International Trade and Labor Markets

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Theory, Evidence, and Policy Implications

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To our families

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1
An Overview of the Issue

It is well documented that during the last two decades, the economic fortunes of less-skilled workers in the United States and Europe have declined substantially. The stylized facts for this group include an erosion of real wages in the United States and sharply higher unemployment rates throughout Europe. Concurrently, both the United States and Europe have witnessed an explosion of trade, particularly with less-developed countries. These changes have sparked significant policy debate among both policy practitioners and within the economics profession concerning the impact of trade on labor-market outcomes, with particular concern being focused on the impact that globalization has had on low-wage workers with few marketable skills.

The vigorous debate surrounding these issues has produced two very different views of the world. For the vast majority of practitioners, the focal point of the debate is the perceived impact of globalization on employment. Those with a predisposition to oppose trade liberalization tend to buttress their positions with arguments that lower production costs and fewer regulations in other countries allow foreign firms to out-compete domestic producers, resulting in less domestic output and fewer domestic jobs. On the other hand, those who wish to see even greater liberalization often argue that freer trade expands our export markets, resulting in a greater demand for our products, greater domestic production, and more jobs.

This focus on trade and jobs is understandable. The media regularly reports on plant closings and mass layoffs. It is often suggested that stiff foreign competition may be one of the causes of such events. Sometimes the facts actually support such attributions. However, the media is not in the habit of reporting a success story each time a worker, displaced by globalization, finds a new job. It is all too easy to fall into the trap of viewing the worldwide number of jobs as fixed. If import penetration costs American jobs, then expanding exports must yield dividends in the form of increased employment for Americans.

In short, the picture that emerges is one of a world in which workers, particularly those near the bottom of the income distribution, cycle between periods of employment and unemployment. Changes in the degree to which the economy is open to trade are bound to affect the transition rates between these states. Proponents of greater liberalization argue that by expanding our export markets we make it easier for the unemployed to return to work quickly. Those in favor of limiting trade tend to focus on workers who lose their jobs as imports flow into our country, or who see their wages eroded as their employers have difficulty competing with foreign competitors using cheaper labor. Proponents of limiting trade point out that some of the workers who lose their jobs may need to retrain in order to find reemployment, and some may face long spells of unemployment. All of these factors can lead to financial hardship, emotional distress, and/or a number of other personal tragedies. There is also concern that the hardships created by unemployment may lead the poor and the jobless to turn to crime or other forms of social unrest to survive. It is only natural to ask whether or not the potential benefits from freer trade are really worth such possible costs.

In contrast to this viewpoint, which might be termed the layman's view, academic economists do not seem concerned at all about the jobs created or destroyed by changes in trade policy. The considered response of most economists is that those who wish to link globalization with employment to push for a particular type of trade policy are using arguments that are misguided and fundamentally incorrect. In fact, for reasons discussed below, the debate about trade policy among economists almost always ignores the impact of trade on employment. Instead, relying on formal models, academics argue that fully flexible wages and other factor prices allow the economy to maintain full employment of all resources, including labor. However, changes in the degree of openness or in the terms of trade impact the distribution of income by inducing changes in factor prices.

Virtually all of the academic research connecting international markets for goods with domestic markets for productive factors centers around one of two basic models of international trade. The first is the Heckscher–Ohlin model, which predicts that liberalization benefits an economy's abundant factor and harms its scarce factor. The alternative is the Ricardo–Viner model, which predicts that liberalization benefits factors that are tied to the economy's export sector, harms those factors that are tied to the economy's import-competing sector, and has an ambiguous impact on factors that are mobile across sectors. Both of these models assume away any impact that trade could have on employment by assuming that all factors are fully employed at all times. In other words, the labor markets included in the models used by academic economists leave no room for many of the concerns outlined previously.

The remarkable divergence between public and professional views of the impact of trade cannot be understated. For example, careful scrutiny of the debate preceding the vote on the North American Free Trade Agreement (NAFTA) in the U.S. House of Representatives and the U.S. Senate reveals that, of the 141 anti-NAFTA statements made, 112 were of the form "NAFTA will destroy jobs" while, of the 219 pro-NAFTA statements made, 199 were of the form "NAFTA will create jobs."[1] In stark contrast, the *Handbook of International Economics*, which is devoted to describing what academic economists know about the impact of international trade and consists of nearly 4,000 pages, does not even include a listing for unemployment in the index.[2]

There are at least three reasons for this dichotomy. First, most academic economists view trade as a microeconomic issue that focuses on the distribution of resources within a given economic environment while viewing unemployment as a macroeconomic concern related to the overall level of economic activity and other measures of economic performance.[3]

Second, international economics has been, since inception, predominately a micro-based theoretical field relying on insights from mathematical models to draw conclusions about the impact of trade policies on real world economies. Since, until recently, economists have been unable to produce convincing microeconomic models of unemployment, trade economists have largely ignored the role of unemployment in the debate over trade policy. Almost all models of international trade, and certainly those that have served as the area's workhorses, are full-employment models.

Finally, the mainstream view among economists is that trade has little, if any, impact on the overall level of unemployment.[4] This is true in spite of the fact that there is very little evidence either way on this issue. Although there is a large amount of empirical work on the impact of trade on employment in a particular sector or in a particular region of an economy, there is very little empirical work on the aggregate employment effects of trade policies.[5] Thus, it could be argued that the absence of an empirically established link between trade and unemployment strongly suggests that it would be futile to create models of trade and unemployment.

In our opinion, the arguments put forth by both policy practitioners and academic economists are flawed. The public's views are based on arguments that are, at best, informal and do not rely on carefully developed analysis. On the other hand, the views held by most academics are based on well-developed but highly stylized models that ignore unemployment and the structure of factor markets completely.[6]

There are at least three good reasons to extend traditional analyses of trade policy to allow for a richer treatment of labor-market dynamics, including the possibility of both short-run and long-run unemployment. To begin with, there is the issue that the public seems most concerned about—does trade policy create or destroy jobs? It would be easier for academics to credibly dismiss such concerns if there was a significant body of empirical evidence showing that changes in trade policy do neither. Although we consider this to be an important issue, it is not one that we address in this monograph. The reason is that we consider this to be primarily an empirical question, and our expectation is that the conventional view is probably right—over the long run, trade probably has only a minor net impact on the number of available jobs. So, instead of tackling this issue, we focus our attention on the two remaining reasons for including unemployment in our trade models.

The second reason that we need to broaden our analysis to allow for unemployment is that even if the conventional view (that trade has no aggregate impact on unemployment) is correct, the link between trade and the distribution of income may be influenced significantly by the informal asymmetries and trading frictions that are inherent in a dynamic labor market. It is impossible to know how this link will be altered without formally modeling the flows of workers into and out of unemployment. Moreover, as labor economists have been emphasizing for some time now, the structure of the labor market varies a great deal across countries.[7] Countries differ in the laws governing the hiring and firing of workers, union coverage rates, minimum wage laws, turnover rates, wage rigidity, and the generosity of the social insurance that they provide for the poor and the unemployed. Since trade is all about exploiting cross-country differences, it is hard to believe that these differences have no implications for the issues of interest to economists studying international trade. Yet, for the most part, academics have ignored such differences by always working with perfectly competitive, frictionless labor markets.

Finally, there is the issue of optimal trade policy. Economists, even the most ardent supporters of free trade, readily admit that some people are harmed by trade liberalization. In fact, enormous efforts have been put forth to identify the groups that win and lose whenever trade policies are implemented. However, after identifying these groups, the usual approach is to simply figure out the net effect of the policy. If the losers lose more than the winners gain, then the policy is considered inefficient. If the winners gain more than the losers lose, it is usually considered a worthwhile policy. In this latter case, the next step is to note that it is possible to compensate the losers for their losses without exhausting the winners' gains so that implementation of the policy generates a potential Pareto improvement. What is usually ignored is the fact that such compensation rarely, if ever, takes place. Moreover, even if we were to try and compensate the losers, we really have no idea as to the best way to go about it. No one has asked the simple question—what is the best way to compensate those who lose when trade is liberalized? After all, how can we try and determine the best way to compensate workers who are pushed into unemployment by liberalization if we only work with models that assume away all unemployment? How can we compare training subsidies, wage subsidies, employment subsidies, and trade-adjustment assistance (which is essentially extended unemployment insurance) in models that ignore the training and job acquisition processes? The obvious answer is that we cannot.

In writing this monograph our intention is to show that there is much to be gained by extending the traditional analysis of international trade to allow for labor markets characterized by workers whose labor-market experiences are punctuated by spells of involuntary unemployment. We hope to demonstrate that such extensions can be made without sacrificing tractability and that they can provide valuable new insights that hold up to empirical scrutiny. And, perhaps most important, we will argue that such models offer the appropriate venue in which to carry out policy analysis aimed at determining the best way to compensate those who suffer when trade patterns change.

Our goal then is to develop simple yet compelling models that allow for documented differences in labor markets across countries in order to investigate the impact of trade and trade policies on the underclass of society. The models that we develop are based on the many micro-based models of unemployment that have emerged over the past 30 years (e.g., search theory and efficiency wages) and will allow us to account for differing degrees of labor-market flexibility. The models will allow us to consider the impact of trade on the poor both through its impact on job opportunities *and* its impact on the distribution of income when unemployment is present.

Developing general-equilibrium models with imperfect labor markets is just a first step in the process of understanding how trade affects the poor and unemployed. The next step entails an investigation of the impact of a variety of policies that are aimed at offsetting some of the costs of worker displacement caused by trade shocks. While empirical evidence suggests that the losses suffered by dislocated workers may be quite high, international trade economists have, for the most part, ignored such costs in discussing trade policy.[8] In this monograph, we use our models to study the relative merits of policies such as trade-adjustment assistance, wage subsidies for dislocated workers, job training subsidies, and other policies aimed at helping workers displaced by changes in the pattern of trade.

The monograph is divided into four additional chapters. In Chapter 2, we review the various literatures that have attempted to link international trade to the distribution of income as well as to the level and composition of employment. We purposefully cast a broad net to include everything from the pseudo-scientific arguments expounded by writers like Ross Perot and Pat Choate (1993) to the empirical and theoretical work undertaken by international trade specialists such as Robert Lawrence and Matthew Slaughter (1993) and Paul Krugman (2000), as well as labor economists such John Bound and George Johnson (1992), Lawrence Katz and Kevin Murphy (1992), and Eli Berman, John Bound, and Zvi Griliches (1994).

We have several goals in Chapter 2. We begin by reviewing the theories put forth by some populist writers. These theories include claims that trade between developed and less-developed countries is harmful for labor employed in the developed economy and calls for "managed trade" to help domestic producers in certain sectors outcompete their foreign rivals. International trade specialists, and we include ourselves in this group, argue that such views are based on incomplete reasoning and have faulty theoretical underpinnings. One of the objectives in this chapter is to point out exactly where the problems with these theories lie.

The remainder of Chapter 2 is spent reviewing the mainstream theoretical and empirical literature on trade, wages, and employment. As we review the theoretical work, we discuss the limitations of using full-employment models to study the link between trade and the distribution of income. As we review the empirical work, we highlight the different approaches taken by trade and labor economists and summarize the recent debate between the two groups with regard to methodology. In summary, our intent in Chapter 2 is to show that mainstream economists leave a void when they simply ignore the possible connection between trade and the structure of the labor market, and that this void is filled by populist arguments that have little analytic support. This presentation sets the table for Chapter 3, in which we show that the populist concerns can be incorporated into fully general-equilibrium models that are subject to the same standards of rigor and empirical scrutiny as, say, the Heckscher–Ohlin model of trade. Moreover, we show how results from traditional full-employment models of international trade must be modified when unemployment is present. We are particularly interested in how the structure of the labor market influences the pattern of trade and how it alters the link between trade and the distribution of income. The development of these models also lays the foundation for the policy analysis that is carried out in Chapter 5.

Since there are many different ways to model unemployment, we look for results that are robust to the way in which unemployment is introduced. We show in Chapter 3 that, regardless of whether unemployment is driven by trade frictions (as in search-based models), monitoring or motivational concerns (as in efficiency wage models), or sticky wages (as in minimum wage models), labor-market turnover rates play a key role in determining the pattern of trade and the way in which trade affects the distribution of income. We briefly summarize our findings here to provide a sense of the kind of results that can be found in the chapter.

Consider first the pattern of trade. In traditional full-employment models of international trade, the primary determinants of comparative advantage are production technologies and factor endowments. It is argued that if a country has a relative abundance of a certain factor, then that country will export goods that are produced using a production process that uses that factor relatively intensively. So, for example, if we assume that the United States is relatively abundant in skilled labor, the United States would export goods using a production process intensive in the use of skilled labor. The reason is that skilled labor would be relatively cheap in the United States, which would allow U.S. firms to produce goods that require a great deal of skilled labor as an input relatively cheaply. It is important to note that the structure of the labor market plays no role in this analysis. The only cost of production in this setting is the cost of the inputs used to produce the product.

Several additional costs of production emerge when unemployment is present. There are costs associated with recruiting, hiring, training, and maintaining a workforce. There may also be significant adjustment costs that must be incurred if the firm wishes to reduce the size of its labor force. These turnover costs influence equilibrium prices and should therefore affect the pattern of trade. Moreover, as we explain in Chapter 3, a casual review of the labor economics literature suggests that these turnover costs are large enough and varied enough to have a nontrivial impact on equilibrium outcomes.

It is well-known that there are significant differences in turnover rates and turnover costs across countries. The average duration of a job is much higher in Europe and Japan than it is in the United States, and workers find reemployment much more rapidly in the United States than they do in Europe (Freeman 1994). In addition, firms in Western Europe face significant government-imposed costs when they attempt to reduce the size of their labor force while far lower costs are imposed on U.S. firms. Labor economists conclude the U.S. labor markets are much more flexible than the European counterparts. They have recognized for quite some time now that this difference in flexibility has important implications for a variety of issues including job training and macroeconomic performance.[9]

In Chapter 3, we show that there are important implications for the pattern of trade as well. For example, we show that if jobs are more durable or easier to find in a particular industry in the United States than they are in the same industry in other countries, then, all else equal, the United States is more likely to export that good. The basic reason is that U.S. firms will face lower costs of attracting and retaining their workers than their foreign rivals. This leads to a lower autarkic price in the United States, making this an industry in which the United States has a comparative advantage. On the other hand, if there is an industry in which jobs are less durable or harder to find in the United States than they are in the comparable industry in other countries, then U.S. firms will have to pay a relatively high compensating differential in order to attract workers to that sector. This will result in a higher autarkic price for that good in the United States, which implies that the United States is likely to import that good.

Now turn to the issue of trade and the distribution of income. As noted earlier, traditional trade theory offers two competing hypotheses. The Stolper–Samuelson Theorem predicts that trade liberalization will benefit an economy's relatively abundant factor and harm an economy's relatively scarce factor.[10] In this case, the industry in which these factors are employed does not matter at all. If labor in one sector of the economy gains from trade, so does labor in all other sectors. In stark contrast, the Ricardo–Viner model predicts that trade liberalization will benefit factors that are tied to the economy's export sector and harm those factors that are tied to the economy's import sector. The main difference between these two models lies in the assumptions that they make about factor mobility. The Stolper–Samuelson Theorem holds in the Heckscher–Ohlin model of trade, in which all factors are perfectly mobile across all sectors at all times. In the Ricardo–Viner model, some factors are tied to certain sectors because they face significant transactions costs if they switch sectors (largely because the acquisition of sector-specific skills effectively binds workers to sectors). Note that neither theory makes any prediction about the impact of trade on the unemployed. After all, there is no unemployment in either model.

In Chapter 3, we explain why the presence of equilibrium unemployment substantially changes the link between trade and the distribution of income. In addition, since our models allow for unemployment, they provide us with the ideal setting in which to investigate the impact of trade on the welfare of the unemployed. We present two sets of results. First, we explain why the Stolper–Samuelson Theorem can be used to determine how changes in trade patterns affect the welfare of the unemployed. Intuitively, since unemployed labor has no tie to any particular sector, they play the role of the mobile factors. It is unemployed labor and idle capital that can react instantaneously to changes in world prices in order to clear markets. This is especially true for low-skilled workers since they have no sector-specific skills. The implication of this result is that unemployed labor gains (loses) from trade liberalization if that particular type of labor is relatively abundant (scarce) in the country in question.

We then go on to explain why the welfare of employed workers is driven by a weighted average of Stolper–Samuelson and Ricardo–Viner effects, with the weights assigned to each effect tied to the industry turnover rates. Briefly, Stolper–Samuelson effects dominate in markets in which turnover rates are high, while the Ricardo–Viner effects dominate in markets in which turnover rates are low. Intuitively, when time and effort are required to find employment, an existing job creates a sectoral attachment since employed agents are reluctant to quit their jobs in order to seek employment elsewhere. This makes employed factors analogous to factors with sector-specific skills in the Ricardo–Viner model. The Ricardo–Viner effects will dominate if the attachment to a sector is strong—meaning that jobs are hard to find and long lasting. The implication is that, in industries with high turnover, employed workers gain (lose) from trade liberalization if their type of labor is relatively abundant (scarce) in their country. However, in industries with low turnover, the welfare of employed workers is tied to the overall fortunes of the sector in which they are employed. Thus, in low-turnover industries, labor gains (loses) from liberalization if it is employed in an export (import) industry. We conclude that adding unemployment to the traditional model leads to a new theory about trade and factor rewards that is a hybrid of the two standard theories, and it is the structure of the labor market that is critical in determining which of the standard forces dominates.

In Chapter 4, we test the theories developed in Chapter 3. We begin by combining the National Bureau of Economic Research (NBER) data on trade flows in the United States with the Davis, Haltiwanger, and Schuh (1996) data on job creation and job destruction in U.S. manufacturing industries to see if our theory concerning trade patterns and labor-market structure holds up to empirical scrutiny. The empirical results are surprisingly strong—high job destruction rates are associated with import industries, just as our theory predicts. Moreover, turnover rates by themselves explain as much variation in trade flows as all of the remaining control variables combined!

In the second half of the chapter we look to see if the predictions of our models regarding the link between trade and the distribution of income are supported by the data. To do so, we expand our data set to include data on political action committee (PAC) contributions given to supporters and detractors of NAFTA and the General Agreement on Tariffs and Trade (GATT). Our theory predicts that labor and capital would have polar opposite views on trade policy when both are employed in high-turnover industries, but their views would be aligned with each other when both are employed in low-turnover industries. By looking at who the PAC represents (both in terms of industry and factor), we can test this hypothesis. The data that we examine provide strong empirical evidence that the lobbying activity that took place with respect to NAFTA and GATT was indeed consistent with our theory.[11]

We conclude Chapter 4 by pointing out that in both cases we find significant empirical evidence in favor of our theories. Our conclusion is that we can improve on our understanding of how international trade affects economies by taking the structure of the labor market into account.

We close the monograph with Chapter 5, in which we carry out our policy analysis. Our goal is to investigate the optimal manner in which to compensate those who are harmed by trade liberalization. We begin by developing a search model that is very much in the spirit of those introduced in Chapter 3. The main distinction is that in Chapter 5 we make the model more complex. We assume that workers differ in ability and that jobs differ in the skills required for employment. Workers first choose the type of training to acquire and then search for employment. In our model, there are two types of jobs. High-tech jobs require costly, time-consuming training but, once acquired, jobs in this sector last a long time (i.e., there is low turnover) and pay relatively high wages. The training cost for jobs in the low-tech sector is low both in terms of time and resource costs. These jobs do not last very long (i.e., there is high turnover) and offer low pay. In equilibrium, workers separate so that high-ability workers are employed in the high-tech sector while low-ability workers are drawn to the low-tech sector.

To carry out our policy analysis, we assume that the low-tech sector is initially protected by a tariff. This means that some workers who should be employed in the high-tech sector (in terms of economic efficiency) are drawn to the low-tech sector instead. We then assume that the tariff is removed in order to improve efficiency. As a result, those workers who were inefficiently employed in the low-tech sector move to the high-tech sector and search for new jobs. The process is gradual, however, since these workers must acquire high-tech skills and then search for high-tech jobs, and both processes take time and use up resources.

Removing the tariff clearly benefits all workers who are initially employed in the high-tech sector since they now face lower consumer prices for the good produced in the low-tech sector. However, there are two classes of workers that are harmed. Those workers who choose to remain in the low-tech sector (because, given their ability levels, the cost of training for a high-tech job is too high) see their real wages fall. We refer to such workers as the “stayers.” These are the workers who earn the lowest wages and have the least skills—they are the “poor” in our model. The other group that is harmed consists of those workers who choose to switch sectors. These workers, whom we refer to as the “movers,” see their real wages rise, but the wages do not increase enough to compensate for the training and search costs that the workers incur while making the transition to the high-tech sector.[12]

Our task is to find the most efficient way to compensate the stayers and the movers for the losses they incur when trade is liberalized. We assume that any compensation program is financed through taxation of earned income. It follows that any compensation scheme will create a distortion. The optimal policy is the one that fully compensates the workers while creating the smallest distortion.

We show that there are two rules that need to be applied in order to find the optimal policy. First, the policy must be targeted to a specific group. Paying wage subsidies to all high-tech workers in order to compensate the movers is costly since it needlessly provides an additional benefit to those workers who were employed in the high-tech sector before liberalization.

Our second rule is somewhat more complex. Define the "marginal worker" to be the worker who is just indifferent between high-tech and low-tech jobs (so that all workers with lower ability work in the low-tech sector while all those with higher ability work in the high-tech sector). Next, define the "average worker" in a sector to be the worker with the average ability level in that sector. We show that the amount that the average worker benefits from a particular policy is a measure of how costly that policy will be in terms of resources—if the average worker's real income is very sensitive to the policy parameter, then only a modest program will be needed to fully compensate the group in question. We also show that the amount that the marginal worker benefits from that same policy is a measure of how distortionary that policy will be. If the marginal worker's real income is very sensitive to the policy parameter, then even a program of modest size will result in a great deal of inefficient reallocation of labor. It follows that the ideal policy is one that is highly valued by the average worker but not by the marginal worker. Such a policy will allow the government to compensate the harmed group cheaply without triggering a great deal of inefficient labor reallocation. Applying this rule, we find that the best way to compensate the movers is with a targeted wage subsidy, while the optimal way to compensate the stayers is with a temporary employment subsidy. Surprisingly, these policy recommendations hold regardless of the structure of the labor market.

For any new area of economic research to be influential, it must satisfy three criteria. First, the theory must provide new insights that improve our understanding of how markets work. Second, the new propositions that are generated must be consistent with the data and explain the data at least as well as (if not better than) competing theories. Third, the theory should have policy relevance. This means that the models must be simple and tractable enough to provide insight into issues of real world importance such as policy analysis and design.

We believe that the results reported in Chapters 3–5 demonstrate that a new theory of international trade that emphasizes the role played by the labor market has the potential to satisfy these criteria. Chapter 3 provides new insights into the link between labor-market turnover and the pattern of trade. It also shows how these turnover rates alter the link between trade and the distribution of income. The results reported in Chapter 4 demonstrate that the insights gained from these models appear to be consistent with data on trade patterns, turnover rates, and political lobbying activity aimed at influencing trade policy. Finally, in Chapter 5, we show that it is possible to build simple models of trade that allow for equilibrium unemployment and training and use them to carry out careful policy analysis. Such models provide new insights into policy design by allowing us to compare policies that are aimed at aiding those who are harmed by changes in trade policy.

Notes

1. Baldwin and Magee (2000).
2. The *Handbook of International Economics* consists of three volumes. Unemployment does not appear in the index to volumes 1 or 3. It does appear in the index to volume 2, but only indirectly (the reader is referred to a small number of entries under the heading of "employment").
3. See, for example, Paul Krugman's and Michael Mussa's articles in the *American Economic Review,* in which they argue that "it should be possible to emphasize to students that the level of employment is a macroeconomic issue . . . depending in the long run on the natural rate of unemployment, with microeconomic policies like tariffs having little net effect," (Krugman 1993) and that "economists . . . understand that the effect of protectionist policies is not on the overall employment of domestic resources, but rather on the allocation of resources across productive activities" (Mussa 1993).
4. Of course, this is probably the primary reason that most economists view trade as a macro issue.
5. These papers focus on how changes in trade patterns affect the distribution of employment across sectors and regions—they do not investigate the overall impact on total employment or the unemployment rate. See Baldwin (1994) for a survey of this work.
6. There are some exceptions. In the 1970s there were several attempts to extend traditional trade theory to examine the consequences of allowing for a variety of factor market distortions (see, for example, Magee 1976). These early attempts did not appear to be very fruitful for a variety of reasons, perhaps the most important of which is that most micro-based models of unemployment were not yet fully developed. More recently, things have begun to change and a number of authors have begun to focus attention on the labor market and its impact on trade-related issues. For example, Krugman (1994) and Davis (1998) argue that the recent change in the distribution of income in the United States and the recent increase in unemployment in Europe may be linked to trade shocks and the structure of the labor markets in the two regions. Krugman's arguments are very informal, while Davis's argument relies on a model in which all European unemployment is due to a minimum wage. Other recent attempts to use the new micro-based models of unemployment to address a number of important trade-related

issues include Davidson, Martin, and Matusz (1987, 1988, 1991, 1999), Hosios (1990), and Sener (2001) using search theory; Copeland (1989), Brecher (1992), Matusz (1994, 1996, 1998), and Hoon (1991, 1999, 2000, 2001a,b) using efficiency wages; Matusz (1985, 1986) and Fernandez (1992) using implicit contracts; and Brecher (1974a,b, 1980, 1992, 1993) and Davis (1998) using minimum wages.

7. See, for example, Freeman (1994), Layard, Nickell, and Jackman (1991), or Nickell (1997).
8. See Jacobson, LaLonde, and Sullivan (1993a,b).
9. See, for example, Freeman (1994) and Layard, Nickell, and Jackman (1991).
10. The original statement of this result is by Wolfgang Stolper and Paul Samuelson (1941).
11. Our approach to this analysis is inspired by the earlier work of Steven Magee (1980), who made one of the few attempts to distinguish between the Stolper–Samuelson and Ricardo–Viner predictions about trade and factor returns. Magee noted that the distributional consequences of trade liberalization create powerful incentives for political lobbies to try to influence the determination of trade policies. Since the Stolper–Samuelson Theorem and the Ricardo–Viner model predict different distributional consequences, careful observation of actual lobbying activity should provide some clues regarding the true link between trade and factor returns. Therefore, Magee examined the Congressional testimony by union and industry representatives leading up to the adoption of the 1973 Trade Reform Act. Based on his reading, the testimony was largely supportive of the Ricardo–Viner predictions in that the representatives of labor and capital within a given industry tended to support the same side in debates over trade policy.
12. Some movers may gain from liberalization while others lose. However, we show in Chapter 5 that the utility of the movers as a group falls.

2
Globalization and Labor: The View from Main Street to Mainstream

One of the most widely accepted propositions in economic analysis is that, for each nation participating in international commerce, the aggregate gains from trade almost surely exceed the aggregate costs. However, it is also quite clear that the costs and benefits of trade accrue to individuals and are not uniformly distributed throughout the economy. The expansion of trading opportunities, whether by a reduction of domestic trade barriers or by an increase in the number of other countries fully participating in the trading system, can create both winners and losers.[1]

The gains or losses that an individual worker might incur can manifest themselves in several ways. In principle, changes in the trading environment can alter the average real wage, can influence the mix of employment opportunities between "good" jobs and "bad" jobs, and may even change the overall number of job opportunities. While the lion's share of research on these issues has been devoted to uncovering the relationships between trade and the average real wage, it is fair to say that populist rhetoric targets the perceived impact of trade on the number and mix of employment opportunities.

The purpose of this chapter is to illustrate some of the arguments that have been put forth to support the view that globalization can have adverse distributional consequences. We do not intend this chapter as a comprehensive review of the literature relating trade to employment or trade to wages.[2] Rather, our purpose is to exposit the concepts that researchers have used to frame their analyses.

GLOBALIZATION AND UNEMPLOYMENT

From its inception, trade theory has been rooted in the micro foundations of Adam Smith's pin factory and David Ricardo's exposition of comparative advantage. As such, the development of the theory has focused relentlessly on showing how trade could alter the allocation of scarce resources. At the risk of sounding cavalier, the two-line summation of more than two centuries worth of research can be simply stated. Trade is good because the induced reallocation of a fixed amount of resources yields greater output. Artificial impediments to trade are bad because they prevent the most efficient allocation of the fixed amount of resources. For our immediate purpose, the key phrase in this two-sentence summary is “fixed amount of resources.” As we noted in Chapter 1, almost all of the formal general-equilibrium models of trade behavior incorporate an assumption of full employment. It is simply taken for granted that the fixed amount of resources available in the economy will be fully utilized regardless of the level of international trade.

In contrast, as we discuss in the introduction, the public seems to have a very different view of the impact of trade on an economy’s utilization of its resource base. There are clearly concerns that an increase in international trade, particularly with less developed countries, will reduce the employment of domestic resources and increase unemployment. In a poll conducted May 8–13, 2002, respondents were asked if they “believe that free trade between the U.S and other countries creates more jobs in the U.S, loses more jobs in the U.S, or do you think it makes no difference one way or the other?” A plurality of 45 percent responded that trade loses more jobs; only 24 percent stated that trade creates jobs.[3] When these same respondents were asked if “U.S. trade policy should have restrictions on imported foreign goods to protect American jobs, or have no restrictions to enable American consumers to have the most choices and the lowest prices,” those surveyed chose “restrictions” by a margin of two to one. In fact, 55 percent indicated that they would be willing to pay more for imported goods, such as cars and clothing, if it meant that American jobs would be protected.[4]

The populist view of the link between trade and jobs was not lost on presidential hopeful Ross Perot, who along with Pat Choate published a book in 1993 with the alarming title *Save Your Job, Save Our Country: Why NAFTA Must be Stopped—Now!* In this publication, Perot and Choate coined the phrase “giant sucking sound” in reference to their belief that the passage of NAFTA would result in the movement of millions of jobs from the United States to Mexico. Their premise (as Perot and Choate would undoubtedly agree) was simple. At a time when the minimum wage in the United States was $4.25 and the average manufacturing wage was $16.17, the comparable Mexican figures were $0.58 and $2.35. Elimination of trade barriers between the United States and Mexico would allow U.S. manufacturing firms to move their production facilities to Mexico where they could save enormous sums on labor costs and sell their output in the United States. They peppered their monograph with anecdotes about particular firms that had already set up shop just south of the U.S.–Mexico border and surmised that nearly six million American workers would be put immediately at risk should NAFTA pass.[5]

The obvious flaw in the Perot and Choate analysis is that they treat wages as exogenous. Clearly the wage differential reflects, in a broad sense, overall labor productivity differentials. Workers in developing countries are less productive because they have acquired less human capital. Higher morbidity rates may also play a role in reducing productivity. In addition, labor is not the only input in the production process. Weaknesses in infrastructure, such as intermittent power failures, poor telecommunications, and inadequate transportation arteries can all conspire to raise costs. The data speak loudly on this point. American firms paying high wages can and do compete with firms from developing countries that pay low wages. Even in 1993, prior to the adoption of NAFTA, Mexico ranked as the third largest market for U.S. exports, buying more than $40 billion of U.S. goods. Presumably these goods were produced using U.S. workers who earned higher wages than their Mexican counterparts. Furthermore, total exports from the United States to Mexico have nearly tripled since then, reaching a level of $112 billion in the year 2000.[6] Between 1993 and 2000, the U.S. unemployment rate fell from 6.9 percent to roughly 4 percent. Under these circumstances, one would be hard pressed to argue that NAFTA cost six million jobs.

At the opposite end of the scale, Gary Hufbauer and Jeffrey Schott (1992) undertook a forecast of the potential effects of NAFTA. In terms of its impact on labor, Hufbauer and Schott projected that NAFTA would *create* 130,000 new jobs in the United States. They arrived at this figure by first conjecturing that NAFTA would improve the annual U.S. trade balance by $9 billion. They then looked at the Statistical Abstract of the United States to find the 1986 value of exported goods along with the number of individuals involved in export-related jobs. Based on these figures, they calculated that each additional billion dollars worth of exports requires 14,542 direct and supporting workers. A $9 billion increase in net exports would therefore create roughly 130,000 new jobs.

The problem with this technique of analysis is that it ignores any general-equilibrium effects that might result from trade liberalization. For example, if we think of a simple macro model of the economy, we might argue that there is a natural rate of employment and output. In the long run, wages and prices adjust to bring the economy to that natural rate of employment. Furthermore, adjustments in the real exchange rate can allow virtually any trade balance to be sustained at a given level of output.

A number of authors have conducted econometric studies of the employment effects of import competition on particular industries. For example, Revenga (1992) examined data for a panel of 38 manufacturing industries for the period 1977–1987. She found that, holding all else equal, a 1 percent decline in import prices resulted in an employment loss of somewhere between 0.24 percent and 0.39 percent. By contrast, her findings suggest relatively little impact of the price decline on wages. Revenga interpreted these results as meaning that "labor is quite mobile across industries—the impact on the return to labor of an adverse trade shock in a particular industry seems to be quite small, with most of the adjustment occurring through employment." Since she did not track the fortunes of individual workers, however, we cannot distinguish between competing hypotheses. One hypothesis is that employment is constant, with declines in some sectors matched by increases in others. The alternative is that negative shocks result in a loss of jobs and an expansion in the number of unemployed workers while positive shocks produce jobs and draw down the number of unemployed.

Perhaps one of the most sophisticated empirical attempts to link trade and employment was undertaken by Robert Baldwin, John Mutti, and David Richardson (1980). In their calculations of the effects on the U.S. economy of a large multilateral tariff reduction, they explicitly assumed that there exists a given level of unemployment "due either to natural forces (e.g., normal quit-and-search behavior) or to government choice (e.g., for anti-inflationary reasons)." They also econometrically estimated the expected duration of unemployment for a given worker based on that worker's demographic characteristics. They then estimated employment changes for 367 industries assuming a 50 percent multilateral cut in tariffs. The duration of unemployment for a worker in a contracting industry was estimated by inserting the industry's demographic characteristics into the econometric model of unemployment duration. Their estimate of the impact effect of the policy is quite small. Roughly 135,000 jobs would be created in export-related industries and 150,000 jobs would be lost in import-related industries. Importantly, one of the basic assumptions underlying the model is that the policy does not change the natural rate of unemployment. All employment effects are transitory.

Most recently, a number of researchers have attempted to quantify the impact of globalization on the employment experiences of individual workers. For example, Lori Kletzer (2001) examined data from surveys of displaced workers to compare the experiences of workers who are displaced by factors associated with globalization with workers displaced for other reasons, such as technological change, cyclical downturns, and so on. She found that workers who are displaced due to imports are slightly less likely to find reemployment than are workers who are displaced for other reasons. Moreover, the average reemployed worker suffers a 13 percent loss in weekly earnings, though there is large variation around this average. For example, more than a third of those workers displaced from import-competing industries reported that their new incomes were the same as or higher than their predisplacement incomes, while one quarter reported losses in excess of 30 percent.[7] This is an important line of investigation since it helps guide the design of policies that can be used to compensate those who are harmed by globalization. However, as we show in Chapter 5, the very act of compensating workers for their losses (along with funding the compensation schemes) changes worker incentives and therefore impinges on the gains from trade. The partial equilibrium approach of looking only at the *ex post* effect of globalization on affected workers fails to capture these subtle interactions.

GLOBALIZATION AND INCOME DISTRIBUTION: A LABOR-MARKET APPROACH

While populist views have tended to link globalization with job loss, the lion's share of economic research has focused on the relationship between globalization and the wage distribution.[8] This line of inquiry essentially began in 1941 with the publication of a very influential paper by Wolfgang Stolper and Paul Samuelson and really blossomed in the 1990s due to significant changes in the distribution of income that occurred during the 1980s.

After decades during which the relative distribution of income in the United States was fairly stable, the 1980s began a period of widening income inequality.[9] Two other sea changes began to occur during the 1980s. First, personal computing and information technology began to explode. One might expect that this sort of technical progress might raise the productivity of skilled workers who are equipped to handle the new technologies but reduce the productivity of unskilled workers who are ill-equipped to deal with the changes. Second, U.S. trade was substantially liberalized following the Kennedy and Tokyo rounds of GATT negotiations. Furthermore, many low-wage developing countries began to abandon their inward-looking orientation and became significant sources for U.S. imports. Intuitively, competition from these low-wage countries may have put downward pressure on the wages of unskilled U.S. workers.

An extensive literature has developed to try to empirically sort out the separate impacts that globalization and skill-biased technical change have had in changing the income distribution. The purpose of this section is to explain the conceptual framework that underlies the majority of empirical work in this area.

Labor economists were among the first to document the rise in wage and income inequality.[10] Likewise, they were among the first to try to sort out the underlying causal factors. To understand the typical approach, assume that there is a single composite output that can be produced via a constant-returns-to-scale production function using only skilled and unskilled labor. That is, assume

$$(2.1) \quad Y = F(L_s, L_u),$$

where Y represents output and L_s and L_u represent the quantities of skilled and unskilled labor used in production.

In a competitive labor market, cost-minimizing firms will hire each type of worker up to the point where the marginal product of the last worker hired equals the market-given wage for that type of worker. Let

ℓ represent the number of skilled workers employed relative to the number of unskilled workers. Letting w_i represent the wage of a type-i worker and using the assumption of constant returns to scale, the marginal product conditions can be expressed as

$$(2.2a) \quad w_s = f'(\ell)$$

$$(2.2b) \quad w_u = f(\ell) - \ell f'(\ell)$$

where $f(\ell) \equiv F(\ell,1)$. Dividing Equation (2.2a) by (2.2b) yields the demand-side relationship between the relative employment and the relative wage of the two types of labor:

$$(2.3) \quad \frac{w_s}{w_u} = g(\ell)$$

where $g(\ell)$ is the inverse demand curve for skilled relative to unskilled labor. Assuming diminishing marginal products ($f''(\ell) < 0$), the inverse demand curve is negatively sloped.

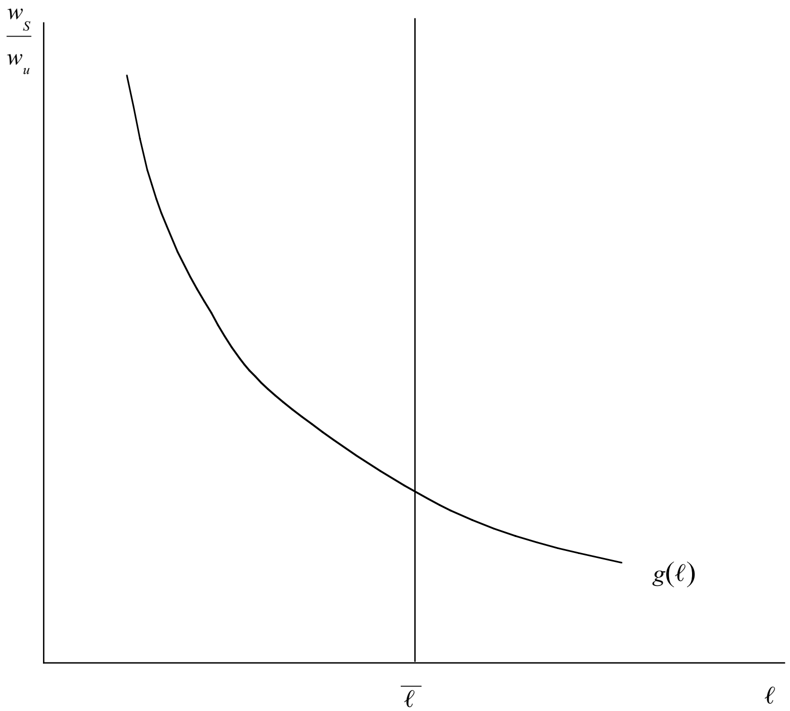
Finally, assume that the supplies of skilled and unskilled labor are both completely inelastic and let $\bar{\ell}$ represent the exogenously specified supply of skilled labor relative to unskilled labor. Equilibrium in the labor market is then simply specified as

$$(2.4) \quad \frac{w_s}{w_u} = g(\bar{\ell}).$$

Equilibrium during the base period is illustrated in Figure 2.1a.

One stylized fact is that the number of skilled workers relative to unskilled workers in the United States has continued to rise during the past two decades, albeit at a slower pace compared with earlier years. For example in 1979, 32 percent of the total U.S. population over age 25 were high school dropouts. Only 16 percent were college graduates with an additional 15 percent having some college experience. By 1999, high school dropouts as a share of the adult population had fallen to only 17 percent, while college graduates accounted for 25 percent of the population, and an additional 25 percent had some college experience.[11] All else equal, this would show up as an increase in $\bar{\ell}$ and a

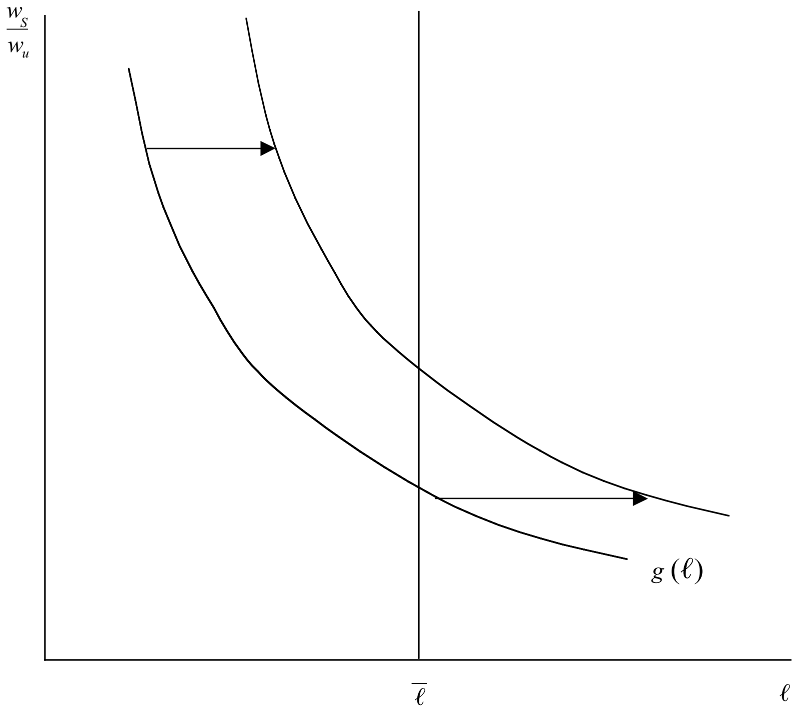
Figure 2.1a Labor-Market Equilibrium (base period)



consequent reduction in the skill premium (the percentage difference between w_s and w_u). However, another stylized fact is that w_s has risen relative to w_u.[12] In 1980 the average annual wage for nonproduction workers in manufacturing was roughly 53 percent higher than the average annual wage for production workers. By 1996, nonproduction workers were out-earning production workers by more than 70 percent.[13] In this simple framework, the skill premium can only increase if the relative demand for skilled versus unskilled labor increases faster than the relative supply. This is illustrated in Figure 2.1b where we have normalized by keeping relative supply constant.

The empirical question is to sort out the factors that may have caused the demand for skilled labor to increase relative to the demand for unskilled labor. As noted above, one hypothesis is that skill-biased technical progress increased the demand for skilled workers relative to

Figure 2.1b Labor-Market Equilibrium after Increased Demand for Skilled Labor



unskilled workers. Formally, this shows up as an increase in both $f(\ell)$ and $f'(\ell)$ for any given value of ℓ. This change clearly shifts the inverse demand curve for labor outward (Figure 2.1b). Substituting $\overline{\ell}$ into Equations (2.2a) and (2.2b), it is clear that the real wage for skilled labor necessarily increases. However, the real wage for unskilled workers can either go up or down, depending on the magnitude of the change in output versus the change in the marginal product of skilled workers.

An alternative hypothesis is that globalization has somehow led to an increase in the demand for skilled labor relative to that for unskilled labor. One way to view this is to consider the amounts of skilled and unskilled labor used to produce exports and imports. We can think of exports as increasing the demand for the inputs embodied in their production, while we can think of imports as reducing the demand for the inputs embodied in their production. The intuition for this story follows from an interpretation of the Hecksher–Ohlin model of trade (discussed below). Namely, because the United States is presumably relatively abundant in skilled labor relative to the rest of the world, we would expect the United States to be a net exporter of goods that intensively use skilled labor and a net importer of goods that intensively use unskilled labor. Globalization would then cause an expansion of sectors that are intensive in the use of skilled labor and a contraction of sectors intensive in the use of unskilled labor. The shift in product mix results in an increase in the demand for skilled labor relative to that for unskilled labor.[14]

A slightly different but formally equivalent approach is to view the factor content of trade as augmenting the domestic factor supplies. If, for example, the United States embodies more skilled labor in exports than in imports, we could subtract the net exports of skilled labor embodied in trade from the domestic endowment of skilled labor. The result could be interpreted as the net supply of skilled labor available to the economy. Likewise, we could add the net imports of unskilled labor to the economy's endowment of unskilled labor to arrive at the net supply of unskilled labor available to the economy. We could then arrive at $\widetilde{\ell}$, the supply of skilled labor relative to unskilled labor that is actually available to the economy. If the United States is a net exporter of skilled labor and a net importer of unskilled labor, then $\widetilde{\ell} < \ell$. This is the equivalent of a leftward shift of the relative labor-supply curve in Figure 2.1a.

The framework set out above can be empirically implemented in one of several ways. First, one might look explicitly for the impact of skill-biased technical progress on relative wages. For example, using annual data on the hourly wages of white males from the Current Population Survey, Jacob Mincer (1993) regressed wage of college graduates relative to that of high school graduates against research and development spending (both private and government) per worker.[15] He found that this variable has good explanatory power, suggesting that higher research and development spending leads to higher relative demand for skilled workers.

Alternatively, one might look for evidence of shifts of workers out of sectors intensive in the use of unskilled workers and into sectors intensive in the use of skilled workers. These shifts can be compared with within-sector changes in relative skill intensity. That is, the changing skill mix of the labor force could either be absorbed by changing the skill mix within sectors, having all sectors become more skill intensive, or by producing more goods that are relatively skill intensive and fewer that are relatively intensive in the use of less skilled labor. Greater between-sector changes imply a role for globalization since this would suggest resources moving out of import-competing sectors and into export sectors, whereas greater within-sector changes imply a greater role for technical progress.[16] This is the approach taken by John Bound and George Johnson (1992), Lawrence Katz and Kevin Murphy (1992), and Eli Berman, John Bound, and Zvi Griliches (1994). All of these authors essentially found that within-sector increases in skill intensity dominate between-sector shifts.

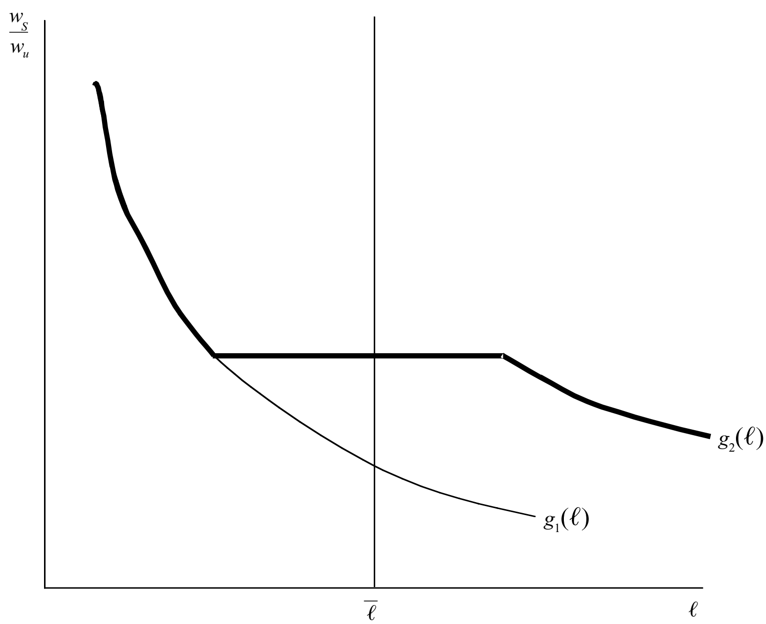
Finally, one could just augment domestic factor endowments by the factor content of trade, make some estimate of the elasticity of relative labor demand, and then calculate the effect that globalization might have on relative wages. This is the approach taken by George Borjas, Richard Freeman, and Lawrence Katz (1992).[17] They concluded that, for the first half of the 1980s, trade and immigration accounted for approximately a two-percentage-point increase in the wage of college graduates relative to the wage of high school graduates.[18]

GLOBALIZATION AND INCOME DISTRIBUTION: A GENERAL-EQUILIBRIUM APPROACH

The labor-market approach described above has been severely criticized by a number of trade economists because it does not allow for the general-equilibrium effects that are at the heart of virtually all models of international trade. To illustrate the complications introduced by general-equilibrium effects, we can change the assumptions of the labor-market model to allow for the production of two goods, rather than a single composite good. Call the goods X_1 and X_2 and assume that each is produced under conditions of constant returns to scale using both skilled and unskilled labor. Now each sector will hire each type of labor up to the point where the marginal product of that type of labor equals its wage. There will now be two sector-specific inverse demand curves for labor. These two curves are shown as $g_1(\ell)$ and $g_2(\ell)$ in Figure 2.2. As drawn, sector 2 is relatively intensive in the use of skilled labor. That is, given any wage ratio, sector 2 will employ more skilled workers per unskilled worker than will sector 1.

The aggregate demand curve for labor is a weighted average of the two sectoral demand curves. However, the weights are not constant. For example, when the wage for skilled workers is very high relative to the wage for unskilled workers, the sector that uses relatively much skilled labor cannot compete and will therefore cease production. In this case, the aggregate demand for labor coincides with $g_1(\ell)$. The reverse is true when unskilled labor is relatively expensive compared with skilled labor (i.e., when w_s/w_u is relatively low). In this instance, the sector that uses relatively much unskilled labor cannot compete and the aggregate demand for labor coincides with $g_2(\ell)$. As we show below, there is a unique relative wage that allows both sectors to produce positive levels of output while earning zero economic profit. The

Figure 2.2 Derivation of General Equilibrium



aggregate labor demand curve is perfectly elastic at this unique relative wage. Changes in relative supplies of the two types of labor cannot change relative wages as long as the relative supply curve continues to intersect the aggregate labor demand curve along its perfectly elastic segment. Alternatively viewed, changes in relative supplies of the two types of labor cannot affect relative wages as long as the labor supply changes do not induce the economy to specialize in the production of just one good.

The invariance of relative wages to relative factor supplies is a version of the celebrated factor-price-equalization theorem in international economics. To gain a deeper understanding of this result (and its weaknesses) requires that we look at the way that product markets drive labor markets.

In a competitive equilibrium, all economic profits are dissipated by the entry of new firms. A product will not be produced if its production would generate economic losses. Given these two limitations, we conclude that economic profits must be zero for all goods that are actually produced. This means that the average cost of production must equal the price of a unit of output. With skilled and unskilled labor being the only inputs in the production process, these conditions can be written as follows:

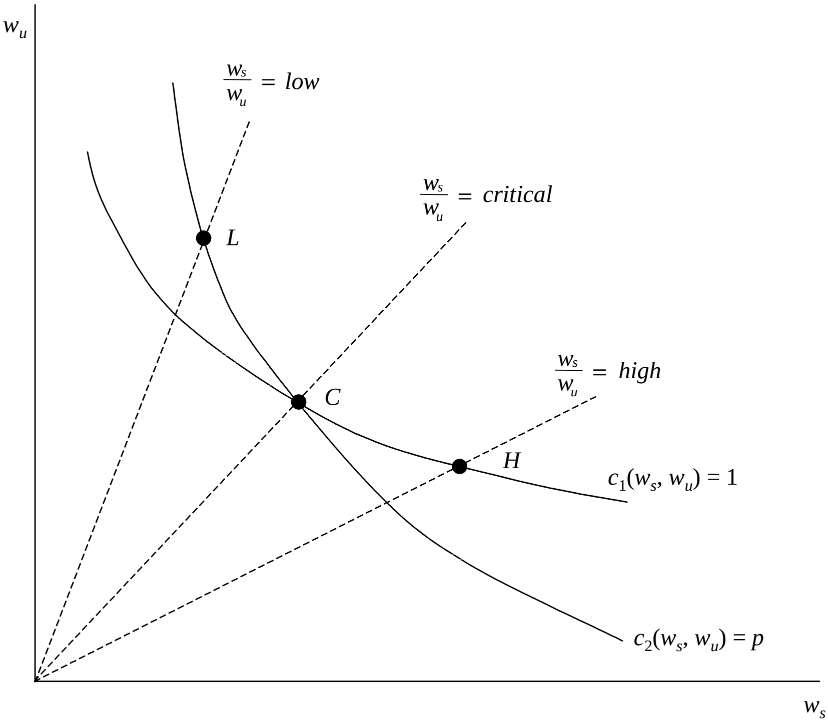
(2.5a) $c_1(w_s,w_u) = 1$

(2.5b) $c_2(w_s,w_u) = p$

where $c_i(w_s,w_u)$ is the average cost of producing good i and where we have chosen X_1 as numeraire. Given some fairly mild assumptions, these two nonlinear equations solve uniquely for w_s and w_u (the ratio of which corresponds to the perfectly elastic portion of the aggregate labor demand curve in Figure 2.2). The solution to this system of equations is illustrated in Figure 2.3, where we graph Equations (2.5a) and (2.5b). The upper contour of the two curves defines the factor price frontier.

When skilled labor is expensive relative to unskilled labor, sector 1 can pay higher wages to both types of labor compared with sector 2 and therefore all workers flow to sector 1 and wages are bid up to correspond to point H in Figure 2.3. A situation like this is illustrated

Figure 2.3 The Factor Price Frontier

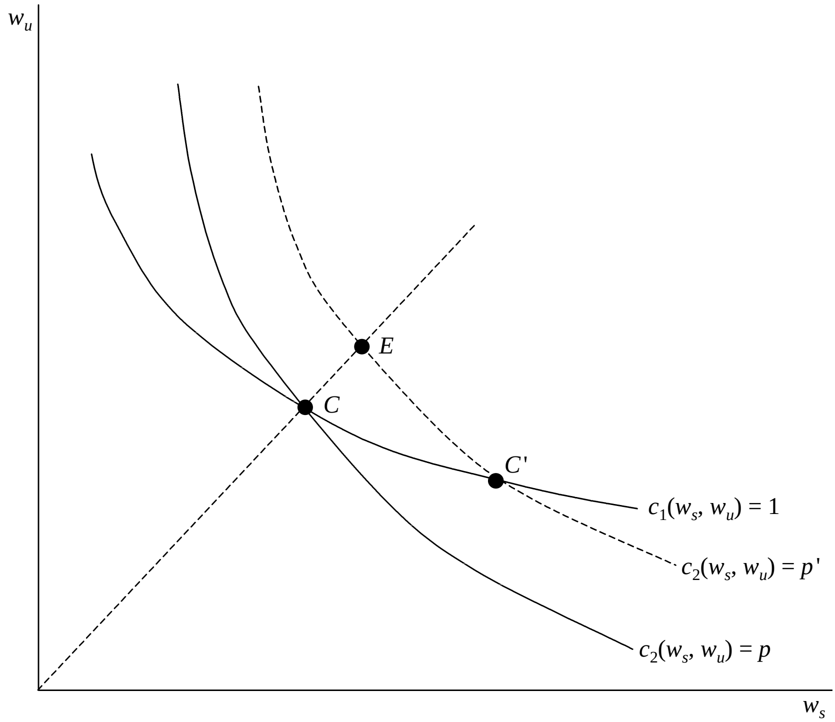


in Figure 2.3 by the ray labeled $w_s/w_u = high$. This is the situation in Figure 2.2 where aggregate labor demand coincides exactly with $g_1(\ell)$. The opposite situation, corresponding to the ray $w_s/w_u = low$, occurs when skilled labor is relatively cheap compared with unskilled labor.[19] Here, sector 2 bids all labor away from sector 1, wages correspond to point L in Figure 2.3, and aggregate labor demand exactly coincides with $g_2(\ell)$ in Figure 2.2. Only when the relative wage is at its critical value can both sectors compete for labor on an equal footing. The solution with diversified production occurs at point C in Figure 2.3. This is the wage at which aggregate labor demand in Figure 2.2 is perfectly elastic.

It can be shown that the absolute value of the slope of each curve in Figure 2.3 is equal to the cost-minimizing ratio of skilled to unskilled labor employed in the given sector for a particular combination of skilled and unskilled wages. Since the zero-profit curve for sector 2 is steeper than that for sector 1, we can conclude that sector 2 is relatively intensive in the use of skilled labor. The configuration of curves in Figure 2.3 is therefore consistent with the implications of Figure 2.2.

Suppose now that the price of the skill-intensive good increases by a certain percentage (e.g., 10 percent). Clearly, the skill-intensive sector could increase the wages of both skilled and unskilled workers by 10 percent and continue to earn zero profit. More generally, the zero-profit curve for the skill-intensive sector moves out from the origin in a radial fashion. Along any ray from the origin, each point on the new zero-profit curve is exactly 10 percent further from the origin than the corresponding point on the original zero-profit curve. The zero-profit curve for the sector intensive in the use of unskilled labor remains unchanged. This situation is characterized in Figure 2.4.

Figure 2.4 The Stolper–Samuelson Effect



Point *E* in Figure 2.4 is 10 percent further away from the origin than point *C*. If both wages were to rise by 10 percent (as at point *E*), both types of workers would be better off since real wages measured in terms of the skill-intensive good would not have changed, whereas real wages measured in terms of the good intensive in the use of unskilled labor will have risen. However, the new equilibrium wages are not represented by point *E*; rather, they are represented by point C'. The wage for skilled labor is actually higher at C' than it is at *E*. Therefore, the real wage for skilled labor (measured in terms of either good) is higher in the new equilibrium compared with the initial equilibrium. Concurrently, the wage for unskilled labor actually falls relative to the price of either good. In terms of Figure 2.2, an increase in the relative price of the skill-intensive good causes the perfectly elastic portion of the aggregate relative demand curve to shift upward. Wolfgang Stolper and Paul Samuelson (1941) were the first researchers to discover the basic result that an increase in the price of the skill-intensive good relative to the good intensive in the use of unskilled labor results in higher real wages for skilled labor and lower real wages for unskilled labor.[20]

The most important aspect of the Stolper–Samuelson Theorem is that it relates changes in input prices to changes in output prices. In particular, holding technology constant, the only way that relative wages can change is if relative output prices change. In particular, the only way for skilled labor to benefit relative to unskilled labor is for the price of the skill-intensive good to increase relative to the price of the good intensive in the use of unskilled labor. This is one of the central points made by Robert Lawrence and Matthew Slaughter (1993), who found no evidence of a significant change in relative output prices during the 1980s. Subsequent research using different methodologies has found at least some evidence of increases in the price of skill-intensive goods, though the causal link with international trade has yet to be established.[21]

One of the clear implications of the Stolper–Samuelson Theorem is that (as long as the economy remains diversified in production) relative wages are independent of changes in factor supplies or factor demands unless such changes either cause changes in output prices or are themselves caused by changes in output prices. That is, the aggregate demand for labor is perfectly elastic at a relative wage that is determined by relative output prices.

To see how it can be possible for relative factor prices to remain unchanged in the face of changing factor supplies, we need to turn our attention to the forces that determine the size of one sector relative to the other. Assume, as is usually done, that both types of labor are always fully employed. Let L_{ij} represent the total amount of type-*i* labor used to produce good *j*. The full-employment conditions can then be written as:

(2.6a) $L_{s1} + L_{s2} = L_s$

(2.6b) $L_{u1} + L_{u2} = L_u$.

Dividing Equation (2.6a) by (2.6b) and rearranging terms yields the following equation that represents full employment for both types of labor simultaneously:

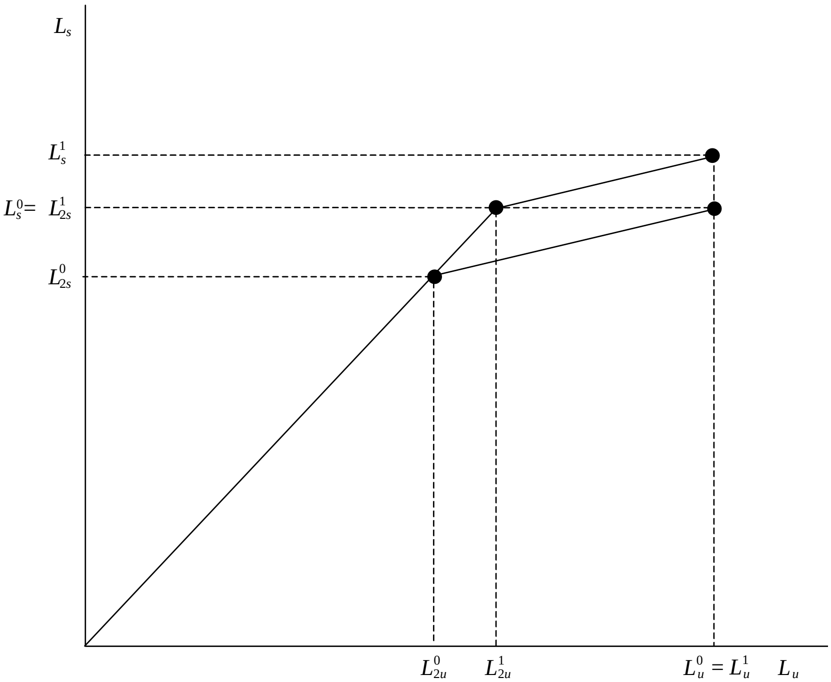
(2.7) $\lambda_{u1}\ell_1 + (1 - \lambda_{u1})\ell_2 = \ell$

where λ_{u1} represents the economy-wide share of unskilled labor devoted to the production of X_1, and where ℓ_j is the ratio of skilled to unskilled labor employed in the production of X_j.

The relative skill intensities used in each sector are determined by relative wages. In turn, relative wages are determined by relative output prices. Barring changes in technology, ℓ_1 and ℓ_2 will not change as long as relative output prices are unchanged. Suppose that the economy's supply of skilled labor increases relative to its supply of unskilled labor (i.e., suppose that ℓ increases). The increased supply of skilled labor is absorbed (at unchanged relative wages) by shifting more of the economy's resources to the production of the good relatively intensive in the use of skilled labor. Assuming, as we have, that $\ell_2 > \ell_1$, this means that λ_{u1} decreases. Less unskilled labor is devoted to the production of X_1. Of course, it is also true that skilled labor shifts out of the production of X_1 and into the production of X_2. This is how ℓ_1 and ℓ_2 remain constant.

We illustrate the geometric representation of this result in Figure 2.5, where the superscript "0" refers to an initial situation and "1" refers to the situation subsequent to the change in endowment. In this figure, we show what happens to resource allocation when the supply of skilled labor is increased holding constant the supply of unskilled labor. The ray emanating from the origin lengthens by the dashed amount, representing the increased labor flowing to sector 2. To save clutter in the diagram, we have drawn it in such a way that the total amount of skilled labor devoted to the production of X_2 after the change in factor supplies just equals the total amount of skilled labor in the economy before the change in factor supplies. Since more unskilled labor is also used in the production of X_2, and since there is no increase in the endowment of unskilled labor, the total amount of unskilled labor used in the production of X_1 actually falls. Given this reallocation of labor and given constant technology, it is evident that X_2 increases while X_1 falls.

Figure 2.5 Full-Employment Distribution of Workers across Sectors

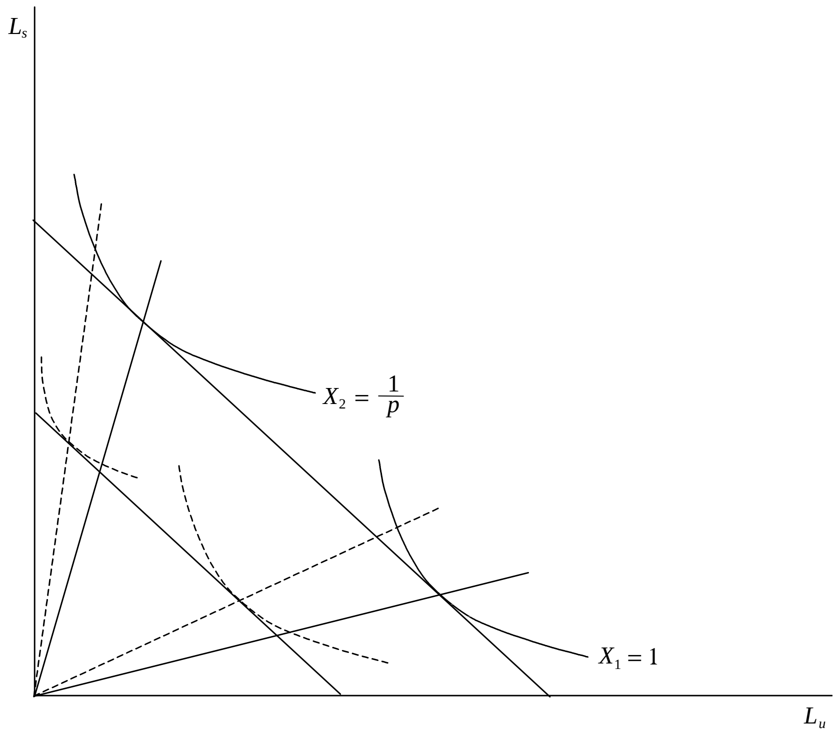


THE GENERAL-EQUILIBRIUM EFFECTS OF TECHNICAL PROGRESS

As discussed earlier, numerous researchers have hypothesized that skill-biased technical progress has been at the root of the changing income distribution. By increasing the demand for skilled labor within each sector, the wage of skilled workers increases relative to that of unskilled workers. However, it has been argued that in a general-equilibrium framework, the variance of technical progress across sectors, not across inputs, is the driving force behind changes in the income distribution. We illustrate this argument with the aid of the Lerner–Pierce diagram in Figure 2.6.[22]

For now, ignore the isoquants that are represented by dashed lines. The two solid-line isoquants represent the amount of inputs required in

Figure 2.6 Skill-Biased Technical Progress and Relative Wages



each sector to produce a "dollar's worth" of output. Since X_1 is numeraire, this means that the isoquants correspond to quantities $X_1 = 1$ and $X_2 = 1/p$. The line tangent to these two isoquants is the graph of the isocost equation:

$$w_s L_s + w_u L_u = 1. \tag{2.8}$$

The slope of this curve is obviously $-w_u/w_s$.

Cost minimization implies that the optimal mix of inputs for each sector is determined by the tangency of the isocost line with the respective isoquant. Zero profit derives from the fact that "one dollar's worth" of inputs are used to produce "one dollar's worth" of output.

Technical progress within a sector means that the same amount of output can be produced with less input. Progress that is biased in favor of skilled labor means that, holding relative wages constant, the sector employs a higher ratio of skilled to unskilled labor. As drawn, both sectors exhibit technical progress. That is, the dashed isoquants are both closer to the origin than the solid isoquants. More importantly, equilibrium relative wages (represented by the slope of the isocost line that is tangent to both unit-value isoquants) are unchanged. Also as drawn, the technical progress is skill-biased in both sectors.

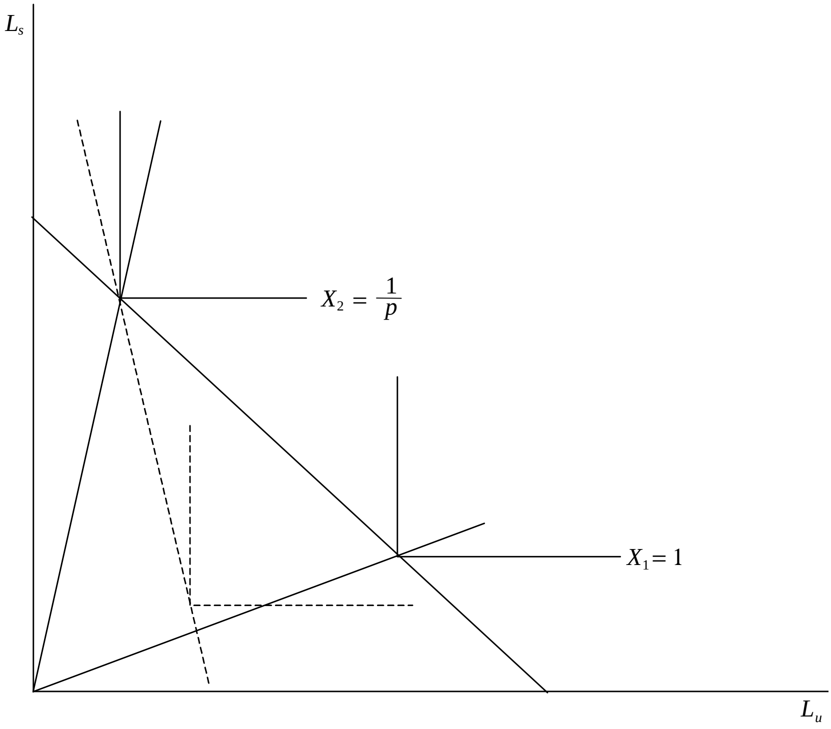
Analysis of Figure 2.6 shows that skill-biased technical progress need not lead to higher relative wages for skilled labor. If technical progress had been slightly greater in the skill-intensive sector (i.e., if the dashed isoquant for $X_2 = 1/p$ were closer to the origin), then the isocost line would have to flatten out to be tangent to the dashed isoquants in both sectors. In this case, the unskilled wage would have to fall relative to the skilled wage. However, the opposite would be true if technical progress in the other sector had been just a little greater. That is, it could be possible that the skilled wage might fall relative to the unskilled wage. Furthermore, these possibilities do not depend on the degree to which technical progress is skill biased. Indeed, the same results are obtained even if the technical progress is biased in favor of unskilled labor.

Paul Krugman (2000) took exception to this analysis of technical progress because it relies on the assumption that product prices are held constant. He argued that the United States is not a price taker in world markets, and technical progress can therefore change relative output prices. In any event, the developed countries as a whole are certainly not price takers, and there is reason to argue that skill-biased technical progress has occurred simultaneously throughout this group of countries.[23]

Krugman's argument is by example and it goes as follows. Suppose for simplicity that technology is characterized by fixed coefficients so that the relative skill intensity used within each sector is independent of factor prices. Suppose, as illustrated in Figure 2.7a, that there is skill-biased technical progress in the production of X_1 only. With constant output prices this would necessarily imply an increase in the wage of unskilled workers relative to the wage of skilled workers. This is demonstrated in Figure 2.7a.

In terms of Equation (2.7), ℓ_1 increased while ℓ_2 and ℓ remain unchanged. Full employment necessitates a shift of resources in favor

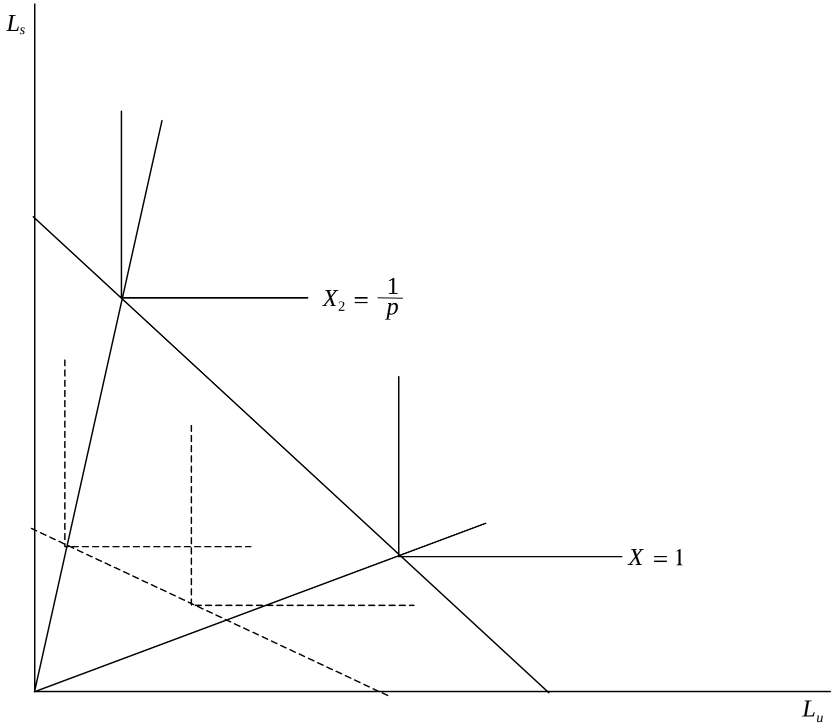
Figure 2.7a Skill-Biased Technical Progress in Only One Sector (holding *p* constant)



of the least skill-intensive sector. In this case, more resources go into the production of the good intensive in the use of unskilled labor. With no technological change in the production of the skill-intensive good and an outward flow of resources from this sector, we can be sure that the output of this good falls. Technical progress in the other sector combined with an inflow of resources guarantees that the production of the good intensive in the use of unskilled labor increases. The combined effect is to place upward pressure on the price of the skill-intensive good. If the resulting price change is sufficiently large, the wage of skilled labor relative to that of unskilled labor may actually rise. This is the case illustrated in Figure 2.7b.

The possibility illustrated by Krugman does not depend on the fixed-coefficients assumption. However, it does depend on the degree

Figure 2.7b Skill-Biased Technical Progress in Only One Sector (allowing *p* to increase)



of substitutability of skilled for unskilled labor combined with the demand elasticities of the two goods. In the end, the effect of skill-biased technical progress on output prices is an empirical question.[24]

GLOBALIZATION AND THE FACTOR CONTENT OF TRADE

As discussed earlier in this chapter, several studies have used the amounts of skilled and unskilled labor embodied in trade as a measure of globalization and therefore as an indicator of the effect of globalization on relative wages. The United States has had trade deficits for more than 20 years. As such, the United States has been a net importer of both skilled and unskilled labor. However, U.S. imports of skilled labor relative to its native endowment of skilled labor are smaller than its imports of unskilled labor relative to its native endowment of unskilled labor. Therefore, if one were to add net imports of factors to native endowments, the result would show a lower ratio of skilled to unskilled labor "availability" compared with the native ratio of endowments. Presumably, the change in the ratio of skilled to unskilled labor causes the wage of skilled workers to rise relative to that of unskilled workers.

The logic underlying this sort of analysis is faulty for at least two reasons. First, as we have already seen, changes in relative labor supplies cannot affect relative wages unless the economy is specialized in production or unless the change in input supplies affects output prices. Perhaps more importantly, the factor content of trade is not a reliable index of globalization.

To see why the factor content of trade is not an indicator of the degree of globalization, define L_s^c as the amount of skilled labor embodied in the aggregate consumption basket and L_u^c as the amount of unskilled labor embodied in the aggregate consumption basket. The budget constraint for this economy is then

$$w_s L_s^c + w_u L_c^u = Y + B \quad (2.9)$$

where Y is national income (equal to the value of the economy's endowment of the two types of labor) and where B is the trade deficit.

Define α as the ratio of skilled to unskilled labor embodied in the aggregate consumption basket.[25] We can then rewrite the budget constraint as

$$\text{(2.10)} \quad \alpha w_s L_u^c + w_u L_u^c = Y + B.$$

We can now rearrange terms to solve for the amount of each type of labor embodied in the aggregate consumption basket:

$$\text{(2.11a)} \quad L_u^c = \frac{Y+B}{\alpha w_s + w_u}$$

$$\text{(2.11b)} \quad L_s^c = \frac{\alpha(Y+B)}{\alpha w_s + w_u}$$

Finally, note that the net import of type *i* labor embodied in trade is simply the difference $L_i^c - L_i$.

From Equations (2.11a) and (2.11b), it is clear that the amount of labor embodied in consumption (and by implication, the amount embodied in trade) can vary for numerous reasons. For example, an increase in the trade deficit or an increase in income will both yield higher net imports of the two types of labor.[26] Importantly, changes in wages can cause changes in the factor content of trade. Since technical progress can change relative wages, changes in the factor content of trade *may* reflect technical progress.

Consider changes in α. Many trade models assume that preferences are homothetic and identical across countries. This means that the consumption bundle for each country is proportional to the world consumption bundle, and the factor of proportionality is just the given country's aggregate consumption as a fraction of world consumption. Combined with the fact that all labor is fully employed, this implies that the amounts of the two types of labor contained in each country's consumption bundle are just proportional to the world supplies of the two types of labor. Again, the factor of proportionality is the given country's consumption as a fraction of world consumption. So, if globalization means bringing previously closed economies into the global trading regime, and if these countries are relatively abundant in unskilled labor, then the consumption mix for every country that had been actively trading prior to the new entrant will contain relatively more unskilled labor. That is, α will fall. The mechanism by which this happens is that goods intensive in the use of unskilled labor become relatively cheaper, inducing countries to switch consumption toward these goods. But, the change in relative prices also has a Stolper–Samuelson effect. Therefore, the implied change in the labor content of trade is associated with a change in relative wages. This is the point that Krugman (2000) makes when he argued that those who use the labor content of trade as an indicator of the effects of trade on relative wages are justified in doing so.

Our point here is to emphasize that the labor content of trade, output prices, and wages are all endogenous. Arguments that relative price changes provide the only credible evidence of the effect of globalization on income distribution are misleading for the same reason that changes in the labor content of trade cannot be said to "cause" changes in the income distribution. Both relative prices and the factor content of trade can change due to either technical progress or greater globalization.

SUMMARY

Questions regarding the interplay of globalization and factor markets are not new. High rates of unemployment and a dramatic increase in the wage differential between skilled and unskilled workers, combined with a surge in imports from low-wage countries, have led to renewed interest in these issues. While there is a widespread popular belief that globalization leads to job loss, the bulk of serious economic research has focused on the role that globalization has played vis-à-vis the change in the distribution of income. While some labor economists have tried to measure the losses incurred by workers displaced due to trade, most have examined the effects of globalization at a more aggregate level.[27] However, this literature tends to ignore general-equilibrium considerations around which all models of trade are based. By contrast, the research undertaken by most trade economists leaves no room to consider the potential for job loss, since this research is firmly grounded in models that assume full employment and instantaneous adjustment to economic shocks.

Our objective in this monograph is to use rigorously specified general-equilibrium models to investigate how the structure of the labor market affects the manner in which globalization alters the welfare of workers. The labor-market structures that we consider include the market imperfections that give rise to equilibrium unemployment. This allows us to explore the relationship between trade, wages, income distribution, and unemployment in a setting that is more realistic than the benchmark trade models that have been used in the past. In addition, as we show in Chapter 5, our main model is rich enough that it can be used to address a whole host of policy issues concerning the appropriate manner to compensate those who are adversely affected by trade liberalization—especially those at the low end of the income distribution.

Notes

1. Henceforth we shall use the term "globalization" to refer to the expansion of trading opportunities.
2. Indeed, this latter literature now consists of scores of contributions and its comprehensive review would require a separate monograph.
3. *Investor's Business Daily/Christian Science Monitor* poll conducted by TIPP, the polling arm of TechnoMetrica Market Intelligence. $N = 906$ adults nationwide. The margin of error is plus or minus 3.3 percent.
4. Having examined more than 60 years' worth of polling data covering in excess of 500 questions, Scheve and Slaughter (2001) similarly found that there is a strong general belief among the public that trade is linked to employment opportunities.
5. More precisely, they estimated the number of at-risk workers to be 5,988,200.
6. These data are available from the NBER trade database (for 1993) and the United States International Trade Commission (for 2000).
7. See Kletzer (2001) and Kletzer and Litan (2001). The latter assert that Steve Hipple at the Bureau of Labor Statistics has found that younger workers (aged 25–34) who are displaced actually find themselves with 5.5 percent *higher* earnings after reemployment.
8. More recently, several researchers have begun to examine the impact of globalization on other aspects of the labor market. For example, Slaughter (2001) argued that increased foreign competition in product markets can theoretically cause increased elasticities of demand for labor. As we show below, the aggregate demand for labor is infinitely elastic in the standard general-equilibrium model of perfectly competitive output markets, but allowing for imperfectly competitive output markets can result in finite labor-demand elasticities. In his work, Slaughter found evidence that the U.S. elasticity of demand for production workers in

several manufacturing sectors increased between 1961 and 1991, while the elasticity of demand for nonproduction workers may have actually become somewhat less elastic. In any event, Slaughter's analysis seems to conclude that globalization had very little effect on the changes in these elasticities. Krishna, Mitra, and Chinoy (2001) conducted a similar study of Turkish manufacturing and also failed to find any empirical support linking greater openness to trade and the elasticity of labor demand. Focusing on imperfections in the labor market, Gaston and Trefler (1995) modeled increased foreign competition with endogenous protection when the labor market is unionized. The theoretical effect of increased competition on union wages is ambiguous, since the union bargains for both wages and employment. Their empirical work based on U.S. data shows that imports and tariffs are negatively correlated with wages, and the degree of influence is relatively large. Similarly, Brown and Sessions (2001) found that, for a sample of British workers, international competition negatively affects the wage (but not employment) of unionized workers, whereas greater competition negatively impinges on employment (but not wages) of non-unionized workers. Pizer (2000) argued that the theoretical prediction depends on the form of industry competition (quantity competition versus price competition), and his empirical results show that there is a positive relationship between import competition and union wages in industries that are not capacity constrained.

9. William Cline (1997) provided a detailed survey of the literature documenting this change in income distribution.
10. For example, see Juhn, Murphy, and Pierce (1993).
11. See Table 4.1 in Scheve and Slaughter (2001).
12. In fact, in real terms, w_u has actually fallen.
13. We used the NBER–CES Manufacturing Industry Database to calculate these ratios. Nonproduction workers are frequently viewed as "skilled" workers (accountants, managers, and so on), while production workers are viewed as "unskilled." Clearly, this distinction leaves something to be desired, since nonproduction workers can also include mailroom clerks, custodians, and others, while production workers can include workers trained to operate highly complex equipment. Despite this ambiguity, a large body of literature continues to make this operational distinction between skilled and unskilled.
14. Since Y is defined as a composite commodity in this simple model, the interpretation of this story is simply that the production of Y becomes more intensive in the use of skilled labor at every set of relative wages.
15. The actual dependent variable used by Mincer is the average logarithm of the wage rate of a college graduate minus the average logarithm of the wage rate of a high school graduate.
16. Feenstra and Hanson (1996a) argued that skill-upgrading within sectors can also be consistent with greater globalization if firms respond to import competition by fragmenting their production process and outsourcing those parts of the process that are intensive in the use of unskilled labor. They marshaled some empirical support for their theory in Feenstra and Hanson (1996b)

17. These authors also augment domestic labor supplies by including the supply of immigrant labor.
18. The total increase over this period was approximately 11 percent.
19. This does not mean that the wage for skilled labor is less than that for unskilled labor. Rather, it simply means that the wage for skilled labor is not extremely large relative to the wage for unskilled labor.
20. Stolper and Samuelson called the two inputs capital and labor, but this is only a semantic difference.
21. See Sachs and Shatz (1994), Krueger (1997), Leamer (1998), and Baldwin and Cain (2000). Slaughter (2000) surveyed the findings of these and related papers.
22. This graph is the dual to the factor-price frontier illustrated in Figures 2.3 and 2.4.
23. Indeed, Eli Berman, John Bound, and Stephen Machin (1998) provided evidence that skill-biased technical change has been pervasive, occurring in almost all developed countries during the past 20 years.
24. More recently, Xu (2001) expanded the Krugman model to allow for more general specifications of preferences and asymmetries in the degree of technical progress in the two countries. One of Xu's important findings is that the sector in which technical progress is most pronounced matters when technical progress occurs at different rates in the two countries.
25. This ratio need not be a constant. It may be a well-defined function of other variables (for example, the price of the skill-intensive good relative to the other good) or it may fluctuate randomly.
26. Changes in income result from changes in labor endowments or from changes in wages.
27. For example, see Kletzer (2001).

3
Some Simple Models of Trade and Unemployment

Our goal in this chapter is to introduce some simple general-equilibrium models of trade that include an equilibrium rate of unemployment. As we pointed out in the introduction, over the last 30 years economists have introduced a whole host of micro-based models of unemployment. These models are similar in that they all include careful modeling of the informational asymmetries, uncertainty, transaction costs, and/or market failures that can generate equilibrium unemployment. However, they differ in the type of market failure that they emphasize as the primary source of unemployment. For example, while the search theory approach emphasizes the transaction costs encountered by unemployed workers and firms with vacancies that seek each other out, the efficiency wage approach emphasizes the problems caused by the informational asymmetries that arise when firms cannot directly monitor worker effort.

In developing our models, we have several goals in mind. First, we want to keep the models simple and tractable in order to show that extending the standard analysis of trade issues to settings with unemployment can be done in a manageable manner. Second, we want to make our models rich enough to capture several important features of the labor market and to allow for nontrivial policy analysis. To be precise, we want our models to be general enough to allow for cross-country differences in the structure of the labor market. We also want to allow for differences in workers in terms of their innate abilities, differences in jobs in terms of the skills required to complete the necessary tasks, and differences in sectors in terms of labor-market turnover rates. This last feature will allow us to analyze the efficacy of different labor-market policies aimed at helping the poor in different labor-market settings. Finally, we want our models to be set up in a manner that allows for empirical verification of their predictions. This means that many of the key parameters of the models must be observable.

We are able to achieve these objectives by using models that are based on the search theory approach to unemployment. The reasons that we have chosen to follow this path are laid out later in this chapter in some detail. At this point, however, it is useful to point out that, although our models are based on search theory, they are largely consistent with many of the other modern approaches to modeling unemployment. The reason for this is that the key parameters of our model—the labor-market turnover rates—also show up as key parameters in most (if not all) of the other approaches. We drive home this point by offering alternative versions of our model that are based on the efficiency wage approach in order to show that the qualitative features of many of our results are quite general.

We begin with a particularly simple model of the labor market in which all workers are alike and jobs differ only in the turnover rates associated with each sector in the economy. This allows us to highlight the important roles that turnover rates can play in trade-related issues. We then show how the model can be adapted to be consistent with different labor-market structures in order to demonstrate that this structure can play an important role in determining the pattern of trade as well as the link between trade and the distribution of income. In Chapter 5, when we turn to policy analysis, we enrich the model by allowing for heterogeneity in labor and job skills.

TURNOVER RATES AND THE PATTERN OF TRADE

A Simple Model of Search with Homogeneous Workers

As we emphasized above, our overall goal is to develop a model of international trade that includes an equilibrium rate of unemployment, jobs that require different skills and training, and a heterogeneous workforce. We also want to develop a framework that is flexible enough to allow us to compare labor markets with different structures. What we have in mind is an economy in which workers with differing abilities must choose between two types of jobs—those that do not require many skills and therefore offer low pay, and those that require significant training and pay relatively high wages. Jobs in the low-skill sector are easy to find but do not last very long (there is high turnover). High-skill jobs are relatively hard to find, because the problem of matching workers and firms is harder to solve, but last longer once the firm and worker meet. The different labor-market structures can be captured by making different assumptions about the turnover rates, the wage determination process, and the public assistance available to workers who are unemployed, poor, or going through the training process.

We begin by introducing a very basic model of search-generated unemployment in which all workers are alike. We do so in order to highlight the role that labor-market turnover rates can play in trade-related issues. Thus, initially we ignore the issues of skill acquisition, training, and heterogeneity among the workforce. Later, in Chapter 5, we extend the model in order to consider these issues explicitly.

We assume that workers must make an occupational choice on entering the labor force. They can seek employment either in the sector with low wages in which jobs are plentiful or in the sector with relatively high pay in which jobs are scarce. To keep the model tractable, we assume that jobs in the low-wage sector (sector 1) can be found immediately while it takes time to find jobs in the high-wage sector (sector 2). Employed workers are free to quit at any time to search for a job in the other sector, although we do not allow for on-the-job search.

For simplicity, we begin by assuming that labor is the only factor of production. In the low-wage sector, if L_1 workers are employed, then output (X_1) is given by the production function

$$(3.1) \quad X_1 = \sqrt{L_1}$$

so that diminishing returns to labor are present.[1] In the high-wage sector, each employed worker produces exactly one unit of output. Thus, if we use L_E to denote employment in sector 2 and X_2 to represent sector 2 output, we have

$$(3.2) \quad X_2 = L_E.$$

Employment in each sector is determined by supply and demand. The demand side comes from profit-maximizing behavior on the part of firms, while the number of workers seeking employment in each sector dictates supply. Low-wage firms hire workers such that the real wage is equal to the marginal product of labor. If we use the sector 1 good as the numeraire and let w_1 denote the sector 1 wage, the production function in Equation (3.1) implies that the demand for labor in sector 1 is given by

$$(3.3) \quad L_1 = \frac{1}{4w_1^2}.$$

In sector 2, we assume that price competition between the firms drives profits to zero, so that all of the revenue goes to labor (the sole factor of production). Thus, the sector 2 wage is equal to P, the price of the output produced in sector 2. This also implies that in equilibrium firms will be indifferent as to the number of workers they hire since each level of employment generates the same level of profit (zero). Employment in sector 2 is therefore completely determined by the supply side.

The number of workers seeking employment in each sector depends on the lifetime rewards offered by each type of job. In sector 1, each job pays w_1 and jobs can be found immediately so that sector 1 workers are never unemployed. If we let V_1 denote the expected lifetime income that can be earned by working in sector 1, use r to denote the interest rate, and allow θ to represent each worker's share of the profits earned by the sector 1 firms (we assume that all workers earn the same share of sector 1 profits, regardless of where they are employed), then a worker who takes a job in sector 1 can expect to earn

$$(3.4) \quad V_1 = (w_1 + \theta)/r$$

over his or her infinite lifetime.

In deciding whether to take a low-paying job in sector 1, the worker must compare V_1 with what she can expect to earn if she seeks higher paying employment in sector 2. We use e to denote the flow rate into sector 2 employment and b to represent the flow rate from employment to unemployment (i.e., e is the rate at which jobs are created and b is the rate at which jobs break-up). These rates can be used to calculate V_E, the expected lifetime income for a worker who is currently employed in sector 2, and V_U, the expected lifetime income for an unemployed worker who has chosen to search for a job in sector 2. Each of these values is defined by an asset value equation in which the product of the discount rate (r) and expected lifetime income is equal to the sum of current income and the capital gain (or loss) of changing employment status weighted by the rate at which those capital gains (or losses) occur. For example, for an employed worker, current income is $P + \theta$, the rate at which jobs are lost is b, and the capital loss associated with becoming unemployed is $V_U - V_E$. For the unemployed, current income is only θ, the job finding rate is e, and the capital gain from finding a job is $V_E - V_U$. This leaves us with the following asset value equations:

$$(3.5) \quad rV_E = P + \theta + b(V_U - V_E)$$

$$(3.6) \quad rV_U = \theta + e(V_E - V_U).$$

We can solve Equations (3.5) and (3.6) for the two unknowns to obtain

$$(3.7) \quad rV_E = \theta + \frac{(r + e)P}{r + b + e}$$

$$(3.8) \quad rV_U = \theta + \frac{eP}{r + b + e}.$$

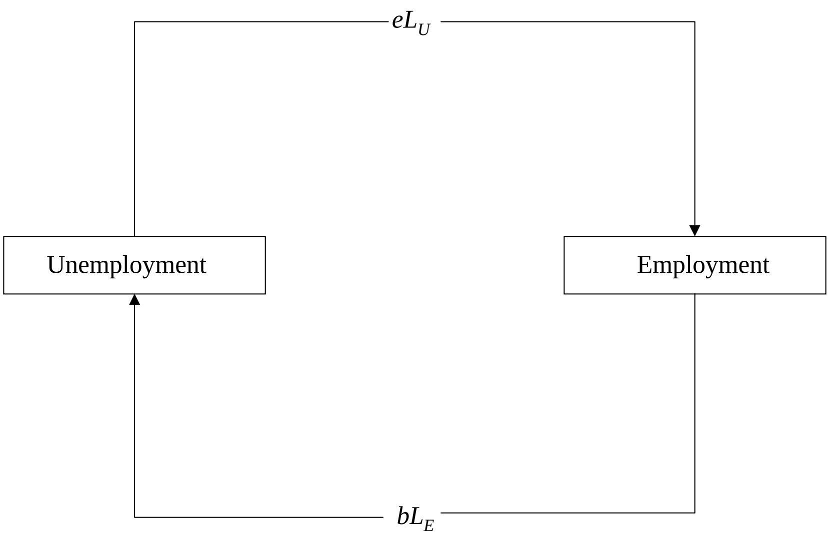
Equations (3.7) and (3.8) are easy to interpret. Each sector 2 worker earns a share of the sector 1 profits (θ) regardless of employment status and earns P while employed. In addition, a sector 2 worker can expect to spend the fraction $e/(b+e)$ of her life employed and the remainder, $b/(b+e)$, unemployed and searching for a job. The interest rate (r) shows up in these equations to take into account the fact that a currently employed worker is already earning P while someone who is unemployed must seek out a job and will not earn P until the future when a job is secured.

An unemployed worker will choose to take a low-paying sector 1 job if $V_1 > V_U$, and she will choose to search for a higher paying sector 2 job if $V_U > V_1$. Thus, in a steady state equilibrium, if both goods are to be produced, it must be the case that $V_U = V_1$. This implies that in equilibrium no worker currently employed in sector 2 will choose to quit and take a job in sector 1 (since $V_E > V_U = V_1$), while those employed in sector 1 will have no reason to quit and search for a job in sector 2. However, policy changes that disturb equilibrium may result in workers quitting if one sector suddenly becomes more attractive.

To close the model, we must explain how sector 1 profits are determined and derive the steady state conditions that ensure that employment does not change over time. As for profits, total revenue in sector 1 is given by X_1 (since $P_1 = 1$, by definition) and total costs are $w_1L_1 = 0.5\sqrt{L_1} = 0.5X_1$ (from Equations 3.1 and 3.3). Thus, aggregate profits are equal to $0.5X_1$ and each agent's share is equal to $\theta = 0.5\ (X_1/L)$ where L is the total number of workers in the economy.

The dynamics of the search sector can be understood with the aid of Figure 3.1. There are two labor-market states in sector 2—employment and unemployment. Let L_U denote the equilibrium number of unemployed workers searching for a job and use L_E to denote equilibrium employment in the search sector. Then, since b is the rate at which jobs break up, at each instant there are bL_E employed workers who lose their jobs (move from employment to unemployment). At the same time, since e is the job-finding rate, there are eL_U unemployed workers who find new jobs (move from unemployment to employment). In equilibrium, total employment and unemployment must re-

Figure 3.1 Labor-Market Dynamics in the Search Sector



main constant over time. Therefore, in equilibrium it must be the case that

$$bL_E = eL_U. \tag{3.9}$$

This completes the description of our model. It is extremely simple by design so that we may focus attention on how the turnover rates, *e* and *b*, influence the equilibrium and affect trade patterns. The autarkic equilibrium price can be solved by finding the intersection of the economy's relative supply and demand curves. The pattern of trade then depends upon how this autarkic price compares to the world price.

The relative supply curve shows the value of X_2/X_1 that is consistent with a supply-side equilibrium in this economy. It can be solved for by using the two equilibrium conditions defined above. The first condition states that, for both goods to be produced, unemployed workers must be indifferent between accepting a job in the low-wage sector and searching for a job in the high-wage sector ($V_1 = V_U$). If this condition does not hold, all unemployed workers would flow to one sector and output in the other sector would shrink to zero. Using Equations (3.1), (3.3), (3.4), and (3.8), it is straightforward to show that $V_1 = V_U$ when

$$X_1 = \frac{r + b + e}{2eP}. \tag{3.10}$$

The second equilibrium condition is Equation (3.9), which guarantees that the flow into employment equals the flow out of employment so that over time the unemployment rate remains constant. Using Equations (3.1), (3.2), (3.9) and the identity which states that each worker must either be employed in one of the sectors or searching in sector 2 (i.e., $L = L_1 + L_E + L_U$), we can show that

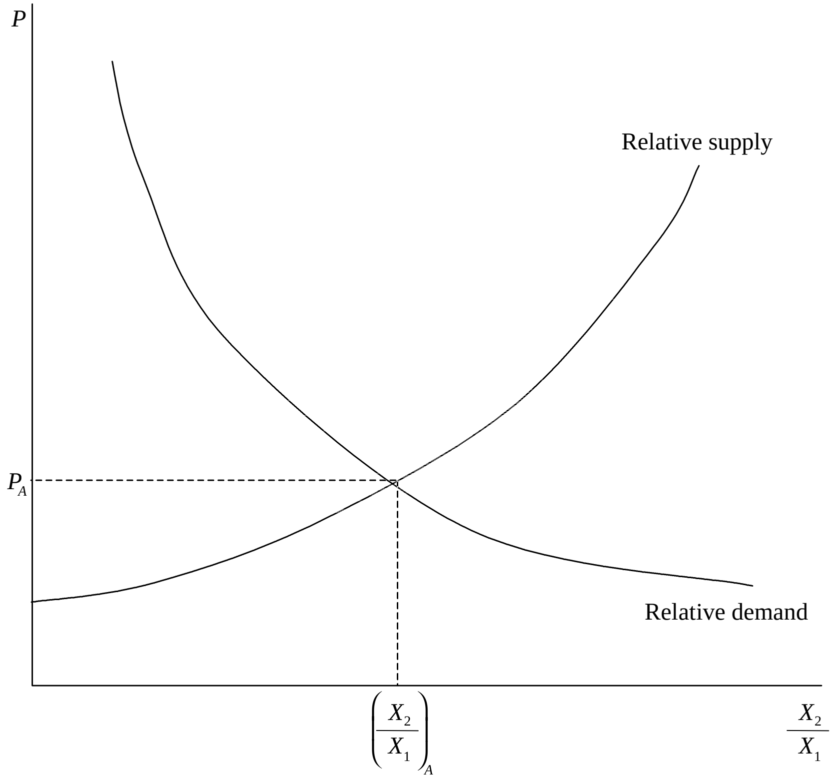
$$X_2 = \frac{e}{b + e}\{L - (X_1)^2\}. \tag{3.11}$$

From Equation (3.10), it is clear that an increase in *P* will result in a reduction in X_1. Moreover, Equation (3.11) indicates that this fall in X_1 causes X_2 to rise. Thus, as the price of the good produced in sector

2 rises, the supply side of the economy responds by increasing its production of the good produced in that sector and reducing the production of the other good. As a result, X_2/X_1 is increasing in P, which means that the relative supply curve is upward sloping (see Figure 3.2). Intuitively, as P rises, the search sector becomes more attractive. This induces workers in sector 1 to quit (causing X_1 to fall) and search for higher-paying jobs in sector 2 (causing X_2 to rise). The intersection of this upward-sloping relative supply curve with the economy's downward-sloping relative demand curve yields the equilibrium autarkic price, P_A.

If the world price of good 2 exceeds P_A, then this country exports good 2 and imports good 1. If the world price of good 2 is lower than P_A, then this country exports good 1 and imports good 2. Thus, all else

Figure 3.2 Autarkic Equilibrium



equal, any factor that lowers P_A makes it more likely that this country will export the good produced in the search sector.

Suppose, then, that we have two countries that are engaged in free trade with one another. Suppose further that these two countries are identical in all respects except for the structure of the labor market in the high-wage sector. Then the pattern of trade is completely determined by the differences in the turnover rates in that sector. Our first two propositions establish the formal link between these labor-market parameters and the pattern of trade.

Proposition 1: The country with the more efficient search technology (higher e) has a comparative advantage in the good produced in the search sector.

Proposition 2: The country with the more durable search-sector jobs (lower b) has a comparative advantage in the search-sector good.

Proof: From Equation (3.10), X_1 is increasing in b and decreasing in e. From Equation (3.11), X_2 is decreasing in b and increasing in e. Thus, X_2/X_1 is decreasing in b and increasing in e. It follows that a reduction in b or an increase in e shifts the relative supply curve to the right. The country with a higher value for e (or a lower value for b) therefore has a lower autarkic price for good 2 and exports that good to the other country.

The intuitions for these results are similar. For a country to produce both goods, unemployed workers must be indifferent between taking a low-paying job in sector 1 and searching for a high-paying job in sector 2. Any reduction in e makes it harder for workers to find jobs in sector 2. To induce workers to keep searching in that sector, the output price of the search good (and hence, the reward to employment) must rise. It follows that the country with the more efficient search technology will have a lower autarkic price for the search good, leading it to export that good under free trade. The logic is just reversed for the break-up rate. An increase in the break-up rate makes the search sector less attractive since jobs do not last as long. To induce unemployed workers to search for sector 2 jobs, they will have to be offered a greater return from employment. This requires P to rise. It follows that the country with the higher break-up rate will import the good produced in the search sector.

It is not at all straightforward to apply Propositions 1 and 2 to draw conclusions about the influence of the labor market on real world trade patterns. For example, it is by now well known that there are significant differences in the labor-market turnover rates in the United States, Japan, and Europe. Jobs last longer in Japan and Europe than in the United States, and the average duration of unemployment is much lower in the United States than it is Europe (Freeman 1994). In other words, the United States has a more dynamic labor market in that the flows into *and* out of employment are both relatively high in the United States. In terms of our model, this implies that b and e are both higher in the United States than they are in Europe and Japan. According to our model, the fact that it is easier to find employment in the United States makes it more likely that the United States will have a comparative advantage in goods produced in sectors where the problem of matching workers and firms is more substantial. On the other hand, the fact that jobs are less durable in the United States makes it more likely that the United States will import such goods. So, taken together, Propositions 1 and 2 yield two forces from the labor market that push in opposite directions in terms of the pattern of trade between the United States, Europe, and Japan. This makes it difficult to draw any conclusions about the overall influence of the labor market on trade patterns without further information about the relative sizes of these effects. Proposition 3 provides us with such information. It allows us to compare these two competing forces by characterizing trade between two otherwise identical countries when one country has proportionally higher turnover rates both into and out of employment.

Proposition 3: Suppose that two countries differ only in their labor-market turnover rates. In one country b and e are both higher than they are in the other country by a factor ϕ. Then the country with more turnover has a comparative advantage in the good produced in the search sector.

Proof: Let e_0 and b_0 denote the turnover rates in the country with the low turnover. Then ϕe_0 and ϕb_0 are the turnover rates in the high-turnover country (with $\phi > 1$). Equations (3.10) and (3.11) give the values of X_1 and X_2 in both countries once the appropriate substitutions are made. Setting $e = \phi e_0$ and $b = \phi b_0$ in both equations yields:

$$X_1(\phi) = \frac{\frac{r}{\phi} + b_0 + e_0}{2e_0P} \qquad X_2(\phi) = \frac{e_0}{b_0 + e_0}[L - \{X, (\phi)\}^2].$$

Thus, X_1 is decreasing in ϕ and X_2 is increasing in ϕ. It follows that the country with higher turnover has a relative supply curve which is further to the right than its counterpart's. As a result, the autarkic price of the search-sector good is lower in the country with the higher turnover.

Propositions 1–3 provide us with testable implications by linking the structure of the labor market to trade patterns. In Chapter 4 we return to this issue and use data on job destruction in the United States to investigate the empirical significance of these results in some detail.

While Propositions 1–3 are useful, they say nothing at all about unemployment. The only unemployed workers in this simple model are those who are searching for a job in sector 2. It follows that total unemployment and the unemployment rate vary directly with the size of the search sector. We can show this formally by letting U represent unemployment (so that $U = L_U = L - L_1 - L_E$), using μ to denote the unemployment rate (so that $\mu = U/L$), and then use the steady state condition in Equation (3.9) along with Equations (3.1) and (3.11) to obtain

$$\text{(3.12)} \qquad U = \frac{b}{b + e}(L - L_1)$$

$$\text{(3.13)} \qquad \mu = \frac{b}{b + e}(1 - \frac{L_1}{L}).$$

As Equations (3.12) and (3.13) clearly indicate, an increase in the size of sector 1 always lowers total unemployment and the unemployment rate. Combining this insight with Propositions 1–3, we conclude that the country with the comparative advantage in the search-sector good (i.e., the country with the more efficient search technology, the more durable jobs, and/or the more dynamic labor market) will experience an increase in unemployment due to free trade as its search sector expands. On the other hand, the country that imports the search-sector good sees its unemployment rate decline as a result of free trade.

Figures 3.3 and 3.4 are useful for displaying the impact of changes in world prices on unemployment. Figure 3.3 is a standard trade diagram that shows us how the equilibrium allocation of labor across sectors is determined. The width of the graph is equal to the total number of number of workers in the economy, L. The number of workers who take jobs in sector 1 is measured from left to right, while the number of workers attached to the search sector (searching and employed) is measured right to left. Vertically, we measure $w_1 = rV_1 - \theta$ on the left side and $rV_U - \theta$ on the right side. Since the marginal product of labor in sector 1 decreases in L_1, the w_1 (or, marginal revenue product) curve is downward sloping. From Equation (3.8), $rV_U - \theta = eP/(r + e + b)$, which is independent of the number of search sector workers. Thus, $rV_U - \theta$ is a horizontal line at $eP/(r + e + b)$. The intersection of these two curves determines the equilibrium allocation of labor across sectors since they cross where $V_1 = V_U$.

Figure 3.3 The Equilibrium Allocation of Labor

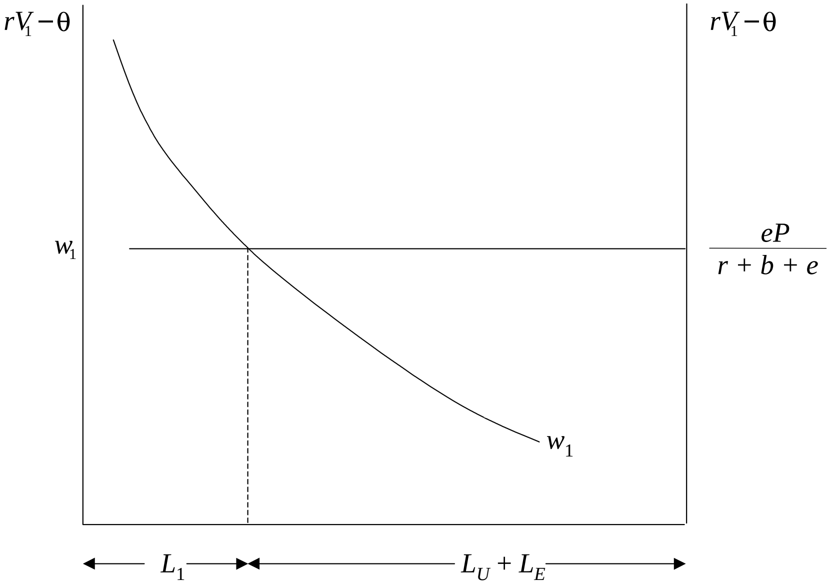


Figure 3.4 Equilibrium Unemployment

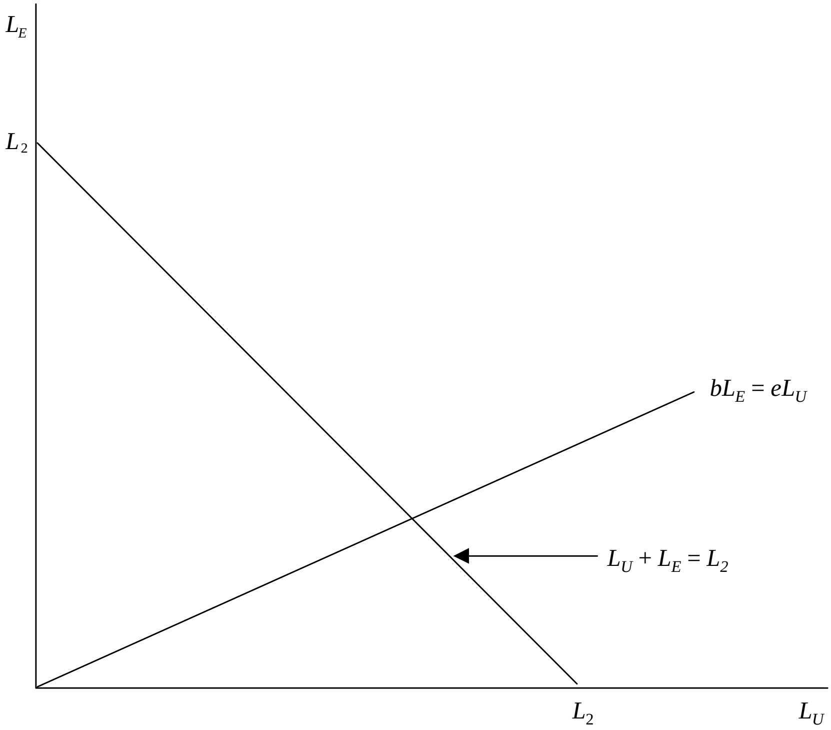


Figure 3.3 is not sufficient to determine employment in the search sector because it only allows us to solve for $L_U + L_E$, but Figure 3.4 shows how this value can be combined with the steady state equation in (3.9) to determine the split between employed and searching workers in sector 2. The downward-sloping curve in Figure 3.4 shows all combinations of L_U and L_E that sum to $L - L_1$ as determined in Figure 3.3. The upward-sloping curve shows all combinations of L_U and L_E that satisfy the steady state equation. The intersection of the two curves yields the equilibrium values for L_U and L_E.

Increases in the world price of the search-sector good cause the $rV_U - \theta$ curve in Figure 3.3 to shift up. Therefore, the increased price shrinks the size of the low-wage sector and causes the downward-sloping curve in Figure 3.4 to shift out. As a result, unemployment increases.

Figures 3.3 and 3.4 also provide us with an alternative way to examine the impact of turnover rates on the pattern of trade. Consider, for example, an increase in the job-finding rate (e) or a decrease in the break-up rate (b). Both changes make the search sector more attractive. Graphically, an increase in e (or a decrease in b) is captured by an upward shift of the horizontal line in Figure 3.3. As a result, workers switch from the low-wage sector to the search sector. The expansion of the search sector causes the downward-sloping curve in Figure 3.4 to shift out. In addition, the increase in e (or the decrease in b) causes the upward-sloping curve in Figure 3.4 to shift up. The two shifts in Figure 3.4 both lead to an increase in sector 2 employment and output, while the changes in Figure 3.3 imply that sector 1 output will fall. This explains why either an increase in e or a decrease in b will cause the relative supply curve to shift to the right. This results in lower autarkic prices for the search-sector good in economies with more efficient search technologies or more durable search-sector jobs. This provides us with another way to view the forces behind Propositions 1 and 2.

Proposition 3 can also be proven using Figures 3.3 and 3.4. A proportional increase in e and b shifts the horizontal line in Figure 3.3 up, causing the low-wage sector to contract and the search sector to expand. The expansion of the search sector causes the downward-sloping curve in Figure 3.4 to shift out. Finally, since e and b both increase by the same proportion, the steady state curve in Figure 3.4 does not change. As a result, sector 1 output falls, sector 2 output rises, and the relative supply curve shifts out to the right. This causes the autarkic price of good 2 to fall. It follows that the economy with the more dynamic labor market will have a comparative advantage in the search sector good (Proposition 3).

Extensions of the Basic Model

The model that we have used so far is extremely basic and includes many simplifying assumptions. For example, the turnover rates are exogenous in our model. In reality, workers can alter the rate at which they find jobs by varying their intensity of job search or changing their willingness to accept an employment opportunity (i.e., lowering their reservation wage). In addition, as more workers enter a sector in search of a job, it may become harder for other workers to find employment. Neither of these features can be found in our model. We have also not allowed firms to affect the rate at which they fill vacancies by changing their recruiting intensity, and we have not made explicit the nature of the search process that generates jobs. In some search models, the nature of the search process plays a critical role in determining the nature of the equilibrium. We have also kept our model simple by assuming that labor is the only factor of production. Finally, we have focused attention exclusively on unemployment that is generated by labor-market frictions as best modeled in a search-theoretic framework.

This raises two important issues. First, would the results derived above extend to more complex settings? Second, would similar results arise if unemployment were modeled in a different manner?

To address the first issue, we turn to our previous work. In Davidson, Martin, and Matusz (1999), we presented a more complex model of trade with search-generated unemployment than the one used here. That model included two factors of production, capital and labor, and allowed the job acquisition rate to be determined endogenously by the choices made by unemployed workers. Moreover, the search process that was used was described and carefully chosen to be consistent with the large (and growing) empirical literature on search technologies. In that more realistic framework, results similar to those described in Propositions 1–3 were derived and held for much the same reasons. Therefore, we conclude that our results are not fragile with respect to search models. We are confident that, in virtually all models of trade with search-generated unemployment, turnover rates will play an important role in determining the pattern of trade because they influence autarkic prices. Moreover, we are confident that the direction of these effects—that a relatively high job acquisition rate in a sector makes it more likely that a country will export that good while a relatively high break-up rate in a sector makes it more likely that a country will import that good—will be robust.

To address the second issue, we first explain why we have chosen to work primarily with models of search-generated unemployment. We then argue that our choice of working in such a framework is not all that restrictive since other methods of modeling unemployment would lead to similar conclusions.

We initially chose to model unemployment using a search-theoretic approach because of its intuitive appeal. The very idea that it takes time and effort for unemployed workers and firms with vacancies to find each other and that this process of matching workers and firms is important for unemployment makes sense to us. But, over the years, another reason for working with search models has emerged. Search theory is, in our opinion, the only rigorous theory of equilibrium unemployment that has been held up to and survived serious empirical scrutiny. In all search models there is a search or matching technology that describes the number of new jobs created as a function of the number of searching workers and the number of vacant jobs. Over the last 20 years a number of authors have estimated this function, and we now have a fairly firm understanding of its properties (see, for example, Blanchard and Diamond 1989; Chirinko 1982; Pissarides 1986, 1990; Warren 1996). Moreover, search models have been tested to see if they can explain experimental results (Davidson and Woodbury 1992, 1993) and important stylized facts (Cole and Rogerson 1999; Mortensen and Pissarides 1994) and have held up well. We do not think that the same can be said for any other micro-based model of equilibrium unemployment.

Having now explained all the virtues of search models, let us explain why we do not think that the framework that we use to model unemployment matters all that much. All three of our Propositions link labor-market turnover rates to the pattern of trade. Had we used any other micro-based model of unemployment (provided that it was rigorous and logically consistent), we believe that turnover rates would again emerge as the main factor linking trade, unemployment, and the labor market. This is not to say that the links between trade and turnover rates will always have the same qualitative features. But, the exact nature of the link is a prediction that must be tested empirically. Our goal is to argue that the link is there and that it may be important. Therefore, in the next section, we turn to some alternative ways of modeling unemployment. We present models of trade in which equilibrium unemployment is due to minimum wages, significant union power, or efficiency wage considerations. Although the models differ in some fundamental ways from the search model presented above, our goal is to show that all of these settings share an important feature—

turnover rates are the key features of the labor market that can influence the pattern of trade.

Some Alternative Models of Unemployment

We begin with a model in which unemployment arises due to the firm's inability to directly observe the effort put forth by each of its workers. In such a setting, the firm must find some way to motivate its employees to work hard. According to the efficiency wage approach to unemployment, one way to achieve this goal is to pay workers a wage rate above the market-clearing level. This high wage creates unemployment, and the fear of losing one's (relatively high-paying) job keeps workers from shirking on the job. The informational asymmetry also provides an explanation as to why the wage does not fall in the presence of unemployment. If the wage were to fall and the unemployment rate were to go to zero, workers would shirk since, even if they were caught and fired, they could immediately find a new job at the same wage rate. Thus, unemployment serves as a "discipline device" that makes it in the worker's private interest to work hard.

These efficiency wage considerations can be introduced into our model in two ways, depending upon the sector in which monitoring and motivation are considered to be more important concerns. Since both extensions have at least one major shortcoming, both are relatively straightforward, and both lead to similar conclusions, we present both models and leave the reader to choose between them.

In the first extension we assume that motivation and monitoring are a greater concern in the low-wage sector than in the high-wage sector. The high-wage sector is therefore modeled exactly as was in our first model. However, the low-wage sector differs in a fundamental way. We now assume that each worker in sector 1 can either put forth no effort and produce no output or work hard. Working hard generates output for the firm but at a personal cost to the worker of γ. Total output in this sector will then be equal to $\sqrt{L_1}$, where L_1 now refers to the number of sector 1 employees who do not shirk.

In deciding whether or not to shirk, sector 1 workers must compare the expected reward from shirking with the expected reward from hard work. Each employee who works hard is assured of keeping his or her job. Thus, if we let V_1 denote the expected lifetime income for a sector 1 employee who is not shirking, it follows that

$$rV_1 = w_1 - \gamma + \theta. \tag{3.14}$$

A worker who is caught shirking is fired immediately and must seek a new job in either sector 1 or sector 2. If we assume that shirking is detected at rate d and use V_S to denote the expected lifetime income for a sector 1 worker who is shirking, then V_S is given by the following asset value equation

$$rV_S = w_1 + \theta + d(V_U - V_S). \tag{3.15}$$

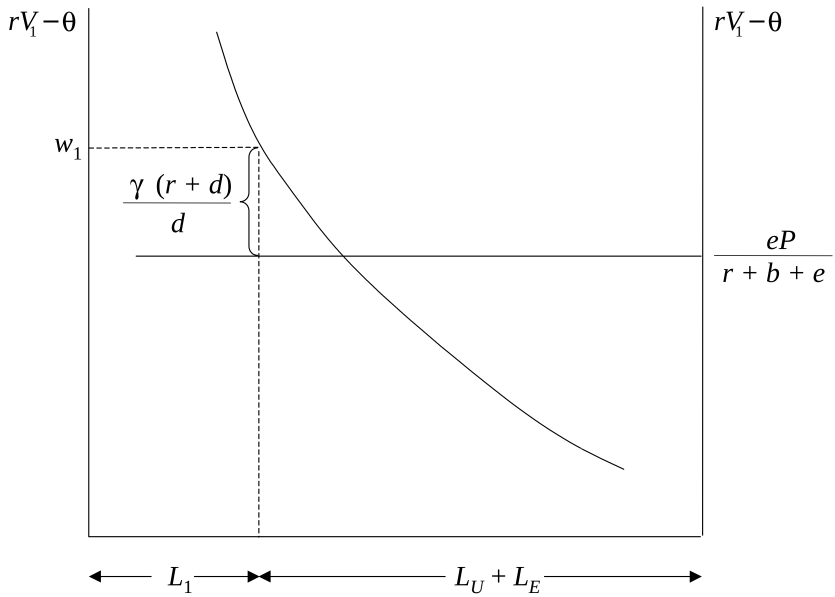
Note that the capital loss associated with termination is the difference between what an unemployed worker in sector 2 can expect to earn (V_U) and what that worker was earning while shirking in sector 1 (V_S). A sector 1 employee shirks if $V_S > V_1$.

We assume that sector 1 firms cannot observe their workers' effort directly. It follows that the only way to insure that they will not shirk is to pay them a wage rate high enough so that $V_1 \geq V_S$. Since profits are decreasing in the wage rate, the firm will not pay the worker more than it has to, so it will set w_1 as low as it can without triggering shirking. Thus, it will set w_1 such that $V_1 = V_S$. This wage is commonly referred to as the "efficiency wage" since it motivates efficient effort by the workforce. We can use Equations (3.8), (3.14), and (3.15) to solve for the efficiency wage. We obtain

$$w_1 = \frac{\gamma}{d}(r + d) + \frac{eP}{r + b + e}. \tag{3.16}$$

The equilibrium can be described using Figures 3.5 and 3.6. As in Figure 3.3, the width of Figure 3.5 is equal to the total number of workers in the economy, L. As in our search model above, $rV_U - \theta$ is given by the horizontal line at $eP/(r+b+e)$. The efficiency wage can be obtained from Equation (3.16) by adding $\gamma(r+d)/d$ to this value. Once the efficiency wage has been determined, labor demand by sector 1 firms can be read off of the downward-sloping marginal revenue product curve. All workers who are not employed in sector 1 are

Figure 3.5 The Equilibrium Allocation of Labor with Efficiency Wages

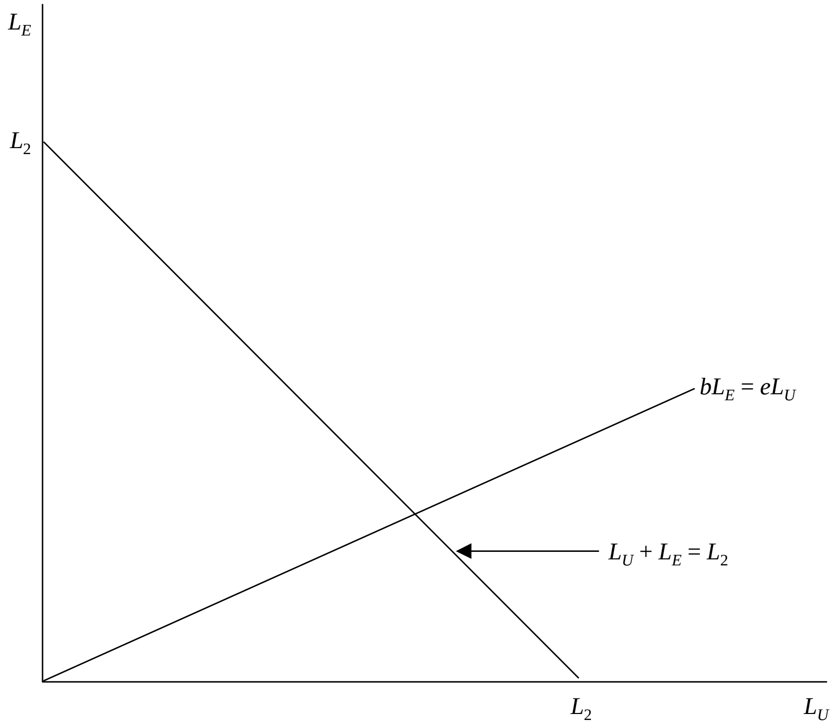


attached, in some way, to sector 2. Figure 3.6 can then be used to determine the number of workers employed in sector 2. Since Figures 3.4 and 3.6 are identical, it follows that unemployment and the unemployment rate are still given by Equations (3.12) and (3.13), respectively, and that both of these values are decreasing in the size of sector 1.

It is clear from Figure 3.5 that an increase in *P* shifts the horizontal line up, expanding the search sector and causing the efficiency wage sector to shrink. This causes the downward-sloping line in Figure 3.6 to shift out, resulting in increases in both sector 2 employment and unemployment. Thus, the relative supply curve is still upward sloping. Moreover, changes in the turnover rates have the same impact that they had in our search model. An increase in *e*, a fall in *b*, or a proportional increase in *b* and *e* all shift the horizontal line in Figure 3.5 up, leading to an increase in X_2/X_1 and a rightward shift of the relative supply curve. It follows that Propositions 1–3 continue to hold.

There are at least two shortcomings to introducing efficiency wages in this manner. First, in this model all unemployed workers wind up searching for sector 2 jobs. That is, there is still no unemploy-

Figure 3.6 Equilibrium Unemployment with Efficiency Wages



ment in sector 1, and it is the fear of having to search for a high-paying job that keeps sector 1 workers from shirking. In addition, all unemployed workers would prefer to have a job in the low-paying sector rather than search for a job in sector 2. The only reason that they cannot obtain a sector 1 job is that if the wage were to fall in order to increase the demand for sector 1 labor, the no-shirk condition would no longer hold, workers in sector 1 would shirk and sector 1 output would drop to zero. We find it unsettling that, in equilibrium, unemployed workers searching for a high-paying job in sector 2 would rather accept a low-paying job in sector 1.

The second problem with this model is that it is not clear that motivational and monitoring problems are more pronounced in the low-wage sectors of the economy; so, it is not clear that we should have sector 1 firms paying an efficiency wage. On the one hand, it is easy to imagine that motivating your workforce is harder to do when the tasks that they perform are menial and uninteresting and compensation is relatively low. On the other hand, it is probably easier to observe effort in such a setting. In high-wage jobs where the tasks that must be performed are more complex, it is much more difficult to discern whether production is low due to poor effort on the part of a particular worker, bad luck, mechanical failure, or some other factor that may not be linked to effort. Therefore, it may be more appropriate to assume that it is the sector 2 firms that must pay an efficiency wage to discourage shirking. We now turn to such a model to see if it has features that are fundamentally different from those shared by our first two models.

In our second extension, we assume that the low-wage sector is identical to the one introduced in the first section—jobs are found immediately and firms can observe workers' effort so that they can pay a competitive wage without worrying about shirking. The motivational and monitoring problems are now assumed to trouble the high-wage search sector. Once a worker finds a job in sector 2, she must now decide whether or not to shirk. While employed, the worker earns a wage of w_2 and faces a break-up rate of b regardless of whether or not she shirks. If she shirks, detection occurs at a rate d, which increases the overall break-up rate to $b + d$. In equilibrium, all firms end up paying an efficiency wage so that no worker shirks. In addition, price competition between firms drives profits to zero so that all revenue goes to labor (i.e., $w_2 = P$).

To solve for the efficiency wage, let V_S denote the expected lifetime income for a sector 2 worker who is employed but shirking. Then the asset value equation for V_S is

$$(3.17) \quad rV_S = P + \theta + (b+d)(V_U - V_S).$$

The asset value equation for V_U is still given by Equation (3.6), while the asset value equation for V_E (the expected lifetime income for a sector 2 worker who is *not* shirking) is given by Equation (3.5) with γ subtracted from the right side to account for the disutility from effort. The "no-shirk condition" is given by $V_E \geq V_S$. Combining Equations (3.17), (3.6), and the appropriately altered (3.5), we find that the no-shirk condition holds if and only if

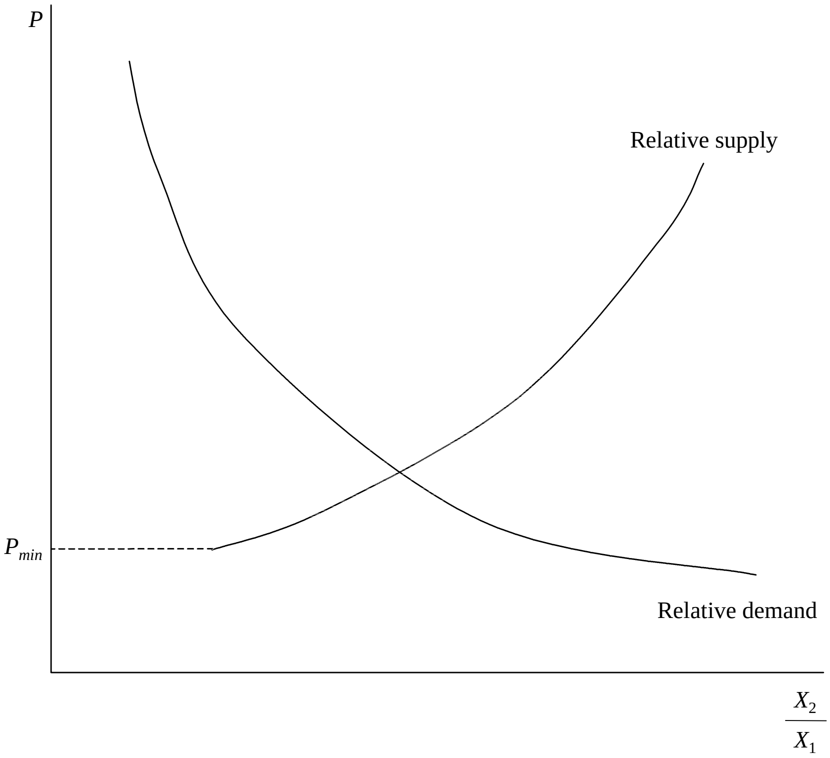
$$(3.18) \quad P \geq \frac{\gamma}{d}(r+b+e+d) \equiv P_{min}.$$

Thus, if $P = P_{min}$, the no-shirk condition is binding; but, if $P > P_{min}$, the reward offered by employment in sector 2 is more than enough to ensure that workers will not shirk once they find a job.

In equilibrium, unemployed workers sort themselves so that they are indifferent between holding a job in sector 1 and searching for one in sector 2. As before, this occurs at the point where $V_1 = V_U$. If we return to Figure 3.3 and replace P with $(P - \gamma)$, we have a graph which shows how the equilibrium allocation of labor is now determined. However, there is one key difference between this model and the search model behind Figure 3.3. In the search model, as P falls, (X_2/X_1) falls until search-sector output shrinks to zero. Thus, the relative supply curve intersects the vertical axis. The no-shirk condition from this efficiency wage model changes that—P can no longer fall below P_{min} because, if it does, sector 2 workers would choose to shirk and sector 2 output would fall to zero. It follows that, with efficiency wage concerns in sector 2, the relative supply curve starts at the point where $P = P_{min}$ and for values of P below this there is no supply side equilibrium (see Figure 3.7). For values of P above P_{min}, the no-shirk condition is not binding and the model behaves just like the search model in the first section. In particular, the relative supply curve is upward sloping for all $P > P_{min}$ *and* changes in the turnover rates cause the supply curve to shift in a manner that leaves Propositions 1–3 unchanged. We conclude that turnover rates affect the pattern of trade in the same manner regardless of whether the model is built around labor markets characterized by search or around labor markets characterized by efficiency wages.

We close this section with one last model—one in which unemployment is caused by a minimum wage (or, alternatively, downward wage rigidity).[2] The search model can be modified in a straightforward manner to allow for this feature by assuming that the wage paid in the low-wage sector cannot fall below some minimum level, $\underline{w}$. If the minimum wage is binding, employment in the low-wage sector is found by evaluating the labor-demand schedule at $\underline{w}$. This case is depicted in Figure 3.8. If the minimum wage is not binding, it has no impact on the model.

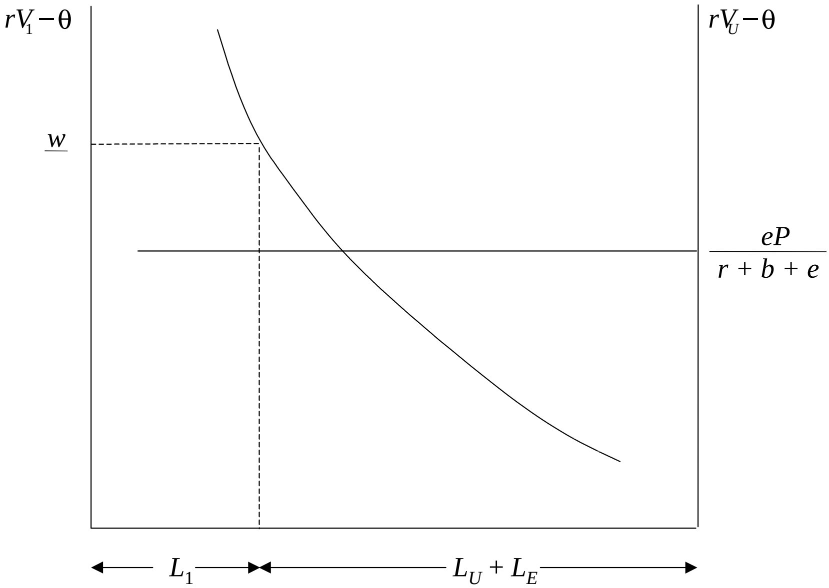
Figure 3.7 Autarkic Equilibrium with Efficiency Wages



There are two features of Figure 3.8 worth pointing out. First, if the minimum wage is binding, small changes in *P* have no impact on the allocation of labor across the two sectors. While the increase in *P* shifts the horizontal line up, employment in sector 1 is set by the minimum wage and all remaining workers are either employed in sector 2 or searching for a sector 2 job. Thus, as *P* rises, relative output remains fixed until the minimum wage is no longer binding. Once *P* rises high enough that the minimum wage constraint stops binding, further increases in *P* shrink the low-wage sector and lead to an increase in X_2/X_1. This leads to the relative supply curve depicted in Figure 3.9.

The second feature of Figure 3.8 that is of concern has to do with the way in which turnover rates alter the supply side equilibrium. To deal with this issue, we need Figure 3.8, which shows how labor is

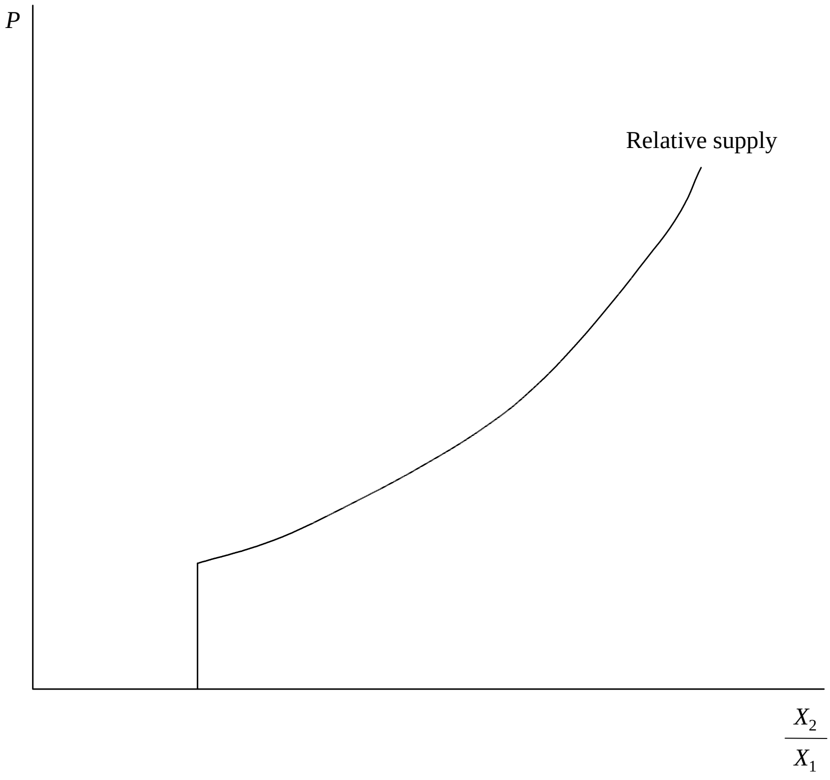
Figure 3.8 The Equilibrium Allocation of Labor with a Minimum Wage



allocated across sectors, and Figure 3.6, which shows how sector 2 employment and output are determined. These two figures can be used to show that changes in turnover rates have the same qualitative impact in this model that they had in our simple search model. If the minimum wage is binding, small changes in the turnover rates may cause the horizontal line in Figure 3.8 to shift, but this has no impact on the equilibrium allocation of labor. This implies that the downward-sloping curve in Figure 3.6 is independent of the turnover rates. However, an increase in *e* (or a decrease in *b*) still causes the steady state equation in Figure 3.6 to shift up, resulting in an increase in X_2/X_1. If the minimum wage is not binding, then changes in the turnover rates operate through exactly the same channels at work in our search model. Thus, just as in our search model, a country with a higher job-finding rate or more durable jobs will have a comparative advantage in the sector 2 good. It follows that Propositions 1–3 continue to hold.

In summary, we have provided four different models of unemployment based on search theory, efficiency wages, and minimum wage laws. In all four, turnover rates affect autarkic prices and the pattern

Figure 3.9 Relative Supply with a Minimum Wage



of trade in qualitatively similar ways. We believe that the reason our results are so robust is that the logic behind them is compelling. All jobs are risky. When a worker chooses an occupation, she must take into account the eventual difficulty that she will face in finding employment once her education and training are complete. In addition, she must consider the likelihood that at some point she may lose her job and have to search for reemployment. Thus, the average durations of unemployment and employment associated with each occupation should affect workers' decisions. All else equal, the easier it is to find a job or the longer that job is expected to last, the more appealing that job will appear to be. It follows that, if a particular occupation is characterized by a relatively long expected duration of unemployment or a relatively short expected duration of employment, compensation in that sector will have to be relatively high to induce workers to search for those jobs. This extra compensation is nothing more than a compensating differential that pushes up the price of the good produced in that sector. The higher domestic price makes it more likely that the consumers in that country will turn to international markets where the good may be offered at a lower price. This logic should carry through in any model in which workers randomly cycle between employment and unemployment, regardless of the underlying cause of the unemployment. That is what we have tried to show in this section. We conclude that Propositions 1–3 do not depend heavily of our choice of search theory as our framework for modeling unemployment.

TRADE, UNEMPLOYMENT, AND THE DISTRIBUTION OF INCOME

Propositions 1–3 emphasize the role of labor-market turnover in influencing the pattern of trade. This is an issue that has received little, if any, attention in the literature on trade and the labor market. Most of the literature concerning trade and labor-market issues has focused on the role of trade in the determination of the distribution of income. The models presented previously are not detailed enough to provide predictions on this issue, primarily because they include only one factor of production. However, we developed a search model that was general enough to address this issue in earlier work (Davidson, Martin, and Matusz 1987, 1999). That model was very much in the spirit of the model presented in the first section, but it included two factors of production, capital and labor. For completeness, we summarize the findings of that earlier analysis in this section. In the next chapter, we provide some data on trade policy lobbying activity aimed at testing the predictions of this more elaborate model.

Standard trade theory provides us with two competing theories about how trade liberalization affects the distribution of income. The Heckscher–Ohlin model predicts that liberalization benefits an economy's abundant factor and harms its scarce factor. The Ricardo–Viner model predicts that liberalization benefits factors that are specific to the economy's export sector, harms factors that are specific to the economy's import sector, and has an ambiguous impact on factors that are mobile across sectors. These two theories have different implications for low-wage workers in the United States. According to the Heckscher–Ohlin model, low-wage workers in the United States will suffer from liberalization since unskilled labor is a scarce factor in the United States (relative to the rest of the world). The Ricardo–Viner model predicts that unskilled labor may gain or lose from liberalization since it has no sector-specific skills that would tie it to any particular sector. If, however, unskilled labor is tied to a sector for other reasons (e.g., geographic), then its welfare depends upon whether the sector is a net exporter or a net importer.

These two models yield different predictions because they model factor markets in very different ways. In the Heckscher–Ohlin model, all factors are perfectly mobile across sectors. Labor has no reason to prefer one sector over another, except if one sector offers higher compensation that the other. Similarly, capital simply flows to the sector that offers the highest profit rate. The fact that factors can react instantly to changes in compensation has strong implications for the link between trade patterns and the distribution of income. For example, suppose that there is an increase in the world price of a good that is produced using a relatively labor-intensive production process. As a result, domestic firms will want to increase production of that good, and this will increase the demand for *all* factors used in that sector. However, other sectors make less use of labor and more use of capital in their production process. Thus, as factors flow out of other sectors towards this sector, the labor intensity of the factors being released will be lower than the labor intensity of the factors being absorbed. As a result, the aggregate demand for labor rises while the aggregate demand for capital falls. When the dust has settled, all labor benefits, regardless of where it is employed, while all capital suffers. This prediction—that trade liberalization in a sector benefits the factor used relatively intensively in that sector and harms the other factor—is known as the Stolper–Samuelson Theorem. This theorem explains why capital employed in an export sector does not benefit from an increase in the world price of its good in the Heckscher–Ohlin model.

In the Ricardo–Viner model, some factors may be tied to a specific sector due to transactions costs associated with relocating (such factors are referred to as “specific factors”). For example, machinery used to produce automobiles and computers cannot be substituted for each other all that easily. If the return to capital increases in Silicon Valley, we would not expect an immediate outflow of capital from the automobile industry to the computer industry. Likewise, when workers make an occupational choice they often acquire skills that are sector specific. If the average wage paid to engineers increases, we would not expect lawyers or economists to immediately quit their jobs and switch occupations. Instead, over time, we might see an increase in the number of students majoring in engineering and a decline in other areas. As a result, over time the number of engineers will grow and the number of economists may shrink. The Ricardo–Viner model stresses that these short-run attachments create an environment in which the fortunes of each factor are intertwined with the fortunes of the sector in which that factor is employed. If the world price for automobiles increases at the same time that the world price of computers falls, any factor that is tied to the automobile sector will gain while factors specific to the computer sector will lose.

Both the Heckscher-Ohlin and Ricardo-Viner models assume full employment. Davidson, Martin, and Matusz (1988, 1999) and Hosios (1990) investigated the extent to which these insights extend to models in which unemployment is carefully modeled. All three papers introduce search-generated unemployment into models that are very much in the spirit of the Heckscher-Ohlin model. There are two factors of production (capital and labor) that are perfectly mobile across sectors and two goods. They found that, under certain conditions, the returns to *searching* factors vary according to the Stolper–Samuelson Theorem (provided that factor intensities are measured taking into account the number of active searchers in each sector). Thus, if a tariff is imposed on a relatively labor-intensive sector, all *unemployed* workers will benefit while all *idle* capital will be harmed. The reasoning is much like the logic behind the Stolper–Samuelson Theorem. An increase in the price of a good will draw *unemployed* factors toward that sector (unless the price increase is large, *employed* factors will be unwilling to give up their secure jobs and switch sectors). If the growing sector is more labor intensive than the sector that is shrinking, the aggregate demand for labor will rise while the aggregate demand for capital will fall. As a result, the return to searching labor increases while the return to idle capital falls. In a setting with unemployment, it is the idle factors that are perfectly mobile across sectors and they are the factors that respond immediately to changes in world prices. These factors and their returns act exactly in the manner predicted by the Heckscher–Ohlin model and the Stolper–Samuelson Theorem.[3]

For *employed* factors, things are slightly more complicated. In Davidson, Martin, and Matusz (1999), we showed that search costs create an attachment to a sector that makes each employed factor much like the specific factors in the Ricardo–Viner model. Because it takes time and effort for unemployed workers and firms with vacancies to find each other, both parties are reluctant to sever the ties once a job match is created unless they are convinced that they can earn significantly more by searching for a different production opportunity elsewhere in the economy. In the terms of the model presented in the first section, once a worker takes a job in the search sector, her expected lifetime income rises to V_E. She will keep this job as long as she can unless V_E falls below V_1. But, in equilibrium, unemployed workers allocate themselves such that $V_U = V_1$ and both of these values are strictly below V_E. Thus, small changes in world prices will not cause employed factors to switch sectors. The implication is that the reward earned by employed factors will be tied to the overall success of the sector. If an export sector is growing, this will tend to increase the reward to labor and capital employed in that sector.

But, at some point, most jobs break up for one reason or another. When that happens, the firm must recruit a replacement for the lost employee and the worker must search for a new job. Thus, the expected lifetime income for employed factors includes what those factors expect to earn when they become unemployed (for labor) or idle (for capital). We have already seen that this component of expected lifetime income varies according to the Stolper–Samuelson Theorem. It follows that the overall return to each *employed* factor is driven both by Stolper–Samuelson *and* Ricardo–Viner forces. Moreover, the force that dominates will depend upon the turnover rates in that sector. If jobs last for a long time (the break-up rate is low) or are difficult to find, then the attachment to a sector caused by search costs will be strong, making it more likely that the Ricardo–Viner force will dominate. On the other hand, if jobs are easy to find and/or do not last long, then employed factors will not feel a strong attachment to their sector. In this case, it is more likely that the Stolper–Samuelson forces will dominate.

To underscore the importance of these results, we turn to two recent papers on labor-market structure. In the first paper, by Blanchard and Portugal (2001), the authors compared labor markets in the United States and Portugal and pointed out that, although the two countries have similar unemployment rates, turnover is roughly three times higher in the United States, resulting in a much more dynamic labor market. They posited that this difference may be largely driven by high employment protection in Portugal. In the second paper, by Haltiwanger and Vodopivec (2000), the authors explored recent changes in the Estonian labor market. They pointed out that Estonian labor markets were essentially stagnant at the time of significant price and trade reforms (1989). However, shortly after instituting these reforms, the Estonian government also began to implement policies aimed at increasing the flexibility of their factor markets. As a result, job flows greatly increased and, by the late 1990s, the Estonian labor market had became just as flexible as those in the United States. Now, let's combine these facts with our results concerning trade and wages. Because of the underlying difference in labor-market structure, the link between trade and wages in the United States and Portugal should be fundamentally different. The United States, with its high-turnover labor market, should see factor rewards driven primarily by Stolper–Samuelson forces, especially in their high-turnover industries. Portugal, with its sluggish labor market, should see the welfare of its factors rise and fall with the fortunes of their sector of employment. Similarly, according to our theory, the labor-market reforms undertaken by the Estonian government should have transformed their economy from one that is consistent with the predictions of the Ricardo–Viner model into one driven by traditional Heckscher–Ohlin–Samuelson forces. One might expect then that the policies that would best help low-wage or unemployed workers should depend on the structure of the labor market. We return to this issue in Chapter 5.

To summarize, when unemployment is present, the returns to employed factors are driven by two forces. The Stolper–Samuelson force, which dictates that an economy's abundant factor gains from trade liberalization while its scarce factor loses, and the Ricardo–Viner force, which dictates that a factor that is specific to an export sector gains from trade liberalization while a factor that is specific to an import sector loses from trade liberalization. While these are the two traditional channels that link factor rewards to trade patterns, they do not emerge simultaneously in full-employment models. The Stolper–Samuelson force is present only when all factors are perfectly mobile across all sectors while the Ricardo–Viner force emerges only in full-employment models with specific factors. The key insight that is gained by allowing for unemployment is that market imperfections (like the transaction costs associated with search) generate an environment in which the returns to employed factors are determined by a weighted average of these two forces. In addition, it is the labor-market turnover rates of each sector that determine which force is given more weight. In the next chapter we will combine data on job creation and job destruction rates across sectors with data on lobbying activities by groups representing the interests of labor and capital in different sectors to see if there is any empirical support for these predictions.

DISCUSSION

Throughout this chapter we have emphasized that the labor-market turnover rates play important roles in determining trade-related issues in models with equilibrium unemployment. For this to be the case, these rates must vary both across industries and across countries. While there is substantial evidence that this is indeed the case, we have not modeled the factors that cause these rates to vary.[4] In fact, we have treated all the turnover rates as exogenous variables throughout. This leaves us with an obvious question—what is the underlying cause of cross-country and inter-industry differential turnover?

A complete list of the determinants of turnover would surely be quite long. It would have to include product characteristics (e.g., seasonality), the nature of the technological process involved in production, cross-country differences in factor endowments (e.g., the mix of skilled and unskilled labor available as well as their outside opportunities), union coverage rates, and culture. However, there can be no doubt that factor market policies, particularly those aimed at the poor and unemployed, also play a role. We have already alluded to this at the end of the last subsection in our discussion of labor-market structure in the United States, Portugal, and Estonia. Countries in Western Europe impose significant hiring and firing costs on their firms (Bentolila and Bertola 1990) and provide generous social programs to help poor and unemployed workers (Ljungqvist and Sargent 1998). The German apprenticeship system, subsidized by federal and state governments, provides workers with a set of general skills that facilitates transitions across jobs (Acemoglu and Pischke 1999). Firms in the United States face safety and environmental regulations that firms in less-developed countries do not face. There can be no doubt that all of these policy decisions influence turnover rates and help explain why labor markets are more flexible in some countries than in others. Moreover, it seems highly likely that such policies have differential effects across industries so that the ordinal ranking of industries in terms of turnover may vary widely across countries. It is highly likely that firing and hiring costs imposed by the French government have a bigger impact on high-turnover industries relative to low-turnover industries. The German apprenticeship program probably has had little impact on industries that require highly specialized skills, while it has probably had a major impact on turnover in sectors that require only general skills. The bottom line is that many of the cross-country and inter-industry differences in turnover may be related to policy choices that were made in an attempt to help the underclass of society.[5]

Our analysis indicates that when countries make such policy decisions, they may alter the role that their country plays in international markets and may also influence the manner in which their country adjusts to trade shocks. In particular, trade patterns may be altered and the link between trade and wages may change in a significant way. This may lead to unintended consequences that affect the welfare of the poor and the jobless. For example, we found that countries with relatively flexible labor markets are more likely to experience increases in equilibrium unemployment than are their counterparts. We also found that the welfare of the unemployed would largely be driven by Stolper–Samuelson forces. This means that jobless workers would tend to lose if they resided in a country in which labor of their type (i.e., skill level) were relatively scarce. Finally, we showed that the welfare of low-wage workers might be tied to relative factor abundance or the fortunes of the sector in which they are employed, depending upon the structure of their nation’s factor markets.

Notes

1. The exact specification of the production function is not important. We choose this form for expositional clarity.
2. We would like to point out some problems with models of unemployment based on minimum wages (or wage rigidity). We do so because there have been a number of attempts to introduce unemployment and other labor-market issues into trade models using this approach. The main problem is that, in reality, the vast majority of workers in the United States are not affected by minimum wage laws (less than 10 percent of the workforce is paid the minimum wage). Moreover, most evidence indicates that minimum wage laws play, at best, a small role in determining unemployment (Brown, Gilroy, and Kohen 1982; Brown 1999). In addition, while it is true that a larger fraction of European workers are affected by minimum wage laws (for example, in 1990 approximately 25 percent of the workforce in France was earning a wage within 5 Francs of the minimum wage [Abowd, Kramarz, and Margolis 1999]), most estimates of the impact of changes in these laws on European labor markets lead to the conclusion that minimum wages are a significant cause of unemployment only among the youngest members of the their labor force (Abowd, Kramarz, and Margolis 1999).

   One natural response to this criticism of minimum wage models is to reinterpret the model as one of downwardly rigid wages. Some might argue that European unemployment is better captured by modeling unemployment as the result of wage rigidity rather than as the result of transactions costs or informational asymmetries. However, we would argue that models with rigid wages are of little value unless they also provide an explanation of the cause of the rigidity. Otherwise, it is impossible to predict how various trade policies will affect unemployment and the distribution of income.
3. This extended version of the Stolper–Samuelson Theorem for searching factors can be found in both Davidson, Martin, and Matusz (1988) and Hosios (1990). But, neither of those papers deals directly with the impact of world prices on the return to *employed* factors.
4. See, for example, Layard, Nickell, and Jackman (1991); Freeman (1994); Davis, Haltiwanger, and Schuh (1996); Haynes, Upward, and Wright (2000); and Greenaway, Upward, and Wright (2001).
5. Of course, it is possible to argue that turnover rates are, at least to some extent, endogenous. After all, firms choose production techniques and different production methods have different implications for turnover. Moreover, changes in trade patterns may affect the rate at which jobs are created and destroyed (so that trade may influence turnover) and changes in labor-market policies may affect the goods that firms choose to produce (so that differences in labor-market policies may influence trade patterns). We consider such issues fertile ground for future research.

4
Some Empirics

The models of international trade that we developed in Chapter 3 give the detailed operation of the labor market more prominence than is typically found in the literature on international trade. Our point in doing so is to allow for the possibility that international trade can impact the distribution of income and welfare in ways that lie outside of the well-understood Stolper–Samuelson effects—that is, the forces that dominate in an environment with perfect factor mobility, fully flexible wages, and full employment. Our purpose in this chapter is to present some data that we believe is consistent with the predictions of our model. We recognize that in at least one case the data that we present is also consistent with alternative models and our evidence is unlikely to persuade the skeptical reader of the relevance of our model. However, a sharper test of the model, allowing us to distinguish among well-specified hypotheses, requires data that we do not currently possess.

Our model points to at least two hypotheses that are amenable to empirical testing. The first hypothesis relates job turnover to trade patterns. In our simple two-good, one-factor model, cross-country differences in job break-up rates (i.e., differences between countries in the values of b_i) and job acquisition rates (i.e., differences between countries in the values of e_i) imply clearly defined cross-country differences in the relative costs of producing the two goods. For example, assume that the two countries are identical in all respects except that $b_2 > b_2^*$ in sector 2, where variables without an asterisk pertain to the "home" country and variables with an asterisk pertain to the "foreign" country. Then we can conclude that the foreign country has a comparative advantage in the production of good 2. The proof is fairly simple. Given the same relative output prices in both countries (and therefore the same sector 2 wage relative to the sector 1 wage in both countries), sector 2 will be relatively less attractive for workers in the home country because of the higher job turnover. Fewer workers will be attracted to this sector in the home country. If the chosen price was the one that equilibrated goods markets in the foreign country absent trade, then there will be shortages of good 2 in the home country, bidding its price (and therefore also wages in this sector) up. We can tell a similar story about cross-country differences in the job acquisition rates.[1]

Given sector-specific data on job turnover and trade patterns for a collection of countries, we could test to see if the variables are related in the manner suggested by the model. This insight motivates the results that we present in the section on turnover in the United States and Canada. As we demonstrate below, we might be able to obtain some suggestive results even when we have data for only one country, which we illustrate in the third and fourth sections of the chapter.

Second, our model predicts a relationship between job turnover and the degree to which the costs and benefits of trade are split among factors as suggested by the Stolper–Samuelson Theorem or, alternatively, in the manner suggested by the Ricardo–Viner specific-factors model. As discussed in Chapter 3, the degree to which workers are "sector-specific" increases as the rate of job turnover decreases. With two factors of production (say, capital and labor), we would then expect that the two would be on opposite sides with respect to their opinions of free trade if both are employed in high-turnover industries, whereas they would be on the same side if both are employed in low-turnover industries. Combining data on sector-specific turnover rates with data on lobbying activity might allow us to test this prediction. This is the subject of the final section of this chapter.

JOB TURNOVER AND THE PATTERN OF TRADE: EXISTING EVIDENCE

As we suggested in Chapter 2, there exists a body of empirical research that examines the links between import pressures (or export successes) and employment outcomes.[2] While some of these studies found that trade contributed marginally to net job losses in the United States, Dickens (1988, p. 41) suggested that ". . . much of the work is piecemeal, and there are no comprehensive models of the effects of trade." Indeed, even some fundamental economic principles, such as the existence of upward-sloping supply curves in competitive markets, seem to be set aside in interpreting this literature. Consider the following quote from Tyson (1988, p. 11):

> If price falls in response to foreign competition, the demand for the product will rise . . . As long as domestic producers share in the resulting increase in demand to some degree, the domestic output and employment effects of the increase in imports will be smaller than they would have been if the price of domestic output had remained constant.

Of course, this is just the reverse of what microeconomic principles would suggest. Since output (and hence employment) depend positively on price in a competitive industry, an exogenous decrease in price caused by foreign competition results in lower employment and output.[3]

More to the point, these empirical studies tend to focus on the employment effects in a selection of industries. At best, they might consider overall manufacturing employment, but they never capture the general-equilibrium flavor of trade models.

While the existence of equilibrium unemployment is a feature of the models that we developed in the previous chapter, our focus is really on the interaction between labor-market turnover and trade. In this regard we note that, to our knowledge, no one has ever systematically explored the possibility that the pattern of job turnover across industries might be related to the pattern of trade.[4] Indeed, there is only one existing study that addresses this issue in even the most tangential manner. In their study of job turnover in the United States, Steven Davis, John Haltiwanger, and Scott Shuh (1996) devoted a summary table to the topic. The relevant portions of their table are reproduced here as Table 4.1.[5]

To interpret both Table 4.1 and our subsequent analysis, it is necessary to understand the terms “job creation” and “job destruction.” Davis, Haltiwanger, and Schuh (DHS) examined plant-level data to determine if, during the course of a year, a plant expanded employment (in which case there was job creation), contracted employment (job destruction), or stayed constant (neither creation nor destruction). For example, if total employment at a particular plant at the end of March in 1996 was 50 and it was 53 at the same plant at the end of March in 1997, then 3 jobs were created. If another plant went from 50 to 44, then 6 jobs were destroyed. The authors then summed all of the jobs created in each four-digit SIC industry to obtain the rate of job creation (relative to the base of employment), and they did the same for all jobs destroyed to get the rate of job destruction.

Table 4.1 Job Creation and Job Destruction by Measures of Foreign Trade Exposure Mean Annual Rates (1973–1986)

Ratio (%)	Job creation	Job destruction
Import penetration ratio of four-digit industry[a]		
Very low (0–0.8)	8.9	10.1
Moderately low (0.8–3.3)	9.6	10.2
Average (3.3–6.8)	9.4	10.0
Moderately high (6.8–13.1)	8.8	9.5
Very high (over 13.1)	9.4	12.2
Export share of four-digit industry[b]		
Very low (0–1.3)	9.5	10.9
Moderately low (1.3–3.1)	9.3	10.9
Average (3.1–5.8)	9.0	9.7
Moderately high (5.8–12.5)	9.0	12.1
Very high (over 12.5)	9.2	10.2

[a] Import penetration ratio is the ratio of imports to the sum of imports and domestic output for the industry.

[b] Export share is the ratio of exports to output for the industry.

SOURCE: Reprinted with permission, Table 3.5 in Davis, Haltiwanger, and Schuh (1996)

Clearly, these measures are not exactly what we have in mind with our parameters and b_i and e_i. For example, in the steady state of our model, job creation and job destruction would both equal zero if measured in this way. During any interval of time, each new worker entering employment replaces a worker who leaves employment. This obviously is not the same as saying that there is no turnover in our model. The DHS measure of job destruction underestimates the "true" break-up rate that drives our model. A plant may experience a year-to-year net loss of 6 workers, but may have accomplished this by hiring 20 new workers and releasing 26 workers during the course of the year. Despite these drawbacks, the DHS measure of job destruction does provide a reasonable proxy for its theoretical counterpart.[6]

The DHS measure of job creation is even more removed from our concept of e_i than is their measure of job destruction from our concept of b_i. This follows because DHS measured job creation as a rate relative to the existing level of industry employment, not relative to the size of the pool of unemployed workers looking for work in a given industry. Because of this shortcoming, we focus our subsequent analysis on the relationship between job destruction and net trade.

Based on their summary data (reproduced here as Table 4.1), DHS concluded that there is "no systematic relationship between the magnitude of gross job flows and exposure to international trade. The only aspect of [the data] suggesting that international trade reduces job security is the large rate of gross job destruction among industries with a very high import penetration ratio. On balance, the evidence is highly unfavorable to the view that international trade exposure systematically reduces job security."[7]

There are several important points to note here. First, DHS performed no serious statistical analysis of the data. They simply scanned the data and concluded that there was no relationship.[8] The second point is related to the first. The turnover rates reported by DHS are weighted averages of the turnover rates of the industries within a particular category, where the weights are employment shares. For example, DHS calculated a job destruction rate of 10.1 percent when import penetration is "very low." The way they calculated this number was to order the data within each year (from 1973 to 1986) by import penetration ratio. They then calculated the weighted average of all job destruction rates within that select group of industries. In essence, the number they calculated was the number of jobs lost among all four-digit industries within that category relative to the level of total employment among that selection of industries. This is a sensible aggregation scheme for many purposes, but it is questionable when the purpose is to look for patterns across industries. At the very least, multiple regression analysis could be used to sort out the relationships among trade patterns, job turnover, and industry size.

Finally, when looking for a relationship between trade patterns and turnover, DHS had in mind a story that is fundamentally different from our explanation of the link. In their story, greater trade exposure *causes* higher turnover. The idea is that greater openness to trade exposes firms to international shocks as well as domestic shocks and this, in turn, leads to greater turnover. Of course, this would only be true if domestic and international shocks are positively correlated because negatively correlated shocks would potentially generate lower turnover. While it is certainly possible to construct a model where trade shocks drive turnover, the models we constructed in Chapter 3 have the cause–effect relationship going in the other direction.

SOME SIMPLE CORRELATIONS

We begin by looking at some simple statistical correlations between trade patterns and job turnover. As noted above, we focus only on job destruction rates in this chapter because the actual data in this case are more closely aligned with our conceptual framework than are job creation rates.[9]

Let X_{it} denote gross exports and let M_{it} represent gross imports associated with industry i in year t. Letting Q_{it} represent domestic production, we define T_{it} as

$$(4.1) \quad T_{it} = \frac{X_{it} - M_{it}}{Q_{it} + M_{it}} \times 100.$$

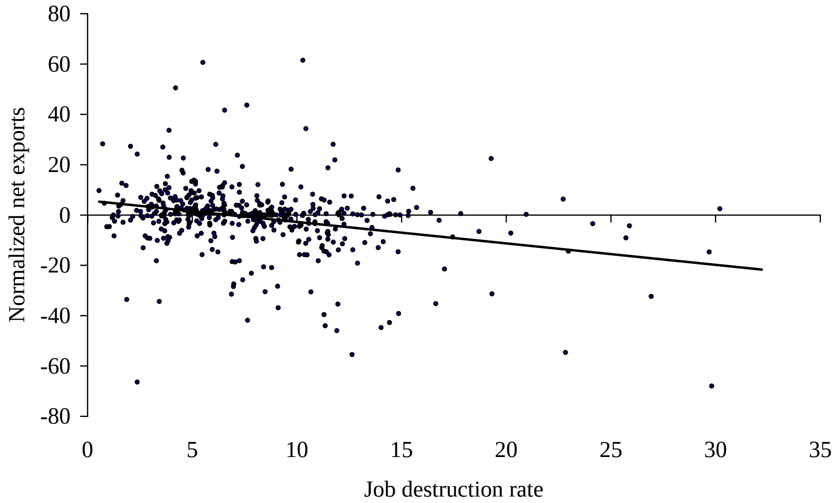
The variable T_{it}, which is a measure of net trade for industry i in year t, attains its minimum value of -100 if good i is not produced in the United States, and it reaches its maximum of $+100$ if everything produced or imported is subsequently exported. Like DHS, we use trade and shipments data for 1973–1986. The NBER provides the trade data,[10] and the turnover data were created by DHS. For each year we can match job destruction rates with trade data for 447 four-digit industries.

Figure 4.1 is a scatter diagram based on data from 1979, the middle of our sample period. This diagram relates our measure of net trade (on the vertical axis) to the DHS measure of job destruction. The trend line superimposed on this graph is the least squares regression line corresponding to the simple bivariate regression

$$(4.2) \quad T_{it} = \hat{\beta}_0 + \hat{\beta}_1 b_{it}.$$

In order to conserve space, we refrain from presenting the scatter for each of the years in our sample; however, we note that this diagram is fairly representative. Indeed, we find that $\hat{\beta}_1 < 0$ in all years. Furthermore, the results are highly statistically significant for all years except

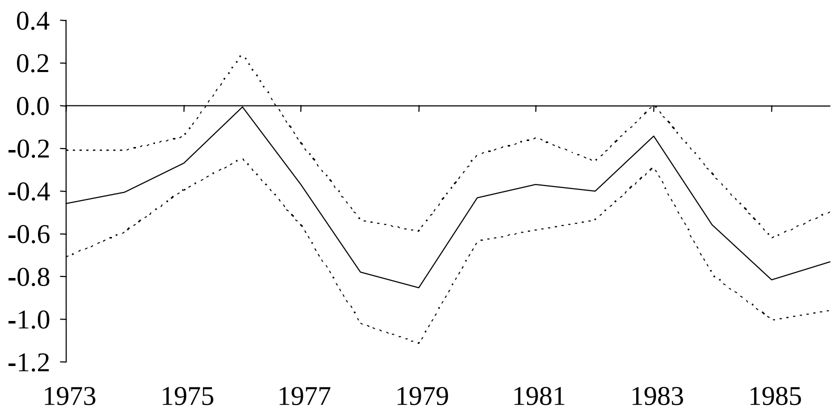
Figure 4.1 Normalized Net Exports and Job Destruction (1979)



1976. The statistical significance of the slope coefficient is most easily seen by examining Figure 4.2, where we plot the estimated coefficient for each year along with the 95 percent confidence interval.

There are clearly three possible explanations for the observed correlations. First, it is conceivable that sectors that are more open to

Figure 4.2 Estimated Coefficient on Job Destruction (solid line) and 95 Percent Confidence Interval (dotted line)



imports face greater job insecurity, while export-oriented sectors have less job insecurity. That is, trade causes turnover. Alternatively, the pattern of turnover may induce the pattern of trade for the reasons suggested earlier. Finally, some third factor might be important in determining both trade patterns and cross-industry differences in turnover rates. For example, industries that are intensive in the use of unskilled labor might tend to be the same industries in which the United States lacks comparative advantage and in which turnover is relatively high.

While these simple correlations cannot be relied upon to distinguish among the three possible relationships, they do appear to be quite robust, suggesting that trade and turnover are related in *some* fashion, and further research on the issue is warranted.

BEYOND THE SIMPLE CORRELATIONS

Our model suggests that higher break-up rates require firms to pay higher wages to attract workers.[11] All else equal, this exerts an upward pressure on costs and, therefore, makes the industry less competitive on world markets. However, there are obviously other determinants of costs and trade patterns. To control for such factors, we now consider the following empirical model of net trade:

$$(4.3) \quad T_{it} = \beta_0 + \beta_1\bar{b}_i + \beta_2\Delta b_{it} + \boldsymbol{Z}_{it}\boldsymbol{\gamma}_i + \epsilon_{it}$$

where $\bar{b}_i$ is the average value of job destruction in industry i over the sample period, Δb_{it} is the percent deviation of the actual job destruction rate for industry i in year t from its long-run average, $\boldsymbol{Z}_{it}$ is a vector of variables presumed to influence the pattern of trade, $\boldsymbol{\gamma}_i$ is a vector of coefficients, and ϵ_{it} is a random disturbance.

Our purpose in using both the long-run average value for job destruction as well as the short-run deviations from this average is to try to sort out the cause-and-effect story. Arguably, the model we presented in the last chapter is a model of long-run behavior. Sectors that are persistently characterized by high rates of job loss will necessarily have to pay more to attract workers compared with those where job destruction is persistently low. A temporarily higher (or lower) rate of job destruction should not influence the decisions made by forward-looking agents. In contrast, a temporary surge of imports in an industry might cause the rate of job destruction in that industry to climb above its long-run average, while a burst of exports might temporarily reduce the job destruction rate below its long-run average. A significant negative correlation between the long-run average rate of job destruction and our index of net exports would suggest that the causality runs from turnover to trade, whereas a significant negative correlation between the deviation of the actual job destruction rate from its long-run average and the index of net exports would suggest that causality runs from trade to turnover.[12]

For control variables, we used the ratio of the total real capital stock to total employment within an industry at time $t(k_{it})$, the ratio of production workers to total employment within an industry at time t ($unskillshare_{it}$), and the relative size of each industry at time t as measured by the share of total manufacturing employment devoted to the specific industry ($employshare_{it}$).[13] We also included the value of the dollar ($dollar_t$), which varies across time but not across industries.[14]

We estimated the model in Equation (4.3) using data from 1973–1986. Our results, reported in Table 4.2, are quite striking. The coefficient on the average job destruction rate is always negative and always highly significant. Furthermore, the magnitude of the estimated coefficient is relatively large. By way of comparison, the estimated coefficient on the value of the average job destruction is roughly 10 times larger in magnitude than the estimated coefficient for the value of the dollar. This implies that the elasticity of the trade index with respect to these two independent variables is roughly the same since the overall average of $\overline{b}_i$ (averaged across all industries) is roughly one tenth of the average value of *dollar*.

We also note that the estimated coefficient for Δb_{it} is always negative but never statistically significant. This finding provides support for our model where the causality runs from turnover to trade patterns rather than the reverse.

Finally, we point out that the first regression reported in Table 4.2, which includes only the average value of job destruction as an independent variable, seems to have more explanatory power (measured by the value of $\overline{R}^2$) than does the last regression, where we only include the nonturnover control variables.[15]

Table 4.2 Ordinary Least Squares Regression Results (dependent variable = *T*)

Independent variables	Regression number				
	(1)	(2)	(3)	(4)	(5)
$\bar{b}_i$	−1.395 (−29.80)		−1.395 (−29.81)	−1.132 (−22.67)	
Δb_{it}		−0.005 (−1.49)	−0.005 (−1.59)	−0.002 (−0.76)	
k_{it}				0.000 (−1.67)	0.000 (3.97)
$unskillshare_{it}$				−0.265 (−16.46)	−0.373 (−23.35)
$employshare_{it}$				1.156 (2.17)	2.285 −(4.13)
$dollar_i$				−0.122 (−11.95)	−0.135 (−12.83)
N	6258	6258	6258	6258	6258
$\bar{R}^2$	0.124	0.000	0.124	0.178	0.110

NOTE: *t*-statistics are reported in parentheses.

TURNOVER AND CANADA–U.S. TRADE

The statistical analysis presented above is provocative, but it is not a rigorous test of our models of turnover and trade. The models suggest that a proper test of the theory requires a *cross-country* comparison of intersectoral differences in turnover. Our data only apply to the United States. A more persuasive test of the theory would require the compilation of a data set including sector-specific turnover rates and trade variables for a variety of countries. If, for example, sector-specific turnover rates in the rest of the world exactly mirrored those in the United States, there would be no independent influence of turnover on the pattern of trade.[16]

Fortunately, we can start to address this issue head on. In their cross-country comparison of job turnover, Baldwin, Dunne, and Haltiwanger (1998) reported average job creation and job destruction rates over the period 1974–1992 for 19 two-digit SIC industries in the

United States and Canada.[17] We can combine these data with data on bilateral trade between the United States and Canada to more closely approximate a true test of the underlying theory. Roughly speaking, the theory suggests that U.S. exports to Canada should be highest in industries where U.S. job destruction rates are lowest relative to Canadian job destruction rates. More specifically, we define the index

$$TC_{it} = \frac{EC_{it} - MC_{it}}{X_{it} + M_{it}} \times 100 \tag{4.4}$$

where for industry i in year t EC_{it} represents U.S. exports to Canada and MC_{it} represents U.S. imports from Canada. This is simply net exports to Canada normalized by the total amount of trade (between the United States and all countries) associated with industry i in year t. The theory suggests that this index should be negatively correlated with the ratio of the industry-specific averages of U.S. job destruction relative to Canadian job destruction rates.

We regressed this index against the ratio of job destruction rates for 19 two-digit SIC industries for the years 1974–1994, providing a total of 399 observations. The estimated slope on the relative job destruction rate is indeed negative and highly statistically significant with a t-statistic of -13.10. Furthermore, the regression line fits the data well as suggested by $\bar{R}^2 = 0.30$. While this result is based on a very limited data set, we find it encouraging that it is consistent with our model.

Finally, we note that Baldwin, Dunne, and Haltiwanger (1998, p. 347) found that "the Canadian and U.S. industry-level job creation and destruction data are remarkably similar." This similarity in job turnover is in stark contrast to the importance of international trade to each country. For the United States, the combined values of imports and exports are less than 30 percent of gross domestic product, whereas the comparable figure for Canada is closer to 80 percent. If openness to trade causes greater job insecurity, we might expect to see such a large disparity in openness reflected in substantially different levels of turnover between the two countries.

JOB TURNOVER AND POLITICAL LOBBIES

At the end of the last chapter we argued that labor-market turnover rates might influence the link between trade and the distribution of income. In particular, we explained how job turnover connects two extreme views of how changes in relative prices affect expected lifetime earnings of the employed. On the one hand, the employment relationship itself creates a sort of fixity in the sense that workers are not likely to immediately quit their jobs in response to small changes in wages, nor are firms likely to immediately shutter their factories in response to a small decline in profits. The underlying reason for the attachment for workers and firms is the fact that workers cannot immediately find new jobs and firms cannot immediately hire new workers. However, as workers and firms are separated over time, the newly unemployed workers and idled capital are freed to search for productive opportunities in other sectors of the economy. Therefore, the impact on lifetime income of a change in relative prices can be thought of as a weighted average of Ricardo–Viner forces and Stolper–Samuelson forces, where the weight placed on each component depends on the rate of turnover. In particular, the weight placed on the Stolper–Samuelson forces increases with the rate of turnover. This intuition leads to the natural conclusion that lifetime incomes of workers and capital owners will move in the same direction if both are employed in low-turnover industries, but they will move in different directions if both are employed in high-turnover industries.

In a recent paper with Christopher Magee, we tested this prediction by looking at the pattern of campaign contributions given by PACs to Congressional representatives who subsequently voted for or against trade-liberalizing legislation.[18] The Federal Election Commission provided data on contributions and identified whether the PAC represented corporate or labor interests. In earlier work, Beaulieu and Magee (2002) used data from the Center for Responsive Politics to link each PAC to a two-digit SIC industry.[19]

A simple nonparametric test of the theory is to look at the fraction of PAC contributions given to proponents of free trade to see if the fractions are different for PACs representing labor than they are for PACs representing capital. In this context, a candidate was considered a proponent of free trade if he or she voted in favor of NAFTA, voted in favor of the Uruguay round of GATT, or voted in favor of both bills. The predictions of our model suggest that the fractions of contributions given to free trade proponents should be the same for both capital and labor PACs if they represent low-turnover industries, but they should be different if they represent high-turnover industries. In particular, since the United States is presumed to be relatively capital abundant, the Stolper–Samuelson Theorem would argue that free trade benefits capital and harms labor, so a stronger prediction is that PACs representing capital ought to have a larger fraction of their political contributions going to free trade proponents than the fraction donated by labor PACs if both represent high-turnover industries. Cleaving the data along an alternative dimension, PACs that are identified with an import-competing industry should give fewer contributions to free-trade candidates compared with those representing export industries if the industries in question are characterized by low turnover, but there should be no difference between contributions of the two if both represent high-turnover industries.

The results of this test are reported in Table 4.3, which are reproduced from Magee, Davidson, and Matusz (2002, Table 2). In this table, we define high-turnover industries as those where the average job destruction rate during the years 1988–1992 were above the median level for all two-digit industries, and we define import-competing industries as those for which the value of imports exceeds the value of exports.

The top half of Table 4.3 compares the share of contributions given to proponents of free trade (representatives who ultimately voted in favor of NAFTA, GATT, or both) by PACs representing the interests of capital and those representing the interest of labor. As predicted, there is no statistical difference between these shares when the PACs are associated with low-turnover industries (where a factor is employed is more important than the functional identity of the factor), but PACs representing capital in high-turnover industries give a significantly higher share of contributions to free trade proponents than do PACs the represent labor (the functional identity of the factor is more important than the sector of employment). The bottom half of the table is also supportive of the model. Significant differences between contribution shares exist only in the group of low-turnover industries, not in the group of high-turnover industries.

In Magee, Davidson, and Matusz (2002) we further explored these results, controlling for a variety of industry-specific and representative-specific factors. Our general findings are that the factor (capital or labor) that a PAC represents exerts a very large effect on the share

Table 4.3 The Fraction of PAC Contributions Given to Free Trade Proponents (Tabulated by identity of factor, sector of employment, and rate of job turnover)[a]

	Capital	Labor	*t*-statistic
Low turnover			
NAFTA	0.609	0.531	1.188
GATT	0.728	0.672	1.021
Both	0.515	0.456	0.929
High turnover			
NAFTA	0.628	0.307	5.644***
GATT	0.746	0.635	2.294***
Both	0.534	0.265	4.955***
	Export industry	Import industry	
Low turnover			
NAFTA	0.624	0.577	1.286*
GATT	0.748	0.692	1.867**
Both	0.531	0.484	1.339*
High turnover			
NAFTA	0.586	0.602	−0.381
GATT	0.759	0.718	1.248
Both	0.516	0.506	0.259

NOTE: * significant at the 0.10 level; ** significant at the 0.05 level; *** significant at the 0.01 level on one-sided *t*-tests.
SOURCE: Magee, Davidson, and Matusz (2002, Table 2).

of its contributions flowing to free trade supporters for high-turnover industries but has a negligible impact for low-turnover industries. Moreover, we find in many different specifications of the model that the critical value of turnover at which the identity of the factor begins to exert a significant influence on contribution patterns lies very near the median level of turnover.[20]

CONCLUSION

Our intent in this chapter has been to provide some evidence suggesting that trade and turnover are linked together and in a manner consistent with the predictions of our model. We first uncovered the stylized fact that, for the United States, the rate of job destruction is negatively correlated with net exports. While we were unable to empirically untangle the direction of causality, we find the robustness of this correlation to be quite provocative. We then showed how the pattern of political contributions is correlated with turnover rates in the manner predicted by our model. Since this set of relationships is self-contained, not relying on conditions abroad, and since there is little doubt about the direction of causality, we view these latter results as more directly supportive of the model.

Clearly, much empirical work remains to be done. Certainly the proliferation of studies documenting rates of job creation and destruction in other countries should facilitate the replication of studies such as those undertaken in Davidson and Matusz (2001b). On the other hand, cross-country differences in political institutions make it less likely that empirical studies of the sort undertaken by Magee, Davidson, and Matusz (2002) can be undertaken for other countries.

Perhaps the most important direction for future work is the compilation of a data set with multiple countries, comparable industries, and comparable measures of job turnover would allow for truer tests of whether or not cross-country, cross-industry differences in turnover provide a basis for comparative advantage.

Notes

1. Consistent with our model, Abowd and Ashefelter (1981) found empirical evidence that, all else equal, jobs that are subject to a greater risk of loss are correlated with higher wages.
2. Dickens (1988) provided a nice survey of some of the earlier work in this literature.
3. Even in a Cournot model, greater foreign competition pushes domestic firms back along their reaction curves, thus reducing domestic output (and employment) even as domestic prices fall.
4. Michael Klein, Scott Schuh, and Robert Triest (2003a,b) do not relate cross-industry differences in turnover to the pattern of trade, but they do explore how changes in the real exchange rate can affect job turnover.
5. See Davis, Haltiwanger, and Schuh (1996, p. 48).
6. In Davidson and Matusz (2001b) we explored the robustness of our results by using job separation data reported by the Bureau of Labor Statistics, a data set

that was discontinued after 1981. The results of our analyses using both data sets were virtually identical.

7. See Davis, Haltiwanger, and Schuh (1996, pp. 48−49).
8. DHS did propose an explanation for observing higher rates of job destruction when import shares are very high. They claimed that, in the U.S. economy, import-competing manufacturing industries are characterized by the heavy use of unskilled labor and they pay low wages. Human capital theory would suggest that turnover would be higher in such instances. Without explicitly reporting their results, they asserted that their statistical test of this hypothesis supports the theory (see Davis, Haltiwanger, and Schuh 1996, p. 49). We note here that this confluence of circumstances is also present in our model. The low-tech (import-competing) good employs relatively unskilled labor, pays low wages, and has relatively high turnover.
9. We did explore the relationship between job creation and trade patterns in Davidson and Matusz (2001b). In that paper, we combined job creation data with employment levels to obtain a proxy for our measure of job acquisition. We then found that, as expected, our proxy of job acquisition is positively related to net exports.
10. See Feenstra (1996, 1997) for a description of the trade data. These data were revised in February 1997, implying that the data we are using here are a revised version of the data underlying Table 1 in Davis, Haltiwanger, and Schuh (1996).
11. Abowd and Ashenfelter (1981) directly studied the impact of job uncertainty on wages. Their finding that inter-industry wage differentials do correlate with differences across industries in the risk of unemployment provides independent support of this result of our model.
12. The more standard approach to sorting through cause and effect would entail the use of instrumental variables for job turnover. Unfortunately, all variables that are known to be empirically correlated with job turnover are also correlated with trade patterns, negating the use of this technique.
13. It is well-known among those who do empirical work in international trade that the inclusion of variables such as capital intensity in a simple regression of this form is not a valid test of the Heckscher–Ohlin–Samuelson model of international trade. See, for example, Leamer and Bowen (1981). Our only purpose for including these variables is to act as industry controls so that we might better isolate the relationship between job destruction and trade patterns.
14. Measures of the industry-specific capital stocks and employment were obtained from the NBER-CES Manufacturing Industry Database. The unemployment rate and the value of the dollar were obtained from various issues of the *Economic Report of the President*. The value of the dollar used here is an index measure of the nominal value of the dollar against a weighted average of the 10 largest trading partners of the United States.
15. We showed in Davidson and Matusz (2001b) that our results hold at the two-digit SIC level as well as the four-digit level, and they also hold when we use the job separation rate (reported by the U.S. Bureau of Labor Statistics until 1981) rather than the job destruction rate.

16. This is analogous to a Heckscher–Ohlin model where two countries have the same factor endowments and the same production technologies. There would be no comparative advantage and no trade in this world.
17. The data are reported in their Table 2. The reason that there are only 19 industries is that they combine industries 38 (instruments) and 39 (miscellaneous products). They note in a footnote that there are slight discrepancies in industry definitions across countries.
18. See Magee, Davidson, and Matusz (2002).
19. Unlike tests aimed at uncovering the determinants of comparative advantage, tests directed at exploring the impact of trade on factor income do not require data from other countries. In that regard, the results that we report in this subsection are more closely tied to (and supportive of) our model than the earlier results reported in this chapter. Moreover, there is less ambiguity regarding the direction of causality. It is hard to imagine that PAC contributions cause either industry turnover or the net trade position of an industry.
20. See Magee, Davidson, and Matusz (2002) for full details.

5
Policy Analysis

One of the points that we stressed in the first chapter of this monograph is that there is a lack of existing research regarding the most efficient way to compensate those who lose from trade liberalization despite the near universal acknowledgment that some workers pay dearly.[1] Perhaps the main reason that researchers have avoided tackling this question is that the standard models used to analyze trade-related issues are simply not suitable to address this issue.[2] As we have noted, most models do not allow for unemployment and do not take into account the training and search processes that most workers must go through to find a job. In Chapter 3 we took a small step toward filling the existing void in the research literature by showing that it is possible to develop tractable general-equilibrium trade models that allow for unemployment. However, we kept the models in that chapter rather simple in order to highlight the role that labor-market structure plays in trade-related issues when unemployment is present. Unfortunately, simplicity comes at a cost. In particular, the simplicity of the models contained in Chapter 3 limits their usefulness for policy analysis. In each of those models, all workers are identical. Workers are unemployed because they are unlucky, not because they do not have the skills or abilities to acquire the jobs that are available. Moreover, since all workers are alike, it is hard to discuss issues related to income distribution. While it is true that expected lifetime income varies as workers cycle between employment and unemployment, there is no real sense in which any group of workers is poorer than any other group.

In this chapter, we enrich our basic search model of trade and unemployment to allow for a workforce that is truly heterogeneous in terms of innate ability and acquired skills. In this enriched model, workers with the very lowest levels of innate ability might find themselves completely shut out of the labor market. This class of workers corresponds to the poorest in society, whose wages are not sufficient to even cover the costs, such as child care or transportation, associated with accepting employment. Those workers with somewhat more ability will find it in their interests to accept jobs that are easy to find and require very little investment in human capital. While workers with slightly higher ability might have slightly higher productivity in these jobs, and therefore slightly higher wages, the relationship between ability and wage is relatively weak. Moreover, we model these jobs as transitory, being of relatively short average duration. Finally, those with the highest ability find it worthwhile to make a significant investment in time and resources in order to obtain the skills needed to acquire the best jobs in the economy. These are the jobs where wages are heavily dependent upon a person's ability and have a relatively long average duration. As a form of shorthand notation, we refer to the two different kinds of jobs as "low tech" and "high tech." To keep matters simple, we structure the model such that only low-tech jobs are available in one of the two sectors of our economy, and only high-tech jobs are available in the other. Therefore, we can also refer to a sector as being either high tech or low tech.

As in the models we illustrated in Chapter 3, equilibrium in this enriched model appears static on the surface where, say, the overall level of unemployment is constant over time. However, closer inspection reveals a beehive of activity as individual workers continually make transitions between job training, searching for employment, and actually working.

To investigate the best way to compensate those who are harmed by trade liberalization, we start by assuming that our economy has a comparative advantage in the high-tech good. As such, imports of the low-tech good place downward pressure on the wages of workers with the lowest abilities and least skills. We assume that the government initially provides protection to this group of workers by levying a 5 percent import tariff. Starting from steady-state equilibrium, we examine what would happen to resource flows and income distribution in the event that the government was to liberalize trade by completely abolishing the import tariff.

One result that follows from removing the tariff is that some workers who had been inefficiently employed in low-tech jobs switch to higher-paying jobs that require more skill. Moreover, one of the central benefits of our model is that we are able to characterize the entire adjustment path between the preliberalization and postliberalization steady states. This means that we can explicitly capture the aggregate costs of adjusting to the policy change.

We show that the economy gains from liberalization, but two classes of workers suffer losses. As a group, the workers who switch sectors lose. Although they end up with higher-paying jobs, they bear *all* of the adjustment costs imposed on the economy by liberalization—they must first retrain and then search for reemployment. These two activities are costly both in time and resources. The other group that loses consists of the workers who remain trapped in low-wage jobs. These workers do not switch jobs because either they are unable to obtain the skills required for the higher-paying jobs or because it would be too costly for them to do so.

We continue our analysis by comparing a variety of policies that could be used to compensate these two groups in order to determine which policy works best. The four policies that we focus on are wage subsidies, training subsidies, employment subsidies (sometimes referred to in the policy community as "reemployment bonuses"), and unemployment insurance (which proxies for trade adjustment assistance). These are the kinds of policies that have been the focus of a great deal of debate within the policy community. Many of the recent contributors to this debate have suggested that wage subsidies are ultimately the best tool to use to compensate dislocated workers because of their incentive effects—wage subsidies reward work and encourage dislocated workers to return to work quickly.[3] By contrast, trade adjustment assistance, which has been the primary instrument used in the United States to compensate displaced workers,[4] reduces the opportunity cost of unemployment, resulting in longer spells of unemployment. While the economic intuition underlying these recommendations appears sound, these recommendations have not been the result of rigorous economic analysis. In the absence of a framework within which various policies can be compared, it is impossible to identify the most important determinants of a particular policy's efficacy. For example, while the incentive effects of wage subsidies and trade adjustment assistance might work in opposite directions in terms of effort put into the search process, wage subsidies may also create incentives that lead to inefficient allocation of labor across sectors.

Our overarching goal in this chapter is to show that serious policy analysis can be carried out in models that are rich enough to capture important features of real world labor markets without sacrificing tractability. We note, however, that tractability is not synonymous with lack of technical sophistication. For example, a complete characterization of the adjustment path requires us to solve a system of differential equations. While it is inevitable that we retain some of the more technical material in the chapter, we strive to provide clear and complete intuition for all of our results. We provide all of the technical details in Davidson and Matusz (2002b).[5]

In what follows, we introduce the model and characterize the initial tariff distorted equilibrium. We then examine how the economy adjusts to liberalization in the absence of policies designed to compensate the losers. The final sections of the chapter are devoted to a description of the conceptual issues involved in designing the optimal compensation policy and a quantitative assessment of the costs of the optimal scheme.

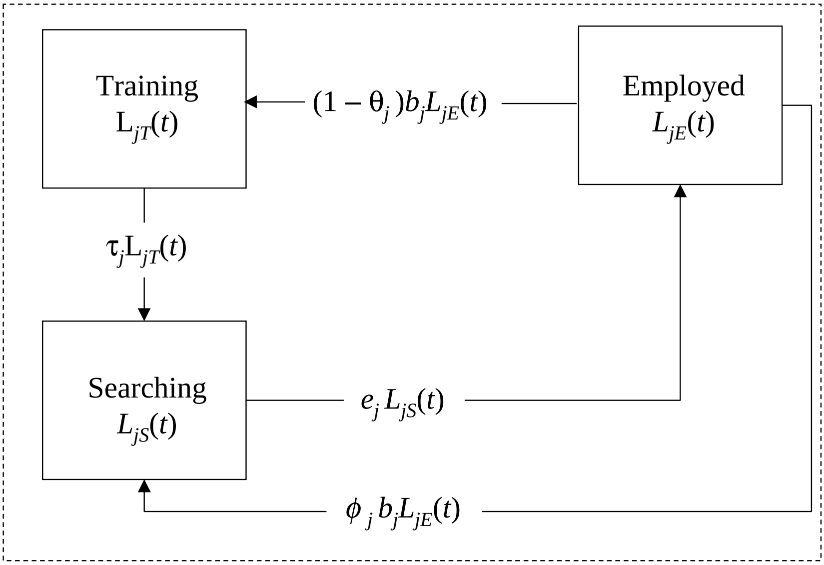
THE MODEL

The model that we use has the same basic structure as the search model introduced at the beginning of Chapter 3. There are two goods and labor is the only input. Each worker must choose an occupation. If they chose to work in sector j, then they must first acquire the skills necessary to perform the tasks associated with a sector j job. These skills are acquired through training that is costly. Once the training process is complete, the worker then begins to search for a job in sector j.[6] As before, jobs are filled randomly and last until exogenous separation forces the worker to seek reemployment. As long as the job lasts, the worker produces output and earns income. For any given job, productivity increases proportionately with the ability of the worker filling the job.

We illustrate the three possible labor-market "states" and the flows between states in Figure 5.1. This figure also helps to set notation.

Each box in Figure 5.1 represents one of the three possible states of the labor market. The variables $L_{jk}(t)$ represent the number of workers in sector j at time t who are either training ($k = T$), searching ($k = S$), or employed ($k = E$).[7] The arrows between the boxes show the flows between states. Initially, all workers start out training. These

Figure 5.1 Labor-Market Dynamics within a Sector



workers commence searching for employment upon completion of their training. The flow out of training equals $\tau_jL_{jT}(t)$, where τ_j is an exogenously specified parameter of our model. Suppose, for example, that there are always 100 workers in training and that training requires three months to complete. Then the three-month completion rate (one quarter of a year) corresponds to a value of τ_j equal to 4. Over the course of a year, 400 workers will complete the training process. While the transition from one state to the next is technically a random process, it is useful to think that 100 workers enter training on the first day of the year and graduate after three months. The moment that these first 100 workers complete training, they are replaced by 100 new workers who require exactly three months to complete training, and so on.

Similarly, the flow of workers out of the pool of searchers into employment equals $e_jL_{jS}(t)$, where e_j is an exogenously specified parameter and has an interpretation analogous to the interpretation of τ_j. In particular, if the average duration of unemployment is, say, six months, then the corresponding value of e_j is 2. During the course of a year, we can expect the pool of unemployed searchers to completely turn over twice.

The number of employed workers who lose their jobs during the year is $b_j L_{jE}(t)$, where b_j is an exogenously specified parameter that should be interpreted in the same way as we interpret τ_j and e_j. A fraction (ϕ_j) of the workers who lose their jobs retain their skills and can immediately commence searching for a new job. However, the remaining fraction find that their skills will not transfer to a new job, and therefore must "start at the bottom," by entering the training process before searching for a new job.

The dashed line that encircles the various boxes and flows in Figure 5.1 represents the boundaries of sector *j*. That is, the area encompassed by this boundary represents the size of the sector measured as the total number of workers training, searching, and employed in sector *j*.

The stocks and flows represented in Figure 5.1 represent a system of differential equations. Given the total number of workers affiliated with this sector, it is a simple matter to solve this system for the numbers of workers in each labor-market state as functions of time. Moreover, the steady-state values of these variables are easily computed by thinking about their limiting value as the time index approaches infinity. For future reference, we will use the notation $L_{jk}(\infty)$ to represent the steady-state value of L_{jk}.

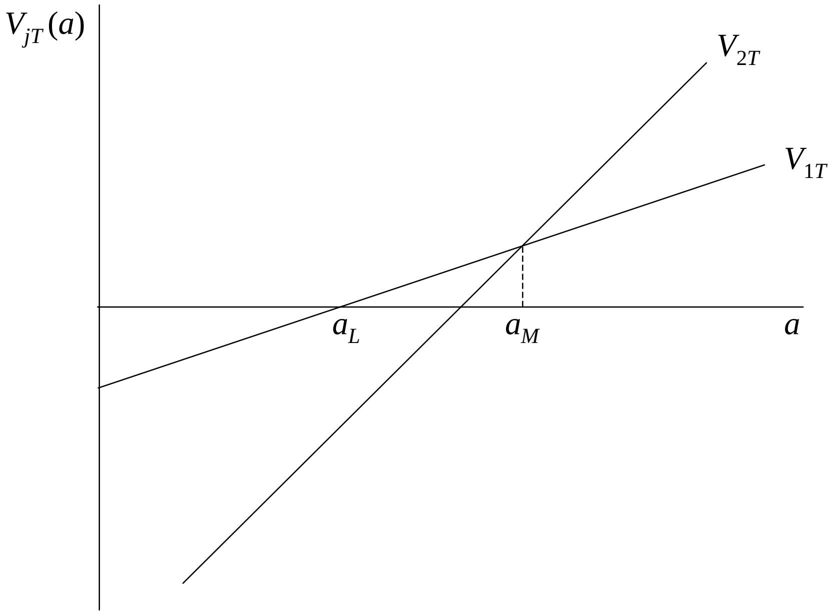
While we are not yet done describing our model, we pause here to use Figure 5.1 to explain a bit more precisely some of the characteristics that distinguish the high-tech sector from the low-tech sector. As we noted earlier, one difference between the two sectors is that jobs in the low-tech sector have a low average duration, whereas those in the high-tech sector have a high average duration. In terms of the parameters of the model, this means that we will assume $b_1 > b_2$, where sector 1 is the low-tech sector. We also assume that jobs in the low-tech sector do not require a heavy investment in training, whereas high-tech jobs do require such an investment. In part, we model this difference by assuming that $\tau_1 > \tau_2$. Finally, we suggested at the beginning of this chapter that low-tech jobs are relatively easy to find compared with high-tech jobs. In our analysis, we make this assumption operational by assuming that e_1 is infinite, implying that workers in the low-tech sector find jobs instantly upon completion of their training. By contrast, we assume that e_2 is finite and choose its value to be consistent with empirical evidence on the average duration of unemployment in the United States.

To complete the basic description of the model, we need to describe how workers move between sectors. In this regard, we assume that all workers are forward-looking, income-maximizing agents. Each untrained worker needs to decide which sector, if any, he or she should enter. To make this decision, the worker calculates the discounted lifetime real income (net of training costs) that he or she could expect to earn by entering the low-tech sector versus the high-tech sector. These values are compared against each other and against the alternative (normalized to zero) of not training for a job in either sector. The worker will choose the activity that generates the highest value of discounted lifetime income.[8] In making this calculation, we assume that the worker knows all of the parameters of the model. That is, he or she knows how costly training is (in both time and resources), the average duration of employment and unemployment in each sector, and the wage that he or she would earn while employed.

We illustrate the decision process with the aid of Figure 5.2. The horizontal axis of this figure represents worker ability. Technically, we assign to each worker an ability index (a), where we normalize this index so the least able workers in the economy have ability $a = 0$, while the most able workers have ability $a = 1$. As illustrated by the positive slopes of the curves labeled $V_{jT}(a)$, discounted lifetime real income from training in either sector is increasing in ability. Moreover, we capture our assumption that income is more sensitive to ability in the high-tech sector than in the low-tech sector by drawing the curve corresponding to the high-tech sector steeper than the curve corresponding to the low-tech sector. The fact that there is a real resource cost of training implies that there may exist some low levels of ability such that discounted lifetime real income from training is negative because wages earned on the job are not sufficient to recover these costs.

There are two critical levels of ability marked off in Figure 5.2. Any worker with an ability level below a_L is effectively shut out of the labor market. There is no way that the wages that this worker could earn can compensate for the expense of training.[9] Workers with ability levels between a_L and a_M will choose to train for low-tech jobs, while those with ability levels above a_M will choose to train for high-tech

Figure 5.2 Discounted Lifetime Income from Training



jobs. In this context, we use our subscripting convention to denote that the worker with ability level a_M is the "marginal" worker who is just indifferent between training for a low-tech job and training for a high-tech job.

The exact positions of the two curves in Figure 5.2, and therefore the precise values of the two critical levels of ability, depend on all of the parameters of the model, including the level of protection afforded to the low-tech sector. For example, if technological improvement implies that workers, regardless of ability, become more productive in the high-tech sector, the curve labeled V_{2T} shifts up, implying a reduction in a_M. After the technological improvement, a greater number of workers find it in their interest to train for high-tech jobs, causing the high-tech sector to expand at the expense of the low-tech sector (all else equal).

More to the point of this chapter, eliminating a tariff on the imports of low-tech goods results in a lower domestic price for these goods, and ultimately lower wages paid in this sector. The curve labeled V_{1T} shifts down, causing a_M to fall.[10] Some of the higher-ability workers who are in the low-tech sector under a regime of tariff protection find it worthwhile to switch to the high-tech sector. Trainees switch immediately, while those employed in the low-tech sector must decide whether to quit their jobs and switch sectors immediately or keep their jobs and switch only after losing their jobs. If we use a_Q to denote the ability level of the low-tech worker who is just indifferent between quitting and keeping her job, then it is straightforward to show that $a_Q \in [a_M^{FT}, a_M]$, where a_M^{FT} denotes ability level of the new marginal worker after liberalization. Employed workers with $a \in [a_Q, a_M]$ quit immediately and start to train for high-tech jobs, while those with abilities $a \in [a_M^{FT}, a_Q]$ wait and switch after losing their low-tech jobs.

This completes the description of our model. While rich in features, the mathematical structure of the model is simple enough that we can provide a complete and explicit solution for all endogenous variables and for every value of t.

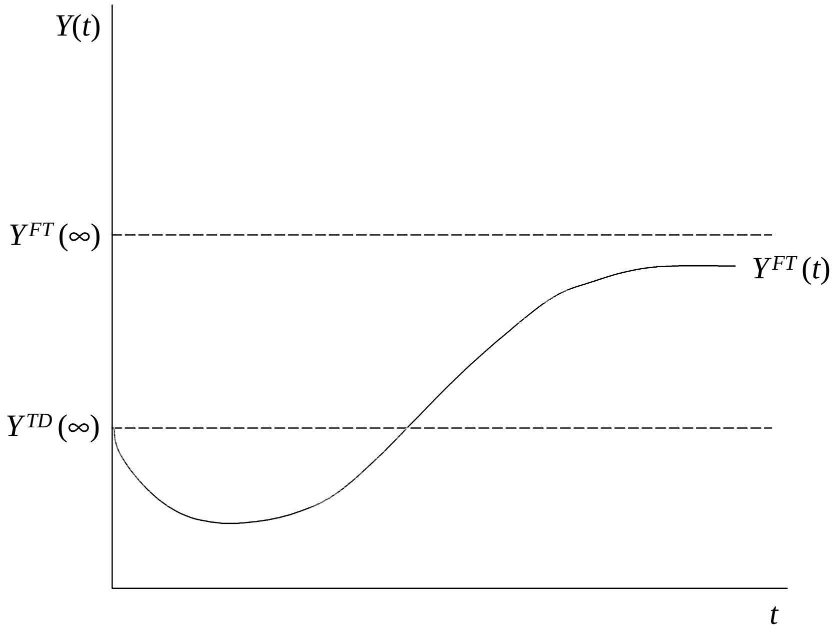
LIBERALIZATION AND ADJUSTMENT

Suppose now that the government abolishes the 5 percent import tariff on the low-tech good. As discussed in the previous section, this will reduce wages in the low-tech sector and ultimately result in some workers moving out of that sector in favor of the high-tech sector. While workers with sufficiently high ability move instantly into the high-tech sector, those with low abilities who are employed in the low-tech sector move only gradually. Intuitively, there will be a dip in national income as workers exit the sector where almost all time is spent in actual production (the training process is short and the search process is instantaneous) into a sector where training and search are time consuming. Real income only recovers after enough time has passed so that the movers start obtaining jobs. Since a worker of any given ability is more productive in a high-tech job than in a low-tech job, the value of income ultimately surpasses the tariff-distorted level. Moreover, since there are no distortions or externalities in our model, the free-trade equilibrium is dynamically efficient. This means that, properly discounted, the eventual increase in the value of income more than compensates in the aggregate for the early losses.

We illustrate in Figure 5.3 a typical time path for real income (evaluated at world prices) net of training costs. In this figure, $Y^{TD}(\infty)$ represents the tariff-distorted steady-state value of income and $Y^{FT}(\infty)$ represents the free trade steady-state value of income. The adjustment path is represented by the curve labeled $Y^{FT}(t)$. A proper comparison between the status quo and trade liberalization requires us to compare the discounted value of $Y^{TD}(\infty)$ with the discounted value of $Y^{FT}(t)$, where the time index t is allowed to go to infinity. For future reference, we use W^{TD} and W^{FT} to represent these discounted values.

In Davidson and Matusz (2001a), we used this model to investigate the size and scope of the adjustment costs imposed on the economy as it moves to its new steady-state equilibrium. For empirically relevant values of the parameters, we found that these costs were surprisingly high. In particular, we found that adjustment costs would eat away anywhere from 30 percent to 80 percent of the potential gains from trade and that it would take the economy approximately 18 months before net output would get back to its preliberalization level.

Figure 5.3 The Value of Output Net of Training Costs over Time



These results have important implications for the effect of liberalization on the distribution of income since these costs are all borne by a relatively small group of workers—those who switch sectors. Although these workers eventually gain by finding higher-paying jobs, their gains may be wiped out entirely by training and search costs. Of course, some of these workers gain while others lose. Below, we examine their aggregate gains or losses by looking at how the group as a whole is affected by liberalization.

The effects of the tariff reduction on all other groups of workers are unambiguous. All those who are initially out of the labor market and remain so (those with ability levels below a_L), and all those who are initially tied to the high-tech sector (those with ability levels above a_M) benefit from the fall in the domestic price of the low-tech good. In contrast, all those who were initially tied to the low-tech sector and remain so (the "stayers") lose as their real incomes fall.

CHOOSING PARAMETERS

We need to choose parameter values in order to quantify the burden placed upon those who lose from liberalization. We explain our choices in this section.

Some of the parameters of our model are fairly easy to pin down. For example, the average duration of unemployment, which equals $1/e_2$ in our model, can be found in *The Economic Report of the President* (for 2001 see table B-44). While this value fluctuates over the business cycle, it is usually close to one quarter (13 weeks), rarely straying from that value by more than 2 weeks. Thus, we set $e_2 = 4$.

Data on job turnover in U.S. manufacturing is also readily available and can be used to pin down the separation rate in the high-tech sector. Davis, Haltiwanger, and Schuh (1996) provided data on annual rates of job destruction in U.S. manufacturing industries and reported that the average annual rate was 10 percent for the period of 1973–1988. This translates into an average duration of employment of 10 years. This value varies over the business cycle, reaching a peak in 1975 at 16.5 percent (implying an average duration of employment of 6 years).[11] Thus, we consider values for b_2, the separation rate in the high-tech sector, such that high-tech jobs last, on average, between 6 and 10 years.

Pinning down the separation rate in the low-tech sector is more complicated. We model these jobs as transitory, low-paying, undesirable jobs that require few, if any, skills. While many of these jobs may be found in the manufacturing sector, it is hard to know how to draw conclusions about the average length of the worst jobs in a sector from industrywide data. So, we follow a different approach. We think of our low-tech jobs as the types of jobs that many workers hold when they first enter the labor force. Data on jobs held over a worker's lifetime indicate that, up to the age of 24, workers start (roughly) one new job every two years.[12] Based on this evidence, we consider two cases—one in which low-tech jobs last one year (so that $b_1 = 1$) and one in which they last two years (so that $b_1 = 0.5$).

Because we view the skills required in the low-tech sector as being very job-specific, we set the value of $\phi_1 = 0$. Any worker who becomes separated from his or her job in this sector must retrain before taking another job. This assumption is made to capture the notion that the skills acquired on low-skill jobs are usually very job specific. For example, it does not take long to learn how to stock shelves in a grocery store or how to prepare fast food. Yet, learning one such skill does not facilitate learning the other skill.

From our previous work with this model, we know that results are fairly insensitive to changes in two of the parameters—r and ϕ_2.[13] For all empirically relevant values for the interest rate (below 20 percent) and for values of ϕ_2 between 0.5 and 0.9, our estimates on the size and scope of adjustment costs vary only at the third decimal place. Since our results are so insensitive to changes in these parameters, the only values for r and ϕ_2 that we consider are $r = 0.03$ and $\phi_2 = 0.8$.

The remaining parameters are connected to the training and production processes. Unfortunately, not much is known about the size and scope of training costs. For the low-tech sector, we want to choose values for resource and time costs of training that are consistent with the notion that low-tech jobs do not require many skills. Thus, we assume that there are no resource costs and assume that the time costs are small by setting $\tau_1 = 52$. The absence of resource costs assumption implies that $a_L = 0$, so that all workers enter the labor force.

Setting $\tau_1 = 52$ implies that it takes only one week to learn the skills required to perform low-tech jobs.

As for the high-tech sector, we turn to the limited information that is available on training costs. Hamermesh (1993) provided a survey of the evidence on turnover costs where these costs are assumed to include the costs of recruiting and training newly hired workers. He concluded that in some instances these costs may be quite high. For example, the cost of replacing a worker in a large firm in the pharmaceutical industry was pegged at roughly twice that worker's annual salary. In the trucking industry, the cost of replacing a driver was estimated to be slightly less than half the driver's annual salary.[14] Similar estimates can be found in Acemoglou and Pischke's (1999) study of the German apprenticeship training system. They report estimates of training costs that vary from 6 to 15 months of the average worker's annual income. We capture this wide range of estimates by assuming that high-tech training lasts 4 months ($\tau_2 = 3$) and then vary the value of the resources involved in training so that total training costs vary from a low of 1 months' pay for the average high-tech worker to a high of 15 months pay. We also consider two intermediate values in which these costs are equal to 5 and 10 months of high-tech income.[15]

This leaves only the parameters that determine the relationship between wages and ability. We assume that each worker is paid the value of his or her marginal product, and the value of that worker's marginal product in sector j is $p_j q_j a$, where p_j is the domestic price of output and where q_j is a productivity parameter. From the structure of the formal model, only the relative values of these two parameters matter for worker decisions. Since all that matters is their relative value, we set $q_2 = 1.4$ (which simplifies the calculation of the resource cost of training in the high-tech sector) and vary q_1. As q_1 varies, the relative attractiveness of the two sectors changes. This results in changes in a_M and the equilibrium size of the low-tech sector. We consider three different values of q_1 for each combination of turnover rates. These values correspond to values of a_M equal to 0.1, 0.2, and 0.33. Assuming, as we do, that workers are uniformly distributed over all levels of ability, our selection of parameter values implies that initially 10 percent, 20 percent, or 33 percent of the workforce is employed in the low-tech sector.

COMPENSATING THE MOVERS: THEORETICAL CONSIDERATIONS

After solving the model for each possible combination of parameters, we calculated the percentage change in the discounted lifetime real income earned by the movers as a group.[16] In each case, the movers are harmed by the removal of the tariff. Even in the case in which high-tech training costs are extremely low and turnover is high (so that the transition to the new steady-state is relatively quick), the adjustment costs imposed on this group outweigh their long-term gains. The losses vary between 0.5 percent to 2.5 percent.

We also find that workers in the high-tech sector enjoy an increase in discounted lifetime real income of less than 0.5 percent, while the lowest income workers, those still trapped in the low-tech sector, see their discounted lifetime real income drop by more than 4.5 percent. This means that liberalization leads to a less equal distribution of income—the rich get slightly richer, the poor get poorer, and those in the middle suffer moderate losses. Yet, in spite of this increase in inequality, there can be no doubt that liberalization is desirable since it generates aggregate net benefits.[17] These results underscore the importance of accompanying liberalization with programs that compensate the losers so that all can share the benefits from freer trade. In this section we focus our attention on determining the best way to compensate the movers.[18] We consider the best way to compensate the stayers in the section that follows.

Any attempt to compensate those who are harmed by liberalization must distort the economy. Our goal is to find the policy that provides sufficient compensation at the lowest cost to the economy.

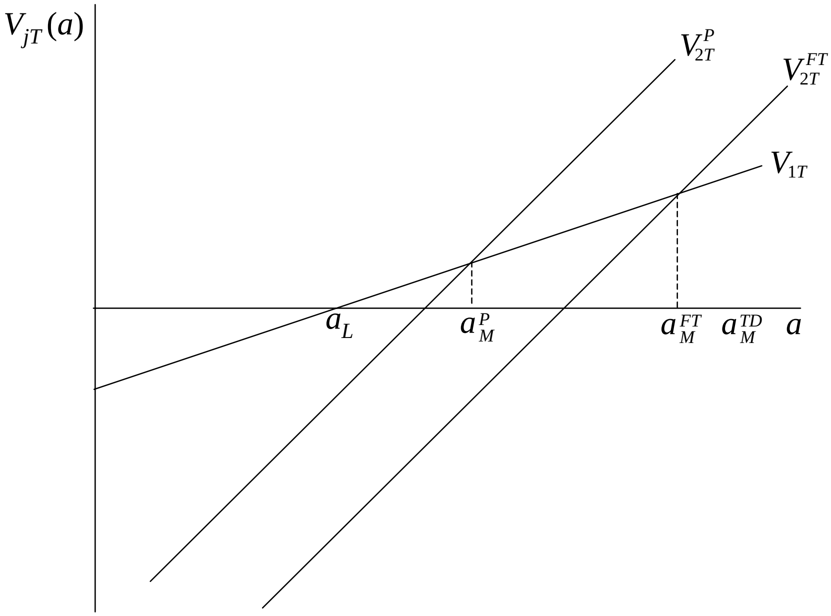
There are two sources of distortion associated with each compensation scheme. The first source comes from the introduction of the policy itself since this distorts incentives. For example, a wage subsidy offered to workers who move to the high-tech sector makes sector 2 more attractive than it ought to be and results in too many workers switching sectors. The need to pay for the compensation scheme creates the second source of distortion. We assume that any policy is financed by taxing earned income at a constant marginal tax rate. The introduction of this tax also distorts incentives, although in a less obvious way. In short, both the implementation of the policy and the introduction of the tax rate change the equilibrium allocation of labor across the two sectors so that the transition from the initial tariff distorted equilibrium to the new steady state is no longer efficient.

In comparing two policies, it should be clear that the policy that fully compensates the losers while having the smaller impact on the equilibrium distribution of workers would generate the smaller distortion. This leads to an immediate conclusion—*any optimal policy must be targeted*. By targeted we mean that only those who lose from liberalization must qualify for assistance. Thus, if we are considering using a wage or training subsidy to compensate the movers, then only those who were training or employed in the low-tech sector at the time of liberalization should qualify for the subsidy. Offering the subsidy to workers who were already attached to the high-tech sector would needlessly add to the cost of the program and thereby create a larger than necessary distortion. In addition, there is no reason that these workers should qualify. After all, they already benefit from the removal of the tariff—why increase their incomes even further?

The second criterion for an optimal policy is that the compensation scheme should have a relatively large impact on the *average* mover and a relatively small effect on the marginal mover. By definition, a policy that fully compensates the average mover also compensates the entire group of movers. Programs that provide little "bang for the buck" will have to be large and expensive if they are to compensate the average mover. On the other hand, programs that have a large impact on the marginal mover will tend to encourage too much inefficient movement into the high-tech sector. Combining these two factors, the ideal compensation scheme will be one that has a large impact on the average mover (so that the program will be small) and a small impact on the marginal mover (so that the number of inefficient movers will be small). Or alternatively, the ideal policy will be one that provides more value to the average mover than to the marginal mover. This is the key to finding the optimal policy.

We use Figures 5.4 and 5.5 to summarize this discussion. The ability level labeled a_M^{TD} represents the ability level of the marginal worker in the initial tariff-distorted equilibrium. We also use a_M^{FT} to denote the ability level of the marginal worker in the free trade equilibrium and a_M^{P} to denote the ability level of the marginal worker when liberalization is coupled with a policy aimed at compensating the movers. Com-

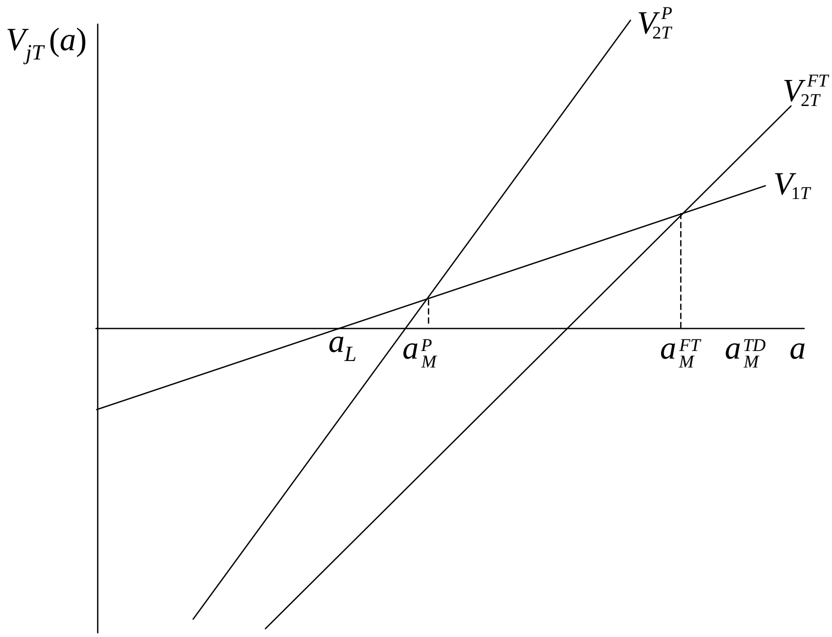
Figure 5.4 Effects of an Employment or Training Subsidy



pensating those who move to the high-tech sector increases the expected lifetime income that can be earned by training for sector 2 jobs. Thus, compensation policies cause the V_{2T} curve to shift up. In terms of economic efficiency, the only workers who *should* switch sectors are those with $a \in [a_M^{FT}, a_M^{TD}]$. However, since the compensation scheme shifts up V_{2T}, we get an inefficient reallocation of labor with those workers with $a \in [a_M^P, a_M^{FT}]$ moving as well. This is the source of the distortion caused by the compensation policy.

The difference between Figures 5.4 and 5.5 is that neither employment subsidies nor training subsidies depend on ability in our model, therefore implying that they have equal value to the marginal and average mover. Thus, in Figure 5.4, employment or training subsidies cause the V_{2T} curve to shift up in a parallel fashion. By contrast, both wage subsidies and unemployment compensation increase with the wage and therefore with ability. This is reflected in Figure 5.5 by the nonparallel shift up in V_{2T}. Note that, since the average mover has higher ability than the marginal mover, these policies are valued more by the average mover than they are by the marginal mover.

Figure 5.5 Effects of a Wage Subsidy or Unemployment Compensation



COMPENSATING THE MOVERS: QUANTIFYING THE COSTS

We consider four policies—wage subsidies, training subsidies, employment subsidies (which are independent of the wage), and unemployment insurance. In each case, we solve for the level of assistance required to exactly offset the losses suffered by the movers (as a group) and then calculate the deadweight loss imposed on the economy. The optimal policy is the one that compensates the movers while generating the smallest deadweight loss.

All of the policies that we consider are targeted, meaning that compensation is only offered to workers who were training or employed in the low-tech sector at the time of liberalization and who subsequently move to the high-tech sector.

In the context of our model, it turns out that wage subsidies and unemployment compensation provide the equivalent incentives regarding movement into the high-tech sector, and both are welfare-superior to training subsidies and employment subsidies (which are themselves equivalent). The reason for this result is that the absolute size of both wage subsidies and unemployment benefits are positively related to wages, which in turn are positively related to ability.[19] Since the first workers to move to the high-tech sector are those who are at the top of the ability distribution in the low-tech sector, the ability of the marginal mover (the one who is just indifferent between remaining in the low-tech sector and moving to the high-tech sector) is less than the ability of the average mover. Hence, the average mover values wage subsidies and unemployment compensation more than the marginal mover does (as shown in Figure 5.5). By contrast, neither employment subsidies nor training subsidies depend on ability. Therefore, the average and marginal movers value them equally (as shown in Figure 5.4).

We only present quantitative results for the case of wage subsidies and unemployment compensation because these policies both dominate employment or training subsidies in terms of the amount of deadweight loss that they generate.

The wage subsidy needed to compensate the movers as a group is quite modest—less than 2 percent for each set of parameters we considered. This value is largely insensitive to the job destruction rates used, varying between one-half of 1 percent to a high of 2 percent. The subsidy is more sensitive to the assumptions made about the magnitude of high-tech training costs assumed. As expected, higher training costs imply that a higher subsidy is needed to compensate this group.

Our main concern, however, is not the magnitude of the subsidy required, but the cost of such a program in terms of deadweight loss imposed on the economy. We therefore now turn to the efficiency cost of the compensation policy. We have already defined W^{TD} as the value of discounted income (net of training costs and measured at world prices) associated with the tariff-distorted equilibrium. We have also defined W^{FT} as the counterpart under a regime of free trade. The aggregate net benefit from removing the tariff is then $W^{TD} - W^{FT}$. However, the introduction of a policy to compensate the movers distorts the allocation of resources away from the (efficient) allocation that would take place under free trade and without any additional government intervention. Define W^{P} to be the value of discounted income associated with a regime of free trade accompanied by a policy to fully compensate the movers. Then, it must be the case that $W^{TD} \leq W^{P} < \mathrm{W}^{FT}$. The main question that we want to address is: What percentage of the gains from freer trade is eaten away by the implementation of a policy to compensate the movers? This measure of deadweight loss is given by $(W^{FT} - W^{P})/(W^{FT} - W^{TD})$?

Our results are somewhat surprising. Regardless of the turnover rates, compensating the movers with a wage subsidy (or unemployment insurance) does not impose a large cost on the remainder of the economy. Deadweight loss varies from less than 1 percent of the net gains from liberalization (when high-tech training costs are set at their lowest levels) to a high of 6 percent (when high-tech training costs are set at their highest levels). There are two factors that contribute to this outcome. First, as we noted earlier in this chapter, the movers in our model do not suffer huge losses from liberalization. Second, liberalization does not trigger that much movement in our model. In the case in which 20 percent of the labor force is initially employed in the low-tech sector, only 4 percent of the labor force switches to the high-tech sector when the tariff is removed.[20] The fact that the cost imposed on the rest of the economy is so small makes these redistribution policies considerably attractive—it is almost costless to compensate the movers for their losses.

Up to this point we have argued that both wage subsidies and unemployment benefits are superior to training and employment subsidies when it comes to compensating the movers. It is natural to ask about the degree to which these policies are better. In other words, if we were to use training subsidies instead, how much higher would the deadweight loss be? The answer to this question depends on the initial size of the low-tech sector and the extent of training costs. At one extreme, when training costs are equal to 10 months of high-tech wages and $a_M = 0.01$, the difference is small—deadweight loss would be about 10 percent higher with training or employment subsidies. At the other extreme, when training costs are equal to just 1 month of high-tech wages and $a_M = 0.1$, the difference is dramatic, with deadweight loss increasing from 0.53 percent to over 2 percent—an increase of about 300 percent! However, in every case the cost of compensating the movers remains small, below 10 percent of the net gains from liberalization, even if the wrong policy is used.

As we noted in the introduction, the United States currently relies on trade adjustment assistance as its primary way to compensate dislocated workers (i.e., the movers in our model). Since trade adjustment assistance is little more than extended unemployment insurance, it appears that our analysis provides support for current practices. However, we close this section by arguing that two simple, natural extensions of our model would lead to the conclusion that it is more efficient to compensate the movers with wage subsidies than unemployment benefits. We begin by reminding the reader that the turnover rates in our model are all exogenous. We chose to set the model up this way in order to keep it tractable and to insure that our free trade equilibrium would be efficient. However, in reality, workers can alter their job acquisition rates by varying their intensity of job search. Our model would therefore be more realistic if e, the rate at which workers return to work, was endogenously determined by worker behavior. In such a model, wage subsidies would be superior to unemployment benefits because of their impact on incentives. Wage subsidies, by increasing the opportunity cost of remaining unemployed, would encourage the movers to search hard and return to work quickly. In contrast, unemployment benefits would lower the opportunity cost of unemployment, reducing e, and slowing down the transition to the new steady state. Thus, if we were to extend our model to allow the turnover rates to be endogenous, wage subsidies and unemployment benefits would no longer be equivalent—wage subsidies would be a superior way to compensate the movers.

The other assumption that would be worthwhile to relax has to do with the manner in which ability affects the wages earned by workers. In our model, the wage in each sector increases linearly with ability. In reality, since ability is more valuable in complex settings, it is probably the case that high-tech wages are more sensitive to ability than low-tech wages. One way to capture this notion would be to assume that low-tech wages are a concave function while high-tech wages are convex in ability.[21] The implication of this assumption is that there will be a larger spread between what the average and marginal worker will earn in the high-tech sector than there is in the low-tech sector. And, since wage subsidies are tied to the wage earned on the mover's new job (in sector 2), while unemployment benefits are tied to the wage earned on the worker's previous job (in sector 1), such an assumption would have important policy implications. In particular, wage subsidies would have a larger differential impact on the average and marginal mover's expected lifetime incomes than would unemployment benefits. It follows that wage subsidies and unemployment benefits would no longer be equivalent ways to compensate the movers—wage subsidies would again be superior.[22]

In conclusion, our results strongly suggest that it would be relatively cheap (in efficiency terms) to compensate those who change jobs as a result of trade liberalization. The optimal way to do so is to offer temporary wage subsidies targeted only at those workers who were tied to the low-tech sector at the time of liberalization. This lends support to the views of those in the policy community who have argued that "wage insurance" is a better way to compensate dislocated workers than our current practice of using extended unemployment insurance (through the training adjustment assistance program).

COMPENSATING THE STAYERS

If we are truly concerned about how liberalization affects the poor, than we should be most concerned about its impact on those who remain trapped in the low-tech sector because they do not have the ability to train for high-tech jobs.[23] These workers have lower incomes than the movers and suffer bigger losses from liberalization. In this section, we compare compensation schemes for this class of workers.

Any policy designed to compensate the stayers will increase the relative attractiveness of the low-tech sector. This creates two problems. First, some workers who should be attracted to the high-tech sector may wind up in the low-tech sector. Second, some workers who, in terms of economic efficiency, should remain out of the labor market may enter instead and seek low-tech jobs. As in our analysis of the optimal policy to compensate the movers, it is again the case that one way to minimize the distortions created by such inefficient labor-market behavior is to make any compensation scheme targeted. For example, wage subsidies should be offered only to those workers who were employed in the low-tech sector at the time of liberalization.

Since there is no low-tech unemployment in our model, and since we have assumed away the resource costs associated with low-tech training, we cannot use unemployment insurance or training subsidies to compensate the stayers. We therefore consider only two programs: a wage subsidy or an employment subsidy. As we noted earlier, the only difference between these two programs is that the wage subsidy is tied to the worker's ability (through the wage), whereas with the employment subsidy all low-tech workers receive the same transfer payment from the government. Thus, all low-tech workers are offered the same employment subsidy regardless of their ability levels.

The fact that there are two marginal workers to worry about—one who is just indifferent between the two sectors and another who is indifferent between entering the low-tech sector and staying out of the labor market—makes the problem of compensating the stayers complex. Thus, we proceed in two steps. First, we discuss optimal compensation under the assumption that all workers are initially in the labor force so that we do not need to worry about inefficient entry. Then, in step two, we relax this assumption and discuss how the optimal policy must be altered.

Suppose then that liberalization takes place and that a compensation scheme targeted at the stayers is implemented at the same time. As in the previous section, there will be some low-tech workers who will choose to relocate to the high-tech sector. However, since compensation is being offered to anyone who remains in the low-tech sector, too few workers will choose to relocate and this is the source of the distortion created when we compensate the stayers for their losses. Analogous to our earlier discussion, the key to finding the optimal compensation scheme is to find a policy that is valued greatly by the average stayer (so that full compensation can be achieved with a modest-sized program) but affects the marginal stayer only slightly (so that there is a minimal amount of temporary relocation).

When our goal is to compensate the stayers, it should be clear that the employment subsidy dominates the wage subsidy. The reason is that the average stayer among this class of workers has a lower ability level than the marginal stayer. Thus, a wage subsidy is valued more by the marginal worker than the average worker because the marginal worker earns the higher wage.[24] In contrast, the employment subsidies affect the marginal and average stayers in exactly the same manner since the employment subsidy is independent of the worker's wage.

It is worth noting that there are no current programs in the United States targeted at compensating those who remain in the sectors that have been liberalized. There are programs in place designed to augment the incomes of low-wage workers, with the most prominent one in the United States being the Earned Income Tax Credit (EITC). In our model, the EITC would be equivalent to a wage subsidy in which the level of the subsidy *decreases* with the worker's wage. This means that the EITC provides lower compensation to high-wage workers than it provides to their low-ability counterparts. It should be clear that using such a policy to compensate the stayers would be superior to an employment subsidy *if it could be targeted at the sector in question* since the average stayer would receive a higher payment than the marginal worker. The problem is that, in practice, the EITC has always been a broad-based program that applies to all low-wage workers. As we pointed out earlier, using a broad-based program adds unnecessarily to the program's cost. However, if a program like the EITC could be targeted to a specific sector, our analysis suggests that it might be the best way to compensate the stayers.

The employment subsidy that fully compensates the stayers as a group is quite low for all of the parameter values that we considered. The reason for this is simple: these workers are quite poor and earn very low wages. While the losses that they suffer in percentage terms are larger than those suffered by the movers, in absolute magnitude they are quite small. Thus, it does not take much of an employment subsidy to make up for these small losses. This is particularly true for the average stayer, since this worker has a relatively low ability level. In contrast, such a small employment subsidy is not valued very highly by the marginal worker, since this worker has a considerably higher ability level and can earn much more than the average stayer by seeking a high-tech job. It follows that the small employment subsidy does not impose a large burden on the economy. In fact, for all of the parameter values that we considered, the deadweight loss imposed on the economy by such a program is less than 1 percent of the net gains from trade reform. This makes for a compelling argument in favor of providing such compensation.

Earlier in this chapter, we noted that attempts to compensate the movers with the wrong policy could increase the deadweight loss by a large percentage, although the loss would never exceed 10 percent of the net benefits from liberalization. Mistakes are even more costly when attempting to compensate the stayers. Suppose, for example, that the government attempts to compensate the stayers with a wage subsidy. In our model, a wage subsidy acts much like a tariff in that it pushes up the wages of low-tech workers. In fact, the only difference is that consumer prices are not affected by the wage subsidy. It follows that the wage subsidy will have to be set at a level slightly below the tariff in order to compensate the stayers. But, such a high-wage subsidy will cause as many workers to remain in the low-tech sector as would have been there when the tariff was in place. As a result, the deadweight loss associated with a wage subsidy is quite high. For many of the parameter values that we considered, the loss amounted to about 60 percent of the net gains from trade reform!

We close this section by relaxing the assumption that all workers are in the labor force at the time of liberalization. Suppose that there exists a real resource cost of training in the low-tech sector so that some workers chose not to train for low-tech jobs in the initial, tariff-distorted steady state equilibrium. Removing the tariff makes the low-tech sector less attractive, so, without a compensation scheme targeted at the stayers, there would be no new entry. However, when the government attempts to compensate the stayers, some low-ability workers may be induced to enter the labor market. Such entry is inefficient and should not be encouraged since these workers do not have the ability to produce positive net output under free trade. Thus, an optimal compensation scheme should not encourage new entry. Unfortunately, any compensation scheme that fully compensates the stayers as a group will do just that since the payment offered as compensation is so large. Therefore, our goal should be to find some way to limit this inefficient entry as much as possible.

The problem with an employment subsidy is that the feature that makes it appealing when entry is not an issue—that the payment is independent of ability—makes it unappealing when entry is taken into account. The reason for this is that low-ability workers (who should remain out of the labor force) value an employment subsidy just as much as the average stayer. What we need is a policy targeted at low-ability workers that is less valuable to them than it is to the average stayer. This problem can be solved in a fairly straightforward manner by slightly altering in the compensation scheme. Suppose that an employment subsidy is offered to all but the lowest ability workers in sector 1 (say, the bottom 10–20 percent). These workers are compensated with a wage subsidy instead. The advantage of a wage subsidy is that, as we saw in the previous section, it is more valuable to workers with higher ability levels. It follows that a wage subsidy offered to low-ability workers will trigger less inefficient entry than a comparable employment subsidy. We conclude that when entry is a concern, the optimal way to compensate the stayers is to offer the bulk of them an employment subsidy and use a wage subsidy for the workers at the bottom end of the income distribution.

CONCLUSION

This chapter has been devoted to an important issue—what is the best way to compensate those who are harmed by trade liberalization? To answer this question, one must use a model that takes into account the training and search processes that workers must go through in order to find jobs. We have provided such a model and have derived some preliminary results. In the context of our model, we have argued that the optimal way to compensate the movers (who bear the entire burden of the adjustment costs imposed on the economy by liberalization) is with a targeted wage subsidy. We have also argued that the optimal way to compensate the stayers (those who remain trapped in the low-tech sector because they find it too difficult to acquire the skills required for high-tech jobs) is with a targeted employment subsidy for all but those at the lowest end of the wage distribution. These low-wage workers should be compensated with a wage subsidy.

In order to keep our model tractable, we were required to make a number of simplifying assumptions. For example, we have treated the labor-market turnover rates as exogenous, we have assumed that these turnover rates do not vary with ability, and we have assumed that additional training does not increase productivity. In the future it will be important to relax these assumptions to see how our results must be modified. Our results should therefore be viewed as the first step in a long process of investigating optimal compensation schemes when labor markets are imperfect.

Notes

1. For example, Jacobson, LaLonde, and Sullivan (1993a,b) found that the average dislocated worker suffers a loss in lifetime earnings of $80,000. In a separate study, Kletzer (2001) found that the average dislocated worker suffers a pay cut of 12 percent.
2. While there is almost no existing academic research that formally addresses the relative merits of providing different means of compensation, there is a literature that seeks to address the question of whether it is even possible to fully compensate all of those who lose from trade reform. Using a full-employment model of trade, Dixit and Norman (1980, 1986) argued that it is possible to use commodity taxes to compensate the losers without exhausting the benefits from freer trade. Brecher and Choudhri (1994) raised concerns about this result by showing that, in a model with unemployment, fully compensating losers may eat away all of the gains from trade. Feenstra and Lewis (1994) showed that similar problems arise when factors of production are imperfectly mobile, but they also showed that the use of commodity taxes coupled with trade adjustment assistance may be adequate to achieve true Pareto gains from liberalization. The only paper that we know of that directly addresses the issue of optimal compensation is Brander and Spencer (1994). In their model, dislocated workers receive wage offers from a distribution that is bounded from above by their previous wage. As such, they always accept lower paying jobs. Taking the wage distribution and a social welfare function that takes into account equity concerns as fixed, they looked for the optimal compensation scheme. In their model, compensation may cause workers to inefficiently reject some wage offers. Finally, since they do not model the search and training processes, the costs of retraining and search play no role in their analysis.
3. For contributions to this debate, see Baily, Burtless and Litan (1993); Burtless et al. (1998); Parsons (2000); Kletzer and Litan (2001); and Hufbauer and Goodrich (2001). It is worth noting that "wage insurance" was recently recommended as a way to compensate displaced workers by the U.S. Trade Deficit Review Commission (2000, pp. 167–168).
4. Limited training programs have also been used for this purpose. See Decker and Corson (1995) for a discussion about the effectiveness of trade adjustment assistance. See Leigh (1990) for a survey of evidence concerning the effectiveness of training programs.
5. This paper can be downloaded from <http://www.msu.edu/~davidso4/current.html>.
6. The assumption that the training process takes place before search is not crucial for the analysis. We could assume instead that training takes place after the search process has been completed without changing the qualitative nature of our results.
7. We are being a little loose with our terminology. Technically, we assume a continuum of workers, so these variables represent the *measure* of workers in each state of the labor market rather than the *number* of workers. However, we will

continue to refer to these variables as the number of workers since this is a more natural phrasing.

8. This is another instance where we are being somewhat loose with terminology. Technically, the workers in our model are infinitely lived so that our use of the term "lifetime" is more metaphorical than literal. Moreover, net income is a random variable for any single worker. In principle, any single worker could be "trapped" in training (or searching or employment) forever, although this is highly unlikely. This is the equivalent of saying that it is possible to flip a fair coin forever and have "heads" appear on every flip. In any event, we should probably refer to "expected" income, but the addition of adjectival modifiers starts to make the terminology unwieldy.
9. Again, we point out that we use the concept of "training" to formalize the model, but we could also think of other expenses, such as the need to provide child care, that are associated with employment and these other expenses could equal or exceed the prospective worker's wage.
10. Technically, the way that we model the resource costs of training implies that trade liberalization will not change the value of a_L and therefore will not push any of the lowest-ability workers out of the labor market. See Davidson and Matusz (2002b) for details.
11. See Davis, Haltiwanger, and Schuh (1996, Table 2.1).
12. See Hamermesh and Rees (1998, Table 8.1).
13. See Davidson and Matusz (2001a, 2002a).
14. Of course, there are some industries in which these costs are quite low. The lowest estimate of turnover costs reported in Hamermesh's survey appears to be about three weeks worth of salary, although such a low figure appears to be an exception rather than the norm.
15. Training costs in our model are independent of ability.
16. To solve the model, we assume that all workers have Cobb-Douglass utility functions, spending half of their income on each good.
17. See Davidson and Matusz (2001a) for a detailed analysis of the size of these benefits and the adjustment costs associated with them.
18. Of course, any change in relative prices will result in labor reallocation and harm some workers. The analysis that follows would also apply if the government were interested in compensating those who are harmed by such changes in relative prices. However, we would argue that changes in relative prices are very different from liberalization. First, we choose to liberalize trade and thus choose to inflict harm on some individuals. It makes sense to try and compensate them for the losses that we have chosen to inflict upon them. Second, in theory, liberalization creates winners who always gain more than the losers lose. Thus, we can afford to compensate the losers without eating away all the gains from freer trade. This is not the case with relative price changes.
19. We model wage subsidies as a percent of the worker's contemporaneous wage, and we model unemployment compensation as a replacement rate based on the wage that the worker earned in his or her most recent job.

20. This fraction grows to 10 percent for the case in which 33 percent of the labor force starts out attached to sector 1 and shrinks to less than 0.5 percent for the case in which $a_M = 0.1$.
21. Of course, such an extreme assumption is not required. If we were to write the sector j wage as a function of ability, $w_j(a_i)$, then it would be sufficient to assume that $w_1(a_1)$ is more concave than $w_1(a_1)$.
22. We verified this assertion by solving the model under the assumption that the low-tech wage is independent of ability.
23. Of course, in our model these workers could train for high-tech jobs but choose not to because it is too costly.
24. If we were to extend the model to allow for unemployment in the low-tech sector, the same argument would apply to unemployment benefits.

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Carl Davidson joined the faculty at Michigan State University in 1982 after completing his Ph.D. in economics at the University of Wisconsin with a specialty in microeconomics. He has published extensively on a wide variety of topics in journals such as the *Journal of Political Economy,* the *Review of Economic Studies,* the *Rand Journal of Economics,* the *Economic Journal,* the *International Economic Review,* the *Journal of Labor Economics,* the *Journal of International Trade* and the *Journal of Public Economics.* Davidson's early research focused on the causes and consequences of horizontal mergers, the various factors that affect the ability of powerful firms to sustain high prices, and the impact of bargaining structure on wage and employment outcomes in markets dominated by a small number of large firms. More recently he has devoted his attention to the implications of international trade for labor market outcomes.

Steven Matusz has been a member of the faculty at Michigan State University since completing his Ph.D. at the University of Pennsylvania in 1983. His doctoral thesis represented one of the earliest attempts in the literature to formally embed endogenously determined unemployment within general equilibrium models of international trade. His interest in this topic was sparked by the disconnect that he observed between popular views of the effect of trade on employment and the existing body of trade theory, which assumed that labor was always fully employed. His research on this topic has been published in the *Quarterly Journal of Economics*, the *Economic Journal*, the *Journal of Political Economy*, the *Review of Economic Studies*, the *International Economic Review*, the *Journal of International Economics*, the *Review of International Economics*, and *Oxford Review of Economic Policy*.

This monograph represents a portion of a larger research project in which Carl Davidson and Steven Matusz have been exploring both the steady-state and dynamic relationships among employment, wages, and trade. It also represents one of the first attempts by academics to determine the best way to compensate the poor when they are harmed by trade liberalization.

Since 2001, Davidson and Matusz have been External Research Fellows with the Leverhulme Centre for Research on Globalization and Economic Policy at the University of Nottingham.

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