought about by structural shifts and changes occurring within occupational and industrial categories.

The general picture of skill change during the 15 years covered by these data is one of increasing requirements. For example, the proportion high-skill (degree-level) jobs rose from 10 to 17 percent from 1986 to 2001. The share of jobs requiring less than one month (of training after employment) "to learn to do well" fell from 27 to 20 percent during the same period. There was also a small but significant rise in the requirement to learn new things on the job, from 76 to 81 percent of all employees

from 1992 to 2001. The perceived (by the employees) importance of computer skills increased more than any other of ten different kinds of skill requirements from 1997 to 2001.

The United States. The most recently published US studies of changes in skill demand based on nationally representative data are Wolff (2000), for the period 1950 to 1995, and Autor et al. (2002), for the period 1960 to 1998. The former analysis is exclusively structural, motivated by the kind of remarks made in the previous section. The point of departure is the US Dictionary of Occupational Titles (DOT, 4th edition 1977), which contains detailed measures of skill requirements for 12,000 different job titles. Data on the skill content of these jobs were collected between 1966 and 1974. Hence, the working assumption of the trend analyses is that the net change in skill content within these detailed occupations during the period considered is not significant. The study by Autor et al. (2003) is also structural in character and again builds on DOT-connected data. It extends on Wolff's (2000) piece by examining changes in skill content among occupations that have received updated skill values in the DOT schema. (For earlier US studies based on DOT, see Spenner 1979, 1988. Discussions of limitations of DOT include Cain and Treiman 1981, Spenner 1990, Attewell 1990, Handel 2000. Spitz-Oener 2006, on Germany, uses the Autor et al. framework to examine skill demand change both between and within occupations.)

The results of both recent studies show a general increase in skill demands. According to Wolff (2000), the pace of this upgrading process was relatively slow in the 1950s, accelerated sharply in the 1960s, and then fell to an intermediate level in the 1970s. Since then, the increase in skill demand has been roughly stable according to these data, at a yearly rate of about 0.4 percent for substantive complexity (SC), and about 0.2 percent for general educational development (GED), i.e., mathematical, language, and reasoning skills. Autor et al. (2003) report estimates of a similar magnitude.

The study by the US National Research Council (1999) is a broad review of a large number of studies based on different kinds of samples, methods and assumptions. The majority of the cited analyses are case studies of specific work organizations or occupational groups. Not surprisingly, the picture of change during recent decades that emerges from this review is highly complex. "Considering all available evidence

...it does not appear that work is becoming more routine or less skilled than in the past, but we are unwilling, at present, to claim that the reverse is true” (p. 162-3).

With regard to variations between occupational segments, the authors (including Arne Kalleberg, David Neumark, Paul Osterman and Kenneth Spenner) conclude (p. 160ff) that an upgrading most likely (but not definitely) has occurred among blue-collar workers, that the development of skill requirements among service workers is very heterogeneous with no clear net change, that the nature of most professional and technical work is hardly changing at all, and that reliable empirical evidence on changes in the content of managerial work is close to nonexistent.

Sweden. There are two main sources of information on long-term changes in skill requirements in the Swedish labor market, the Level of Living surveys (LNU) and the Surveys on Living Conditions (ULF). The LNU surveys have so far been carried out five times: in 1968, 1974, 1981, 1991 and in 2000. The ULF surveys are carried out yearly since 1975, with a focus on work-life issues every eighth year since 1986.

le Grand, Szulkin and Tåhlin (2001) use the LNU surveys to establish trends in the skill content of jobs in Sweden since 1974. They explicitly distinguish between structural shifts and changes within occupational and industrial categories. In general, they find that a significant amount of upgrading has occurred between 1974 and 2000, evident from a variety of measures. For instance, the average educational requirements beyond compulsory school increased from 1.8 to 3.1 years. The proportion jobs with no educational requirements fell from half to just above one quarter. This process has been almost entirely driven by structural change. Middle and high-level white-collar jobs expanded from 25 to 41 percent of all employment during the last quarter century, while the share of unskilled manual jobs dropped from 37 to 23 percent. Employment in health care, education, finance, consulting and insurance grew while the number of jobs in the manufacturing sector declined. These developments, well-known across the OECD, produced a turnover of jobs in the direction of higher skill requirements. Net of this ecological transformation very little change took place in Sweden during the period considered.

As reported above, significant skill upgrading net of structural change appears to have taken place in Britain between 1986 and 2001 (Zhou 2005) and in West Germany

between 1979 and 1999 (Spitz-Oener 2006). It would be of great interest to examine the extent to which net skill change has occurred in other countries in recent decades.

Aside from changes in the average demand for skill, it is important to assess trends in the *distribution* of skill demand. Recent studies of the US and Britain indicate a combination of general growth in skill requirements with tendencies to polarization. Employment growth over recent decades has been strongest in the high-skill section of the skill demand distribution and slowest in the intermediate section, while low-skill jobs have shown an intermediate growth rate. Overall, the skill-growth pattern in both countries has thus been J-shaped. In Sweden, by contrast, the pattern has been more linear during the same period (1970s through 1990s) with negative employment change in the low-skill section. The decline in the number of low-skill jobs shows a markedly decreasing rate over time, however. The shape of the skill-growth pattern is essential to consider for many purposes, for instance when accounting for changes in earnings inequality, as has recently been shown for Britain.

Technological and institutional factors can be expected to underlie these temporal and international variations. As suggested by several studies (on the US: Wright and Dwyer 2002, Autor et al. 2003; on Britain: Goos and Manning 2006; on France: Maurin and Thesmar 2004; on Germany: Spitz-Oener 2006), recent technological change is not simply skill-biased. Many non-routine tasks that are complementary to technology (such as shelf-filling or house-cleaning) require less skill than many of the routine tasks in which technology substitutes for human labour (such as book-keeping). Hence the J-shaped skill-growth pattern, but with institutional variations: the wage structure in countries like Sweden depresses demand for low-skill service jobs, mainly due to relatively high and rigid minimum wages (making low-skill jobs costly to employers) but also due to relatively low high-skill wages (decreasing the high-skill wage-earners' demand for personal services). Accordingly, the Swedish pattern of job growth is closer to a straight slash, i.e., a more consistently positive association among jobs between skill content and employment growth rate (Åberg 2004).

## Changes in the skills of employees

### General remarks

As already stated, the (acquired) skills of employees have two main sources: formal education (schooling) and work-life experience (including on-the-job training). I confine the review below to changes in educational attainment in various countries. Aside from this quantitative aspect, there is also the important issue of educational quality that I will disregard here. (For a recent summary of US studies, see Handel 2003.)

Workplace training is covered elsewhere in the paper. Changes in experience aside from training, mainly of interest in the perspective of gender inequality, would be useful to document, but fall outside the scope of the present review.

### Pattern of findings

The strong long-term rise in average educational levels among all populations in the OECD countries is well-known. Of more interest to document here are the variations around this general trend, between nations and between time periods. The main source of information is official national statistics, assembled for internationally comparative purposes by the OECD. Various attempts at improving comparability have been carried out. For a comprehensive and recent effort, see Barro and Lee (2001).

Table 2. Trends in educational attainment in seven countries, 1970s to 1990s. Average number of years of schooling of working age population, and relative change across decades (1970s=100) . Source: OECD data, assembled by Bassanini and Scarpetta (2001).

	1970s	1980s	1990s	70s-80s	80s-90s	70s-90s
France	9.2	9.7	10.4	106	106	113
Germany	10.5	12.0	13.3	115	110	127
Ireland	8.2	8.9	9.8	109	110	121
Netherlands	9.5	10.6	11.5	111	109	121
Sweden	9.6	10.6	11.4	110	108	119
UK	9.6	10.5	11.4	109	109	119
USA	11.9	12.4	12.6	104	102	106
Average	9.8	10.7	11.5	109	108	118

As in the case of skill demand, skill supply (as reflected by educational attainment) has grown markedly from the 1970s to the 1990s in all the countries considered (table 2). Again, there is some variation across nations in the growth rate. Germany exhibits the most rapid increase and the United States the clearly slowest. The rise in educational attainment in France was somewhat below the average rate, while Ireland, Britain, Sweden, and the Netherlands form a middle group with relative growth rates close to the general average.

## **Skill matching between jobs and workers**

### General remarks

So far we may conclude (a) that the skill requirements of jobs have increased significantly in recent decades (certainly in Great Britain and Sweden, close to certainly in the US, and most probably in other OECD countries), and (b) that the supply of skills as measured by the educational attainment of workers has also increased significantly (with the exception of the US in recent years).

An important issue is how these two trends are related to each other. In the literature, there are two main strands. The first is the over-education perspective. The sense that educational expansion was outstripping the demand for skills in the labor market dates back at least as far as the late 1940s (see Harris 1949). In the wake of the rapid growth of student enrollment at colleges and universities this impression became a widespread view in the 1970s (Berg 1970, Freeman 1976, Collins 1979), and began to be documented empirically. A literature on over-education and earnings started with a paper by Duncan and Hoffman (1981) and has since become substantial. See also Sicherman (1991). There is by now a large body of international evidence on the incidence and wage effects of over-schooling (see below). Rubb (2003) provides a meta-analysis of many empirical studies of the effects of mismatch on earnings. Korpi and Tåhlin (2006) extends on previous studies by considering wage growth.

Studies of overeducation are dominated by economic contributions. After early analyses by Berg (1970) and Kalleberg och Sørensen (1973), and subsequent contributions by Burris (1983) and Shockey (1989), sociologists appear to have

deserted the field. A critical paper by Halaby (1994) seems to have put an end (at least temporarily) to sociological efforts. Åberg (2003) takes up the issue again with an empirical analysis of the Swedish labor market.

The second major strand in the literature on skill matching is the upgrading view, i.e., that skill demand is increasing at a higher rate than skill supply (education). The starting point of this perspective was the growth in wage inequality, in particular across skill or education categories, in the United States and Britain in the 1980s. In a standard supply-and-demand model, the joint occurrence of rising returns to education and an increase in skill supply can only be explained by an even faster growth in skill demand. The main rationale behind such a growth in demand is skill-biased technological change (SBTC), i.e., changes in production processes favoring employment of high-skill workers. The rapid expansion of information technology is seen as the prime feature of this development. In addition to SBTC, globalization (in particular increased international trade, of which especially across the north-south divide) is viewed as a cause of skill bias in the evolution of labor demand in advanced countries. (See Feenstra and Hanson 2001 for a recent overview of the trade-inequality literature and Alderson and Nielsen 2002 for a general sociological review of explanations of trends in income inequality.)

The currently dominant view (within the upgrading strand) is that technological change is the clearly more important of these driving forces. Acemoglu (2002a) gives an extensive overview of the technology-inequality literature, with a useful summary in Acemoglu (2003). In addition, Autor et al. (2003) provide a large-scale and long-term analysis of changes in the US industrial and occupational structure, documenting a link between the expansion of information technology and a rise in skill demand. Gallie et al. (2002) draw similar conclusions based on British survey data. See also Fernandez (2001), a recent sociological case study establishing a connection between within-firm technological change and an increase in internal wage dispersion. Important dissenting accounts, where the link between computerization and growing wage inequality is questioned on a number of empirical grounds (in the US), are Bernstein and Mishel (2001) and Card and DiNardo (2002).

### Pattern of findings

The two different (partly opposite) perspectives tend to use different kinds of evidence. The over-education literature is more directly empirical, in the sense that it looks at observed matches between workers and jobs, and in a straight-forward manner compares the educational attainment of the former with the schooling requirements of the latter. If attainment is higher than the job requirements, the worker is seen as over-educated; if attainment is lower, the worker is seen as under-educated; and all the rest are seen as properly matched. There is no explicit theory to guide these observations and classifications. Theory does not enter the scene until the causes and consequences of mismatches are at issue. The upgrading literature, by contrast, works by combining empirical information on wage determination with the standard neo-classical price model. If employers pay more for skills than previously when the supply of skills is growing, it must be that their demand for skills grows even faster. Given the strong theory, the rapid growth in demand is not really an empirical issue – it simply must be true. The more interesting empirical questions, in this view, lie elsewhere: what factors drive the growth in skill demand, what are the consequences of the growth aside from increasing wage inequality, and how do these causes and consequences differ across labor markets, i.e., across different institutional contexts?

It is therefore not surprising that the over-education literature is much more empirical than the upgrading perspective. Estimates of the incidence of mismatch between individual educational attainment and job requirements are available for many countries. New empirical results were presented at a recent conference (November, 2002) in Berlin (all papers can be downloaded from MPIB 2002). There are also collections of papers in Borghans and de Grip (2000) and in a special issue of the *Economics of Education Review* (2000) as well as an overview paper by Green, McIntosh and Vignoles (1999).

A fair amount of over-education appears to exist in Western labor markets, both in the United States and in Europe. Between 20 and 40 percent of all workers (depending in part, of course, on the definition used) seem to have more schooling than their job requires, with the American rate tending to be higher than the European. Trends in

over-education are very poorly established. What we know is mainly confined to the US and a rather small number of countries in Europe, including Britain, the Netherlands, Portugal, Spain and Sweden. These studies indicate that over-education has increased in Europe in recent decades, while it appears to have decreased in the United States. (On the US case, Gottschalk and Hansen 2003 is the most recent analysis.) However, the international empirical basis is not sufficiently solid to draw any firm conclusions.

The longest established trend is for Sweden (le Grand, Szulkin and Tåhlin 2001b, 2004, Böhlmark 2003). According to data from the Level of Living surveys (LNU), over-education increased from about 15 percent of all employees in 1974 to one third in 2000, while the proportion properly matched (individual attainment and job requirements differing no more than one year of post-compulsory schooling) dropped from about 70 percent to 50 with an unchanging share (just under one in five) of under-educated workers.

It can be shown, however, that the categories of under-educated, well matched, and over-educated are internally heterogeneous with regard to worker composition, in a way that may make simple trend analyses more or less misleading (cf. le Grand et al. 2004). Consider table 3, where a combination of educational attainment and job requirements is cross-classified with the three match categories.

Table 3. Logical covariations between different combinations of education and job requirements. (Combinations: N = logically necessary, P = logically possible but not necessary, – = logically impossible.)

		E > 0 R > 0	E > 0 R = 0	E = 0 R > 0	E = 0 R = 0
E < R	Under	P	–	N	–
E = R	Match	P	–	–	N
E > R	Over	P	N	–	–

Note: E = individual education beyond compulsory school.  
R = educational requirements (beyond compulsory school) of the job.

Several interesting observations can be made from the table. Of the twelve cells, six are logically impossible and therefore empirically non-existent. Another three cells are logically necessary combinations, two of which pertain to workers with only compulsory schooling ( $E = 0$ ). This means that the proportions matched and under-educated will, all else equal, fall as these workers (most of whom belong to older cohorts) retire from the labor market. In fact, this exit pattern explains most of the rise in over-education in Sweden, and is likely to do so for several other countries as well. Within the left-most category in the table, i.e., the rapidly growing group of workers who have some post-compulsory education and have jobs that require such schooling, the increase in under-education has been larger than the increase in over-education in recent decades.

Hence, there is not only a need to establish trends in skill matching, but also to take this and other kinds of heterogeneity within the three different match categories into account in such analyses. Of obvious importance in this regard is the heterogeneity with regard to type (field) of education. Given that a significant share of jobs that require post-compulsory education requires schooling in some particular field (or fields), any estimate above zero of over-schooling that fails to take educational field into account is likely to be upward-biased (see Wolbers 2003 for a cross-national analysis of mismatch with respect to educational field). For Sweden, le Grand et al. (2004) show that match quality with respect to educational field has been constant between 1981 and 2000. Further, it is important to study the long-term career effects of initial mismatch (see, e.g., the analyses of Germany in Büchel and Mertens 2000 and the cross-national comparison in Scherer 2004).

## **Trends in wage inequality**

### General remarks

According to simple market logic, the trends in skill supply and demand documented above should go a long way in explaining trends in wage inequality by skill groups in different countries. I deal with this issue in the current section. In addition, it may be noted that the supply of and demand for skills also affect each other. The supply side is of course in part responsive to changes in demand, via individual choices of labor market actors or through shifts in educational policies. But skill demand might also

respond to changes in supply. With growing amounts of human capital among workers, technological change could endogenously become more biased toward high skills (see, e.g., the overview in Acemoglu 2003b and Lucas 2002).

### Pattern of findings

In a recent study, Manacorda and Manning (2003) examine how shifts in skill demand and supply in recent decades are related to changes in wage inequality in Italy, the UK and the US. Puhani (2005) compares the US, Britain and West Germany in the context of the 'Krugman hypothesis'. For earlier studies on this issue, see for the US: Katz and Murphy 1992; for Canada and the US: Murphy et al. 1998; and for Canada, the UK and the US: Card and Lemieux 2001. All of these analyses document that skill supply and demand dynamics are important for the evolution of the wage structure.

In table 4, I extend previous empirical studies by showing the evolution of the market for skills (as revealed in tables 1 and 2 above) and of earnings inequality for the seven countries in focus in this review. In the simple market framework, returns to education should be especially responsive in this regard, but overall rates of inequality are also of interest. (On cross-national estimates of returns to education, in addition to the sources reported below, see, e.g., Psacharopoulos 1994, Asplund and Pereira 1999, Trostel et al. 2002 and Harmon et al. 2003. On earnings inequality, see, e.g., Levy and Murnane 1992, Freeman and Katz 1995, OECD 1996, Gottschalk 1997, Gottschalk and Smeeding 1997, Gottschalk and Joyce 1998, Katz and Autor 1999, Morris and Western 1999, Atkinson 1999, Nielsen and Alderson 2001, Acemoglu 2002, 2003a.)

On average for the considered countries, the period of the 1970s to the 1990s saw an approximate balance between the growth rates in skill demand and skill supply.

Disaggregating by individual nations, however, only Ireland exhibits a balance throughout the period. In France, the UK and the US, the change in skill demand tended to outpace skill supply, thus creating (all else equal) an upward pressure on wage inequality, or at least on returns to education. This excess demand was clearly concentrated to the first half of the period, with a balance subsequently emerging, at least in France and the UK. By contrast, skill supply outgrew skill demand in several

countries, especially in Germany, but to some extent also in Sweden and the Netherlands. In the case of this group too, a better balance was achieved in the second part of the period, even if skill demand growth in Germany was still slow relative to the increase in educational attainment.

Table 4. Trends in earnings inequality and the market for skills in seven countries, 1970s to 1990s. (Relative change in skill demand (from table 1) minus relative change in skill supply (from table 2), and relative change (1970s=100) in male earnings returns to education and in overall male earnings inequality (p90 / p10)).

	$\Delta$ (demand) – $\Delta$ (supply)			$\Delta$ (return to educ.)			$\Delta$ (p90 / p10 earn.)		
	70-80	80-90	70-90	70-80	80-90	70-90	70-80	80-90	70-90
France	+ 9	– 1	+ 7	99	102	101	89	105	94
Germany	– 9	– 6	– 18		94			91	
Ireland	+ 2	0	+ 1		119			111	
Netherlands	– 7	0	– 7	79	104	82		102	
Sweden	– 3	– 1	– 5	96	103	99	100	107	107
UK	+ 4	+ 1	+ 6	98	108	107		103	
USA	+ 5	+ 3	+ 9	114	118	135	121	103	125
Average	– 1	– 2	– 4	97	107	105		103	

Sources. Returns to education: Harmon et al. (2001) except Sweden, le Grand et al. 2001b, and USA, Mishel et al. (2003). Earnings inequality: Germany, Netherlands, UK, OECD (1996), France, Piketty (2001), Ireland, Barrett et al. (1999), Sweden, le Grand et al. (2001b), USA, Mishel et al. (2003).

How did the evolution of wage inequality respond to these changes in the market for skills? In all nations except France and Ireland the picture is fairly consistent with a simple market model. Excess demand for skills generally tended to push inequality upward, and vice versa. In France, however, the wage distribution was more stable than expected in the first half of the period, while in Ireland inequality rose much more than expected during the time for which earnings data are available. But there are other deviant cases too. For instance, the comparatively large rise in inequality in the United States squares rather well with cross-national variations in the trends in skill demand and supply, but seems to overshoot significantly in magnitude. And in Britain, the timing seems partly off the mark: returns to education grew later than the appearance of excess demand. (Updated figures show the 90/10 ratio growing by 5 percent from 1997 to 2005 in the UK; see Dobbs 2006; in Sweden by 9 percent between 1997 and 2005; see Statistics Sweden 2006; and in Germany, that had a

stable or falling distribution of wages through the mid-1990s, a surge in inequality took place between 1994 and 2004 when the 90/10 ratio increased by 22 percent; see Gernandt and Pfeiffer 2006. For a recent general overview of education and wage inequality in Europe, see Asplund and Barth, eds., 2005.)

In accounting for the observed deviations above, two factors are especially important to consider: unemployment and labor market institutions. First, if labor prices (wages) do not respond as expected to relative shifts in skill demand and supply, it might be that the response instead emerges in the form of changes in labor quantities (employment). This has been a common view of the causes of cross-national variations in the evolution of wage inequality and unemployment: if there is an excess demand for skills, differential unemployment rates by education will appear to the extent that increasing wage differentials by education do not (Krugman 1994). Empirically, however, the support for this view has been weak (Nickell and Bell 1995, Nickell 1997, Card et al. 1999). And it is not helpful in accounting for the deviance of the French wage structure that we just noted. As we see in table 5 below, although unemployment grew faster among the less than the more educated in France during the period when wages failed to respond to the excess in skill demand (the 1970s to 1980s), the entire cross-national pattern of changes in unemployment rates by education is apparently inconsistent with the simple market view indicated above. (See also Brauns et al. 1998 for an analysis of youth unemployment differentials by education in France, Germany and the UK.)

Table 5. Trends in male unemployment rates by education in six countries, 1970s to 1990s. Ratios between rates among (a) workers with less than secondary schooling and (b) workers with completed secondary schooling or higher, and relative change across decades (1970s=100). Source: Nickell and Bell (1996).

	1970s	1980s	1990s	70s-80s	80s-90s	70s-90s
France	3.1	3.6	2.3	116	64	74
Germany	1.9	2.8	2.6	143	93	137
Ireland						
Netherlands	2.0	2.9	2.0	145	69	100
Sweden	4.0	3.7	2.5	93	68	63
UK	3.2	3.9	2.6	122	67	81
USA	3.9	4.7	3.9	121	83	100
Average	3.0	3.6	2.7	124	74	92

Second, labor market institutions are obviously important in accounting for trends in wage inequality. Such institutions may not only modify the impact of shifts in skill supply and demand, but may also affect supply and demand more directly (see, e.g., Acemoglu 2003a). Vital factors to consider include minimum wage regulations, union strength, employment security legislation, and social norms. A discussion of these factors fall outside the scope of the present review (for overviews see, e.g., Fortin and Lemieux 1997, Katz and Autor 1999 and Morris and Western 1999). Specific analyses of the employment effects of minimum wages include Card and Krueger (1995) and Stewart (2001). For the impact of unions on wages, see, e.g., Freeman (1991), Card (1996) and Card et al. (2003), and for recent discussions on the relation between social norms and income inequality see, e.g., Atkinson (1999) and Piketty and Saez (2003).

In addition, it is important to underline that the empirical account above is highly general, and needs to be specified in a number of ways. Aside from shifting the focus on macro patterns to micro-level information on job-worker matches, it would be desirable to disaggregate the macro data by worker categories. First of all, women should of course be included in the analysis. Secondly, for both men and women, it is essential to apply a life-course perspective on the associations that we consider. Most matches are formed in early stages of individual work-life careers. Therefore, the relationship between skill supply and skill demand should ideally be assessed within a framework that takes the timing in matching processes into consideration. Needless to say, this is a complex task. In pursuing this issue in future research, the growing availability of detailed national data sets on career development should be a significant asset.

## **Conclusions**

According to the estimates provided in this review, both skill demand (in the form of skill requirements of jobs) and skill supply (educational attainment) have grown substantially in recent decades in the considered group of OECD countries. While data on trends in skill matching between individual workers and jobs are scarce, I

have tried to establish the cross-national variation in the balance between these trends at the macro level. With some important exceptions discussed above, the macro pattern that emerges is roughly consistent with expectations based on a standard market model.

This general picture is quite coarse, however, and does obviously not allow strong conclusions. In a number of respects, much more research is needed before a fine-grained account of major developments can be achieved. (See Tåhlin 2006b for a recent analysis of inequality in skills and wages in Germany, Spain, France, Britain and Sweden by class and gender.) The existing state of knowledge is particularly weak in two areas: assessments of trends in skill demand and of job-worker matches at the micro level. For the former, I have utilized data on changes in broad occupational class distributions as a preliminary device. While certainly useful, there is a need to establish nationally specific estimates of trends in skill requirements at the level of individual jobs, and to examine how well one can account for such trends by taking structural change into account. In this task, a variety of skill requirement measures should be used in addition to the major indicator considered above, i.e., educational requirements. This indicator has several advantages, but also significant drawbacks. For instance, it is probably tied to changes in national education systems that are partly unrelated to actual shifts in skill demand.

With regard to job-worker skill matches, cross-nationally comparable information on trends is quite scarce. Before such information is assembled, it is essential to carefully consider conceptual and logical issues in the classification of employees into the categories of overeducated, undereducated and matched. These wide categories are highly heterogeneous in a number of ways, including experience, on-the-job training, and field of education. This heterogeneity needs to be taken into account before it is possible to arrive at meaningful estimates of matching trends.

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