Qualitative Mismatches

Michael Sattinger
University at Albany
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Abstract: Qualitative mismatches arise when the qualifications of workers, individually or in the aggregate, are different from the qualifications required or specified for their jobs. This study reviews the literature on qualitative mismatches, including overeducation, job mobility and shifts in demands and supplies of workers, and relates it to ongoing phenomena such as search and matching models of unemployment, job polarization, inequality, and the race between technology and education. The approach taken here introduces the distinction between short run qualitative mismatches for individual workers and employers and long run aggregate qualitative mismatches arising from changes in the quantity demanded or supplied in a category of the labor market. The study considers the role of employment agencies in reducing qualitative mismatches as well as other policies that would improve the operation of the labor market.

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Introduction

Qualitative mismatches arise when the qualifications of workers, individually or in the aggregate, are different from the qualifications required for their jobs. Qualitative mismatches cause losses to individual workers in reduced wages, career interruptions, and reduced job satisfaction. They cause losses to firms in reduced productivity, and to economies in restricted growth potential. As a result of these serious consequences, major research institutions have conducted studies to understand future skill needs and mismatches. For example, the Organization for Economic Cooperation and Development (OECD, 2011), the European Expert Network on Economics of Education (2008), the National Research Council (2008) and the European Centre for the Development of Vocational Training (CEDEFOP, 2010a, 2010b) have undertaken major efforts to analyze qualitative mismatches. In addition to direct consequences, qualitative mismatches are related to significant ongoing empirical labor market phenomena, including increasing inequality, technological change that favors more skilled workers, organizational change, computerization, job polarization, and globalization. Furthermore, the explanation of qualitative mismatches involves central elements of modern labor market theory, including search theory, assignment theory, human capital, and unemployment. Major social science researchers around the world have conducted analysis of issues related to qualitative mismatches, future skill needs, and educational and training policies, generating an extensive relevant literature.

The approach taken in this Randstad study differs from previous work by introducing the distinction between short run qualitative mismatches for individual workers and employers and long run aggregate qualitative mismatches arising from changes in the quantity demanded or supplied in a category of the labor market. These two forms of qualitative mismatches are conceptually distinct and proceed from different causes and processes. Without the distinction between the two forms, a measurement of one could be mistaken for the other. The methods and data used to examine the two forms of qualitative mismatches also differ.

Short run qualitative mismatches arise as a consequence of extensive job and worker variety combined with imperfect information and frictions in the labor market that require workers and employers to engage in search to establish employment. "Search" refers to the study of how workers go about finding a job, and how firms recruit workers. When looking for a job, a worker does not know which firms would be willing to hire him or her. When the worker gets an offer from a possible employer, the worker needs to decide whether to accept the offer or continue looking. Search theory describes the optimal strategy for a worker looking for a job, and has been extended to describe how firms look for workers. Since the wage offer that a worker could get at different employers varies according to the relation between the worker's characteristics and the characteristics of the job, continued search by the worker can generate a higher wage. However, since search is costly, the worker at some point will decide to stop searching and accept a job that pays less than the maximum attainable wage. Similarly, the productivity of a worker at a particular job varies depending on the worker's characteristics, but the employer fills the job before finding the ideal worker because it would be costly to leave the job vacant for so long. As a consequence of this search, the characteristics of the worker and firm are not perfectly matched compared to the best assignment determined with perfect and costless information. These short run qualitative mismatches are an inevitable

consequence of the operation of the labor market in the presence of costly information obtained through search. Although inevitable, the short run qualitative mismatches cause losses to both workers and firms. Workers lose because they spend time unemployed, are paid less than they could potentially earn, and must perhaps engage in on-the-job search to obtain further advancement in their careers. Employers lose because a job may remain vacant until they can find someone to fill it, they may get less production from the worker than they could hope for, and the worker may leave for a better job, generating a costly separation. The extent of the losses from qualitative mismatches in the short run depends on policies that promote efficient matching. Labor market intermediaries and temporary help agencies can reduce short run qualitative mismatches by placing workers in jobs more efficiently than the rest of the labor market. Short run qualitative mismatches would arise even in the absence of the long run aggregate qualitative mismatches that are described next, and would not disappear as a result of long run adjustments in the labor market. Short run qualitative mismatches are studied by examining how the labor market assigns workers to jobs through search by workers and employers, and how qualitative mismatches arise as a consequence of the strategies of workers and employers in the presence of costly search.

In contrast, long run aggregate qualitative mismatches arise when the economy changes in a way that alters the mix of job characteristics, or the incentives for individuals to obtain education and training change in a way that alters the mix of worker characteristics. For job characteristics, the causes could be technological change, capital investments, globalization, or organizational change. For worker characteristics, the causes could be subsidies to different levels of education, quality of preparation at earlier educational levels, or private costs of education. To understand the nature of a long run aggregate qualitative mismatch, it is convenient to consider a single labor market for jobs with a particular combination of characteristics and a corresponding group of workers. A long run qualitative mismatch should be understood as a situation in which a shift in demand in this market is not balanced by a shift in supply over a longer period of time, perhaps because the changes are not fully anticipated. To the extent that the labor market responds to these imbalances through wage and other changes, long run qualitative mismatches may not show up in comparisons between individual workers and their jobs. Long run qualitative mismatches would respond to policies that anticipated changes on the demand side and promoted changes in the educational and training system that balanced the changes in demands for skills with changes in supplies. Long run qualitative mismatches are studied by examining the consequences of trends in economies and societies that generate shifts in demands and supplies, including technology, globalization, organization of work, and educational institutions.

As an example of the differences between short run and long run qualitative mismatches, evidence of workers overeducated for their jobs is regularly observed, while at the same time analysts conclude that there is no aggregate overeducation (Ulrich Teichler and Harald Schomburg, 2007; Stephen Machin and Sandra McNally, 2006). Differences between short run and long run qualitative mismatches are summarized below.

Table: Short Run and Long Run Qualitative Mismatches

	Short Run	Long Run
Causes	Costs of searching by worker or firm prevent best matches	Unbalanced shifts in supply and demand
Methods of Analysis	Study how workers search for jobs and how firms recruit workers	Examine consequences of trends in technological and organizational change, globalization, ICT, education
Methods of Observation and Measurement	Differences in individual job and worker characteristics	Forecasts of aggregate differences in supply and demand for labor categories
Consequences	Costly search for workers and firms, losses in worker wages and lower firm output	Lost returns to worker investments in education and training, inadequate labor force for firm expansion and growth
Policies that Address Mismatches	Labor institutions that encourage more efficient matches, reduction in search and recruitment costs	Adapt educational policies to anticipated changes

The relation between short run and long run qualitative mismatches can be understood using Richard Freeman's book, "The Overeducated American." In this book, Freeman describes the long run qualitative mismatch that arose in the U.S. in the 1970's as a result of the supply of college educated labor increasing more rapidly than the demand. One consequence of this long run qualitative mismatch was that many individuals with higher levels of education were unable to find jobs that required their educational preparation. That is, the long run qualitative mismatch contributed to a short run qualitative mismatch in the form of overeducation for many individuals. Nevertheless, even in the absence of any long run qualitative mismatches, short run qualitative mismatches would continue to exist because of the difficulty of finding a job without mismatches in a reasonable amount of time.

One may believe that a competitive labor market would be able to handle any qualitative mismatches, whether in the short run or in the long run. In the short run, individuals may eventually resolve qualitative mismatches by changing jobs. But not all mismatches get eliminated by individuals, and there are always new entrants who begin their labor careers with mismatches. Consideration of short run qualitative mismatches suggests changes in institutions that could reduce the levels of short run qualitative mismatches occurring at any point in time. In the long run, workers and employers that accurately foresee labor market developments would be able to avoid imbalances between supplies and demands. However, in the current episode of a long run qualitative mismatch, discussed below in Chapter 3, the increase in relative wages for U.S. college graduates did not generate a sufficient increase in enrollment and graduation rates to avoid the mismatch. Market forces by themselves cannot be relied upon to eliminate qualitative mismatches in either the short run or the long run.

Labor market qualitative mismatches play a central role in current debates regarding macroeconomic policy. Peter Diamond (2011, p. 1064) reacts to the following statement by Narayana Kocherlakota (2010, p. 6), President of the Federal Reserve Bank of Minneapolis:

> "What does this change in the relationship between job openings and unemployment connote? In a word, mismatch. Firms have jobs, but can't find appropriate workers. The workers want to work, but can't find appropriate jobs. There are many possible sources of mismatch—geography, skills, demography— and they are probably all at work. Whatever the source, though, it is hard to see how the Fed can do much to cure this problem. Monetary stimulus has provided conditions so that manufacturing plants want to hire new workers. But the Fed does not have a means to transform construction workers into manufacturing workers."

Diamond argues against the conclusion that structural mismatches are generating a higher level of unemployment that would not be affected by aggregate demand policies. He cites evidence (William T. Dickens, 2010; Barnichon, Elsby, Hobijn, Sahin, 2010) that most of the shift in the unemployment-vacancy relation in the current recession arises from fewer hires instead of mismatches. The next chapter, on short run disaggregated qualitative mismatches, is concerned with mismatches generated by the business cycle as well as ongoing mismatches generated by continuing frictions and inefficiencies in the labor market (see CEDEFOP, 2010b, Chapter 5, for a discussion of skill mismatches over the business cycle).

In this study, mismatches at a point in time can be regarded as arising from three sources. First, there is a level that arises from the search procedures that workers use to find jobs and employers use to find workers. This level can be called the Natural Rate of Mismatch and is probably fairly stable over time.[1] It would arise even if there were no other sources of mismatches and parallels the Natural Rate of Unemployment as discussed in macroeconomics. Second, there is a level of mismatch that arises over the course of a business cycle as a result of workers with high education and skill levels taking jobs at which they are overqualified during high unemployment, or firms hiring workers that do not meet their requirements during low unemployment. Third, there are additional mismatches that could arise if there are imbalances between supplies and demands from long run aggregate qualitative mismatches. It is possible that overqualification at one level could cancel out some underqualification at another level, so that the three levels are not simply added together.

Qualitative mismatches lie in the background of current unemployment and business cycle theory. Whether or not these theories explain unemployment and business cycles, they do not explain much about qualitative mismatches. Qualitative mismatches impose serious costs on workers, firms and economies. Economic theory must move in the direction of explaining unemployment and mismatches as they evolve together. Qualitative mismatches, both short and long run, play significant roles for temporary help agencies and other organizations engaged in placing workers in jobs. By managing information about workers and firms, temporary help agencies can match workers with jobs better than the labor market, and thereby reduce short run mismatches. By providing

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[1] The authors thank Joop Hartog for suggesting the idea of a Natural Rate of Mismatch.

incentives to invest in training, temporary help agencies can reduce long run mismatches. They can also reduce the costs of adjustment in response to long run mismatches. Chapter 5, on labor market intermediaries, describes inefficiencies in labor markets that can be affected by temporary help agencies, thereby reducing mismatches in the short and long run.

Chapter 1: Short run qualitative mismatches

This chapter explains how mismatches can arise in a labor market even if there are no long run imbalances between supplies and demands for workers with particular skills and qualifications. The explanation lies in the underlying problem in any labor market of determining which worker should take which job. Worker actions in looking for a job, and firm actions in looking for workers, provide a solution to this problem, but the solution may not be the best possible because of difficulties in finding jobs and workers. This imperfect solution generates mismatches. The chapter outlines the basic labor market approaches that explain mismatches in Section 1.2, and then goes on to describe measures of mismatches in Section 1.3. Mismatches can be viewed from the perspective of the labor market as a whole and from the individual worker-firm job level. Similarly, Section 1.4 considers losses from both perspectives. By describing how short run qualitative mismatches are generated, it is possible to consider how institutions and procedures in the labor market could be modified to reduce them. Policies to address short-run mismatches are considered in Section 1.5. Policies involving temporary help agencies and other labor market intermediaries that could reduce mismatches are further considered in Chapter 5.

1.1   Causes of short run qualitative mismatches

In a perfectly competitive labor market without frictions, an employer would know immediately which worker would be optimal for a job, and the worker could be hired immediately. No worker would want to change job, and no employer would want to change workers. Neither unemployment nor mismatches would occur in this unrealistic model of the labor market. Qualitative mismatches arise from two fundamental features of labor markets. The first is that jobs differ by the activities required to perform them, and workers differ by their capabilities and skills in performing those activities. The second feature is that frictions prevent firms and workers from forming the same matches that would occur in a perfectly competitive labor market with complete information. With both these features present, mismatches arise.

As an example of how qualitative mismatches can arise, consider the following characterization of jobs developed by the U.S. Department of Labor to assist in job counseling:

Table 1.1: Dictionary of Occupational Title Categories and Activities

Data	People	Things
0 Synthesizing	0 Mentoring	0 Setting Up
1 Coordinating	1 Negotiating	1 Precision Working
2 Analyzing	2 Instructing	2 Operating-Controlling
3 Compiling	3 Supervising	3 Driving-Operating
4 Computing	4 Diverting	4 Manipulating
5 Copying	5 Persuading	5 Tending
6 Comparing	6 Speaking-Signaling	6 Feeding-Offbearing
	7 Serving	7 Handling
	8 Taking Instructions-Helping	

In this system, a lower number in a category (data, people or things) is intended to be more complex and incorporate higher number work activities in the same category, although the hierarchical structure may not hold for people. For example, a worker who could perform data activity 3 (compiling), could also do computing, copying and comparing (data activities 4, 5 and 6). Of course, jobs can also differ in the specific information used in a particular occupation or industry. Now consider an unemployed worker with data level 4, people level 6 and things level 3. If the worker does not know the characteristics of a job at a firm, the job might involve, say, data level 6, people level 4, and things level 3. If the worker took this job, he or she would be underqualified for data, overqualified for people, and exactly matched for things. The firm may not make an offer to the worker because of the worker's underqualification in the data category. The wage rate for the worker might be less than what the worker could get in another job, since the worker has more qualifications than the job requires in the people category. However, since the worker would need to continue in unemployment while searching to find a job paying more, the worker may accept a job offer in spite of the mismatch. This mismatch arises both because of the variety (heterogeneity) of worker and job characteristics, and because of the costs of searching for a better match.

With both worker and job heterogeneity, a mismatch in terms of a single characteristic (for example, the worker's underqualification in the data category above) may incompletely characterize the relation between the worker and the job. If the overqualification in the people category exactly compensates for the underqualification (that is, the people skill can be substituted for the data requirement), then the mismatch will not be important. The consequences of mismatches then depend both on the substitutability among different categories of qualifications as well as on the distributions of mismatches.

Mismatches are commonly characterized in terms of a difference between the educational requirement of the job and the worker's education. However, workers are also characterized by whether they have the skills required for a job. From the discussion above, employment characterized by a worker's overeducation may overstate the extent of the mismatch if the overeducation is compensated by shortfalls in other job skills, or it may understate the extent of the mismatch if it is accompanied by overqualifications in other skill categories.

To maintain consistency with concurrent research on qualitative mismatches, the following definitions provided by CEDEFOP (2010b, p. 13) are adopted:

Table 1.2:   Skill mismatch knows many faces, a typology

Overeducation	To have completed more years of education than the current job requires.
Undereducation	To have completed fewer years of education than the current job requires.
Overqualification	To hold a higher qualification than the current job requires.
Underqualification	To hold a lower qualification than the current job requires.
Overskilling	To be unable to fully use one's skills and abilities in the current job.
Underskilling	To lack the skills and abilities necessary to perform the current job to acceptable standards.
Skill shortage	Demand for a particular type of skill exceeds the supply of available people with that skill.
Skill surplus	The supply of people with a particular skill exceeds the demand for it.
Skill gap	The level of skills of the person employed is less than that required to perform the job adequately or the type of skill does not match the requirements of the job.
Economic skills obsolescence	Skills previously used in a job are no longer required or are less important.
Physical obsolescence	Physical or mental skills and abilities deteriorate due to atrophy or wear and tear.
Vertical mismatch	The level of education or skills is less or more than the required level of education or skills.
Horizontal mismatch	The level of education or skills matches job requirements, but the type of education or skills is inappropriate for the current job.
Crowding out	Better qualified workers are hired to do jobs that less qualified workers could also do, thus replacing (crowding out) less qualified workers from traditional employment possibilities for their level of skill.
Bumping down	Bumping down refers to this process working from top to bottom, pushing less qualified workers to even lower level jobs. At the extreme some lower level workers may become unemployed.

1.2   Methods of Analysis

This section describes the major labor market theories, assignment and search, that generate short run qualitative mismatches as a natural consequence of the day-to-day operation of labor markets.

1.2.1   Assignment Models

Given the extent of differences among jobs, and corresponding differences among workers, there exists an allocation problem within any economy of deciding which workers will perform which jobs. Using the job characteristics in the previous section, consider the entire economy as one huge firm, and suppose there is a single manager that knows everything. There is a group of workers differing by which job levels in Table 1.1 they can perform, and there is a group of jobs at one point in time that differ by the characteristics in that table. The problem for the manager is to determine how to assign different jobs to different workers so as to maximize production. The problem of determining which workers should do which jobs is called the assignment problem in the literature, and arises in any type of economy whether or not there is an all-knowing central manager.

Assignment models originate with Jan Tinbergen's analysis of the determinants of income distribution (1951). In this early model, there is a distribution of jobs (varying by some characteristic) and a different distribution of workers. Workers are affected by the mismatch between jobs and their own characteristics. Differences in wage rates arise that reconcile the distributions of jobs and workers by compensating workers for taking a job that does not match their characteristics. Tinbergen later implemented the assignment

model empirically by estimating trade-offs between different types of labor and using the estimates to analyze changes in the relative wages of college (university) graduates (1975). Based on the empirical model he developed, Tinbergen characterized the evolution of wage differences as a race between technology and education. He documented the substantial decline in wage differences (between incomes for workers with college training and average incomes) from 1900 to the time of publication of the book in 1975, but foresaw the possibility that, at least in the United States, the race could be lost by education (1975, p. 103).

Alternative forms of the assignment model have been developed following Tinbergen's original contribution. A.D. Roy (1951) considers how individuals would choose between sectors. Robert Willis and Sherwin Rosen (1979) adapt the Roy model to consider how individuals choose among educational levels, and James Heckman and Guilherme Sedlacek (1985) and Heckman and Bo Honoré (1990) estimate empirical versions of the Roy model. Tjalling Koopmans and Martin Beckmann (1957) apply the operations research assignment model to explain how activities would be assigned to different locations in a way that is directly analogous to a labor market. Sattinger (1975) explains how comparative advantage operates in an assignment model (see also the survey in Sattinger, 1993). Comparative advantage operates in a labor market in a manner similar to its operation in international trade. In David Ricardo's theory, a country produces one good (cloth) rather than another (wine) when producing extra cloth and trading it for wine yields more wine for the country than it could get by producing the wine itself. Comparative advantage works in the same way in a labor market. Using Adam Smith's example of the pin factory, suppose Ernest draws out wires for pins and Maikel cuts them. Suppose the numbers they can perform in an hour are given in the following table.

Table 1.3: Performances of Ernest and Maikel at Pin Factory

	Drawing out wire for pin	Cutting wire for pin
Ernest	90 per hour	120 per hour
Maikel	60 per hour	90 per hour

Ernest can get his job done in two ways. He can draw out wires himself, or he can ask Maikel to draw out wires while he does Maikel's job. Can Ernest save any time by switching jobs? In an hour, Ernest can cut wires for 120 pins. In the time it takes Maikel to cut 120 wires, he could draw out wires for 80 pins.[2] That is not enough. Ernest would end up with 10 fewer wires drawn out than if he did it himself, and he would need to spend extra time making up the difference. A manager that knows what each worker could do would assign Ernest to draw out wires and Maikel to cut them. As in international trade, we would say that Ernest has a comparative advantage at drawing out wires and Maikel has a comparative advantage at cutting them. When comparative advantage occurs in a labor market, it determines how workers should be assigned to jobs.

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[2] Note that Ernest gives up drawing ¾ of a wire for every wire cut, while Maikel gives up drawing 2/3 of a wire for every wire cut. So in an economic sense Ernest has a higher cost of cutting wires.

Coen Teulings (1995) adapts assignment models to compare wage differentials in two economies, or in a single economy at two points in time. Comparing an economy at two points in time, if a given type of worker is assigned to a more complex job at the later point in time, the wage differential will be steeper. Teulings applies data for the Netherlands to show that between 1982 and 1988, worker skills increased more rapidly than job complexity. Then in the 1988 assignment of workers to jobs, each type of worker was in a less complex job and wage differentials were lower, explaining a reduction in inequality. Teulings' model offers an alternative basis for Tinbergen's race between education and technology.[3]

1.2.2   Job Search

With free and perfect information about each worker, finding the worker for a particular job would be no more difficult than finding a book in a library, and the labor market would be reduced to a Dewey Decimal system. However, along with the great heterogeneity in jobs and workers, the labor market is also characterized by costly and incomplete information about workers and jobs.

Consider an unemployed individual looking for a job. The individual checks with friends and relatives about jobs, reads help wanted ads, looks online, and submits job applications to different firms. The individual may not know whether a particular firm is seeking to hire someone, or whether the job's requirements match the individual's qualifications. When the individual submits an application to a firm, the firm may make an offer depending on how similar the worker's qualifications are to the job requirements. Then the worker needs to decide whether to accept that job offer or continue searching. On the one hand continuing to search could lead to a better match between the worker's qualifications and the characteristics of the job, with a correspondingly higher wage rate. On the other hand, continuing to search means the individual remains unemployed for a period of time and does not receive employment income. Search theory describes an individual's problem in deciding when to accept a job offer. Unemployment benefits, costs of looking for a job, and the current unemployment rate (by influencing how long it will take the individual to find a job) all affect the wage rate than an unemployed worker would be willing to accept. Search theory explains how unemployment and wage differences are generated for workers[4] Although the original search theory explained many features of the labor market, such as why unemployment occurs, it did not explain the source of differences in wage offers, a shortcoming noted by Diamond (1971). General equilibrium search models and search and matching models explain both sides of the labor market.

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[3] Recent work on assignment models includes Teulings, 2005; R. M. Costrell and G.C. Loury, 2004; X. Gabaix and A. Landier, 2008; L. Garicano and E. Rossi-Hansberg, 2004; W. Suen, 2007; and M. Tervio, 2008.

[4] See the Nobel Memorial Prize lectures by Peter Diamond, 2011, Dale T. Mortensen, 2011, and Christopher A. Pissarides, 2011, as well as surveys by Mortensen and Pissarides (1999), Richard Rogerson and Robert Shimer (2011), and James Albrecht (2011). Firms also engage in search for workers (Paul Oyer and Scott Schaefer, 2010).

The significance of the problem of searching for jobs and workers is that it prevents the labor market from generating the best (optimal) assignment. With costly search, a worker would typically accept a job before finding the optimal job, and an employer would typically accept a worker before finding the optimal worker. As a consequence, the optimal assignment of workers to jobs could not be achieved. With search, the combination of worker qualifications and job characteristics at a particular job would differ from the optimal combination, and this difference would constitute a qualitative mismatch. Short run qualitative mismatches would arise even if aggregate worker characteristics corresponded to aggregate job characteristics.

1.2.3   Assignment with Search

Search by workers and firms can be regarded as a labor market mechanism that assigns workers to jobs less accurately than in an economy without the frictions requiring search. Assignment and search together provide the theoretical explanation for how mismatches arise. With an underlying assignment problem, search by workers and employers generates not only unemployment and vacancies but also mismatches between workers and their jobs. The model developed by Sattinger (1995) shows how wages can vary depending on overqualification or underqualification. In the model, there are three types of workers varying by education or some other characteristic, and three types of jobs. Workers engage in search to find jobs, and accept jobs when the wage exceeds their reservation wages (minimally acceptable wage levels). In the Mixed (1,2) equilibrium considered in the paper, Type 1 and Type 2 workers accept jobs at either Type 1 or Type 2 jobs, and only Type 3 workers are at Type 3 jobs. The wage rates for the first two types of workers in the first two types of jobs are as follows:

Table 1.4: Example of Wages in Assignment Model with Search

	Job Type 1	Job Type 2
Worker Type 1	0.50	0.3015
Worker Type 2	0.8785	1.5

Two comparisons are possible. Looking at workers, Type 1 workers get 0.50 if they are correctly matched with a job of Type 1, but only earn 0.3015 if they are underqualified in a Type 2 job. Workers of Type 2 get 1.5 if they are correctly matched with a Type 2 job, but only 0.8785 if they are overqualified in a Type 1 job. Looking at jobs, workers of different types are paid different amounts in a given job. In a Type 1 job, correctly matched Type 1 workers get 0.50, but overqualified Type 2 workers earn more, 0.8785. In a Type 2 job, correctly matched workers are paid 1.5, while underqualified workers earn only 0.3015. These wage differences correspond to the differences observed in the overeducation literature, although specific empirical results are not completely explained. Corresponding to the wage differences, there are also production losses to employers from mismatches. Similar wage differences can be generated in a model of overlapping labor markets (Sattinger, 2006).[5]

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[5] Connections between mismatches and the underlying assignment problem are discussed in Lex Borghans and Andries de Grip, 2000; Jacques-François Thisse and Yves Zenou, 2000; Hartog, 2000; Allen and van der Velden, 2001; Séamus McGuinness, 2006; Kostas Mavromaras and Séamus McGuinness, 2007; Allen and de Weert, 2007; Francis Green

1.3   Methods of Observation and Measurement

    Mismatches can be observed and measured either from the perspective of the labor market as a whole or from the perspective of the individual worker or firm. Measurement of mismatches in the labor market as a whole are based on abstract models of how the labor market operates. These are considered in Section 1.3.1. Methods that apply to individual workers or firms are described in Section 1.3.2. Studies of the operation of labor markets during the business cycle have generated a number of methods of observing mismatches, and these are considered in Section 1.3.3.

1.3.1. Mismatches in the Aggregate Labor Market

    Coen Teulings and Peter Gautier (2004) combine assignment and search in a model that examines the costs of search, including mismatches.[6] In the underlying assignment problem, workers with greater skill have a comparative advantage at more complex jobs. Output produced by different workers is not perfectly substitutable, generating a trade-off among different workers that changes with the difference between their types. That is, workers that are more similar can be substituted more easily for each other, in a structure previously developed by Teulings (1995). Teulings and Gautier first consider the optimal assignment and then introduce search frictions. With search frictions, workers accept a wider range of jobs than they would with the optimal assignment, and similarly for employers. The cost of search is measured by the relative difference between a worker's value added in the optimal job and the lowest amount the worker would accept in a job. This cost of search is greater when workers are less easily substitutable for each other. Teulings and Gautier are able to break down the costs of search into three components, unemployment, vacancies and mismatches. If the bargaining power between workers and employers is equal, these three components are equal. This suggests that the costs of mismatches to the economy are equal in magnitude to the costs of unemployment.
    In a hierarchical model with search (in which more skilled workers would optimally be assigned to jobs that are more productive), the pattern of assignment of workers to jobs differs from the pattern that would arise in an optimal allocation, generating mismatches. These hierarchical mismatches correspond to vertical mismatches. Gautier and Teulings (2011) analyze output losses from search frictions using a circular model, corresponding to horizontal mismatches. In a circular model, workers and jobs have characteristics that are placed around a circle. These characteristics correspond to different types of workers and jobs rather than having more

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and Steven McIntosh, 2007; Peter J. Sloane, 2003; François Rycx, 2010; CEDEFOP, 2010b, p. 29; and Catherine Béduwé and Jean-François Giret, 2011.

[6] Other labor market analysis that combines assignment and search includes Ramon Marimon and Fabrizio Zilibotti, 1999; Robert Shimer and Lones Smith, 2000; Giuseppe Moscarini, 2001; Shimer, 2007; and Juan Dolado, Marcel Jansen and Juan Jimeno, 2009.

or less skill or complexity. For a worker, having a job further away along the circle would generate a less favorable match. Because of costly search, workers generally find jobs close to their placement on the circle, but not exactly at the same place. Gautier and Teulings find that the mismatches generated by search frictions cause a loss of output between 7 and 15.6 percent. The output loss depends on the wage determination mechanism (Pieter Gautier, Coen Teulings, and Aico Van Vuuren, 2010).

The search and matching literature provides indirect methods of observing mismatches in the labor market. Matching arises from Boyan Jovanovic's description (1979) of the hiring process in which the amount of production from a worker at a firm is unrelated to observable characteristics of the firm or worker and must be discovered over time. The outcome of the job search process is described abstractly by a matching function that relates the number of matches formed between workers and employers to the numbers of unemployed workers and vacant positions. The matching function does not make explicit reference to characteristics of workers or requirements of jobs. However, mismatches between workers and employers they meet in the job search process prevent the formation of all matches and lower the rate that matches are formed (Pissarides, 2000, pp. 22-23). Greater losses from mismatches are then reflected in a lower job finding rate for workers.

Coordination frictions provide a basis for generating a matching function (see the discussion in Barbara Petrongolo and Christopher Pissarides, 2001, pp.401-402). In this process, each of U unemployed workers sends an application to one of V vacancies. Since the workers are uncoordinated, some of the vacancies get no applications, and some of the vacancies get more than one application. When a vacancy gets more than one application, only one is chosen, leaving the rest of the workers unemployed. Mismatches in this context are unrelated to characteristics of workers and jobs and instead take the form of lost output from unemployment and vacancies. When U and V are large, this process leads to a specific functional form for the matching function. Shimer (2005) incorporates these coordination frictions in an assignment model with heterogeneous workers and jobs.

A general matching function is used in search and matching models (Pissarides, 2000; Mortensen and Pissarides, 1999) to describe the aggregate characteristics of a labor market, including the Beveridge Curve relating vacancies to unemployment, the job finding rate, and the unemployment rate. Shimer (2007) provides an alternative to the search and matching model that does not depend on a matching function, and instead is based on aggregation of unemployed and vacancies generated by mismatches over separate labor markets. Mortensen (2008) develops a related model in which workers and firms seek matches in labor markets located on separate islands, with aggregation generating a matching function.

Kenneth Burdett and Dale Mortensen (1978) develop a general equilibrium model of a labor market in which worker on-the-job search generates heterogeneous search behavior by workers, thereby providing firms with an incentive to offer different wage rates. Workers may be unemployed or employed. If they are employed, they continue to search for a job that pays more than their current job. The model generates an equilibrium distribution of wage offers by firms such that firm profits are the same at each wage rate. The model explains how identical workers could be paid different wages (Mortensen, 2003). It can be extended to incorporate differences in productivities of firms, and can be

used for empirical analysis (see the review of worker and firm heterogeneity in Rasmus Lentz and Dale Mortensen, 2010). With heterogeneous productivities among firms, mismatches arise because a worker's current productivity in a job is low relative to what could be produced in an alternative match. Reallocation of workers from less productive employment to more productive employment then raises aggregate productivity (Lentz and Mortensen, 2005).

Search and matching models that do not incorporate explicit heterogeneity in workers and jobs are useful in explaining aggregate labor market behavior, including dynamics in response to shocks. Although their construction is based indirectly on the presence of potential mismatches, they are limited in describing current or future mismatches in terms of skills, education, or other characteristics of interest.

1.3.2. Mismatches Between Individual Workers and Jobs

The existence of a mismatch for a particular worker at his or her job can be established by direct comparison of the worker's characteristics with the job's requirements. The comparison can be made by the worker in a subjective approach, or by the researcher in an objective approach. In the subjective approach applied to survey data, a respondent may indicate directly whether they are well matched, or they may be asked to provide their own evaluation of the job requirements. In the objective approach, the job requirements may be determined by job content analysis (for example the Dictionary of Occupational Titles cited in Section 1.1), or the average for the worker's occupation can be used. Combined, these methods yield four methods of measuring mismatches, as described in the following table:

Table 1.5.   Four Ways of Measuring Mismatches

Approach	Method	Example
Subjective	A	Direct question (European Community Household Panel): • Do you feel that you have skills or qualifications to do a more demanding job than the one you have now?
	B	Comparison (REFLEX questionnaire): • What was the type of qualification? (referring to type of education) • What type of education do you feel is most appropriate for this work?
Objective	C	Comparison • Respondent A's highest level of education attained • Respondent A's occupation (classified via a standard that specifies a job level, e.g. ISCO-88 occupational specifications)
	D	Comparison • Respondent A's highest level of education attained and occupation • Mean educational level for a range of relevant occupation

These different methods have advantages and disadvantages, and can yield different results at a particular point in time. For example, Wim Groot and Henriëtte Maassen van den Brink (2000, 2007) find that mismatch incidence is higher with the subjective approach. Relative merits of the approaches have been extensively discussed in the literature.[7]

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[7] See discussions in Dolton and Vignoles, 2000; Hartog, 2000; and McGuinness, 2006.

Overeducation

By far the most commonly observed form of mismatch is overeducation. Richard Freeman, in "The Overeducated American," established overeducation as a major topic of interest by describing a fundamental change in society in which workers were chronically overeducated for their jobs (1976). The prophesy was perhaps premature but generated an expanded interest in the phenomenon. Gregory Duncan and Saul Hoffman (1981) redirected inquiry away from chronic overeducation towards individual wage determination when the individual's education was greater or less than the education required for a job. They specified and estimated an extension of the Mincer earnings equation in which the wage depends on the required education for the worker's job, years of overeducation, and years of undereducation, allowing for different coefficients for the three measures. In a survey, Joop Hartog (2000) concludes that this is a useful extension of the Mincer framework but only if the estimation is placed within a model of how the labour market works. Wim Groot and Henriëtte Maassen van den Brink (2000, 2007) conduct a meta-analysis of empirical studies of the extended Mincer equation. Their review indicates that overeducation declined over time, from 16 percent in the 1970's to 13 percent in studies using data from the 1990's. In research using Dutch data, Groot and Maassen van den Brink (2003) conclude that overeducation exhibits substantial dynamics. They conclude that mobility between jobs provides a substantial mechanism to move out of a position of overeducation and that greater tenure at a given firm reduces the likelihood of being overeducated. Young workers are more likely to leave overeducation.

Edwin Leuven and Hessel Oosterbeek (2011) review the evolution of this subtopic of labor economics (see also surveys by Peter J. Sloane, 2003, Séamus McGuinness, 2006, and Peter Dolton and Oscar Marcenaro-Gutierrez, 2009). Leuven and Oosterbeek express skepticism concerning how such an estimated wage equation should be interpreted, citing different explanations provided by researchers and different policy inferences drawn. Additionally, overeducation and undereducation are calculated using different measures of required education for a job based on worker self-assessment, job analysis (for example as provided by DOT), and realized matches. Leuven and Oosterbeek report that on average (over all studies), 26 percent of workers are underschooled and 30 percent are overschooled (2011, Table 1, p. 16). Considering estimated effects of overeducation and undereducation on earnings, Leuven and Oosterbeek argue that there are extensive problems with omitted variable bias and measurement error that interfere with interpretation, and that these problems have not been resolved. Estimates of the Duncan and Hoffman earnings equation vary among studies depending on how variables are measured and the estimation method (2011, Table 2, p. 31). The results also vary by continent, by decade, and by gender. Over all studies, the estimated return for required education is .089, the return for overeducation is .043, and the return for undereducation is -.036. The results are consistent with human capital theory, if being overeducated for a job arises from a human capital investment opportunity that advances an individual's career, as suggested by Nachum Sicherman and Oded Galor (1990). Leuven and Oosterbeek also relate overeducation and undereducation to theories of job competition, signaling/screening, preferences, and search and frictions. They conclude that the results of the overeducation literature do not provide a guide to investment in schooling because the estimated wage equation cannot be interpreted as a

causal relation. However, they regard the results of such equations as potentially informative about the costs of mismatch and they encourage continuing work on efficiency questions arising from overeducation.

Skills Mismatches versus Educational Mismatches

Consistent with heterogeneity in jobs and workers, mismatches occur in skill categories as well as in educational level. Jim Allen and Rolf van der Velden (2001) consider the relation between skill mismatches and educational mismatches and their relative contributions to wages, job satisfaction, and job mobility. Using Dutch data from a project providing data on eleven European countries and Japan, Allen and van der Velden base the measures of educational and skill mismatches on self-ratings. For educational mismatches, data include measures of both level and field. Skill mismatches are based on whether respondents agree with the following statements:
1. My current job offers me sufficient scope to use my knowledge and skills.
2. I would perform better in my current job if I possessed additional knowledge and skills.

Disagreement with the first statement indicates skill underutilization, while agreement with the second statement indicates a skill deficit. Allen and van der Velden find that about 15 percent of individuals indicate skill underutilization, and about 49 percent indicate skill deficit. The two categories are not mutually exclusive, since the responses to the two questions are only weakly related and about 6 percent indicate skill underutilization simultaneously with skill deficits. The authors find that educational mismatches are only weakly related to skill mismatches, contrary to what they expected based on a hierarchical assignment model. Similarly, Kostas Mavromaras, Seamus McGuinness and Mark Wooden (2007), using data from the Household, Income and Labour Dynamics in Australia, find low correlation between overeducation and overskilling. In estimates of wages, Allen and van der Velden find that skill underutilization has a significant negative effect, skill deficits have negligible effects, and skill mismatches in general have small effects relative to educational mismatches.

Etienne Wasmer, Peter Fredriksson, Anna Lamo, Julián Messina and Giovanni Peri (2005), in an analysis of the macroeconomics of education, consider skill mismatch and over-qualification in Europe. They consider whether skill mismatch is a temporary condition for individual workers or a long-lasting episodic phenomenon arising from rapid changes on either the demand or supply side. Mismatches are determined from two questions in the European Community Household Panel (ECHP):
1. Do you feel that you have skills or qualifications to do a more demanding job than the one you have now?
2. Have you had formal training or education that has given you skills needed for your present type of work?

The first question determines whether the individual is over-qualified, and the second question determines whether the individual mismatched. The answers generate four categories labeled as follows:
- NOWM ("non-over-qualified and well-matched"): the individual is not over-qualified (a negative answer to the first question) and education and training are suited for the job (a positive answer to the second question)

- NOBM ("non-over-qualified and mismatched")
- OWM ("over-qualified but correctly matched")
- OBM ("over-qualified and mismatched")

Data are combined for countries and years available, but limited to full-time employees 15 to 64. About 54 percent indicate that they are over-qualified (yes to the first question), and about 42 percent indicate that they are mismatched (no to the second question) (2005, Table 5.1). Only about 21 percent are in the category NOWM. The percentage with NOWM increases with age, and the percentage with over-qualification decreases with age. NOBM and OWM do not appear to change with job tenure, while OBM declines. Using weighted averages for ten European countries, Figure 5.1 shows movement in the categories over seven years. The figure shows a stable incidence of skill mismatch, with a slight decline in OWM combined with an increase in properly matched individuals, contrary to what one would expect from a deepening long-run aggregate mismatch. Figure 5.2 shows variations in the four categories across thirteen European countries. Figure 5.3 shows rank correlations between Employment Protection Legislation and the four categories. The data support the argument that EPL makes it more difficult for younger workers to find a job without a skill mismatch (Bertola et al 2005).

Wasmer et al also undertake an analysis to examine the relation between personal characteristics and the mismatch categories. Male workers are more likely to be over-qualified. Over-qualification also increases with years of education (except that the relation is not significant for Germany). Over-qualification declines with labor market experience in all countries. The authors also apply multinomial logit to analyze all four categories. Estimates of wage equations incorporating over-qualification and mismatch variables suggest that wage penalties are generated by skill mismatches rather than over-qualification.

Jim Allen and Egbert de Weert (2007) examine the relation between educational and skill mismatches further using comparable survey data for graduates from Spain, Germany, the Netherlands, the United Kingdom, and Japan. Educational and skill mismatches are generally related: graduates in jobs above their educational level or outside their fields use less of the skills and knowledge from university than those in matching jobs. The relation between educational mismatches and use of skills and knowledge is weakest in Germany and the Netherlands, and greatest in the United Kingdom and Japan.

Francis Green and Steven McIntosh (2007) use results from the 2001 British Skills Survey to examine the relation between qualification mismatches (in terms of education) and use of skills. They find that that there is a positive relation between overqualification and overskilling. However, since the correlation between the two conditions is low (0.20), less than half of workers who were overqualified were also overskilled. The results support their view that one of the explanations for observed qualification mismatch is that many workers with the same qualifications have heterogeneous skill levels, so that some overqualified individuals may in fact have appropriate skills for their jobs.

Vertical versus Horizontal Mismatches

E. Berkhout, S. Van der Werff and A. Heyma (2010) examine the relation between vertical and horizontal mismatches using the Dutch Labour Force Survey. By confronting a worker's level and field of education with his job level and direction (method C, see Table 1.5) they are able to determine both the incidence of horizontal (field) as well as vertical mismatch (level). The results are shown in Figures 1.1 and 1.2 and reveal that the incidence of mismatch is highest among the middle educated workers. Among higher educated workers incidences of vertical and horizontal mismatch do not differ a substantially. Among the middle educated workers, on the other hand,

Figure 1.1   The incidence of vertical and horizontal mismatch in the Netherlands among middle educated workers
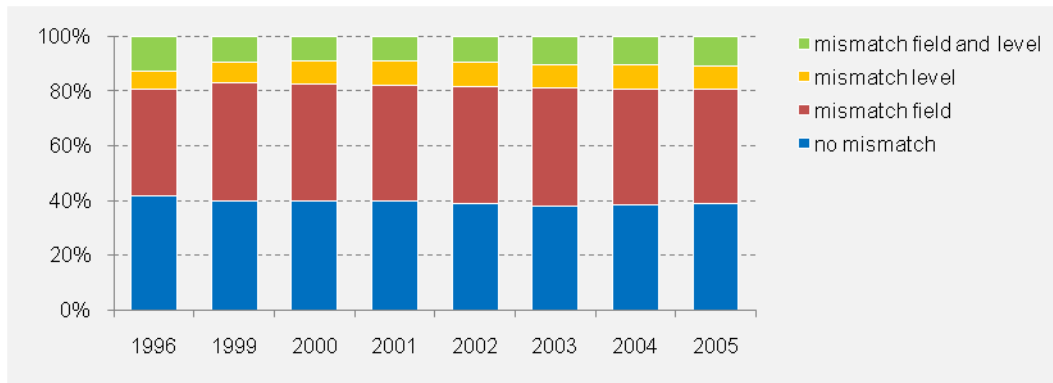
Source: SEO Economic Research, based on CBS (1996-2005)

Figure 1.2   The incidence of vertical and horizontal mismatch in the Netherlands among higher educated workers
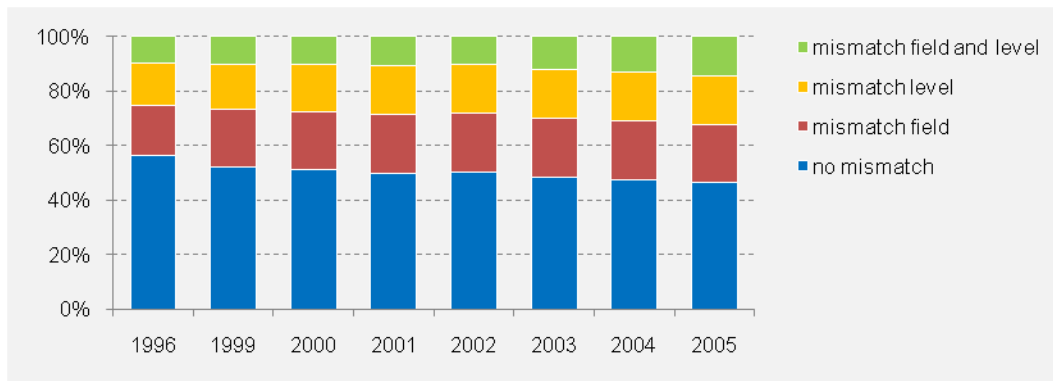
Source: SEO Economic Research, based on CBS (1996-2005)

horizontal mismatch is dominant.

J. Koucky, C. Meng & R. Van der Velden (2007) offer a comparative approach by using the 2005 REFLEX dataset. This dataset surveys university graduates in 16 European countries three to four years after graduation. The survey includes subjective questions on both horizontal and vertical mismatch. The authors establish that 9 percent of the graduates are mismatched vertically, 8 percent horizontally and 6 percent both

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vertically and horizontally.[8] Incidences of mismatch are higher among those with a bachelor (or equivalent) degree than for those with a master degree. Horizontal mismatch also differs across countries: Estonia, the Czech Republic and the United Kingdom report relatively high levels of 15 percent or more among bachelor graduates, while Norway and Spain report as little as 2 to 3 percent.

Robst (2008) analyses 1993 data on U.S. graduates and finds that vertical mismatch is more common than horizontal mismatch. Robst finds that horizontal mismatch has a negative effect on wages. Whereas overeducated workers suffer a wage penalty of 7 percent, the wage penalty triples for overeducated workers who are also working in a job unrelated to their field of graduation.

1.3.3   Business Cycle Mismatches

The state of the economy can have significant effects on levels of mismatches. Periods of high unemployment, such as the recession following the 2008 crisis, make it difficult for unemployed workers to find jobs that match their qualifications. New entrants, particularly graduates with higher levels of education, find it difficult to establish themselves in the labor market and often take jobs for which they are overqualified. During business cycle peaks, employers find it difficult to hire qualified workers and often must settle for underqualified workers that must be trained. As a result, mismatches can be expected to change systematically over the business cycle. From the comments by Diamond and Kocherlakota in the introductory chapter, measures of mismatches have been used by economists studying aggregate labor markets to explain shifts in the Beveridge curve relating aggregate unemployment to aggregate vacancies in an economy.

The business cycle may affect sectors of the economy unequally, generating different ratios of unemployed workers to vacancies in labor submarkets. Search behavior by workers and firms then produces unequal unemployment rates. Measures of mismatch can be based on the differences between ratios of vacancies to unemployed, even though they do not explicitly describe the heterogeneous characteristics of workers and jobs.

Richard Layard, Stephen Nickell and Richard Jackman (1991, Chapter 6) provide an index of mismatches based on differences in unemployment rates among disaggregated labor markets. The measure indicates the proportional increase in unemployment over the minimum that would occur if all unemployment rates were equal. Jackman and Roper (1987) develop measures of mismatches (or structural imbalances) based on differences within sectors between the proportion of aggregate unemployed in the sector and the proportion of aggregate vacancies in the sector (equivalently, the ratio of vacancies to unemployed varies among sectors). In their analysis, mismatches (or

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[8]   This is far lower level of the incidence of mismatch than Berkhout, Van der Werff and Heyma (2010) find. However, both studies use different data, a different sample and a different method to measure mismatch. Most importantly, Koucky, Meng and Van der Velden (2007) only survey one particular cohort of graduates, whereas Berkhout, Van der Werff and Heyma analyse the whole labor force including highly educated workers of all ages.

structural imbalances) arise when the characteristics of unemployed workers (in terms of skills, experience or location) differ from the corresponding characteristics of jobs in the same sectors. Compared to a labor market with equal proportions across sectors, the consequence of unequal proportions of aggregate unemployed and vacancies is that the hiring rate is below the rate that would otherwise occur, and the combination of unemployed and vacancies lies above the relation that would otherwise occur. Jackman and Roper observe a sharp increase in mismatches around 1979-1981 using industrial sectors, primarily caused by imbalances between manufacturing and services (1987, p. 32). Ayşegűl Şahin, Joseph Song, Giorgio Topa and Giovanni L. Violante (2011) develop a related measure of mismatch based on a comparison between the observed pattern of unemployment and the optimal allocation that a planner would choose to minimize the overall unemployment rate. Their measures indicate that less than one percent of the increase in the unemployment rate in the recent recession (starting in 2008 in the U.S.) is attributable to increasing mismatch.

Javier Birchenall (2011) develops a theory of mismatches in which heterogeneity also takes the form of locations on a circle, as in Gautier and Teulings (2011). Workers are distributed clockwise around the circle starting from an ex ante assignment, and jobs are distributed counterclockwise. Production takes place where workers and jobs overlap on the circle, forming matches, and unemployed workers and vacant jobs occur where there is no overlap. The distance that workers and jobs move around the circle depends on the length (circumference) of the circle, and variations in this length generate short-term variations in unemployment and vacancies. Unemployed workers and vacant jobs are eventually reallocated, so that an increase in unemployment is related to an increase in dispersion across sub-markets on the circle. The model is used to explain the midterm relationship between the unemployment and vacancy rate, which differs from the short-term relationship.

1.4   Consequences of Short Run Mismatches for Workers and Firms

In a model of the aggregate labor market, Gautier and Teulings (2004) found that losses from mismatches were about equal in magnitude to losses from unemployment, and in a different model (2011) they concluded that losses from mismatches caused a reduction in output between 7 and 15.6 percent. These are substantial amounts and suggest the gains that can be obtained if mismatches can be reduced. This section considers consequences of mismatches for individual workers and firms.

1.4.1   Losses for Workers

Looking at mismatches from the perspective of a worker provides a method of organizing the consequences of mismatches over a worker's career, from human capital investment decisions through obsolescence and retirement. A common observation is that workers upon entering the labor market are willing to take jobs with mismatches in order to gain experience. Many workers in initial mismatches change jobs or get training to compensate for their mismatches, while other workers continue in a condition of mismatched employment. At later ages, changes in jobs may cause worker skills to become obsolete, while technical skills may also decline over time. Along the way they

may experience different levels of job satisfaction or wages depending on how well they are matched with their jobs. Specific results for workers over their careers follow.

- Type and level of education.

Decisions of type and level of education can affect workers throughout their careers and increase the difficulty of entry into the labor market. One in three workers experience horizontal mismatches in their fields of study (Glenda Quintini, 2011, p. 5).

- Initial entry into the labor market.

Workers seeking entry into the labor market for the first time are likely to accept jobs at which they are overqualified or underqualified. Glenda Quintini and Thomas Manfredi (2009) review school-to-work transitions in the United States and Europe. The transitions are characterized by different pathways taken by individuals in establishing themselves in the labor market, often involving frequent job changes and spells of unemployment. These frequent interruptions reflect underlying mismatches between workers and jobs upon entry into the labor market, and show that information on a worker's education does not fully characterize worker's qualifications for jobs. Highly educated individuals are likely to start out in jobs for which they are overqualified.

- Wage losses for individuals.

From the Leuven and Oosterbeek survey of all studies (2011), a given worker earns less when overeducated at a job than when the job's required level matches the worker's.

- Job satisfaction

Using ECHP survey data, Quintini (2011) finds that workers have lower job satisfaction when they are over-qualified or over-skilled, compared to well-matched counterparts. Under-qualified workers tend to be more satisfied.

- Job training in response to mismatches

George Messinis and Nilss Olekalns (2007a, 2007b) argue that workers respond to educational mismatches by getting training that modifies the consequences of overeducation and undereducation. Workers with inadequate education for their jobs get training in an attempt to get the same return as workers well-matched to the job. Using data from the 1997 Survey of Education and Training collected by the Australian Bureau of Statistics, they find that training brings wages for undereducated workers closer to the levels associated with the job. They argue that training also benefits overeducated workers by reducing the wage loss associated with their overqualification.

- Job search and job mobility

In general, overeducated workers have higher turnover rates (P. Sloane, H. Battu and P. Seaman, 1999). Wim Groot and Henriëtte Maassen van den Brink (2003) study the dynamics of mismatches in the Dutch labor market using data from the OSQ-Labour Market Survey. They estimate the likelihood of leaving or entering a condition of overeducation in a job, and conclude that the dynamics of movement are high. In the two year period studied, 40 percent left overeducation while five percent entered. They also observe that overeducated workers are about three times as likely to search for work as those who are not overeducated.

Alfonso Alba-Ramírez and Maite Blázquez (2003) consider transitions among six different categories of mismatches using data from the European Community Household Panel for Spain. They find that overeducated workers have shorter job tenures than adequately educated workers. Workers with more than three years job tenure who are

overeducated but whose formal training is closely related to their work are more likely to move to a different firm.

Using the HILDA (Household, Income and Labour Dynamics in Australia) survey data, Mavromaras, McGuinness and Wooden (2007) view job separation rates and outcomes for workers according to whether they are overskilled in their jobs. The HILDA survey provides five waves of data. Over the five waves, severely overskilled workers had on average a job separation rate of 28.4 percent, while well matched workers had a job separation rate of 17.1 percent (2007, Table 1, p. 310). However, the data indicate that improvement in skills match was slow (2007, Table 2, p. 311). Among workers who were severely overskilled in the first wage, only 30 percent were well matched by the fifth wave. The authors conclude that overskilling is not temporary and instead is a relatively persistent phenomenon (see also McGuinness and Wooden, 2007, and Mavromaras, McGuinness and Fok, 2009). Miller (2007), using Australian data, finds that overall overeducation declines with labour market experience.

- Promotion within firms.

Sandra Groeneveld and Joop Hartog (2004) investigate the likelihood that overeducated or undereducated workers get promotions or wage increases within a firm. Their data come from a single firm in the energy and telecommunications industry that has three major sections. One section, central staff, is primarily an internal labour market with little hiring from the labour market. Another section, commercial, employs workers through an external labour market in which workers face competition with workers outside the firm. Required education for different jobs is determined by the firm's hiring standards. Using personnel information from the firm, Groeneveld and Hartog estimate the likelihood of promotion and relative wage growth between 1995 and 1998. They find that being overeducated significantly increases both the likelihood of job promotion and wage growth, while undereducation has no significant effects. Separating out data for the section with the internal labour market, undereducation additionally reduces job promotion significantly. For the section with the external labour market, the only significant effect is that overeducation increases the likelihood of promotions. Groeneveld and Hartog also observe differences with respect to age. With the combined data, overeducation significantly increases job promotion and wage growth for younger workers but not for older workers.

- Changes in likelihood of mismatch over career

Wasmer et al (2005) find that overqualification declines with labor market experience, consistent with workers continuing to engage in job search to find a job that matches their qualifications. The percentage of workers that are neither overqualified nor mismatched increases with age. Nevertheless, there is substantial persistence in mismatches over a worker's career.

Among United Kingdom graduates, Peter Dolton and Mary Silles (2003) find that in initial employment, about half of university graduates are in jobs where they are overeducated, but after some time in the labor force, this falls to about one-fifth.

- Skill obsolescence

Andries De Grip and Jasper Van Loo (2002, p. 4), in a review of skills obsolescence, distinguish the following forms and causes:

Table 1.6: Types of Skills Obsolescence

Type of Skills Obsolescence	Subcategory	Cause of Human Capital Depreciation
Technical Skills Obsolescence		
	Wear	Natural aging process, illness, or injury
	Atrophy	Insufficient or no use of skills
Economic Skills Obsolescence		
	Job-specific skills obsolescence	New skill requirements due to developments in society
	Skills obsolescence by sectoral shifts	Shrinking employment in occupation or economic sector
	Firm-specific skills obsolescence	External mobility
Occupational forgetting		The aggregate of wear of skills of individual workers, or quits of workers with firm-specific skills

Computerization, technological and organizational change, discussed in the chapter on long run aggregate mismatches, provide a major explanation for the job-specific skills obsolescence that occurs to individuals. New technologies make certain skills redundant and at the same time create new ones (Allen and De Grip, 2007). Sherwin Rosen (1975) describes skills obsolescence caused by technological changes as vintage effects, reducing the value of human capital obtained earlier. Although aging is related to some forms of skills obsolescence, Lex Borghans and Bas ter Weel (2002) find that computerization does not differentially affect older workers, whose wages are not negatively affected by lack of computer skills. De Grip and Van Loo cite a number of studies that argue that higher levels of education protect workers against skills obsolescence, either because workers obtain secondary skills that they can still use, or because they can continue to maintain their skill levels through training (see 2002, Table 2, p. 16, for an overview of obsolescence studies). Lex Borghans and Andries De Grip (2000) find that while new technologies allow highly skilled workers to continue employment, lower educated workers no longer have sufficient skills to keep their jobs. Sectoral shifts, as described by David Lilien (1982), also cause skills obsolescence and mismatches, by preventing workers from shifting to other sectors where their skills could be used. Skills obsolescence has often been measured by estimating wage effects in earnings functions, but worker skill surveys offer the opportunity to obtain objective measures.

Jim Allen and Rolf van der Velden (2002) use survey data to determine when job specific skill obsolescence occurs. They use data on Dutch graduates of tertiary education, who were asked "What percentage of the knowledge and skills that you acquired during (tertiary) education is now out of date?" They find that about 30 percent of skills are out of date, with a standard deviation of 21 percent. Since the respondents had graduated seven to eight years previously, the half-life of competencies lies between ten and fifteen years. Allen and van der Velden find that skills obsolescence is as likely to occur in generic as in specific fields of study.

- Decline in cognitive abilities from mismatch

Andries de Grip, Hans Bosma, Dick Willems and Martin van Boxtel (2008) study the consequences of job-worker mismatches for cognitive decline using longitudinal data on worker cognitive abilities from the Maastricht Aging Study. They consider the "use-it-or-lose-it" hypothesis, in which overeducated workers lose cognitive abilities over time, and the "intellectual challenge" hypothesis, in which workers who are challenged by working beyond their educational level experience less cognitive decline. The data provides an objective method of determining overeducation based on systematic job analysis. Measurement of cognitive abilities occurs at two points in time six years apart and covers verbal memory, cognitive flexibility, verbal fluency and information processing speed. De Grip et al also consider the hypothesis that overeducation occurs when workers lack cognitive skills for a particular educational level, so that overeducation compensates for lack of ability in a job. Contrary to this hypothesis, the authors find that the cognitive abilities of overeducated workers are not lower than workers with jobs that correspond to their educational levels. Also, workers in jobs that require higher levels of education do not have higher cognitive abilities. De Grip et al find that overeducation usually does not have significant effects on cognitive decline, although the magnitudes of the effects are high. However, when overeducation and undereducation are combined into a single job-mismatch variable, the resulting variable has a significant but mixed impact on cognitive changes. Also, risk of cognitive decline is lower at higher levels of education. A measure of extent of overeducation is significantly negatively related to immediate recall, delayed recall, and verbal fluency.

- Mismatch Among Ageing Workers

Ageing workers (over 50) are less likely to be overskilled than younger workers, but more likely to be overeducated (CEDEFOP, 2010c, p. 5).

1.4.2   Losses for Firms

François Rycx (2010) provides direct evidence of the impact of educational mismatches on firm productivity. He first reviews the literature relating mismatches to productivity. Using human capital theory, one approach has inferred the effects of educational mismatches on productivity by observing the effects on wages and then assuming that wages correspond to productivity. A second approach observes the effects of educational mismatches on variables that are believed to be related to productivity, such as job satisfaction. These approaches yield different conclusions and impose methodological limitations. For example, Felix Büchel (2002) analyzes the effects of overeducation on productivity in Germany using data from the German Socioeconomic Panel. In contrast to results using United States data, Büchel finds that overeducation yields positive effects on productivity as measured by job satisfaction, health status, participation in on-the-job training, and job tenure. He argues that it is therefore reasonable for firms to hire workers that are overeducated for their positions.

Using firms as observations, Rycx estimates the effects of proportions of overeducated and undereducated workers on firm value added per worker using two linked Statistics Belgium data sets, the Structure of Earnings Survey and the Structure of Business Survey. The results indicate that firm productivity depends positively on the proportion overeducated and negatively on the proportion undereducated. Furthermore,

by distinguishing workers that are younger than 36 or at least 36, Rycx concludes that the impacts of educational mismatches on productivity come from the younger workers. This is consistent with younger workers experiencing real mismatches, while older workers have levels of education that compensate for other productivity-related characteristics. Also, the result is consistent with the observation of Groeneveld and Hartog (2004) that overeducation increases job promotion and wage growth for younger workers. Rycx concludes that the results can be reconciled with the literature on wage effects of educational mismatches.

1.5   Policy Conclusions for Short Run Mismatches

The causes of qualitative mismatches are closely tied to the features of the labor market that generate unemployment. Costly job search, arising from frictions and imperfect information about workers and jobs, leads workers to accept jobs that do not fully correspond to their qualifications, rather than continue to be unemployed. Employers choose workers that do not completely meet their job requirements rather than leave vacancies unfilled. As a consequence, the correspondence between worker and job characteristics will not be the same as in the optimal assignment, as reflected in qualitative mismatches. This link between qualitative mismatches, unemployment and vacancies shows up explicitly in the Gautier and Teulings model (2011) that estimates the costs of mismatches to be about the same magnitude as costs of unemployment and of vacancies. The immediate conclusion from this link is that policies that reduce unemployment will reduce qualitative mismatches, and vice versa. These can be categorized as follows.

1.5.1. Education

A major concern of educational researchers is to design programs that prepare people for their working careers, and there is substantial research in this area. A common conclusion is that educational systems should at the least provide students with numeracy and literacy skills, especially among poor performers, so that they will not be underskilled in the jobs they are able to find (Quintini, 2011, p. 10).

1.5.2. School-to-work transitions

The process of transitioning from school to work generates both high unemployment and high levels of mismatches for younger workers as many individuals struggle to establish themselves in the labor market. Job experience in the form of internships and summer employment can shorten the periods of both unemployment and mismatches (Quintini, 2011, p. 10).

1.5.3. Information

Imperfect information in the labor market plays a central role in preventing the best placement of workers at jobs. Overcoming these imperfections is a recognized strategy to reduce mismatches and unemployment. Before employment, while individuals

are still in school, improved career guidance could enable students to make better decisions and avoid field-of-study mismatches later in their careers (Quintini, 2011, p. 9).

1.5.4. Institutional features of labor market

Economists have attempted to explain differences in the unemployment rate between the United States and European countries in terms of the degree of flexibility in the labor market. Taxes at low income levels, the minimum wage, employment protection legislation, levels of unemployment compensation, and active labor market policies can affect how much mobility there is in the labor market and overall levels of unemployment. These institutional features can also be expected to affect mismatches, by affecting the decisions of workers to accept jobs and employers to make offers to workers. In particular, Wasmer et al (2005) argues that employment protection legislation increases the incidence of mismatches as well as increasing unemployment levels.

1.5.5 Reduction of skills obsolescence

Policies to encourage life-long learning and on-the-job training can maintain the relevancy of worker skills and thereby reduce skills obsolescence (Quintini, 2011, p. 10).

1.5.6. Labor market imperfections

The labor market exhibits a number of imperfections that prevent its efficient operation. A commonly recognized imperfection is the distortion of incentives for workers to acquire training or employers to offer training because of mobility in the labor market. Another imperfection is the loss of information about workers or jobs that occurs when jobs break up. Policies that would address these imperfections, and reduce mismatches, will be considered in Chapter 5 because they can often be addressed by labor market intermediaries, such as temporary help agencies.
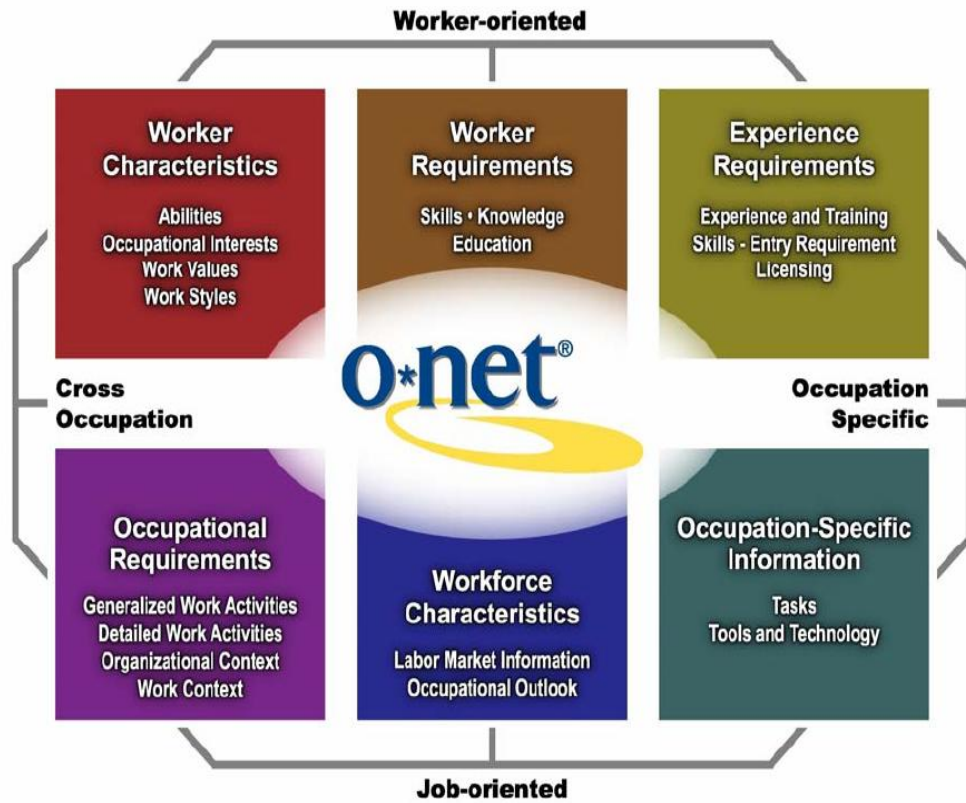
Appendix: Job Characteristics

Differences in jobs play a longstanding role in the history of economic thought. Joop Hartog relates job heterogeneity to Adam Smith's explanations of specialization and division of labor (1992, p. 18). Job differences have been documented through the analysis of job content. The Dictionary of Occupational Titles (hereafter DOT), developed for job counseling by the U.S. Department of Labor, provides descriptions of occupations in categories of data, people and things as shown in the following table (DOT information is available at www.occupationalinfo.org).

Hartog (1977, 1981) uses DOT data for the demand side to model the determination of the distribution of income. The U.S. Department of Labor has supplanted DOT with the Occupational Information Network (O*NET), which provides greater detail about job content. Suzanne Tsacoumis (2007) reviews O*NET and its use in studying changes in job skills. O*NET provides information on six categories of work: worker characteristics, worker requirements, experience requirements, occupational requirements, workforce characteristics, and occupation specific information. The relations among the categories are shown below in Figure 1.3 from Tsacoumis (2007, p.

2). Both DOT and O*NET are used in recent analyses of consequences of computerization (Autor, Levy and Murnane, 2003, discussed in the chapter on long run mismatches), skill-biased technological change (Acemoglu and Autor, 2011, discussed in the chapter on long run mismatches), the allocation of workers to jobs (Autor and Handel, 2009), and job polarization. In research on tasks that goes beyond the DOT and O*NET descriptions, Michael Handel (2007) describes the survey on Skills, Technology, and Management Practices (referred to as STAMP), prepared by the Center for Survey Research at the University of Massachusetts-Boston. Among other shortcomings, Handel argues that DOT and O*NET are weak in some content areas including information technology and employee involvement practices. In addition to skill and task requirements, STAMP includes questions on supervision, autonomy and authority; computer and other technology; employee involvement; job downgrading; and job satisfaction (Handel, 2007, Table 1). The new category of employee involvement covers job rotation and cross-training; pay for skill; formal quality control program; teams activity levels, responsibilities, and decision making authority; and bonus and stock compensation. Autor and Handel (2009) describe an additional source of job information adapted from the STAMP survey, the Princeton Data Improvement Initiative (PDII) survey, which extends previous job description systems by documenting how jobs vary within occupational categories. This variation within occupations is systematically related to the gender, race and English-language proficiency of the person in the job. Autor and Handel use the information on job characteristics that vary within occupations to provide a better model to explain wage determination. Alexandra Spitz-Oener (2006) uses the German IAB/BIBB dataset to examine changes within occupations in an analysis of rising educational demands. The 1997 British Skills Survey provides an additional source of information on job tasks (Francis Green, David Ashton, Brendon Burchell, Bryn Davies and Alan Felstead, 2000; Alan Felstead, Duncan Gallie and Francis Green, 2002).

Figure 1.3: O*NET

Worker-oriented

Worker Characteristics
Abilities
Occupational Interests
Work Values
Work Styles

Worker Requirements
Skills • Knowledge
Education

Experience Requirements
Experience and Training
Skills - Entry Requirement
Licensing

Cross Occupation

O*net®

Occupation Specific

Occupational Requirements
Generalized Work Activities
Detailed Work Activities
Organizational Context
Work Context

Workforce Characteristics
Labor Market Information
Occupational Outlook

Occupation-Specific Information
Tasks
Tools and Technology

Job-oriented

Chapter 3. Long Run Aggregate Qualitative Mismatches

Currently the United States is experiencing a long run aggregate qualitative mismatch between demands for college-educated labor and supplies, as suggested by increases in the relative wages of college graduates. How did changes in jobs and the labor force contribute to this qualitative mismatch? What prevented the labor force from fully adapting to future changes in jobs? To what extent did this qualitative mismatch occur in other economies? Fortunately, in an attempt to explain rising inequality and increasing educational premiums, extensive economic research has focused on the generation and explanation of the current qualitative mismatch. This research is reviewed here. Possible causes include technology, the spread of computerization, globalization, organizational change, and changes in the education provided to and chosen by individuals. Consequences of long run aggregate qualitative mismatches include missed investment and employment opportunities, and job polarization. Eventually, long run aggregate qualitative mismatches would decline, perhaps to be replaced by new mismatches, as the extent of the mismatch is recognized and individuals react to it. Losses from the mismatch would be reduced by early recognition and development of appropriate policies. The chapter considers future changes in job requirements as well as policies that can help an economy to adapt to change.

3.1   Causes

Technological change, consumer preferences and trade alter the mix of jobs in a country over time. As a result of the development of new products by firms and the development of new consumer needs, the products produced today in a country differ from the products produced a few decades ago. New production procedures displace older processes that used earlier sets of worker skills. Simultaneously, individuals choose types of education (e.g. occupations, trades, and industries) and levels of education based on their incentives, opportunities and expectations. New generations of workers come to the labor market while older generations retire, with new skills, career goals, and attitudes about work. Long run aggregate qualitative mismatches arise when over time the mix of requirements for jobs in an economy differs from the mix of qualifications that individuals have obtained in preparation for employment.

In addition to the qualitative mismatch examined by economists studying the recent increases in higher educational premiums and mismatches, other episodes of qualitative mismatches occurred in the past and illustrate how they arise. In their discussion of the high school movement, Claudia Goldin and Lawrence Katz describe the growth of office jobs in the early twentieth century that arose as the result of the reorganization of production and distribution (2008, p.172). This growth generated extremely high returns to training for office work (2008, p. 181) and endogenous technological change in the development of office equipment. The high returns to office work, as well as the high returns to blue collar manufacturing workers with high school training, provided communities with an impetus to provide high school education and generated incentives for individuals to acquire high school education. In this case, the qualitative mismatch arose both from changes on the demand side and from the inability to anticipate the changes that would take place. As a result, the growth of high schools

lagged the demands for high school workers, gradually eliminating the qualitative mismatch and reducing the high school premium over time.

Trade in grain in the nineteenth century generated another qualitative mismatch. As a result of transportation development in the United States, large quantities of grain were exported to Europe, depressing prices of grain. This generated substantial movement of farmers and resources out of grain production and either into other forms of food production or out of agriculture altogether (T.K. Derry and Trevor I. Williams, 1960, p. 685). Continental European countries (which also imported grain from Russia and the Ukraine) were affected less severely because they imposed tariffs, unlike the United Kingdom. Denmark responded to lower grain prices by emphasizing a high level of rural education through the folk high school movement (Derry and Williams, 1960, p. 686). Denmark also moved towards cooperative forms of production that disseminated technological change such as the mechanical cream-separator.

A third episode arises in the different responses of England and Germany to the rapid technological change in the last two decades of the nineteenth century. German advances in chemical and electrical manufacturing arose from cooperation between industry and university research departments and on a planned network of technical institutes and trade schools that provided trained workers with scientific backgrounds (Derry and Williams, 1960, p. 703). In Saxony, there was one technical school per 10,000 individuals, and chemical manufacturers had on average one university-trained chemist per forty workers (Derry and Williams, 1960, p. 308). In contrast, insufficient attention was placed on science at Oxford and Cambridge, Britain lacked the technical colleges developed in Germany and France, and their Mechanics' Institutes failed to develop because of inadequate elementary education (Derry and Williams, 1960, p. 704). This episode shows that educational policy responses to technological change can exacerbate or ameliorate qualitative mismatches.

3.2   Methods of Analysis

The fundamental method of studying these long run qualitative mismatches is shifts in supply and demand for different combinations of job characteristics. The relative size of these shifts can be observed indirectly through their effects on the wage rates for different groups of workers. For example, consider a very simple version of the labor market in which workers are either skilled or unskilled, and jobs require combinations of skilled and unskilled workers. Suppose the market for unskilled labor is stable over time, with changes in the numbers supplied or demanded growing at the same rate. In the market for skilled labor, two alternatives are possible. In the first alternative, shown in Figure 3.1, the supply curve shifts further to the right than the demand curve, generating a decline in the wage rate for skilled labor and a decline in the wage premium (the wage for skilled labor relative to the wage for unskilled labor). In the second alternative, shown in Figure 3.2, the demand curve shifts further to the right than the supply curve, and the wage rate for skilled labor and the wage premium increase. In Jan Tinbergen's characterization of the evolution of income distribution, technology is constantly shifting the demand curve for skilled labor to the right, and educational institutions are always shifting the supply curve to the right. Whether the wage premium for skilled labor and income inequality increases then depends on the race between technology and education.

In Figure 3.1, education wins and inequality declines. But in Figure 3.2, technology wins and inequality increases.

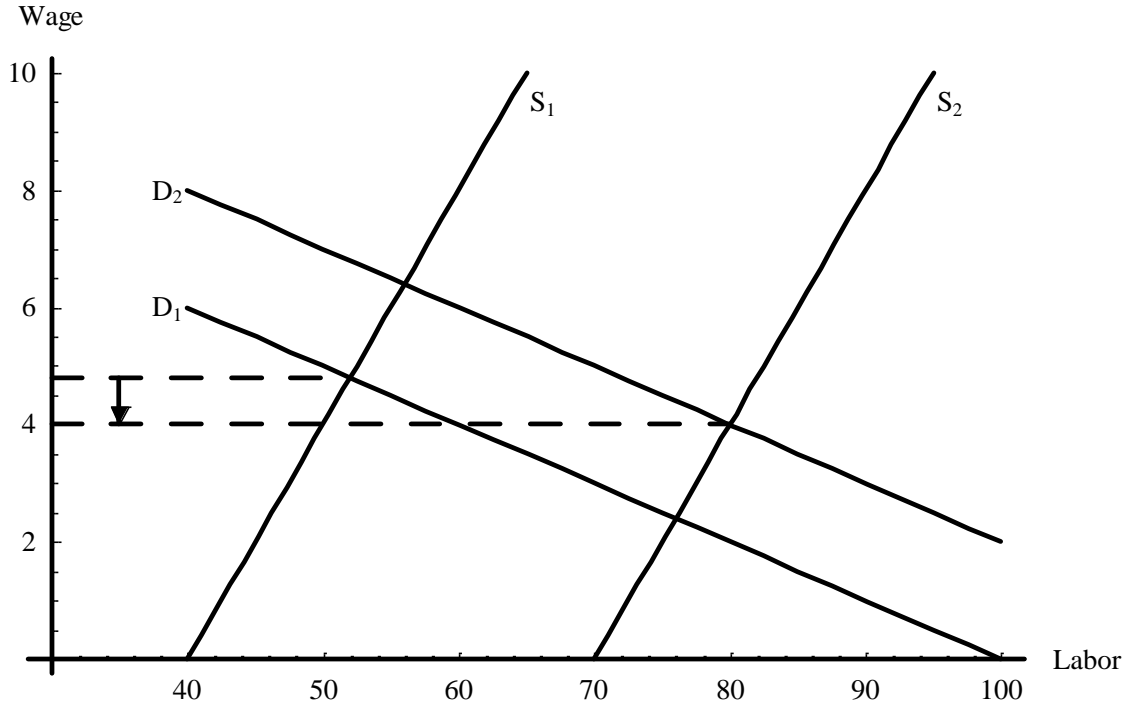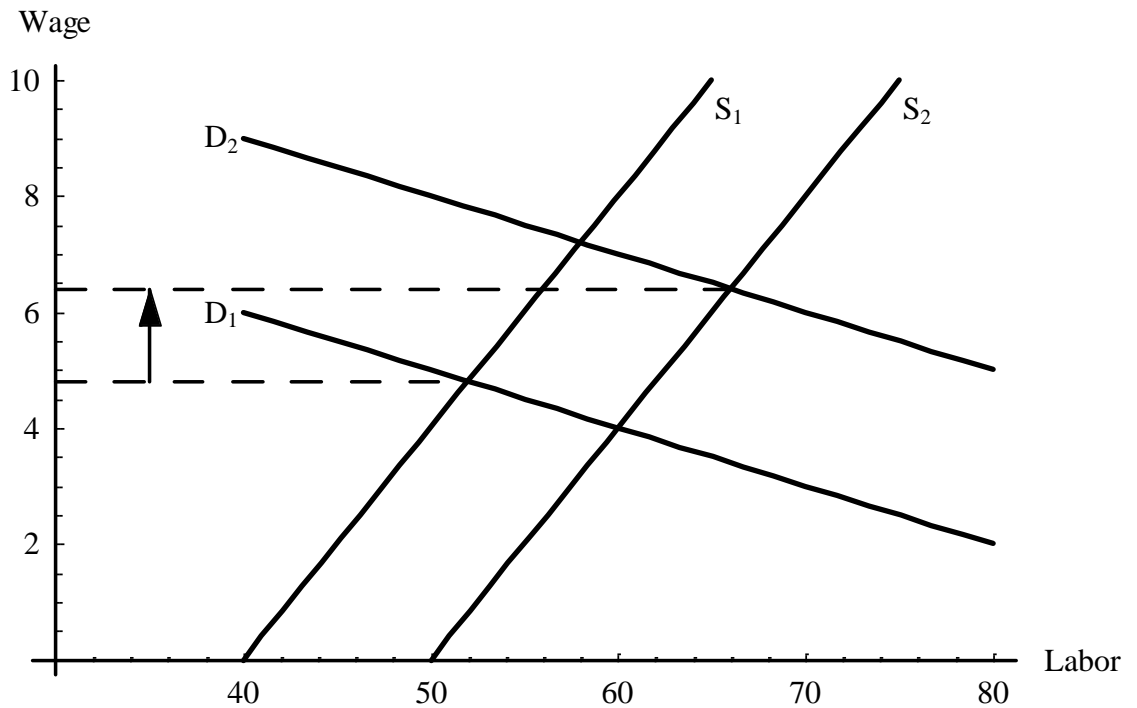Figure 3.1: Wage Decline When Demand Shifts Less Than Supply

Figure 3.2: Wage Increase When Demand Shifts More Than Supply

Sharply increased levels of inequality in recent decades have been documented for the United States and other countries. Social scientists have sought to explain

increases in inequality caused by phenomena that would generate greater shifts in demands for skilled workers than have occurred in the past. This section examines how capital-skill complementarity, skill-biased technological change, computerization, globalization and organizational change could explain relative increases in demands for skilled workers. Additionally, there could be a relative increase in the demand for skilled labor even if the demand curve has continued to shift to the right at a constant rate. This could occur if the change has occurred on the supply side, through a slowdown in the rate at which the supply of skilled labor is shifting. This explanation, proposed by Claudia Goldin and Laurence Katz (2008), will also be considered.

3.2.1   Capital-Skill Complementarity

A central feature of processes that produce goods and services is the extent to which using more capital (structures, machines and equipment) will allow a firm to reduce the number of workers needed. When capital can be easily substituted for worker's labor, a firm's use of capital is very sensitive to the prices of capital and labor. Economists measure how easily capital can be substituted for labor by the elasticity of substitution. Capital-skill complementarity can arise when a production process uses three factors of production (for example, capital, raw labor and skilled labor) instead of just two.

Zvi Griliches (1969) introduced the concept of capital-skill complementarity to explain how increases in capital could raise the demand for skilled labor relative to the demand for raw labor. Then the process of capital accumulation in advanced economies by itself generates greater requirements for skilled workers over time, and greater inequality through its effect on skilled labor's wage premium (the higher wage paid to skilled labor over what is paid to unskilled labor).

Per Krusell, Lee E. Ohanian, José-Víctor Ríos-Rull, and Giovanni L. Violante (2000) examine whether capital-skill complementarity, in combination with changes in factors of production, could explain observed patterns of skill premiums in the United States (see also Fallon and Layard, 1975). They distinguish between capital structures and capital equipment, and observe that the growth of capital equipment has accelerated since the 1970's. Their main finding is that observed changes in amounts of capital and labor can explain most of the changes in skill premiums over a 30 year period, even in the absence of technological change that would increase skill premiums. The underlying cause of changes in the distribution of job characteristics would be the relative decline in the price of capital equipment.

3.2.2   Skill-Biased Technological Change

Considering the many ways that computers and information technology have transformed our workplaces, skill-biased technological change (hereafter SBTC) is extremely appealing as an explanation for increased relative demands for skilled workers. John Hicks (1932) introduced the concepts of technological change to explain how progress would affect labor and capital, treated as aggregate, homogeneous factors of production. Technological change would be biased in the form of capital using or labor using depending on whether the relative expenditure on capital increases or decreases at

the current capital to labor ratio, and would be neutral if the relative expenditure is unaffected. Roy Harrod (1956) developed a classification based on what happens after the economy adapts to the technological change. These concepts can be applied to demands for skills by extending the list of homogeneous factors to include aggregate skills in addition to raw labor, or by including unskilled labor and skilled labor separately.

Daron Acemoglu (2002) provides a survey of skill-biased technological change.[9] Technological change occurs by expanding the effective amounts of skilled and unskilled labor. Depending on how easily skilled and unskilled labor can be substituted for each other, technological change that augments skilled labor will increase the skill premium, given by the wage of a skilled worker divided by the wage of an unskilled worker. This type of technological change would then be skill-biased. Acemoglu also emphasizes that the direction of bias of technological change responds to profit opportunities, and that an expansion of skilled labor in the economy could generate skill-biased technological change.

Arnaud Dupuy and Philip S. Marey (2008) examine SBTC in the context of an assignment model. As in the standard literature, SBTC changes the relative efficiencies of skilled and unskilled labor. However, it can also change how easily different types of labor can be substituted for each other. Both changes in relative efficiency and the ease of substitution are involved in the determination of wage differentials. Using U.S. data from the Current Population Survey, Dupuy and Marey find support for the argument that the substitution between types of labor has changed over time. By considering technological changes in relative efficiency and substitution among types of labor, they explain both changes in wage differentials and the rate of change of labor productivity.

Acemoglu and David Autor (2011) develop a tractable assignment model that explains consequences of different types of changes on the supply and demand side. A shortcoming of models based on a few aggregate homogeneous factors of production (specifically capital, skilled labor, and unskilled labor) is that they can only explain a single skill premium. In contrast, labor markets exhibit different behavior of educational premiums at different educational levels. For example, in the United States, wages of low-skilled labor have fallen, job polarization has occurred (in the form of increases in employment of high-skilled and low-skilled workers relative to middle-skilled workers), and offshoring of jobs occurred at different intervals of the job spectrum. In the Acemoglu and Autor model, a range of tasks contributes to final output. Workers are of three types: high, middle or low. Applying the standard comparative advantage assumption (higher groups have a comparative advantage at higher tasks), it is possible to determine the assignment of workers to tasks consistent with competitive markets. The solution is characterized by the threshold tasks at which types of workers change from low to medium and from medium to high. Technological change that augments the productivity of high skilled workers generates a reassignment of workers to tasks that can be determined from the model, with consequent changes in the wages of the three groups.

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[9] See also Eli Berman, John Bound and Stephen Machin, 1998, and Stephen Machin and John Van Reenen, 1998. Arnaud Dupuy (2008) reviews technological change in the context of an assignment model.

Offshoring takes the form of a subinterval of tasks performed by individuals outside the country, resulting in reassignments of workers within the country to maximize production. The model also describes what happens when capital replaces workers previously performing a subinterval of tasks. The model provides a general method for analyzing changes in demands for different types of workers.

3.2.3   Computerization

Much of the argument favoring skill-biased technological change is based on the belief that widespread computerization has altered the skill content of jobs in a manner that favors workers with greater skills or education. David Autor, Frank Levy and Richard J. Murnane (2003) apply a disaggregated analysis to examine consequences of computerization for the skill content of jobs over time. They argue that computer capital substitutes for workers engaged in routine tasks and helps workers carrying out non-routine tasks. To analyze demands for routine and non-routine labor inputs, they assume a production function in which routine labor inputs and computer capital are perfect substitutes, and output is generated by a standard production function that uses non-routine labor input and the sum of routine labor input plus equivalent computer capital. This assumption about production generates predictions of the responses for labor demands to declines in the price of computer capital. To test these predictions, Autor, Levy and Murnane obtain data on the skill content of jobs from the United States Dictionary of Occupational Titles. Indicators of non-routine tasks include Direction, Control and Planning (DCP) and quantitative reasoning requirements (GED-MATH). Routine cognitive tasks are indicated by a variable STS, for Set Limits, Tolerances, or Standards. Routine manual tasks are measured by a variable for finger dexterity. A fifth variable, for eye-hand-foot coordination, indicates non-routine manual task requirements. Combining the DOT data with samples from the Census and Current Population Survey, the authors distinguish two sources of shifts in the skill content of U.S. jobs. The first, described as an extensive margin, arises from changes in the occupational distribution of employment, which would lead to changes in the aggregate skill content of labor demands even without any changes in the skill content of individual jobs. The second source, described as the intensive margin, arises from changes in the skill content of occupations over time. In support of their hypothesis regarding the relation between computer capital and routine and non-routine labor, Autor, Levy and Murnane find that routine labor inputs declined while non-routine labor inputs rose; shifts towards non-routine labor were greater in rapidly computerizing industries and occupations; and the shifts towards non-routine labor were pervasive at all task levels.

Francis Green, Alan Felstead and Duncan Gallie (2003) analyze changes in skill requirements for jobs as a result of computerization directly from responses to consistent survey questions in 1986, 1992 and 1997. They cite methodological problems in using occupational status or educational attainment to observe changes in skill requirements and argue that responses to the survey questions provide more detailed information. They conclude that increases in job skill requirements are strongly related to computer usage, and that the increases were more rapid for women than for men. Skills did not rise more quickly in industries that faced greater trade.

Levy (2010; see also Levy and Murnane, 2005) provides more detail on the kinds of work that can and cannot be taken over by computers. Levy observes that technology changes the nature of work faster than people can change their skills, making it hopeless to list future occupations. Instead, it is possible to identify the skills that future occupations will use. Computers can substitute for humans when the information needed is in a form that can be used by a computer, and when the processing of the information can be expressed in terms of rules. Often, however, an individual needs to engage in complex communication to discover the relevant information, for example when a doctor speaks to a patient or a teacher tries to find out whether a student understands a point. Complex communication differs from exchange of data because the information needs a wider context to be interpreted, and computers are limited in going beyond the data itself. The second area where computers are limited is in expert thinking, where a problem cannot be solved by applying fixed rules but instead a solution path must be found based on recognition of patterns from previous cases.

Stuart Elliott (2007; see also discussion in Hilton, 2008) develops a pilot project to forecast impacts of computers in 2030. The approach looks forward to future uses of computers instead of backwards to determine past consequences of computerization for the labour market. In this view, labour market tasks taken over by computers would not be limited to simply routine tasks as considered by Autor, Levy and Murnane (2003). In Elliott's procedure, he first uses O*NET to determine the human abilities that are relevant to work. The human abilities are sorted into four groups: language, reasoning, vision and movement. He then reviews articles in the computer science literature to see how much computers will be able to do within these four groups. The third step is to consider which occupations have abilities that could be taken over by computers. The non-automated occupation mix then determines the future distribution of skills needed in the labor force.

In language, computers would be able to handle the medium level of difficulty in the O*NET scale. Computer reasoning depends on whether common sense can be incorporated into knowledge databases. With this development, Elliott concludes that computer capabilities will lie between medium and high. Vision and movement abilities would lie between low and medium. Overall, by 2030, about 60 percent of employment would be displaced by computers (Elliott, 2007, Table 8). The displacement ranges from 6 percent for legal work to 93 percent for sales and related (education, training and library is displaced by 74 percent). In Table 9, Elliott provides the ability distribution across the four groups for the labor force in occupations that are not displaced. The following table compares percentages above a specified ability level between 2004 (from U.S. Bureau of Labor Statistics) and the 2030 projections for the labor force not displaced by computers for each of the four groups. For example, in 2004, 15 percent of jobs used reasoning levels at level 5 or higher in the O*NET system. Subtracting out the jobs that computers will be able to do in 2030, 36 percent of jobs will require reasoning levels at 5 or higher.

Table 3.1: Projected Changes in Ability Levels

	Language	Reasoning	Vision	Movement
O*NET Ability Level	≥ 5	≥ 5	≥ 4	≥ 4
2004 (BLS)	21%	15%	17%	18%
2030 Projections	52%	36%	44%	45%

The implications of this analysis for qualitative mismatches is that computerization, or the price of computer equipment and computation, would be a significant variable explaining shifts in demands for different types of labor in different countries.

3.2.4   Globalization

Globalization affects demands for different types of workers through trade, outsourcing and offshoring. Continuing declines in costs of goods transportation and information transmission together with formation and strengthening of trade unions and pacts along with reductions in tariffs and quotas will generate greater trade in goods and services. Reduced barriers to migration will change supplies of different types of workers. Technological change, by breaking down the labor processes and production steps, will expand opportunities for trade according to comparative advantage in the form of outsourcing and offshoring.

Consequences of trade and migration for demands for workers have been examined in the literature on income distribution. Richard B. Freeman (2009) describes three major consequences of globalization for future labor markets. The first is the approximate doubling of the number of workers in the world market economy as a result of the shift to markets in China and the former Soviet bloc, and India's market reforms. While the labor force available for world market production doubled, the available world capital stock did not, generating a fall in the global capital to labor ratio. With unequal ratios of capital to labor around the world, there are incentives to move capital to areas where it is more productive, or to combine labor from populous areas with capital in advanced economies. Second, improvements in information and communication technology expand the scope over which market forces can operate. The third element that expands globalization's effects is the more rapid dissemination of knowledge and technology from advanced to developing economies, disproportionately increasing the participation of the newer world economy members in highly technical industries.

While trade, migration and outsourcing have long been elements influencing supplies and demands for workers, offshoring is relatively new and offers the greatest prospect for changes in future labor markets. Alan Blinder argues that offshoring is a "big deal," and that in the United States 30 to 40 million jobs are potentially offshorable in the next few decades (2009, p. 37). Offshoring occurs when a firm's jobs are moved out of the firm's country. A common example would be call centers for a firm's products staffed by individuals in another country. Offshoring of these services has been made possible by improvements in communication combined with rapid declines in communication and information transmission costs. Blinder bases his estimate of the extent of offshorability on characteristics of jobs as listed in the O*NET, the successor to the Dictionary of Occupational Titles developed by the U. S. Bureau of Labor Statistics. In his "subjective" measure, offshorability depends positively on whether services can be delivered to a remote location without being severely degraded, and negatively on the importance of personal face-to-face contact and the requirement that a service be performed at a specific location. Continuing changes in information and computing technology can be expected to extend the range and complexity of services that are

offshorable. The large job losses for the United States will continue for decades and generate substantial transition effects (2009, p. 32). Blinder also argues that the United States and the United Kingdom face more offshoring than Europe because of India's comparative advantage in services in English. Lori G. Kletzer develops an alternative index of offshorability that is consistent with Blinder's estimate of 30 to 40 million (2009, p. 89). Alan Blinder and Alan Krueger (2009) compare alternative measures of offshorability, including self-reporting and professional coding. All measures indicate that about 25 percent of U.S. jobs are offshorable.

In addition to the large transitional employment effects, offshorability will have a compositional effect on jobs that differs from the effects of capital-skill complementarity or skill-biased technological change on relative demands for more skilled or educated workers. The criterion of offshorability cuts across educational levels and can include white-collar professionals such as radiologists (Levy and Yu, 2006). Kletzer (2009, p. 89) observes that there is a positive correlation between educational level and offshorability (for example, economists' services are offshorable, but bartenders' services are not).

The contribution of offshoring to future demands for workers and qualitative mismatches could be determined by applying indices of offshorability to the job mix of different countries, taking into account the effects of languages on offshorability. OECD provides estimates of job losses from offshoring and outsourcing for OECD countries (2007).

3.2.5   Organization of Work

Although technological change is usually characterized as taking place through a given production function (for example in terms of augmenting the amounts of factors available), it also affects the process of production itself, and thereby changes how work is organized and the characteristics of workers that contribute to a firm's output.

Paul Milgrom and John Roberts (1990) describe changes in manufacturing that affect the organization of work and the activities of workers. Advanced manufacturing involves flexible machine tools and programmable, multi-task production equipment instead of specialized, single-purpose equipment used in mass production. These advances allow a much wider product line with individual items produced in small batches, involving shorter production cycles, less work-in-progress, speedier response to demand fluctuations or changes in customer requirements, and increased emphasis on fewer defects. In terms of employee activities, these changes lead to a parallel, team approach to design and marketing, a redefinition of worker responsibilities, and multiple responsibilities for individual workers (for example, production and quality inspection). Increased flexibility of productive assets reduces the marginal value of governance activities, so that manufacturing organizations have fewer layers of governance.

Assar Lindbeck and Dennis Snower (1996) also describe the organizational changes taking place in firms. Unlike traditional hierarchical production, activity occurs in teams that report to a central management with few intervening organizational layers. Production processes have been transformed through the application of computers, use of flexible tools, and programmable equipment that can perform multiple types of tasks, yielding greater flexibility in production. Computers allow more individualized treatment of employees and customers and decentralized decision-making, and enable employees to perform multiple tasks while exploiting complementarities among them. Firms are able to

offer broader product lines in smaller quantities in response to customer requirements, leading to greater customer participation in product design and greater emphasis on product quality and ancillary services. The nature of work is also changing, with occupational boundaries breaking down in favor of multi-tasking and work rotation. Lindbeck and Snower describe the firm's decision in allocating tasks to workers. Depending on how much a worker's knowledge of one tasks helps in another task, the firm may choose complete specialization or multi-tasking. This decision is affected by information technology, production technologies that affect how tasks are related, and the human capital of workers.

Eve Caroli and John Van Reenen (2001) consider Skill Biased Organizational Change (SBOC). Organizational change takes the form of decentralization of authority, reduction in managerial layers, and increased multi-tasking. As authority is decentralized, the managerial hierarchy gets flatter. They formulate three empirical predictions concerning organizational change. Under the assumption that organizational change is complementary to skills, it would lead to a fall in the demand for less skilled labor. Second, since organizational change is more costly when skilled labor is relatively more costly, a fall in the relative cost of skill will lead to more organizational change. This reflects the endogeneity of organizational change. Third, organizational change will have a greater impact on workplaces with higher skill levels. They find empirical support for these predictions using British and French data on organizational changes.[10]

These observations on the organization of work carry strong implications for the worker skills and characteristics that will be required in the future. Employees will need to engage in multi-tasking, often engaging in activities that combine production with management. For example, just-in-time inventory systems require not only that goods be produced, but that they be available at a particular point in time and without defects. Quality and time add management dimensions to the activities of production workers. Employees will also work in teams to coordinate the requirements of customer, production and marketing constituencies, placing greater emphasis on communication skills. Increasing variety of products in small batches places greater emphasis on innovation to find new products and services for customers. These developments affect firm recruitment policies, generating potentially new categories of mismatches between workers and firms.

3.2.6 Supplies of workers

Supplies of workers occur in response to individual incentives to invest in human capital combined with educational institutions and public policies in support of education and training for different types of workers. In explaining increases in the college premium in the U.S. over the last few decades, researchers analyzing the problem have combined an economic basis for increases in demands with a characterization of changes in supplies. Goldin and Katz (2008) provide perhaps the most thorough analysis of supply

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[10] See also Timothy Bresnahan, Erik Brynjolfsson and Lorin M. Hitt, 2002; Thomas K. Bauer and Stefan Bender, 2004; Frederick Guy and Peter Skott, 2008; and Borghans and ter Weel, 2006.

changes, covering not only the last few decades but the history of education in the United States from the nineteenth century on.

Goldin and Katz argue that the United States led European and other nations at various stages in the advancement of education and training. These include the common school crusade (2008, p. 142), which substantially increased enrollments through the age of about 14 by the 1870's; the high school movement (Chapter 5, p. 163), which provided secondary education to a majority of students by 1940; and mass higher education (Chapter 7, p. 247), which initially provided the United States a lead in college education. However, these advances in supplies of workers did not continue after about 1980. For cohorts who turned 24 between 1900 and 1975, average years of schooling increased by .82 years per decade (2008, p. 19). For the years 1975 to 1989, the change was negligible, and in the decade between 1989 and 1999 the increase was only half a year. According to Goldin and Katz, the most remarkable aspect of the U.S. labor market from 1970 on has been the rapid slowdown in accumulation of human capital relative to the steady growth in the previous century. This slowdown contrasts with increases in educational levels in Europe as documented by Wasmer et al (2005).

3.3   Observation and Measurement of Long Run Qualitative Mismatches

This section considers three methods of observing and measuring long run qualitative mismatches. The first method observes mismatches indirectly through their consequences for relative wages of different categories of workers. Increases in the wages of more educated workers relative to less educated workers provides an example of the first measure and has provided the major motivation for the study of long run qualitative mismatches.[11] A second method arises by examining consistently measured changes in mismatches observed at the individual worker-job level. For example, a decline in overeducation would suggest that supplies of educated individuals had grown more rapidly than demands for them. A third approach uses economic theory to draw inferences from changes in the relative shares of income going to skilled and unskilled labor for the relative shifts in supply and demand that generate long run mismatches. These methods are considered here in order. All the methods point to significant differences in the evolution of long run qualitative mismatches between the United States and European countries.

3.3.1   Changes in Relative Wages

The motivation for the study of the recent qualitative mismatch for skilled and educated labor in the United States has been the steeply rising college premium and

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[11] The methods of analysis in Section 3.2 calculate how factors such as capital-skill complementarity, skill-biased technological change, computerization, globalization and organizational change have shifted demands for more skilled workers, or how the supplies of workers have shifted in response to educational changes. This additional method, incorporated into the analysis in the previous section, does not need to be repeated in this section.

increasing inequality. Goldin and Katz (2008, p. 290) derive changes in the college graduate wage premium and the high school graduate wage premium, as shown in the following figure from their book. These premiums declined from 1915 to about 1950. The college graduate premium then rose strongly, declined in the 1970's, and thereafter continued to rise until, by 2005, it had reached the high levels it started from in 1915. The high school premium (comparing high school graduates with individuals having only an eighth grade education) shows a similar decline from 1915 to 1950, followed by a stable premium from 1950, and thereafter a slightly increasing premium to 2005.

Figure 3.1   College graduate and high school graduate wage premiums
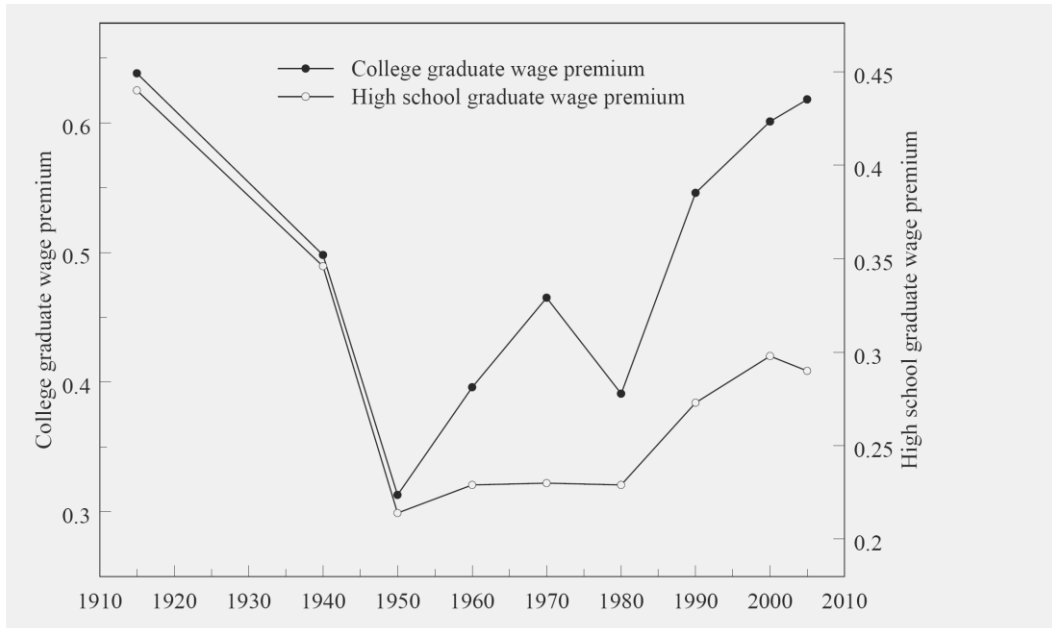
Source: Goldin & Katz (2008, p. 290)

The analysis in Section 3.2 above proposes several different explanations for what happened in the race between education and technology to generate the qualitative mismatch. Capital-skill complementarity, skill-biased technological and organizational change all provide explanations based on significant shifts on the demand side, assuming that changes on the supply side have continued as before to increase the numbers of educated and skilled workers. Globalization, operating through immigration and trade, does not appear to provide a major explanation for the current increases in educational premiums, although offshorability is clearly relevant to future qualitative mismatches. Goldin and Katz argue that the source of the qualitative mismatch lies on the supply side, in the form of a substantial slowdown in the accumulation of human capital in the United States (see also supporting evidence in Pedro Carneiro and James Heckman, 2003, p. 86). In particular, Goldin and Katz argue that skill-biased technological change occurred throughout the twentieth century (2008, p. 92), so that there was no acceleration in the bias that would generate a relative demand shift.

The increase in the college premium, combined with the slowdown in the accumulation of human capital, raises an important issue: why did individuals in the United States fail to respond to higher college and high school premiums by greatly increasing their human capital investments? Carneiro and Heckman argue that there are

widening gaps in college attendance by income and ethnic group (2003, pp. 84-85), so that many groups are not responding to increasing wage and educational differentials. They emphasize noncognitive skills in explaining why some individuals would not invest in human capital in response to higher wage differentials. Credit constraints are unlikely to be the cause of lower growth in numbers of skilled workers. Also, although the average return to college in the United States has increased, the return that particular individuals could achieve by attending college has not necessarily gone up. Carneiro and Heckman suggest that improving noncognitive skills at early ages would increase college attendance more than reductions in tuition.

3.3.2   Changes in Qualitative Mismatches at the Individual Worker-Job Level

Long run aggregate qualitative mismatches generated by the factors considered above can be expected to affect the levels of short run individual qualitative mismatches observed at a point in time. An increase in numbers of individuals with higher levels of education relative to the educational requirements of jobs would generate, through the job and employee search process, an increase in the number of individuals that are overeducated for their jobs and a decrease in the number that are undereducated. However, labor markets may also adapt to shifts in supplies and demands in ways that would reduce effects on overeducation or undereducation. With hierarchical assignment, an increase in educational levels of workers would generate a new assignment in which workers ended up in jobs with lower educational requirements. Peter Dolton and Mary Silles (2003) argue that firms may react to grade inflation by upgrading the educational requirements for jobs, in order to get the most able graduates. Also, an oversupply of individuals with higher levels of education may lead to substitution among forms of human capital that would reduce the effective level of overeducation.

Although the connection between long run aggregate qualitative mismatches and levels of individual worker-job mismatches deserve further examination, it is reasonable that there would be some connection. Observations on patterns of overeducation and undereducation over time would therefore provide additional information on causes of changes in long run qualitative mismatches. Collecting results from different sources, Hartog (2000, p. 134) presents evidence from previous studies on overeducation and undereducation for separate years based on job analysis (JA) or worker self-assessment (WA), summarized in the following table to show changes:

Table 3.2: Changes in Overeducation and Undereducation Over Time

Country	Period	Method	Overeducation	Undereducation
Netherlands	1960-1977	JA	Up from 7% to 26%	Down from 36% to 21%
Netherlands	1974-1995	WA	Up from 17% to 24%	Down from 30% to 12%
Spain	1985-1990	WA	Up from 17% to 28%	Down from 23% to 11%
Portugal	1985-1992	JA	Up from 26% to 33%	Down from 43% to 38%
United States	1969-1977	WA	Down from 35% to 32%	

Hartog suggests that the evidence for the Netherlands, Spain and Portugal reflect an increase in supplies of educated workers relative to demands. For the United States, the results indicate the opposite, with a decrease in supplies of educated workers relative to demands. Assuming that the factors influencing labor demands are common for the United States and European countries (skill-biased technological change, capital-skill complementarity, skill-biased organizational change, computerization), the difference in results suggests that the source is the slowdown in growth of educational levels in the United States as argued by Goldin and Katz. The results also show that long run aggregate qualitative mismatches have consequences for individuals through increased or reduced likelihood of being in mismatches.

The overeducation and undereducation results cited in Hartog are limited in the span of time covered and do not cover recent years. Also, evidence on undereducation for the United States is absent. Wasmer et al (2005) provides information on European countries between 1994 and 2001, as shown in Figure 3.3. Overall, skill mismatch has been relatively stable, with a small decline in OWM (overqualified but well-matched) and an increase and then decline in NOWM (non-overqualified and well-matched). This evidence does not suggest a significantly strong pattern of long run qualitative mismatches in Europe during the period covered.

Figure 3.3: The Incidence of Skill Mismatch in EU-15, Time Series
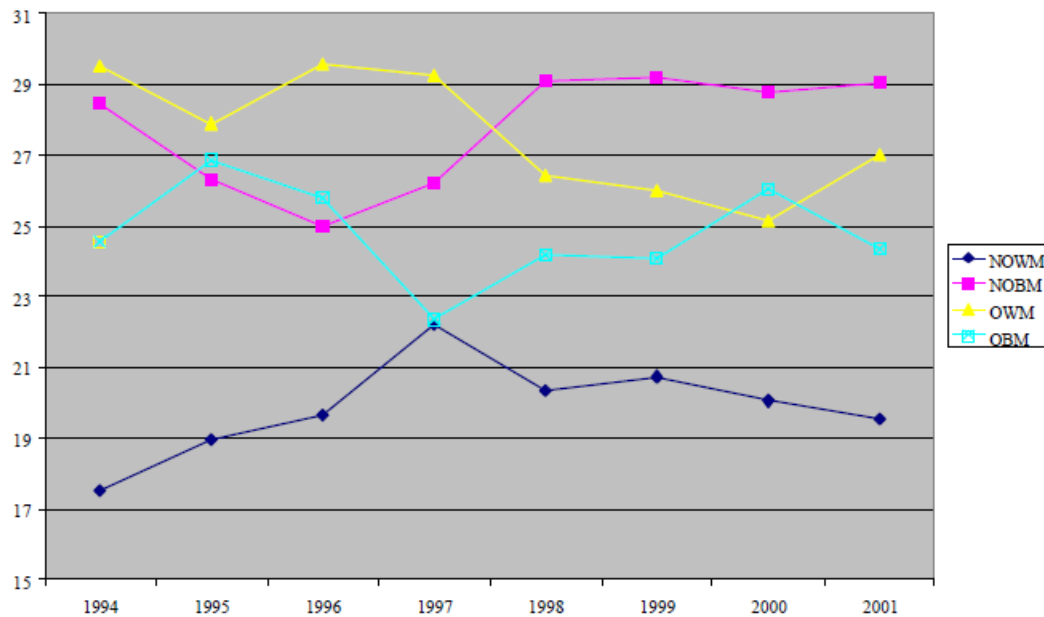

Notes: Weighted averages (using population shares in 2001) of 10 European countries (Austria, Belgium, Denmark, Finland, France, Greece, Ireland, Italy, Portugal and Spain). Germany and the UK are excluded from the averages since data is only available for the period 1994-1996

Source: Wasmer et al, 2005, p. 103

For the Netherlands, Berkhout, Van der Werff and Heyma (2010) provide estimates of vertical and horizontal mismatches between 1996 and 2005 (see the discussion in Section 1.3.2). They find that there was a slight increase in mismatch among higher educated workers in the period considered. For middle educated workers, they found no trend.

Jean-François Giret (2007) provides a long time series of overeducation from 1981 to 1997 based on the French Labour Force Survey, shown in Figure 3.4. The figure shows overeducation at different educational levels, with the measure of overeducation taken 3 years after leaving school. In this figure, CAP (for Certificate of Professional Competence) and BEP (for Vocational Studies Certificate or Vocational Baccalaureate) are diplomas at the secondary education level. France experienced a rapid expansion of student numbers in the last decades of the twentieth century. This growth in supply is reflected in the levels of overeducation shown in the figure. Overeducation increased more than 10% at all school levels. The growth in overeducation was greater during the 1990's in the presence of a recession. These results support the conclusion that a long run shift in the balance between supplies and demands (generated in the case of France by the growth in supplies of educated and trained workers) is reflected in the individual worker-job incidence of overeducation, and that a recession contributes to that incidence.

Figure 3.4: Overeducation Rate by Educational Level 3 Years after Leaving School
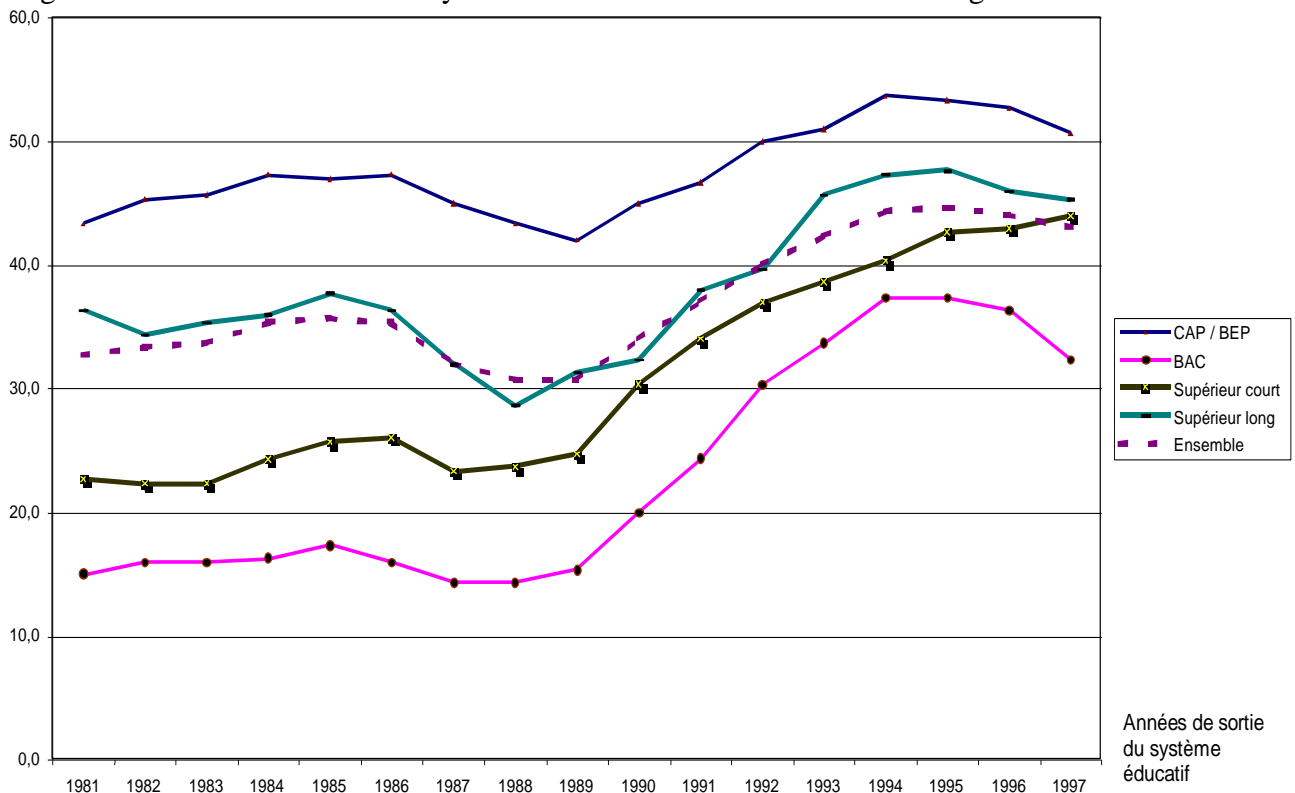
Source: Jean-François Giret (2007)

3.3.3   Measurement Based on Economic Theory

Marco Manacorda and Barbara Petrongolo (1999) develop an empirical index of skill mismatch based on economic inferences from both wage and employment variables. They assume a standard (Cobb-Douglas) production function with two types of inputs, skilled and unskilled labor. In this production function, the parameter for an input will be the input's share in production. Manacorda and Petrongolo assume that technological

change takes the form of changes in these parameters (this differs from the representation of technological change discussed in the section on skill-biased technological change). Their mismatch index is given by the proportional change in input shares minus the proportional change in employment (1999, equation 4, p. 189). The index can reflect either supply or demand shocks. If this index is zero, the changes in demands for the two skill types are exactly matched by the changes in supplies, and the net impact is neutral. A positive mismatch index for skilled labor reflects skill-biased technological change. A given level of the mismatch index is resolved into either relative wage changes or relative unemployment changes for the two groups, depending on wage-setting institutions in a country. Manacorda and Petrongolo calculate the mismatch index for OECD countries based on estimates of the production functions for each country. Their measures (1999, Column 5, Table 2, p. 192) indicate that there have been shifts against the unskilled (and for the skilled) in Britain, France, and Germany over the periods considered, virtually no shift for Italy, and shifts against the skilled in the Netherlands. For the United States, there was a substantial shift in favor of skilled labor in the 1980's, apparently caused by a slowdown in the supply of skills rather than an acceleration in demand. This observation supports the Goldin and Katz view of the causes of increases in the U.S. college premium, discussed in Section 4.3.1.

Manacorda and Petrongolo consider Paul Krugman's argument (1994) that increasing unemployment in Europe and increasing wage differentials in the United States are simply alternative responses to the same underlying cause, a relative shift in demand favoring more skilled workers. Their model is consistent with Krugman's view, since either increasing wage differentials or greater unemployment could arise from a given skill mismatch. Manacorda and Petrongolo combine their skill mismatch index with assumptions regarding wage determination to explain the generation of unemployment for different skill groups. They assume that a skill group's wage rate depends on a measure of its wage pressure factors, the responsiveness of the group's wage to its unemployment rate, and the group's unemployment rate. The parameters of this relationship can vary among skill groups and among countries. Manacorda and Petrongolo conclude that, except in the United States and Britain, skill mismatch could not have explained all of the increase in unemployment of the unskilled, and there must also have been some increase in wage pressure. In Britain, mismatch explains more than half of the growth in unskilled unemployment, while in the United States skill mismatch can explain all of the growth.

3.4   Consequences of long run aggregate qualitative mismatches

3.4.1   Job Polarization

Job polarization describes a major consequence of qualitative mismatches for the labor market and provides a means of distinguishing between different causes of changes in jobs. Dividing jobs into three categories of low skilled, middle and high skilled, job polarization arises from a decline in the middle category relative to the upper and lower categories. Although job polarization was once attributed to the operation of a capitalist system in reducing the discretion and authority of the middle category of workers, current

explanations attribute the phenomenon to technological change, globalization, or institutions.

Maarten Goos, Alan Manning and Anna Salomons (2011) undertake an empirical examination of job polarization in 16 European countries and compare alternative causes of that polarization. Pooling data for the 16 countries between 1993 and 2006, the authors find that the lowest-paid and highest-paid categories of occupations have grown relative to the middle category (2011, Table 1 and Figures 1 and 2), documenting the magnitude of job polarization. They construct a model of the demands for occupations within industries using a production function in which tasks provided by occupations are combined with other factors to yield output, similar to the use of tasks in Autor, Levy and Murnane (2003), Autor and Dorn (2010) and Acemoglu and Autor (2011). They use O*NET data on occupational tasks to derive three measures of tasks for each occupation: abstract, routine or service. They also summarize this information in a single-dimensional Routine Task Index (RTI). To compare the effect of these variables with Skill Biased Technological Change, they also calculate the mean educational attainment by occupation. To construct an index of offshorability for each occupation, Goos, Manning and Salomons process information from the European Restructuring Monitor of the European Monitoring Centre on Change. Corresponding information on wages is taken from the European Community Household Panel, the European Union Statistics on Income and Living Conditions and, for the United Kingdom, the Labor Force Survey.

The data are used to estimate changes in demands for occupations assuming industry outputs have not changed. With the three task measures and offshorability included, the estimates indicate that employment growth was .81 percent higher per year for occupations one standard deviation higher in abstract tasks, and was .75 percent lower for occupations one standard deviation higher in routine tasks (Table 6A, column 10; the table includes other combinations of variables). In the same estimation, employment growth was higher when the service task measure was greater and offshorability lower, but these relations were not significant. In Table 6B, the authors consider whether technological change affects jobs through its effects on demands for skills or through its effects on demands for tasks. The difference is that in SBTC, the change in demand for an occupation depends only on the skill (or educational) requirements of the occupation. In contrast, in the routinization hypothesis of Autor, Levy and Murnane, the relevant characteristic of an occupation is the extent of routine tasks rather than the skill level, and routine tasks and skill levels vary differently from occupation to occupation (Goos and Manning, 2007). If the SBTC hypothesis were valid, information about the task measures would provide no additional information about occupational demands. Column 2 of Table 6B shows that the measures of abstract and routine tasks remain significant when educational level of an occupation and offshorability are included, indicating that the routinization (or task-biased technological change) theory provides a significant explanation for changes in demands for occupations. The authors also conclude that employment in some occupations has been offshored to a limited extent.

Goos, Manning and Salomons additionally consider product demand effects, which would dampen the effects of technological change. To explain this phenomenon, they describe an example provided by Paul Krugman (1999), in which the production of a hamburger requires one bun and one meat patty. If the labor needed to produce a bun declines, the direct effect (not accounting for any change in hamburger production)

would be a decline in employment of bun workers with no change in number of patty workers. However, the price of a hamburger would decline, increasing employment of patty workers and reducing the loss of employment of bun workers. The authors conclude that these price effects are non-trivial and must be included in the analysis.

While Goos, Manning and Salomons consider task-biased technological change, Guy Michaels, Ashwini Natraj and John Van Reenen (2010) investigate whether job polarization arises more specifically from information and communications technologies (ICT). Their strategy is to estimate the relation between the rate of growth of ICT and the rates of growth of wage bill shares for high education and middle education workers using industry data for eleven countries (Austria, Denmark Finland, France, Germany, Italy, Japan, the Netherlands, Spain, the United Kingdom, and the United States). The major source of data is EUKLEMS, which provides an internationally-comparable industry-level panel data set for countries using each country's census bureau over the period 1980 to 2004. The authors compare changes in wage bills to changes in ICT investment over the 24 year period in Table 3. With both ICT and non-ICT investment included along with country fixed effects (column 3), the change in ICT investment significantly raised the wage bill for high-skilled workers and lowered the wage bill for middle-skilled workers. The coefficient for non-ICT capital is not significant for the wage bills, suggesting that a narrow version of capital-skill complementarity (with no distinction between ICT and non-ICT capital) is inconsistent with the results. The results remain valid when the data are limited to industries with tradable goods. The ICT data does not provide a significant explanation for changes in the low-skilled wage bill share. The authors also check whether trade could cause the wage bill changes. While trade is significant in some specifications, the coefficient is insignificant when ICT investment and initial research and development intensity are included.

David Autor and David Dorn (2010) investigate more closely the consequences of job polarization for low skilled workers. They consider an economy where there are basically three groups of labor, highly skilled workers engaged in abstract tasks producing goods, and low skilled workers that are either engaged in routine tasks producing goods or low skilled labor producing services. As computers fall in price, they are substituted for the routine tasks performed by low skilled workers, leading those workers to shift to services, generating employment polarization. At the same time, if consumption preferences are such that goods and services are weakly complementary (meaning that consumers prefer combinations of goods and services to all of one or the other), increased incomes will generate higher wages for service workers, yielding wage polarization. Autor and Dorn develop a model showing how mobile high skill workers would sort themselves among localities, equalizing their real wages. The authors use definitions of local labor markets determined by commuting patterns (Charles Tolbert and Molly Sizer, 1996). A routine employment share is determined for each Commuting Zone using routine-task intensities for occupations from Autor, Levy and Murnane (2003). The authors show that Commuting Zones that specialized in routine-intensive work showed greater employment polarization (Figure 3A) as predicted by the model. Figure 3B shows that Commuting Zones with more routine-intensive work also had more wage polarization. Using a measure of computer penetration for each Commuting Zone, The authors also show that higher routine-intensive work is associated with greater adoption of computer technology (Table 2) and greater growth of service employment

(Table 3). Autor and Dorn show that the impact of initial routine-intensive work remains after inclusion of alternative explanatory variables including changes in ratios of college and immigrant workers to the non-college population, manufacturing employment, the unemployment rate, female employment, and workers over 65 (Table 4) or offshorability (Table 5). The authors also provide more detailed evidence on the effects of initial routine-intensive work on wages for six groups of occupations (Table 6).

3.4.2 Restricted Firm Expansion and Economic Growth

A potentially large consequence of a long run aggregate qualitative mismatch, with supplies of highly skilled workers falling behind demands for them, is that the mismatch may constrain the growth of an economy. In particular, firms in advanced, high-technology sectors of the economy may be unable to expand because of an inability to hire adequate numbers of educated and skilled workers. Using surveys of information technology, electronic engineering and mechanical engineering industries in Northern Ireland, Jessica Bennett and Seamus McGuinness (2009) investigate whether unfilled and hard-to-fill vacancies arising from skill shortages limit the productivity of firms. They find that high productivity firms are much more likely to experience these skill shortages, and the vacancy constraints reduced productivity by 65 percent to 75 percent.

As noted by Hartog (2000) and Leuven and Oosterbeek (2011), the wage regressions that include overeducation and undereducation cannot be used to determine the investment returns to education since the causal relation between education variables and wages cannot be determined. In a separate literature, economists studying the determinants of economic growth have estimated the contributions of education and cognitive skills. Eric Hanushek and Ludger Woessmann (2010) construct three scenarios to forecast the contributions of higher educational achievement on economic growth through 2090, presented in Table 3.3. The scenarios are expressed in terms of alternative changes in countries on the PISA tests of cognitive skills (OECD, 2007b). The third scenario is determined by the European Union's benchmark goal for low achievers to reduce their percentage below 15 percent by 2020 (Commission of the European Communities, 2009).

Table 3.3: Present Values of Educational Reforms

	Description	Present Value of Change for EU Countries Through 2090
Scenario I	Raise Performance on PISA Tests by 25 points, or ¼ Standard Deviation	€32 Trillion
Scenario II	Bring Each Country Up to PISA Level for Finland	€87 Trillion
Scenario III	Reduce Percentage of Low Achievers to Less Than 15 Percent by 2020 (EU Benchmark)	€21 Trillion

Source: Hanushek and Woessmann, 2010

These figures are enormous. Of course, a major problem is that estimates of the contributions of cognitive skills may include returns to other changes in economies that occurred at the same time (see Hanushek and Woessmann, 2009, for a discussion of causality concerns). In particular, the estimates disregard the importance of noncognitive

skills emphasized by Pedro Carneiro and James Heckman (2003, p. 137). Also, if Daron Acemoglu (2002) is correct regarding endogenous technological change, it would be difficult to disentangle the effects of educational variables from simultaneous technological changes taking place in economies.

The qualitative mismatch literature provides an additional perspective on contributions of educational changes to economic growth. The Hanushek and Woessmann estimates of educational achievement effects on growth are constant and independent of the states of the economies. In contrast, in the qualitative mismatch literature, an increase in supplies of individuals with higher educational and skill levels will generate increases in overeducation for a given level of job requirements, with potentially lower effects on growth. Lower levels of educational achievements could serve as a limitation on growth rates, so that raising educational achievements would have greater effects on growth. As a consequence, the qualitative mismatch perspective suggests that the effects of greater levels of educational achievement will be nonlinear and depend on demand factors. Whether such nonlinearities could be detected in the economic growth data is unclear.

3.5   Policies

The major policy to reduce future long run qualitative mismatches is to anticipate them by preparing the labor force for changes in jobs. A first step is to determine future supplies and demands for labor, followed by a description of what future work will be like. Finally, policies need to be developed to prepare individuals for future work through formal education, on-the-job training, and life-long learning.

3.5.1   Future Supplies and Demands

CEDEFOP (2010a) has undertaken a major project to provide detailed forecasts to 2020 of supplies and demands for labor by sector, occupation, and qualification for each of 27 European countries using common methods and comparable data sources. The components of the forecasts are divided into modules. Module 1 is based on the E3M3 (Energy-environment-economy model of Europe) multisector econometric macroeconomic model that generates both supplies and demands for labor. On the demand side, modules then generate employment levels, expansion and replacement levels by occupation and qualification as well as job openings. On the supply side, modules generate the stocks of people by economic status and ISCED (International Standard Classification of Education), flows and graduates and labor force by ISCED category. Imbalances between supplies and demands by ISCED level are reconciled by the final module, which among other adjustments reallocates supplies to the jobs calculated on the demand side. Different scenarios (p. 36) are considered based on recovery from the recent economic crisis, growth in Gross Domestic Product, and alternative labor supply and demand growth rates. The forecasts provide detailed results for each country by occupation, sector and qualification level. The results reflect some degree of job polarization, with substantial growth in high-skilled non-manual occupations, little growth in skilled non-manual occupations, decline in skilled manual

occupations, and slight growth in elementary occupations (pp.68-70). In terms of qualifications, increased skill requirements are expected for all jobs.

For the United States, David Neumark, Hans P. Johnson and Marisol Cuellar Mejia (2011) forecast the levels of skill shortages through 2018 using U.S. Bureau of Labor Statistics occupational projections (see also CEDEFOP, 2010c). Usually, individuals that retire are replaced by young graduates that have more education, raising average educational levels. However, baby boomers (born between 1946 and 1964) have educational and skill levels that are almost as high as graduates that are entering the labor force, so their retirement in the next few decades will not raise educational averages. Neumark et al conclude that these retirements are unlikely to cause skill shortages by the end of the decade, except possibly in some states with large and increasing immigrant populations. Nevertheless, skill shortages could occur as retirements continue beyond 2018.

The same subject has been examined in less quantitative detail in a workshop convened on "Research on Future Skill Demands," organized by the National Research Council of the National Academies, chaired by Richard Murnane, and summarized by Margaret Hilton (2008, available at http://www.nap.edu/catalog/12066.html.) The workshop reviewed different research methodologies and data sources that could be used to forecast future skill demands and supplies, and considered whether skill demands would be significantly different in the future, requiring public policy responses in preparing individuals for work. Papers prepared for the workshop are discussed at various points in this book, including Autor (2007), Handel (2007) and Elliott (2007).

3.5.2   Future Jobs and Skill Needs

The following table indicates the range of results regarding future jobs and skill needs that have been generated by various studies. The conclusions extend beyond the brief citations listed here and are not contradictory since they may apply to different segments of the workforce.

Table 3.4: Statements of Future Jobs and Skill Needs

Source	Region, Country or Countries	Conclusions
Assessment and Teaching of 21st Century Skills, Univ. of Melbourne (2010, p. 15)	All countries, with particular consideration of Australia, Finland, Singapore and United Kingdom	Ten skills grouped into four categories: ways of thinking, ways of working, tools of working, living in the world.
Autor, Levy and Murnane (2003)	United States	Non-routine jobs that would not be performed by computers
Autor and Dorn (2010)	United States	Non-routine low-skilled jobs and jobs requiring high skills
Blinder (2009)	United States	Jobs that require face-to-face interactions and that cannot be performed at a remote location without being severely degraded
Caroli and Van	United Kingdom,	Workplaces with decentralized

Reenen (2001)	France	authority, flatter managerial hierarchy, increased multi-tasking
CEDEFOP, Skills Supply and Demand in Europe (2010a, p. 70)	EU-27	Continued strong growth in high qualification jobs, decline in low qualification jobs, small growth in medium qualification jobs; more specific results in tables
Elliott (2007)	All Countries	Jobs with Language or Reasoning O*NET ability levels ≥ 5 or Vision and Movement levels ≥ 4.
European Expert Network on Economics of Education (2008, p. 28)	Europe	More general skills providing interpersonal and environmental adaptability or flexibility
Goldin and Katz (2008)	United States	Provide students academically prepared for college (p. 347); highly analytical individuals who can think abstractly or can provide skilled in-person services (pp. 352-353)
Holzer and Nightingale (2007)	United States	Greater education and skills, wide range of skills, education and training somewhat targeted to private-sector
Levy (2010)	OECD Countries	Foundational skills including numeracy and literacy, advanced problem-solving skills, and advanced communication skills
Lindbeck and Snower (1996, p. 320)	United States and United Kingdom	Workers with broad-based education, multi-tasking, customer-oriented teams, reduction in middle management
Murnane (2008, p. 84)	United States	Interpersonal skills including written communication skills, knowing how to work well with various people cultures, and knowing how to give and receive advice
National Research Council (2010)	United States	Adaptability, complex communication/social skills, nonroutine problem solving, self-management/self-development, systems thinking
OECD (2011, p. 29)	OECD Countries	Apart from basic literacy and numeracy skills, little evidence of what other skills are required for better outcomes or more fluid labour market
SEO Economic Research (2010, p. 49)	Europe	Ageing will increase employment in health and leisure sectors, while manufacturing declines

Wasmer et al (2005, p. 79)	Europe	Increase tertiary education

3.5.3   Changes in Educational, Training, and Vocational Systems

Robert Lerman (2008) has reviewed U.S. education and training policies in comparison with European policies and recommends a number of changes. The U.S. lacks a well-structured approach to skills development compared to Germany and Japan, and has emphasized academic skills to prepare individuals for college rather than career and technical education. At the high school level, Lerman emphasizes the importance of recognizing the diversity of student interests, abilities, career aspirations, and career outlets (2008, p. 61). Students should be able to combine school-based instruction with work-based learning that leads to occupational certification and entry into post-program training. For adults, Lerman argues that apprenticeships are a form of work-based learning that provides long-term training to potential workers while requiring little or no foregone earnings for participants. However, federal funding for apprenticeships has instead been at extremely low levels. Lerman suggests that a change in accounting practices to count skill development as investment would improve the ability to measure and observe returns to firm investments in training.

James Heckman and Dimitriy Masterov (2007) emphasize positive outcomes from developmental child care before elementary school, particularly in the area of noncognitive skills (see also Pedro Carneiro and James Heckman, 2003).

Statements of appropriate changes in educational and vocational systems have been issued by the Asian Development Bank (2008), the International Labour Organization (2008), the Leitch Review of Skills (2006), the Scottish Government (2007), Lerman, Turner, Osterman.

Chapter 5:   Role of Labor Market Intermediaries in Reducing Mismatches

The foregoing results of this book have important implications for the operation of employment agencies and other labor market intermediaries that help workers find jobs. The chapter on short run qualitative mismatches describes the difficulty of workers and employers in forming the best matches, the costs of continued search for workers or jobs, the mismatches that occur when search costs make it difficult to hold out for better results, and the costs of those mismatches in terms of reduced production, earnings, or job satisfaction. These costs of using search to assign workers to jobs create an opportunity for institutions to profit by assisting in the operation of the labor market and thereby improving its operation. However, the chapter on long run aggregate qualitative mismatches shows that labor markets are changing in ways that will also require adaptation by employment agencies. Specifically, to the extent that temporary help agencies focus on low-skilled workers performing routine jobs, skill-biased technological change and computerization will reduce the scope for those agencies. If firms hire flexible labor that can perform multiple tasks, there may be less need for temporary help to fill vacancies. If work activities take place in teams, as suggested by skill-biased organizational change, a temporary worker may be an inadequate substitute for a missing

team member. Given these ongoing changes in labor markets, an employment agency would need to consider what types of labor it should seek to engage in the future, and which labor markets offer the greatest opportunities.

This chapter considers the role that labor market intermediaries play in the operation of the labor market. The basic argument is that differences between the labor market and full-information, perfectly competitive markets generate opportunities for labor market intermediaries to make profits by doing better than the labor market in matching workers with jobs. This leads to an approach in which imperfections in the operation of labor markets are first identified, and then an activity of a labor market intermediary can be found that corrects for these imperfections. If an employment agency can provide enough of an increase in value to employers and workers over what they can achieve in the labor market, the employment agency may be able to cover its costs and make a profit while increasing the efficiency of the labor market. The next section describes temporary help agencies and public employment agencies and how they differ among countries. The following section explains how deviations from perfectly competitive labor markets create opportunities for labor market intermediaries. Section 5.3 considers evidence of other inefficiencies in labor markets

5.1   Description of Labor Market Intermediaries

5.1.1   Temporary Help Agencies

Temporary Help Agencies vary significantly from country to country depending on labor market institutions and practices. In the United States, temporary help workers were primarily in office and clerical work, and have recently expanded into work categories for low-skilled workers. In contrast, in the Netherlands, the relevant market was for workers in all categories of employment to replace sick workers or supplement regular workers during peak periods (piek and ziek). In the United States, private employment agencies arose first, and public employment agencies arose in reaction to them. In contrast, in the Netherlands, public employment agencies came first and only later were private agencies allowed to operate. These contrasts illustrate the variation in market and operation of employment agencies. While national institutions directly affect some markets, labor market institutions such as employment protection, severance pay and dismissal regulations affect demand and supply of temporary workers. Agencies can also vary by the extent they serve unemployed workers, new labor force entrants, disabled, low-skilled, or workers transitioning from public support. The following tables describe some of these differences.
[Table 5.1: Temporary Agency Workers as Percent of Employment, 2006-2009]
[Table 5.2: Temporary Agency Workers as Percent of Employment, By Country]
[Table 5.3: Sector of Temporary Agency Workers by Country, 2009]
[Table 5.4: Gender of Temporary Agency Workers by Country, 2009]
[Table 5.5: Full/Part Time Employment of Temporary Agency Workers by Country, 2009]
[Table 5.6: Educational Level of Temporary Agency Workers by Country, 2009]
[Table 5.7: Field of Study of Temporary Agency Workers by Country, 2009]
[Table 5.8: Nationality of Temporary Agency Workers by Country, 2009]

5.1.2   Public Labor Exchanges

Public labor exchanges provide labor market intermediation services in competition with private agencies. Randall W. Eberts and Harry J. Holzer (2004) review labor exchange policies and services for the United States, and Douglas Lippoldt and Melvin Brodsky (2004) describe public provision of employment services in selected OECD countries. Eberts and Holzer argue that public employment services are regarded as necessary because of market failures in the provision of job information by the private sector and because of the goal of redistributing employment opportunities equitably. Support for employment services has declined in the United States as responsibility has shifted to states and localities. Among alternative search methods, 62 percent of unemployed job seekers in 2001 indicated they contacted employers directly, 51.3 percent sent out resumes or filled out applications, and 18.8 percent used a public employment agency, with individuals indicating each method they used. On the employer side, 72 percent used direct contact (for example, walk-ins), 90 percent used informal referrals, and only 30 percent used public employment services. Eberts and Holzer (2004, p. 26) found that for employers' most recent hires, only 2.6 percent were generated by public employment services.

Targeting is a procedure by which unemployed individuals are selected for participation in employment services. It is related to active labor market policies used in OECD countries (OECD, 1998). Stephen A. Wandner (2002) reviews targeting of employment services in the United States. Unemployed workers are selected for services in two steps. First, workers subject to recall to their previous jobs or subject to union hiring hall agreements are screened out. Second, statistical models are used to determine which workers are likely to exhaust their unemployment insurance benefits. These procedures are also referred to as profiling.[12] Using these methods in the United States, the employment services determine which unemployed workers should receive staff assistance including individual and group counseling, expanded job search workshops, service coordination assistance and development of service plans (2002, p. 3). Possible training includes occupational job skills, job search skills, remedial reading and mathematics, or on-the-job training. Wandner recommends that employment services would be especially effective for employed workers that are overskilled for their current jobs (2002, p. 21)

5.2   Opportunities for Labor Market Intermediaries

In the introduction to an edited volume on labor market intermediaries, David Autor (2009) provides a framework for analyzing their role in the labor market. Labor market intermediaries are ". . .entities or institutions that interpose themselves between workers and firms to facilitate, inform, or regulate how workers are matched to firms,

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[12] Their use in Europe is described by Helmut Rudolph and Regina Konle-Seidle (2005). Michael Rosholm, Jonas Staghøj, Michael Svarer and Bo Hammer (2006) describe the Danish profiling system, and Stefanie Behncke, Markus Frölich and Michael Lechner (2007) describe a randomized experiment targeting labor market services in Switzerland.

how work is accomplished, and how conflicts are resolved" (2009, p. 1). Autor argues that labor market intermediaries (LMI's) arise because labor markets deviate from the operation of neoclassical competitive markets. These deviations can result, through decentralized search, in mismatches in various forms, so that LMI's have the potential to reduce overall mismatches.

Autor describes three types of deviations. The first is costly information, for example concerning available jobs and workers and their characteristics. Because of costly search, workers and employers must engage in search to find suitable agents with which to match. Information about labor market participants is in some respects a public good and is therefore underprovided by the market. Some LMI's simply collect this information and make it available, perhaps on the internet. LMI's in this category can identify potential employees for large employers and lower the costs of contacting them.

The second deviation arises from adverse selection in response to asymmetric information, which occurs when one side of the market has information that is not available to the other side. For example, a worker may have negative characteristics (poor attendance, quitting jobs, or criminal record) that he or she can conceal when posting information to an internet job site. Employers, knowing that on average many job applicants will have these characteristics, will devalue the site's postings, perhaps even abandoning the site. Autor proposes compulsory revelation of information as a solution to this problem.

The third deviation, collective action problems, arises when actions are optimal for individuals but yield a suboptimal collective outcome. Muriel Niederle and Alvin Roth (2009) describe an example in the market for medical fellowships for gastroenterology. In entry-level labor markets for highly specialized positions, employers face the problem that their initial offers may be declined, after which only marginal candidates would remain. Employers then try to secure candidates by making early "exploding" offers that require candidates to make decisions quickly. These procedures, if widely adopted, make it difficult for market participants to evaluate and find alternative matches. A centralized fellowship match provided a resolution to this problem but was later abandoned.

Autor also provides an analysis of temporary help agencies in the United States (see also Autor, 2003). He notes that employment resulting from temporary help agencies has grown significantly and has moved from office and clerical jobs to production, transportation and material-moving jobs. With this movement, temporary help agencies have increased their importance to less-skilled workers. For example, among former welfare recipients who got jobs following the 1996 welfare reform, 15 to 40 percent got jobs in the temporary help sector (Autor and Houseman, 2002, 2005). Autor argues that temporary work agencies redress market imperfections caused by the fixed cost of job search, arising from identifying, screening and hiring workers. Temporary help firms pay for these sunk costs and spread them over alternative employers, lowering the barriers to employment for temporary workers. An important research question is what effect temporary help employment has on subsequent worker labor market outcomes. Because use of temporary help agencies is voluntary for both firms and workers, Autor argues that they would be unable to make substantial changes in the labor market outcomes of participants by getting them better jobs or reducing unemployment.

5.3   Labor Market Inefficiencies

       This section considers additional inefficiencies in the operation of labor markets that could suggest opportunities for labor market intermediaries.

5.3.1   Entry-Level Hiring

   Amanda Pallais (2010) describes a major inefficiency in entry-level hiring that arises because new workers produce information about their productivity as well as provide labor services. The labor market considered by Pallais is a public learning environment (Marko Tervio, 2009), in which information about a worker's performance on jobs is a public good observable for free. When the information about a worker's productivity is available to other firms, a worker with positive information can earn higher wages as a result, so that the firm that initially hired the worker cannot gain from the information produced. As a result, firms hire too few new workers, and there is underinvestment in information about new workers. Pallais establishes this result in a model of a labor market in which workers provide labor in two periods as novice and veteran workers. Firms vary by the cost of establishing a job, and workers vary by productivity. In the equilibrium that would arise with competitive markets, there will be a threshold level of firm costs such that firms with lower costs establish jobs, and workers with higher expected productivity are hired. However, part of the gain from hiring a novice worker is that the resulting information generates more accurate employment and production from veteran workers. This gain is disregarded by individual employers since they do not benefit from it. In the social planner's solution (the solution that maximizes total gains for workers and firms), the threshold would be set lower, so that employment of novice workers would be greater.
   Pallais tests these results using experiments on temporary help workers who obtain jobs performed online through oDesk (www.oDesk.com). In the experiment, a subset of applicants for a ten hour data entry job was hired. In addition to standard worker evaluations provided by employers, some of the workers among the subset got uninformative comments about their work while others received detailed comments that provided information on data entry speed, accuracy, following directions and timely completion. The results showed that the subset hired for the data entry job as a whole were more likely to be employed and had higher earnings than the applicants that were not hired, reflecting the positive effects of the information produced about the workers. Among the workers in this subset, those who received positive detailed comments earned substantially more, while those receiving negative comments earned less than those who got uninformative comments. Pallais concludes that the information generated by the experimental jobs raised employment, production and earnings in later jobs. The problem for workers in developing a reputation constitutes a significant barrier to entering the labor market, reducing employment and output. Given the conditions of the experiment, the results could not have been caused by human capital accumulation, information on ability provided by inclusion in the experimental group, or increased worker labor supply through oDesk.

Pallais's results explain why workers entering the labor market are willing to take first jobs where they are overqualified in order to generate information about their work characteristics.

Christopher Stanton and Catherine Thomas (2011) describe how labor market intermediaries affect the inefficiencies generated when employment of new hires produces information about workers in their first jobs. In the oDesk online employment system, intermediaries take the form of agencies that provide information about the workers that are affiliated with them. About one third of oDesk workers are affiliated with agencies. Agencies are formed more often in low-wage countries than in the United States. Affiliates of agencies are often in the same city. Agencies have an advantage in providing information about new workers, perhaps by screening the workers. In this respect, agencies operate in a manner similar to referrals in social networks. Since a firm can observe the agency that an affiliate belongs to, expected productivity is greater for an affiliated new hire than for a non-affiliated new hire. The difference in expected productivity declines as workers gain more experience through oDesk and as more information on their job performance becomes available. Although agencies may facilitate the formation of teams, the decline in earnings differences with experience suggests that the major effect of agencies is through the provision of information about new hires. Their operation therefore reduces the inefficiencies described by Pallais.

5.3.2   Referrals

The importance of referrals in hiring provides some measure of informational imperfections in the labor market and the potential for temporary help agencies to reduce qualitative mismatches and search costs. Manolis Galenianos (2011) considers a labor market where workers form social networks to provide referrals (see earlier work on referrals by James Montgomery, 1991). Galenianos notes that more than 85 percent of workers use informal contacts in job search and get more than half of their jobs through social networks. Firms fill about 36 percent of their vacancies through referrals. Referrals generally result in less time finding a job and improved wages. In a model without worker heterogeneity, referrals simply reduce search frictions. When worker heterogeneity takes the form of high or low type workers, a meeting between firm and worker generated by a referral is more likely to be with a high type worker, and employment is expected to be more productive and yield a higher wage (Galenianos, 2011, p. 22).

Christian Dustmann, Albrecht Glitz and Uta Schönberg (2011) provide additional support for the effects of referrals. Under the assumption that social networks are based on membership in ethnic groups, the likelihood that a firm gets a referral from a particular ethnic network is increasing in the proportion of employees from that ethnic group. In the analysis worked out by Dustmann, Glitz and Schönberg, workers may get job offers through referrals or through the formal (external) labor market. They predict that workers who got their jobs through referrals get higher wages and are less likely to leave the firm. They use data from German Social Security Records for a large metropolitan area to support these predictions. Referrals therefore convey valuable information that is not otherwise available in the labor market.

The relevance to temporary help agencies is that they could substitute for many of the functions of a social network in providing referrals, improving the operation of the labor market in the way that referrals do.

5.3.3   Acquisition of Skills

A number of inefficiencies in skill investments are described in an edited volume on acquiring skills by Alison Booth and Dennis Snower (1996). Among the arguments that are potentially relevant to temporary help agencies are the following:

- Gary Becker (1962) argued that market incentives to acquire on-the-job training will be efficient whether training is specific or general. However, Margaret Stevens (1996) argues that training is usually transferable to a limited number of firms, so that there is a poaching externality among firms that leads to underinvestment in the training.

- In David Ulph's analysis (1996), skilled workers are adaptable and lower the costs of innovation. Since firms cannot hire skilled workers for indefinitely long periods, they cannot capture all the benefits of workers' contributions to reduced innovation costs, generating insufficient market incentives for skill investments.

- Dennis Snower (1996) outlines a situation where low levels of skilled workers reduce the incentives of firms to provide jobs using skilled labor, and low levels of jobs for skilled workers reduce incentives of workers to obtain skills. The result is described as a low-skill, bad-job trap.

Autor's argument (2009) that temporary help agencies increase the efficiency of labor markets by spreading around the sunk costs of participation can be extended to the costs of acquiring skills if the agencies can either provide the skills themselves or arrange for dividing the costs among firms. This would address the Stevens and Ulph arguments. For Snower's argument, suppose a simplified version of the labor market only has low-skilled or high-skilled workers and jobs. The proportion of high-skilled jobs can only affect incentives to acquire high skills, as in Snower's analysis, if the proportion affects the likelihood of a high-skilled worker getting a high-skilled job. Suppose employment agencies, with more information than individual participants in the labor market, can match high-skill workers with high-skill jobs and low-skill workers with low-skill jobs more accurately than the rest of the labor market. Then workers would still have incentives to acquire skills and the low-skill, bad-job trap for the labor market could be avoided.

5.3.4   Quality of Matches

A characteristic of the labor market is that firms and workers do not learn everything about each other before a worker is hired. Instead, both firm and worker learn over time as employment continues. If either the worker or the firm does not meet expectations, a separation often occurs, causing a loss in hiring costs, a loss in production during the employment, putting the employee back into unemployment to search again, and leaving the firm with a vacancy to fill. The information gained by the firm about the worker is lost and cannot be credibly conveyed to another firm seeking to hire the same worker (except incompletely through job references), and the information gained by the

worker is also lost. Evidence supporting the existence of these losses could be found in calculations based on the extent of early separations. Firm use of promotion within a firm and preference for referrals as a device to find workers suggest that there are significant difficulties in obtaining relevant information about workers. A temporary help agency that has longstanding relationships with both firms and workers can retain information about workers and firms, determine favorable matches better than the labor market could achieve through random meetings between workers and firms, and minimize time spent by firms with jobs unfilled and by workers without jobs.

5.3.5   Job Conversion

To some extent, temporary help agencies operate like financial intermediaries that convert short-term deposits into long-run sources of funds. Similarly, there is in general a mismatch between the length of employment sought by workers and firms. Workers generally seek long-run job stability, while firms often seek to have short-term positions filled to remain flexible in production plans. A temporary help agency can convert sequences of short-term positions at firms into long-run employment by moving a given worker from position to position, thereby reconciling the distribution of firm job-lengths with the distribution of job-lengths that workers seek.

5.3.6   Incentives

In general, a worker in a short-term position has limited incentive to work in the interests of the employer. Any variation in the worker's performance will not have an effect on the worker's outcome in this or future jobs. Similarly, a firm offering a short-term position has little incentive to improve the working conditions beyond the minimum since the firm's reputation has a limited effect on future recruiting ability. A temporary help agency would make reputation effects operable by retaining information about working conditions at firms, and conveying that information to prospective workers. By retaining information about worker job performance, a temporary help agency provides incentives to workers to do well even at short-term jobs.

5.3.7   Equilibrium Adjustment

A potential labor market problem during a business cycle is that the wage level may be slow to adjust. In particular, during a recession with high unemployment, the wage rate may be too high for businesses to hire. An alternative form of labor market adjustment is that the temporary help agency could shift the costs of job search between the firm and the worker, bringing about a more rapid response to labor market disequilibrium.

5.3.8   Two-Part Tariffs

Employment agencies earn their revenue by charging firms more for the labor of workers than the workers receive. This difference works as a wedge between the wage rate paid and the wage rate received in the same way that a consumption tax (such as the value added tax) generates a difference between the price paid for an item and the amount

received by the seller. In the study of taxes, this difference reduces the amount of trade (the quantity bought and sold) that takes place between buyers and sellers. If the amounts that buyers want to buy and sellers want to sell are insensitive to the price, the loss in trade is relatively small. However, if the amounts bought and sold are sensitive to the price, then the loss in trade is relatively large and the tax generates inefficiencies in the market.

Two-part tariffs offer an alternative pricing structure that can potentially reduce the inefficiency caused by the wedge between wages paid and received, making employers and workers better off while increasing profits of employment agencies. Walter Oi (1971) explains how two-part tariffs operate in the context of an amusement park that charges a fee for entry to the park and a fee for each ride. The problem facing the park is to decide whether to collect its revenues from the entry fee or the ride fee (the two parts of the tariff or charge to customers). Lowering the ride fee makes entering the amusement park more attractive to customers and allows the park to collect a higher entry fee. The best solution for the park is to charge a fee for a ride that equals the cost of giving another ride to a customer. This solution maximizes the benefit that customers get from going on rides, which the park then collects in the form of a higher entry fee.

The two-part tariff pricing structure could be adapted to employment agencies depending on what types of workers and jobs are handled by the agency. An agency that handles more workers seeking long term contracts or permanent employment would be more suitable for a two-part tariff. Instead of charging a fixed "entry fee" to be represented by the employment agency, an individual worker would start by receiving less in wages than the firm pays the agency as in the current pricing structure. But once a given amount is collected by the employment agency, the difference would be reduced to the administrative costs of the agency. Workers looking for a permanent job would be willing to seek an employment agency that used this pricing structure since the cost would be a fixed amount. If one job does not work out, the amount paid by the worker would count towards the total amount to be paid. The two-part tariff would reduce labor market inefficiencies (in the form of disincentives to use the employment agency) because the marginal or extra unit of labor supplied has a relatively small "tax" or wedge corresponding to the agency's administrative costs.

For workers seeking temporary employment, there could be a maximum amount to be paid in a given time period, perhaps a year. These workers would want to supply more labor since the additional labor would earn a higher wage. The greater value to workers would also increase the numbers of workers seeking to go through a temporary employment agency. Of course given the inevitable uncertainty regarding the effects of such a pricing structure, it would be best to begin in some smaller labor markets.

5.4   How Employment Agencies Could Improve the Efficiency of Labor Markets

The results of the previous section suggest that the following preliminary directions could be emphasized.

5.4.1   Collect and Maintain Credible Information about Workers and Firms

As noted previously, David Autor is negative about the possibility of temporary help agencies improving the outcomes for low-skilled workers in the labor market. As participation would be voluntary, workers would not need to provide negative information about themselves, for example criminal records, poor attendance, likelihood of quitting, or non-productive behaviors. With asymmetric information (workers know the truth about themselves but employers do not), adverse selection would lead prospective employers to discount information provided by a temporary help agency that could not compel workers to provide truthful information. This conclusion would also extend to employment agencies placing workers in long term employment relations.

Ordinarily, it would not seem to be in workers' interests to provide negative information about themselves, or agree to have negative information verified by an employment agency. However, a simple story from game theory can explain why workers would choose to do so. Among bullfrogs, a male with a deeper croak would be more attractive to a female, according to authorities. A bullfrog with a high croak would perhaps be expected not to croak and thereby reveal the unfavorable frequency. Suppose all bullfrogs with frequencies below *f1* croak, while those with higher frequencies decide not to croak. Suppose the average frequency of bullfrogs who do not croak is *fa*. Any bullfrog with a croak frequency between *f1* and *fa* would then choose to croak rather than have females expect him to have the higher frequency of *fa*. In this way, the threshold frequency for croaking and the average frequency of non-croaking bullfrogs would gradually increase until all bullfrogs croak.

In analogy, any workers who would choose not to reveal negative information about themselves (or agree to have information verified) would be expected to have even worse information about themselves than the worker with the worst revealed information. In the labor market, the likely outcome would be that workers with negative information about themselves would not seek a job through an employment agency. This would provide workers who do go through an employment agency a significant advantage in the labor market. It would further induce more workers to agree to provide truthful information and have it verified to use an employment agency, even if the information is negative. In this way, an employment agency could overcome the problems caused by its voluntary nature.

In addition to establishing the credibility of information about workers (and presumably about firms), employment agencies can maintain the information for use in future periods of unemployment or recruitment.

5.4.2   Build Long-Term Relationships with Workers and Firms

One way that labor markets differ from commodity markets is that workers and employers have strong incentives to have long run relationships with each other. These long run relationships enable firms to train employees and raise productivity and wages over time. Firms retain information about workers that facilitates efficient promotion within the firm. The long run relationships increase the incentives for workers and employers to operate in each other's interests and share the rewards from the relationship.

Many of the inefficiencies of the labor market arise because workers and firms are not yet in long term relationships. Workers who are just entering the labor market face difficulties in credibly establishing their work capabilities, as identified by Pallais (2010).

Costs of learning about employers or workers, or searching for them, are not present (at least not to the same degree) in a long term employment relationship.

An employment agency could build long term relationships with employers and workers that capture many of the gains, even through the workers do not necessarily have long term relationships with specific employers. These relationships would allow agencies to accumulate credible information about workers and firms over multiple spells of employment. The information would facilitate later matching of workers with employers, reducing the incidence of mismatches. Training could be provided by the agency or a firm, with costs shared among all potential employers as described by Autor (2009).

The two-part tariff structure described in the previous section would encourage a long term relationship. Once a worker has paid the initial cost of using the employment agency, the worker would stay with the agency.

5.4.3 Expand Markets

The literature for the employment agency industry (CIETT, 2010, 2011; EUROCIETT, 2007, 2010; and ING, 2006) indicates that workers have many motivations for using their services. Workers seek temporary work as stepping-stones to permanent employment, to gain experience or training, earn additional income, or engage in flexible work. Most workers using agencies are young and have at most a secondary education. In addition to unemployed workers in general, there would appear to be markets for services for new graduates seeking entry into the labor market, workers currently mismatched who seek job-to-job transitions, workers who have been out of the labor market and wish to re-enter, and older workers whose skills in an occupation have become obsolete, but who wish to continue employment. If agencies can design services that meet the needs of these groups and improve their chances in the labor market, while simultaneously providing services to firms, they can potentially expand their operations to new groups. These services would be designed specifically for the needs of these groups. The services would differ from placement of temporary workers, with different pricing structures. Employment agencies would also need to consider the types of services needed by employers. Whether such services would be profitable would of course need to be studied.

Unemployed workers face a substantial risk because they do not know how long they will need to search to find a job. Employment agencies can increase the value of services to workers by providing partial insurance using the two-part tariff pricing structure described above. A worker engaged in search for a permanent job who has paid the initial amount (the entry fee of the two-part tariff) would not face the risk of continuing job search expenses through the agency if it takes a long time to find a permanent job. Similarly, firms face risks in hiring a worker with unknown employment characteristics because of employment protection legislation and other costs of terminating an employment relationship. Employment agencies can reduce risk to firms by increasing their flexibility to change workers.

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