On Adjustment Costs

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Even the most strident advocates of free trade would readily admit that it takes time for economies to reap the benefits from trade liberalization. As trade patterns change, some workers lose their jobs and must seek reemployment in expanding sectors. There may be some cases in which these workers need to retool in order find new jobs. Of course, while searching for reemployment and/or retraining, these workers do not produce any output. As a result, during the adjustment process, there may be a period during which national welfare falls below its initial level.

Recent research suggests that the ***personal*** cost of worker dislocation may be quite high. Jacobson, LaLonde and Sullivan (1993a, b) find that the average dislocated worker suffers a loss in lifetime earnings of $80,000. Yet, as disturbing as this finding may be, it tells us nothing about the ***aggregate*** costs of adjustment. It is quite possible for individual workers to lose a great deal while at the same time the economy is suffering only minor aggregate adjustment costs. Nevertheless, those who oppose trade liberalization often point to such personal losses, along with wage losses to those who remain employed in import competing industries, and ask whether the gains from freer trade are really worth such costs. Academic economists tend to dismiss such concerns by either suggesting that the aggregate costs of adjustment are probably very small compared to the gains from trade or by pointing out that the gains from trade are always large enough that we can fully compensate all those who suffer personal losses without exhausting the gains. Unfortunately, there are problems with both of these arguments. The latter argument ignores the fact that such compensation rarely, if ever, takes place. And, the problem with the former argument is that there is almost no solid research on which to base such claims. That is, we know very little about the magnitude and scope of aggregate adjustment costs.

Estimates of aggregate adjustment costs are rare.[1] The two main contributions are Magee (1972) and Baldwin, Mutti, and Richardson (1980), both of which follow a similar

[1] A number of authors have attempted to measure adjustment costs within specific industries. See, for example, de Melo and Tarr (1990) who focus on the US textile, auto and steel industries or Tackas and

approach. First, estimates were made about the number of workers who would lose their jobs due to liberalization. These job losses were then evaluated based on an appropriate measure of the displaced workers' wages. Finally, the authors then assumed that these workers would find reemployment after a length of time determined by estimates of the average duration of unemployment. Both papers conclude that adjustment costs are probably very small when compared to the gains from liberalization. For example, with a 10 percent discount rate, they both estimate that the short run costs of adjustment would eat away no more than 5 percent of the long run gains from trade.

It is hard to know what to make of these estimates. Neither paper attempts to take into account either the time or resource costs that are involved in the retraining that dislocated workers may be forced to go through. The resource cost of job search is also ignored. Moreover, since the reemployment process is not modeled, it is hard to take into account any displacement that may occur as dislocated workers find reemployment in new sectors. There are other problems as well, but all stem from the same basic issue – since there is no model of the adjustment process underlying these estimates, there may be many general equilibrium spillover effects that are not being captured. This is not intended as a criticism of these papers. At the time that these papers were written, rigorous models that explicitly allow for the trade frictions and informational asymmetries that lead to equilibrium unemployment were only in their infancy.[2] It would have been difficult to extend the type of general equilibrium models typically used for trade analysis to allow for equilibrium unemployment and retraining. The empirical approach adopted by these authors was entirely appropriate given the state of the trade literature at that time.

Winters (1991) who studied the British footwear industry. In additions, adjustment costs have played a role in a number of important debates. For example, there is a large literature devoted to the issue of whether it is better to liberalize trade gradually or all at once. The answer to this question depends on the nature of the adjustment process and the type of adjustment costs faced by labor (see, for example, Falvey and Kim 1992; Karp and Paul 1994; Li and Mayer 1996; and, Furusawa and Lai 1999 for recent contributions to this debate). However, none of these papers attempt to determine the size and scope of aggregate adjustment costs.

Our goal in this paper is to build on recent advances in the theory of equilibrium unemployment by presenting a simple general equilibrium model of trade that includes unemployment and training. We then use the model to explore the scope and magnitude of adjustment costs relative to the gains from trade. In our model, workers differ in ability and jobs differ in the types of skills they require. Workers sort themselves by choosing occupations based on expected lifetime income. These workers then cycle between periods of employment, unemployment and training with the length of each labor market state determined by the turnover rates in each sector. One of the advantages of the model is that it is simple enough to allow us to solve analytically for the adjustment path across steady states; thereby allowing us to calculate the adjustment costs associated with trade reform. Another advantage is that many of the model's key parameters, the labor market turnover rates, are observable, so that we can rely on existing data to determine their likely values. However, one of the shortcomings of the model is that there are few existing estimates on which to base our assumptions about the resource and time costs associated with training and these values play important roles in our analysis. We therefore solve the model for a wide variety of assumptions about these values and look for conclusions that are robust. Surprisingly, with even our most modest assumption concerning training costs, we find that their inclusion in the model significantly increases our estimates of aggregate adjustment costs. For example, we find that when we take the time cost of retraining into account our estimate is that the short run adjustment costs amount to (at least) 10 to 15 percent of the long run benefits from liberalization. When the resource costs of retraining are taken into account as well, our estimates of the short run costs jump to 30 to 90 percent of the long run gains from freer trade!

In the latter part of the paper we turn to a related issue, and ask whether there is any way to know a priori which type of economies are likely to face relatively large adjustment costs.

[2] We are referring to the literatures on trading friction (search theory), efficiency wages, and insider/outsider models of the labor market, among others.

Labor markets and the institutions that govern them vary greatly across the world. Jobs tend to last longer in the U.S. than they do in Europe and Japan. The average duration of unemployment is relatively short in the U.S., while it can be quite long in some European countries. The implication is that all labor market turnover rates tend to be higher in the U.S. than they are in most European countries. In addition, wages are more flexible in U.S. labor markets than they are in their European counterparts. Consequently, labor economists typically characterize U.S. labor markets as flexible while European labor markets are considered sluggish. One would expect that the flexibility of the labor market would play a key role in determining the relative importance of adjustment costs.

We investigate this issue by determining how the ratio of adjustment costs to the gains from trade varies as turnover rates increase uniformly. In our model, we find, somewhat surprisingly, that there is a non-monotonic relationship between labor market flexibility and the relative importance of adjustment costs with the ratio of adjustment costs to benefits higher in economies with sluggish labor markets than they are in economies with either flexible or slothful labor markets. Furthermore, we find that the net benefits from trade reform have the same non-monotonic relationship so that economies with sluggish labor markets gain the least from liberalization. We also show that these relationships appear to be robust to the manner in which ability affects net output. To do so, we consider two models, one in which output is increasing in ability in all sectors and another in which training costs within a sector are decreasing in ability, and show that these non-monotonic relationships arise in both settings.

Although the complete argument is far more complex, these non-monotonic relationships appear to have their roots in the manner in which tariffs distort economies with different degrees of labor market flexibility. We find that in both of our models tariffs distort slothful and flexible labor markets more than sluggish ones. The removal of the tariff therefore generates large benefits in such economies; in fact, they are even large enough to swamp the slothful economy's

high level of short run adjustment costs. As a result, it is the economies in the middle, those with sluggish labor markets that gain the least from trade liberalization.

2. The Model

A. Background

In developing our model, we have several goals in mind. First, we want to use a general equilibrium trade model that is rich enough to capture some essential features of the employment process. In particular, we want a model that explicitly allows for both a training process in which workers acquire the skills required to find a job and a search process those same workers must go through to find an employer. Second, we want to keep the model simple and tractable in order to be able to solve analytically for the transition path across steady states. This allows us to calculate the adjustment costs associated with trade reform. Third, we want the model to be general enough to allow for cross-country differences in labor market structure so that we may investigate the relationship between labor market flexibility and adjustment costs.

The basic structure of the model is as follows. We have an economy in which workers with differing abilities must choose between two types of jobs – those that do not require many skills and offer low pay, and those that require significant training and pay relatively high wages. Jobs in the low-tech sector are easy to find, do not last very long (there is high turnover) and require skills that are job specific. In contrast, high-tech jobs are relatively hard to find, presumably because the matching problem is harder to solve, last longer once employment is secured and require a combination of job specific and general skills. We assume that in each sector high-ability workers produce more output than their low-ability counterparts. Under certain assumptions, this implies that in equilibrium workers sort themselves so that high-ability workers train for high-tech jobs while low-ability workers are drawn to the low-tech sector.

We begin by assuming that the low-tech sector is protected by a tariff. This raises the return to training in that sector and causes some workers who should train in the high-tech sector

to seek low-tech jobs instead. When the tariff is removed, these workers shift to the high-tech sector. This shift is gradual, however, since these workers will first have to enter the high-tech training process and then search for jobs. In addition, many of the workers who may eventually want to shift sectors may already hold low-tech jobs and since training and search are costly, they may choose to wait until they lose their low-tech jobs before making the switch. As a result, it may take significant time before the economy gets close to the new steady state. In this setting, adjustment costs are measured by comparing what the economy could gain if it could jump immediately to the new steady state with what it actually gains taking into account the costly transition that it experiences in moving to the new steady state.

B. Formalizing the Model and Finding the Initial Steady State

We consider a continuous time model of a small open economy consisting of two sectors and a single factor of production, labor. We use a_i to denote worker i's ability level and we assume that a_i is uniformly distributed across [0,1] with the total measure of workers equaling L. To obtain a job in either sector, workers must first acquire the requisite skills. Training is costly, both in time and resources. In sector j, workers seeking a job must pay a flow cost of $p_j c_j$ while training where p_j denotes the price of good j (so that sector j training costs are measured in units of the sector j good). The length of the training process is assumed to be random, with sector j trainees exiting at rate τ_j. This implies that the average length of training in sector j is $1/\tau_j$. Our notion that training is more costly both in time and resources in sector 2, the high-tech sector, is captured by assuming that c_1 and τ_2 are small while c_2 and τ_1 are large (we will be more precise below). We use $L_{jT}(t)$ to denote the measure of workers training in sector j at time t.

After exiting the training process, workers must search for employment.[3] Jobs in the low-tech sector are plentiful, so that jobs are found immediately.[4] In contrast, it takes time to find high-tech jobs and we use e to denote the job acquisition rate in that sector. It follows that the average spell of sector 2 unemployment is 1/e. We use $L_S(t)$ to denote the measure of workers searching for high-tech jobs at time t.

Once a job is found, a type i sector j worker produces a flow of $q_j a_i$ units of output as long as she remains employed. Since output is increasing in a_i, higher ability workers produce more than their lower ability counterparts in each sector.[5] This output is sold at p_j and all of the revenue goes to the worker in the form of earned income (so that the sector j wage earned by a type i worker is $p_j q_j a_i$). Sector j workers lose their jobs at rate b_j, so that the average duration of a sector j job is $1/b_j$. Since high-tech jobs are assumed to be more durable than low-tech jobs, it follows that $b_1 > b_2$. The measure of workers employed in sector j at time t is denoted by $L_{jE}(t)$.

Upon separation, a worker must retrain if her skills are job specific. In contrast, if her skills are general, she can immediately begin to search for reemployment. As noted above, we assume that the skills acquired during low-tech training are job specific. We make this assumption because, to us, it seems natural. While training, a store clerk may need to learn the layout of the store in which she is employed, the procedures involved in opening and closing the store, the functioning of a particular type of cash register, and so on; but, in gaining this knowledge the worker learns nothing about how to prepare fast food (or perform other low-skill tasks). In contrast, high-tech workers like accountants, managers and lawyers all must complete

[3] 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 completion of search without altering the nature of our results.

[4] Of course, many low-ability workers face difficulty finding any job whatsoever and therefore face a long expected duration of unemployment whenever they lose their job. We believe that this is largely due to their work history and overall ability level. By assuming that low-tech jobs are plentiful (so that sector 1 employment can be found immediately), we are trying to capture the notion that the ***marginal*** worker (who has the ability to train for a high tech job) would be able to find menial employment quite easily if she chooses to do so.

[5] Ability could refer to attributes that the worker is born with, or it could refer to a combination of attributes that are either innate or acquired during the elementary education process.

college and obtain some post-graduate education. If they lose their job, many of these workers will be able to obtain reemployment in the same field and in doing so they will not be required to go back through school. Moreover, even if these workers choose to change occupation, they will have acquired some general skills along the way that may allow them to land new jobs without acquiring additional skills. The implication is that all unemployed low-tech workers need to retrain in order to find reemployment, while some high-tech workers can move into a new job without having to retrain. To make this precise, we assume that with probability ϕ high-tech workers need not retrain after losing their jobs.

The dynamics of the two labor markets are depicted in Figures 1 and 2. The evolution of the labor markets over time can be described with the aid of these figures. Let $\dot{X}(t)$ denote the growth rate of X at time t. These growth rates can be found by comparing the flows into and out of each labor market state. For example, in sector 1, the flow out of training is equal to the measure of workers who complete the training process and take low-tech jobs, $\tau_1 L_{1T}(t)$. The flow into training is equal to the measure of low-tech workers who lose their jobs due to exogenous separation, $b_1 L_{1E}(t)$. It follows that the growth rate of low-tech trainees is given by

$$\dot{L}_{1T}(t) = b_1 L_{1E}(t) - \tau_1 L_{1T}(t) \tag{1}$$

Similar logic can be used to find the growth rates of employment, $\dot{L}_{2E}(t)$, and the unemployment pool in sector 2, $\dot{L}_S(t)$. We have

$$\dot{L}_{2E}(t) = eL_S(t) - b_2 L_{2E}(t) \tag{2}$$

$$\dot{L}_S(t) = \tau_2 L_{2T}(t) + b_2 \phi L_{2E}(t) - eL_S(t) \tag{3}$$

In (2), the flow into high-tech employment consists of searching workers who find employment, $eL_S(t)$, while the flow out is made up of employed high-tech workers who lose their jobs, $b_2 L_{2E}(t)$. In (3), the flow into the pool of searchers is made up of those who complete the high-tech training process, $\tau_2 L_{2T}(t)$, and those workers who lose their high-tech jobs but do not have to retrain

because their skills are transferable, $b_2\phi L_{2E}(t)$. The flow out of unemployment is equal to the measure of high-tech searchers who find jobs, $eL_S(t)$.[6] Finally, in sector 1, workers are either employed or training, while in sector 2, they are employed, training, or searching. Thus, we have the following adding up conditions (where $L_j(t)$ denotes measure of sector j workers at time t):

$$L_1(t) = L_{1E}(t) + L_{1T}(t) \tag{4}$$

$$L_2(t) = L_{2E}(t) + L_{2T}(t) + L_S(t) \tag{5}$$

In Appendix A we show how the differential equations in (1) – (5) can be used to solve for transition path across steady states. But, to do so, we must first explain how to solve for $L_1(t)$ and $L_2(t)$. These values are determined by the behavior of individual workers, who choose their occupations based on the lifetime income that they expect to earn in each sector. When workers initially enter the labor market they have no skills. Thus, their initial choice depends on the relative values of V_{1T} and V_{2T}, which measure the expected lifetime income for workers training in sectors 1 and 2, respectively. If we define V_{2S} as the expected lifetime income for sector 2 workers who are currently searching for a job and use V_{jE} to denote the expected lifetime income for employed workers in sector j, then we have the following asset value equations (with r denoting the discount rate)

$$rV_{1T}(t) = -p_1c_1 + \tau_1[V_{1E}(t) - V_{1T}(t)] + \dot{V}_{1T}(t) \tag{6}$$

$$rV_{1E}(t) = p_1q_1a_i + b_1[V_{1T}(t) - V_{1E}(t)] + \dot{V}_{1E}(t) \tag{7}$$

$$rV_{2T}(t) = -p_2c_2 + \tau_2[V_{2S}(t) - V_{2T}(t)] + \dot{V}_{2T}(t) \tag{8}$$

$$rV_{2S}(t) = e[V_{2E}(t) - V_{2S}(t)] + \dot{V}_{2S}(t) \tag{9}$$

$$rV_{2E}(t) = p_2q_2a_i + b_2[\phi V_{2S}(t) + (1-\phi)V_{2T}(t) - V_{2E}(t)] + \dot{V}_{2E}(t) \tag{10}$$

[6] Similar growth equations for L_{1E} (low-tech employment) and L_{2T} (trainers in sector 2) could also be defined. However, given the adding up conditions in (4) and (5) they would be redundant.

In (6) - (10), the first term on the right hand side represents current income. For employed workers, current income is equal to the value of the output they produce ($p_j q_j a_i$ for a type i worker in sector j). Trainees and searching workers earn nothing while unemployed, and trainees must pay training costs while acquiring their skills. Thus, current income for searchers is equal to zero while trainees lose their training costs. The second term on the right hand side of each equation is the product of the capital gain (or loss) from changing labor market status and the rate at which such changes take place. For example, the flow rate from searching to employment in sector 2 is e while the capital gain associated with employment is $V_{2E} - V_{2S}$. Note that for workers who are employed in the high-tech sector, there are two possibilities when they lose their job. With probability ϕ these workers retain their skills and begin to search for a new job immediately, while with the remaining probability they must retrain before they can seek a new job. The final term on the right hand side, the $\dot{V}$ term, represents the growth rate of V. This term captures the appreciation (or depreciation) of the asset value over time and it is equal to zero in a steady state.

In order to describe the initial steady state equilibrium, we now set each $\dot{V}$ term in (6)-(10) equal to zero and solve for the expected lifetime income associated with each labor market state. We obtain

(11) $$V_{1E} = \frac{p_1\{(r+\tau_1)q_1 a_i - b_1 c_1\}}{r\Delta_1}$$

(12) $$V_{1T} = \frac{p_1\{\tau_1 q_1 a_i - (r+b_1)c_1\}}{r\Delta_1}$$

(13) $$V_{2E} = \frac{(r+e)p_2\{(r+\tau_2)q_2 a_i - b_2(1-\phi)c_2\}}{r\Delta_2}$$

(14) $$V_{2S} = \frac{ep_2\{(r+\tau_2)q_2 a_i - b_2(1-\phi)c_2\}}{r\Delta_2}$$

(15) $$V_{2T} = \frac{p_2\{\tau_2 eq_2 a_i - [(r+b_2)(r+e) - \phi e b_2]c_2\}}{r\Delta_2}$$

where $\Delta_1 = r + b_1 + \tau_1$ and $\Delta_2 = (r + b_2)(r + \tau_2 + e) + e\tau_2 - b_2\phi e$.

Unemployed workers with no skills choose to train in the low-tech sector if $V_{1T} \geq \max\{V_{2T}, 0\}$ and they choose to train in the high-tech sector if $V_{2T} \geq \max\{V_{1T}, 0\}$. Workers with ability levels such that $0 \geq \max\{V_{1T}, V_{2T}\}$ stay out of the labor market since it is too costly for them to train for any job. These workers are effectively shut out of the labor market – there are no jobs available for them to train for since their training costs would exceed any income that they could expect to earn after finding employment.

As for employed and searching workers, we assume that they are free to change occupations at any time, but each time they do so they must start out by retraining. It follows that, in equilibrium, these workers never switch sectors. In fact, small changes in parameters or world prices never result in searchers or employed workers changing occupations – all labor reallocation involves workers who are in the training process.

To complete the characterization of equilibrium we must place some restrictions on our parameters. What we have in mind is a model in which high-ability workers are better suited to produce the high-tech good. It is clear from (12) and (15) that V_{1T} and V_{2T} are linear and increasing in a_i. Moreover, in each sector there is a critical value for a_i, denoted by $\underline{a}_j$, below which $V_{jT}(a_i) < 0$. Workers separate in the desired way if V_{2T} is steeper than V_{1T} at the initial world prices and if $\underline{a}_1 < \underline{a}_2$. This is the case if $p_1(r + \tau_1)q_1\Delta_2 < p_2\tau_2 eq_2\Delta_1$ and $(r + b_1)c_1\tau_2 eq_2 < [(r + b_2)(r + e) - \phi e b_2]c_2\tau_1 q_1$. With these two assumptions in place, V_{1T} and V_{2T} are as depicted in Figure 3. Note that we have defined two new terms, a_L and a_H, with $a_L \equiv \underline{a}_1$ and a_H is the ability level for the worker who is just indifferent between training in sector 1 or sector 2, that is $V_{2T}(a_H) = V_{1T}(a_H)$.

From Figure 3, it is easy to see that workers with ability levels below a_L do not enter the labor force. For these workers, the cost of training for any job is too high. Workers with ability

levels $a_i \in [a_L, a_H]$ find the low-tech sector more attractive and choose to train in sector 1. It follows that $L_1 = (a_H - a_L)L$. Finally, workers with ability levels above a_H find the high-tech sector relatively more attractive. These workers train for high-tech jobs, so that $L_2 = (1 - a_H)L$.

We can now return to (1)-(5), set the $\dot{L}$ terms equal to zero and solve for the measure of workers in each labor market state in the initial steady state. We obtain

(16) $$L_{1T} = \frac{b_1(a_H - a_L)L}{b_1 + \tau_1}$$

(17) $$L_{1E} = \frac{\tau_1(a_H - a_L)L}{b_1 + \tau_1}$$

(18) $$L_{2T} = \frac{(1-\phi)eb_2(1-a_H)L}{(e+b_2)\tau_2 + (1-\phi)eb_2}$$

(19) $$L_S = \frac{\tau_2 b_2(1-a_H)L}{(e+b_2)\tau_2 + (1-\phi)eb_2}$$

(20) $$L_{2E} = \frac{\tau_2 e(1-a_H)L}{(e+b_2)\tau_2 + (1-\phi)eb_2}$$

where, from (12) and (15),

(21) $$a_H = \frac{p_2c_2\Delta_1[(r+b_2)(r+e) - \phi eb_2] - p_1c_1\Delta_2(r+b_1)}{p_2\tau_2 eq_2\Delta_1 - p_1\tau_1 q_1\Delta_2}$$

and

(22) $$a_L = \frac{(r+b_1)c_1}{\tau_1 q_1}.$$

These values can now be used to determine the value of output net of training costs in the initial steady state, Y_{SS}. Since the average low-tech worker produces $(a_L + a_H)/2$ units of output while the average high-tech workers produces $(1 + a_H)/2$ units, we have

(21) $$Y_{SS} = \frac{1}{r}\left[p_1\{q_1\frac{a_L + a_H}{2}L_{1E} - c_1L_{1T}\} + p_2\{q_2\frac{1+a_H}{2}L_{2E} - c_2L_{2T}\}\right]$$

Finally, national welfare in the initial steady state is given by $W_{SS} = Y_{SS}/r$. In Appendix B, we show that the laissez-faire equilibrium is efficient, so that W_{SS} is maximized under free trade.

C. Adjustment

Changes in world prices cause the V_{jT} curves in Figure 3 to pivot with the point at which $V_{jT} = 0$ remaining fixed. Thus, if we assume that sector 1 is initially protected by a tariff, then when trade is liberalized the V_{1T} curve pivots down causing a_H to fall. If we use a_{HN} to denote the new value of a_H, then all workers with ability levels in the interval $[a_{HN}, a_H]$ eventually want to switch from the low-tech to the high-tech sector. Trainees switch immediately while those employed in the low-tech sector switch only after losing their jobs (assuming that the initial tariff is small).

Because of the model's simple structure, it is possible to slove analytically for the transition path across steady states. We begin by noting that all V terms jump immediately to their new steady state values once trade is liberalized. This is due to the fact that these values depend only on prices, ability, turnover rates and other parameters that are independent of time (see 11-15). Thus, a_H jumps to its new value immediately as well. The gradual transition to the new steady state occures in the labor market, where the measures of trainees, searchers and employed workers change according to the differential equations in (1)-(5). We provide the solution this system of differetial equations in Appendix A. Given this solution, we can calculate the value of output net of training costs along the transition path, Y(t). We have

$$(22) \qquad Y(t) = \int_{a_L}^{a_{HN}} p_1 \frac{q_1 a_i L_{1E}(t) - c_1 L_{1T}(t)}{a_{HN} - a_L} da_i + \int_{a_{HN}}^{1} p_2 \frac{q_2 a_i L_{2E}(t) - c_2 L_{2T}(t)}{1 - a_{HN}} da_i$$

Welfare after liberalization, taking the adjustment path into account, is then $W_A = \int e^{-rt} Y(t) dt.$

The last step in solving for the cost of adjustment is to compare W_A with the welfare that the economy could achieve if it were able to jump immediately to the new (free trade) steady-

state equilibrium (W_{FT}). To find this value, define Y_{FT} as the value of output net of training costs in the new steady state equilibrium. This value is given by (21) with a_{HN} replacing a_H. It follow that $W_{FT} = Y_{FT}/r$.

Typical time paths for Y_{SS}, Y(t) and Y_{FT} are depicted in Figure 4. Liberalizing trade increases steady state net output from its initial value of Y_{SS} to its new free trade value of Y_{FT} (this must be the case since the free trade equilibrium is efficient). However, to reach the new steady state, the economy must first go through a costly transition with net output following along the Y(t) path. Note that there is a period of time (up to t^*) during which net output falls below its initial steady state value. The ***potential*** gain from trade reform is defined by the properly discounted area below Y_{FT} and above Y_{SS}; or, $W_{FT} - W_{SS}$. The ***actual*** gain is the properly discounted difference between the areas below Y_{SS} and Y(t); or, $W_A - W_{SS}$. It follows that aggregate adjustment costs are measured by the approriately discounted area below Y_{FT} but above Y(t); or, $W_{FT} - W_A$.[7] In the next section, we simulate the model and calculate aggreagte adjustment costs and compare them to the potential gains from reform.[8] We do so by focusing on two key variables – the ratio of aggregate adjustment costs to the potential benefits from trade reform (defined by R^* in (23) below) and t^*, which measures the length of time it takes for the economy to get back to its original level of net income (so that t^* solves $Y_{SS} - Y(t^*) = 0$). By looking at t^* we are able to get some sense as to how long it takes the economy to begin to reap the benefits from liberalization.

$$R^* \equiv \frac{W_{FT} - W_A}{W_{FT} - W_{SS}} \tag{23}$$

D. Strenthes and Weaknesses of our Model

[7] This method for calculating adjustment costs was suggested by Neary (1982).
[8] In Davidson and Matusz (2001) we explore other aspects of the adjustment path including the time paths of employment and unemployment during the adjustment period. We show, for example, that overshooting is a common feature of adjustment in our model.

At this point, it is useful to highlight some features of our model that we consider strengthes as well as some of the weaknesses. There are several attractive features that are worth emphasizing. First, we have modeled the training and search processes that workers must go through in order to find jobs. This allows us to take into account both the time and resource costs that dislocated workers must incur after losing their jobs. This is a unique and innovative feature of our model and we consider it one of its main strengthes. The second important feature is that we have modeled these processes and managed to keep the framework relatively simple and tractable. In fact, it is so simple that we can solve explicitly for the transition path between steady states by solving the differential equations in (1)-(5).

Another attractive feature of our model is that many of the key parameters, for example, the labor market turnover rates, are observable. This makes it easy to calibrate the model and find estimates of aggregate adjustment costs for parameter values that have some empoirical significance. Moreover, as we emphasized in the introduction, it is well known that labor markets in Europe, the United States and Japan differ significantly in their structure and that much of the difference has to do with differences in turnover rates. Since it is these turnover rates that drive our model, we can easily model the differences in labor market structure across these regions and see how our estimate of adjsutment costs relative to the benefits from trade liberalization vary with labor market flexibility.

Finally, there is one other positive feature of our model that we would like to underscore. As mentioned above, it is straightforward to show that the equilibrium in our model is efficient (see Appendix B). This is unusual for search models. It is usually the case that search decisions are rife with externalities. For example, if an unemployed worker chooses to seek a job in a particular sector, this may make it more difficult for other unemployed workers to find a job (that is, there may be congestion externalities). Such externalities typically distort behavior and lead to sub-optimal equilibria. This is not the case in our model. In fact, we set up our model with certain features (such as exogenous turnover rates) specifically designed to aviod this problem.

The reason that we did this is so that we can be sure that when we calculate adjustment costs and compare them to the gains from trade we can be certain that our results do not depend on how trade liberalization affects the distortions created by controversial, hard to measure, impossible to observe search generated externalities.

As for weaknesses, there are two that deserve special attention. The first has to do with our assumption that turnover rates are fixed. As trade is liberalized the economic incentives that agents face change. Firms in import competing sectors may start to layoff workers and unemployed workers competing for the new jobs in the expanding export sector may find that they can now secure reemployment quickly without searching too hard. In terms of our model, this means that trade liberalization may increase both the job separation rate in the low-tech sector (b_1) and the job acquisition rate in the high-tech sector (e). By treating the separation and job acquisition rates as exogenously specified parameters, we are ignoring such possibilities. We return to this issue in the conclusion and discuss ways in which our analysis can be modified in the future to deal with it.

The other weakness concerns the parameters that measure the resource and time costs of retraining (c_j and τ_j). Although these parameters play a key role in our analysis, we know very little about their likely values. We handle this problem in two ways. First, since it is unlikely that training costs in the low-tech sector are significant, we set c_1 equal to zero and assume that τ_1 is quite high (so that low-tech training is very brief). Given that we have also assumed that there are no resource costs associated with job search (note that in (9) there is no cost of search), this means that our estimates of aggregate training costs are likely to be biased downward. Second, we consider a wide variety of assumptions about the magnitude of high-tech training costs and then try and draw conslusions that are robust across these sets of assumptions.

3. Aggregate Adjustment Costs

The parameters of our model include those that determine the average durations of sector-j training (τ_j), sector-j employment (b_j) and high-tech search (e), those that determine the resource cost of sector-j training (c_j), those that help to determine output per worker in sector j (q_j), ϕ, which measures the tranferability of high-tech skills across jobs and r, the discount rate. In this section, we choose values for these parameters, solve the model and provide measures of the aggregate adjustment costs associated with trade reform. We do so under the assumption that the low tech-sector is initially protected by a 5% tariff.

To make certain that we do not discount the future too heavily, we set r = .03, the lowest discount rate considered by Balwin et al (1980) and Magee (1972). The average duration of unemployment in the U.S. can be found in *The 2001 Economic Report of the President* (see Table B-44). Although this value has fluctuated over the years, it remains fairly stable at about one quarter (or 13 weeks). Our model is consistent with such estimates if we set e = 4. Since this value rarely fluctuates by more than a week or two, this is the only value for e that we consider.

For the average duration of employment in the high-tech sector, we turn to the job creation and destruction data of Davis, Haltiwanger and Schuh (1996), who report that the average annual rate of job destruction in U.S manufacturing during the period 1973-1988 was about 10% (this translates into an average job duration of 10 years). There is some variation in this number across years, with the largest rate of job destruction coming in 1975 at 16.5% (implying an average job duration of about 6 years).[9] We therefore assume, for our base case, that an average high-tech job lasts ten years (which is the case if $b_2 = .1$). However, we also solve the model and report results for the case in which high-tech jobs last only six years (which is the case if $b_2 = .167$).

It is harder to find data on the average duration of a job in the low-tech sector. We consider these to be transitory, undesirable jobs and although many of these jobs may be found in

[9] See Table 2.1 on p. 19 in Davis, Haltiwanger and Schuh (1996).

the manufacturing sector, it is not possible to look at industry-wide data and draw conclusions about how long the worst jobs in each industry last. So, we take a different approach. Our low-tech jobs require few skills and little training. These are the types of jobs that many hold while still in school or when they are just starting out in the labor force. If we look at data on the number of jobs held over the lifetime, we find that up to the age of 24 workers hold (roughly) one new job every two years.[10] We therefore consider two cases – one in which low-tech jobs last two years (so that $b_1 = .5$) and another in which they last just one year (so that $b_1 = 1$). Combining these two cases with the assumptions that we have made about job tenure in the high-tech sector leaves us with four different settings. In the setting with high turnover in both sectors, job last only a year in the low-tech sector and just six years in the high-tech sector. In the setting with low turnover in both sectors, jobs last two years in the low-tech sector and ten years in the high-tech sector. In the other two cases, jobs last either three or ten times as long in the high-tech sector than they do in the low-tech sector. This gives us a wide range of assumptions about labor market turnover.

Turn next to the parameters of the training processes. Since very little is known about the magnitude of training costs we want to be careful not to assume values that seem unreasonably high, and we want to make sure that we consider a wide range of possible values. As we mentioned above, we assume that there are no resource costs associated with low-tech training (i.e., $c_1 = 0$).[11] In addition, we assume that the low-tech training process takes only one week (so that $\tau_1 = 52$). For the high-tech sector, we turn to the limited information that is available on training costs in the labor economics literature. A review of what is known about turnover costs can be found in Hamermesh (1993) where turnover costs are assumed to include both the costs of recruiting and training the newly hired worker. This literature suggests that such costs may be quite high. For example, a large firm in the pharmaceutical industry estimated that the present

[10] See Table 8.1 on p. 210 in Hamermesh and Rees (1988).
[11] With $c_1 = 0$ we have $a_L = 0$ so that all workers enter the labor market.

value of the cost of replacing one worker amounted to roughly twice that worker's annual salary. Similar, although not quite so dramatic, estimates were obtained for less-skilled jobs. One study estimated that the cost of replacing a truck driver amounted to slightly less than half of that worker's annual pay. The lowest estimate of turnover costs reported by Hamermesh appears to be about three weeks worth of salary. To capture this wide range of estimates, we assume that high-tech training lasts four months ($\tau_2 = 4$) and then we vary the value of c_2. At the low end, we choose c_2 so that training costs for the average worker in the high-tech sector are equal to one months pay.[12] At the high end, we choose c_2 so that the average high-tech worker's training costs equal 15 months of pay. We also consider two intermediate cases in which training costs equal 5 and 10 months of the worker's annual salary. This gives us a wide range of values for high-tech training costs. Below we look for results that are robust across this range of estimates.[13]

This leaves only q_1 and q_2, the productivity parameters in the two sectors, and ϕ, which measures how often high-tech workers need to retrain after losing their jobs. We have argued that high-tech jobs require both general and job-specific trainging with much of the training general. The implication is that retraining is not all that common in the high-tech sector, which means that ϕ should be fairly high. In Tables 1-4 we provide estimates of the two variables that we are interested in, R^* and t^*, under the assumption that $\phi = .8$. However, we also calculated these values assuming that ϕ ranged between .5 and .9 and found that the values in Tables 1 and 3 were affected only at the third decimal place while those in Tables 2 and 4 varied only at the

[12] High-tech workers pay a flow cost of p_2c_2 while training and training lasts, on average, $1/\tau_2$ periods. Thus, training costs are given by p_2c_2/τ_2. Annual income for the average worker in the high-tech sector is $p_2q_2(a_H + a_L)/2$.

[13] At this point, it is useful to first clarify what we mean by training costs. While acquiring the skills necessary to perform certain tasks, there may be periods during which no production occurs whatsoever (while workers are in school, going through orientation, getting hands-on on-the-job training, and so on). However, there may also be a period during which the worker is producing and yet productivity is below its ultimate level because the worker is still learning about the production process. The output lost during the period of learning-by-doing should also be considered as part of training costs. With this interpretation, it is hard to imagine that our most modest assumptions – that there are no resource cost to training in the low-tech sector, that the low-tech training process takes only one week, and that high-tech training costs amount to only one month's worth of high-tech wages – could be considered excessive.

second decimal place. Thus, we conclude that our estimates are largely insensitive to our assumptions about ϕ, provided that this value remains above .5.

For q_1 and q_2 what matters is their relative values. Thus, we set $q_2 = 1.4$ (this makes the calculation of c_2 described above relatively easy) and then vary q_1. As q_1 varies, the relative attractiveness of the two sectors changes and thus, a_H, which determines the fraction of the workforce that starts out in the low-tech sector, is altered. For completeness, we consider five different values for q_1 for each combination of turnover rates. These are the values that correspond to a_H equal .2, .33, .5, .67 and .8. This gives us a sense as to how our measures of R^* and t^* vary with the size of the sector that is initially protected (sector 1) and the size of the sector that is associated with significant training costs (sector 2).

Our estimates of R*, the ratio of aggregate adjsutment costs to the benefits from trade reform, and t^*, the time at which net output gets back to its initial steady state level, are reported in Tables 1 and 2. These results were obtained by assuming that the world prices of the two goods are the same and that the low-tech sector is initially protected by a 5% tariff. Two results stand out. First, our estimates are consideably higher than any obtained by Baldwin et al (1980) or Magee (1972). Our lowest estimate in Table 1 is that adjustment costs eat away about one third of the gains from trade reform; and, from Table 2, that it takes almost 3 years for net output to get back to it pre-liberalization level. At the other extreme, some estimates are as high as .9 for R^* and 5 .9 years for t^*! Given that we have assumed away search costs and resource costs for low-tech training, these estimates are surprisingly high.

Second, the results with respect to R^* are remarkedly robust across our assumptions about break-up rates – going from high turnover in both sectors to low turnover in both sectors never changes the ratio by more than .01. The break-up rates do influence our estimates of t^*, but, in all cases that we consider t^* remains quite high. Finally, our estimates of R^* and t^* are fairly insensitive to our assumptions about the initial size of the low-tech sector. As a_H increases, R^*

and t^* both fall, with the rate of decrease increasing in the magnitude of high-tech training costs.[14] In fact, it is the magnitude of these training costs that clearly matter the most. Not surprisingly, as training costs increase, so do R^* and t^*.

One natural question to ask at this point is whether our results are driven by our assumption that training involves a real resource cost or whether the costs are this high simply because the training and search processes take time and no production occurs while search and training take place. To get some handle on this issue, we introduce two new terms, R^*_{GO} and t^*_{GO}. These terms are defined in exactly the same manner as R^* and t^* with one exception – they measure only gross output (and ignore the resource cost of training). So, for example, t^*_{GO} measures the amount of time it takes for gross output to get back to its reliberalization level. Our estimates of R^*_{GO} and t^*_{GO} are reported in Tables 3 and 4. While our estimates fall significantly, they remain considerably above those found in previous studies. Most of the estimates indiacte that when we take into account only the time cost of training, around 15 to 20% of the gains in gross output are lost due to adjustment costs. Moreover, it takes over two years for gross output to return to the level enjoyed in the initial tariff-distorted steady state equilibrium. These estimates are robust across our assumptions concerning break-up rates and the initial size of the low-tech sector, but do vary significantly as we change our assumptions about the magnitude of high-tech training costs.

4. Adjustment Costs and Labor Market Flexibility

Tables 1-4 indicate that changes in break-up rates have little influence over our estimates of aggregate adjustment costs. Yet, if we look across the world, it is not only break-up rates that

[14] Increasing the initial size of the low-tech sector has two effects on R^*. On the one hand, if the low-tech sector is large then trade reform will generate large benefits. On the other hand, with a large low-tech sector trade reform will also lead to a great deal of worker reallocation and this will increase adjustment costs.

vary but also the rate of job acquisition. In the U.S. most unemployed workers find reemployment relatively quickly and long-term unemployment is not a significant problem. In contrast, many European economies face serious problems with a large population of workers who have been classified as long-term unemployed. Combining this with the fact that job duration is also longer in Europe leads to the conclusion that labor markets are much more flexible in U.S. than they are in Europe. This difference in labor market flexibility has been emphasized by labor economists and macroeconomists studying a variety of issues.[15] In this section, we investigate the implications for aggregate adjsutment costs.

To do so, we add a new variable s to our model, which we refer to as speed. We introduce this term by multiplying the turnover rates in the high-tech sector, b_2 and e, by s.[16] As s increases, high-tech jobs become easier to find but they also become less durable. Thus, an economy with a high value for s has a great deal of turnover in the high-tech sector while an economy with a low value for s has a high-tech sector with a long average duration of unemployment and a relatively long expected job tenure. It follows that s measures the flexibility of the labor market with increases in speed assocaited with more flexible labor markets.[17]

Figure 5a shows how R^* varies with s for the case in which there is low turnover in the high-tech sector, high turnover in the low-tech sector, high-tech training costs are equal to 5 months of the average high-tech worker's income and one-third of the labor force starts out in sector 1 (i.e., $b_1 = 1$, $b_2 = .1$ and $a_H = .33$). Qualitatively similar figures apply for all other parameter values in Tables 1-4. The surprising thing about Figure 5 is that the relationship is non-monotonic – increases in labor market flexibility do not always lead to decreases in relative adjustment costs. In fact, R^* increases at first, then reaches a maximum and decreases after that.

[15] See, for example, Freeman (1994) and Layard, Nickell, and Jackman (1991).
[16] Similar results can be obtained by multiplying ***all*** turnover rates by s so that an increase in s results in higher turnover in both sectors. However, doing so makes that analytics that follow below much less transparent. See footnote 19 for details.

It follows that economies at the two ends of the spectrum – those with very flexible labor markets and those that are slothful – have the most to gain from trade reform. Economies in the middle – those with sluggish labor markets – see a greater fraction of their potential gains eaten away by adjsutment costs. In Figure 5, R^* reaches its maximum value for $s < 1$, so that if the initial values are representative of the U.S., economies with labor markets that are less flexible than the U.S. , like those in most European countries, have relatively less to gain from trade reform. Table 5a shows the value for s that maximizes R^* and how this value varies with the initial value for a_H.[18] In all cases, R^* peaks for a value of s below 1, suggesting that the Americans should be less concerned about adjustment costs than Europeans and/or the Japanese. Finally, although the relationship between s and R^* is non-monotonic, it is useful to note that it relatively flat for $s < 1$. Thus, although slothful and flexible labor markets result in a smaller R^* than do sluggish labor markets, the difference is not all that great – all three economies see about the same fraction of their gains from liberalization disappear as the economy goes through its costly transition to the new steady-state equilbrium (around 70%).

This non-monotonic relationship does suggest however, that it would be useful to look at how the actual gains from trade (net of adjustment costs) vary with s. To do so, define NB to be the benefit from trade liberalization net of adjustment costs (measured as a percentage of initial steady state welfare). That is,

$$NB \equiv \frac{100(W_A - W_{SS})}{W_{SS}} \tag{24}$$

Figure 5b shows how NB varies with s for the case in which $b_1 = 1$, $b_2 = .1$ and $a_H = .33$. As with R^*, the relationship is non-montonic. Economies with sluggish labor markets gain less than those

[17] Note that we do not multiply the turnover rates associated with training by s. It is out view that the length of the training process is determined by the complexity of the job that is linked to technology, not the flexibility of the labor market.

[18] Similar values of s maximize R^* for the other parameter values considered in Tables 1-4. In fact, as we move from one case to another (in terms of the parameter vales considered in Tables 1-4), this value changes only at the second decimal place.

with slothful or flexible labor markets. However, unlike Figure 5a, this relationship is not at all flat for s < 1 – there is a large difference in what economies stand to gain from trade reform. An economy with a very slothful labor market gains over 2 percent of welfare (s < .16) as do economies with very flexible labor markets (s > 3.66). In contrast an economy with a sluggish labor market gains less than .2 percent.

The non-monotonicity present in Figure 5 can be traced to manner in which the gross benefits from trade and aggregate adustment costs (the two components of R^* and NB) vary with speed. The gross benefits from trade reform depend on two features – the amount of workers who switch sectors as a result of liberalization and the ability level of those workers. The more workers that switch and the more able these workers are, the greater the increase in gross output. Aggregate adjustment costs also depends on how many workers move (with greater movement implying higher adjustment costs) but they also depend on speed directly – as labor market flexibility increases, workers make the transition across sectors more quickly and adjustment costs fall.

Figure 3 can be used to see how the amount of worker reallocation varies with s. Trade reform lowers the return to training in the low-tech sector, causing the V_T^1 curve to shift down. The amount of worker reallocation that occurs then depends on the slope of the V_T^2 curve with a flatter curve implying more reallocation.[19] The ability levels of the switching workers depend on the position of the V_T^2 curve, which is determined by $\underline{a_2}$. From (15), we can write V_T^2 as $V_T^2 = \beta(s) p_2 q_2 a - \eta(s) p_2 c_2$ where β(s) and η(s) measure (roughly) the fraction of a high-tech worker's life that he or she expects to spend employed and training, respectively. It is straightforward to show that $\beta(s)p_2q_2$, the slope of V_T^2 with respect to ability, is increasing in s for

[19] If we increase b_1 at the same rate as b_2 and e then the slope of the V_T^1 curve matters as well. However, since turnover plays a more prominent role in the high-tech sector, it turns out that changes in the low-tech

$s < \sqrt{\frac{r(r+\tau_2)}{(1-\phi)eb_2}}$ and decreasing in s thereafter. Intuitively, if s = 0 a worker who is currently training has no hope of ever finding a job (since the job acquisition rate is 0) and thus ability, which only affects output while employed, plays no role in determining the value from training. In this case, the V_T^2 curve is horizontal. Increasing s leads to an increase in the fraction of life spent employed and makes ability more important. Thus, when s is low an increase in s causes the V_T^2 curve to become steeper. However, as s becomes large the relationship changes. Consider, for example, what happens when s approaches infinity – workers now find employment very quickly but the job breaks up almost instantly so that the worker spends most of his or her life training. Thus, for large s the V_T^2 curve is once again very flat. As s falls, the fraction of life spent employed rises, making ability more important. This means that when s is high, decreases in s make the V_T^2 curve steeper. It follows that trade reform results in a great deal of reallocation when s is either very low or very high.

As for the ability of the movers, this depends on $\underline{a}_2 = \frac{\eta(s)c_2}{\beta(s)q_2}$. It is straightforward to show that this value is decreasing in s for $s < \sqrt{\frac{r}{(1-\phi)eb_2}}$ and raising thereafter. The same logic applies – when s is very low or very high the ratio of time spent training to time spent employed is high and thus V_T^2 is low (implying a high value for $\underline{a}_2$). This ratio is minimized for some intermediate value of s, and this is the value of s that minimizes $\underline{a}_2$. Thus, it follows that when s is very low or very high, there is a great deal of reallocation ***and*** those who move have relatively high ability levels. Both of these forces result in a large gross benefit from trade reform. As a result, the gross benefits from trade reform are U-shaped in s.

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curve are dominated by changes in the high-tech curve. A brief desription of this case can be found in Davidson and Matusz (2000).

As for aggegate adjustment costs, the large amount of reallocation that occurs when s is high or low leads to large adjustment costs. We refer to this as the "indirect effect" of increased flexibility. However, there is also a direct effect of increasing s on these costs – as labor markets become more flexible, workers make the transition across sectors more quickly and this reduces adjustment costs. It follows that when s is very low, increasing s leads to lower adjustment costs through both the direct and indirect effects. But, when s is very high, an increase in s leads to lower adjustment costs through the direct effect but higher adjustment costs through the indirect effect. Thus, aggregate adjustment costs are either downward sloping in s, or, they may be U-shaped if the indirect effect is stronger than the direct effect. The gross benefits (GB), adjustment costs (AC) and net benefits (NB) associated with trade reform are shown in Panel A of Table 6 for the same parameter values that generated Table 5 (the qualitative features of Table 6 are the same for all parameter values in Tables 1-4). The fact that adjustment costs are U-shaped indicates that for high values of s the indirect effect is dominate. Note that NB (net benefit) is the difference between GB and AC. From this Table, we see that NB is high when there is either a great deal of labor market flexibility or very little. Net benefits are minimized when labor markets are somewhere inbetween, that is, when they are sluggish but not stagnant.

These results can be viewed one of two ways. On the one hand, there is good news for economies with slothful and flexible labor markets. For those with flexible labor markets things go as one would have expected a priori – they have much to gain from trade reform and need not worry much about adjustment costs. For those with slothful labor markets, they have much to gain as well, even though they are likely to face high costs of adjustment during the transition to the new steady-state. However, the reason that they gain so much is the bad news – in such economies tariffs have large distortionary effects because they cause a great deal of worker reallocation. Removing the tariff therefore generates gross benefits that are large enough to swamp the high costs of adjustment. Economies in the middle do not gain as much from trade

reform and still face relatively high adjsutment costs. As a result, economies with sluggish labor markets have the least to gain from trade liberalization.

It does, however, take time for the economy with the slothful labor markets to realize these large gains and since turnover is low it may be quite some time before net output returns to its prereform level. For example, for the case reported in Panel A of Table 6, while it takes 3.54 years for the base case economy (s = 1) to get net output back to its initial level, it takes almost an additional 2 years for the most stagnant economy (with s = .15 we find that $T^* = 5.31$). The implication is that although the gains from liberalization may be quite large in such economies, it may be very difficult to find any politician willing to push for such reform.

We close this section by investigating just how robust these non-montonic relationships are with respect to one of our key assumptions – that ability affects output but not training costs. To so so, consider how our model would change if we assume instead that all sector j workers produce the same output and that higher ability sector j trainers incur low training costs. In particular, assume that a worker with ability level a_i faces sector j training costs of c_j/a_i, reflecting the notion that higher ability workers pick up skills easier (i.e., at a lower personal cost). Then all of our earlier equations and analysis would carry through, with all $q_j a_i$ terms simply replaced by q_j and all c_j terms replaced by c_j/a_i. Higher ability workers would still be attracted to the high-tech sector and lower ability workers would still seek low-tech jobs. In order to investigate the relationship between flexibility and the costs and benefits from reform, we focus on the same features as before. In particular, we must look at what happenes to the amount of worker reallocation and the ability of the movers as speed increases.

We begin with worker reallocation. In this model, the V_T^2 curve takes the form $V_T^2 = \beta(s) p_2 q_2 - \eta(s) \frac{c_2 p_2}{a_i}$. Thus, the slope of V_T^2 with respect to ability evaluated at a_H is $\frac{\eta(s) c_2 p_2}{a_H^2}$. It is straightforward to show that $\eta'(s) > 0$ – that is, the fraction of a worker's life

that he or she can expect to spend training is increasing in speed (since increases in speed shorten both spells of unemployment and the time spent employed). However, as we saw above $\underline{a}_2$ (and therefore, given that the V_T^1 curve is fixed, a_H) is large when s is very small or very large. It follows that the V_T^2 curve is very flat when labor markets are slothful and the curve becomes steeper as s rises. So, just as in our earlier model, the amount of worker reallocation is large when s is small and it is initially decreasing in s. However, as s gets large the impact on the slope of the V_T^2 curve appears to be ambiguous – $\eta(s)$ is increasing in s but so is a_H. Simulations of the model for all of the parameter values in Tables 1-4 reveals that a_H rises faster that $\eta(s)$ so that, as in our earlier model, the amount of reallocation starts to rise again when s starts to becomes large.

As for the ability of the movers, the qualitative relationship between $\underline{a}_2$ and s is exactly as it was in our previous model. This means that the most able workers move either when s is very low or very high. Consequently, when s is very low there is a great deal of worker reallocation and those who move have high ability levels (so that their training costs are low). This means that, as in our previous model, the gross benefits from reform are high when s is very low. As s starts to increase, fewer workers move and those who do move are of lower ability. Thus, at first, the gross benefits are decreasing in s. However, as s rises further the amount of reallocation starts to increase while those who move begin to have higher ability levels. Thus, for high values of s the gross benefits are increasing in s. Panel B of Table 6 shows a typical case for this alternative model (the underlying parameter values are the same as those used to generate Panel A). In this case, as in all other cases for the parameter values that we consider, the relationship between gross benefits and labor market flexibility has the same qualitative flavor as it did in our first model – it is U-shaped.

As for adjustment costs, when s is low there is a great deal of reallocation but those who reallocate have high ability levels (and face low training costs). In addition, the reallocation

occurs very slowly. As a result, adjustment costs are high. As s rises, there is less reallocation and it occurs faster, causing adjustment costs to fall. Eventually, however, the amount of reallocation begins to rise again as s increases further and the ability levels of the movers start to rise as well. Thus, although reallocation occurs quickly when s is high, adjustment costs start to rise.

Table 6 indicates that the qualitative relationships between labor market flexibility, the gross and net benefits from liberalization and adjustment costs are the same in both models. Thus, our result that economies with sluggish labor markets gain less from trade reform that do economies with slothful or flexible labor markets appears to be robust to the manner in which ability affects net output.

5. Conclusion

There is no dispute about the fact that workers lose their jobs due to changes in trade patterns and that protecting an industry saves jobs. For example, Hufbauer and Elliott (1994) estimate that eliminating protection in the U.S. apparel industry would cost over 150,000 workers their jobs. It is also well documented that dislocated workers suffer large personal losses with some estimates for the average loss ranging as high as $80,000 in lifetime earnings (Jacobson, LaLonde and Sullivan 1993a, b). It is therefore not surprising that political leaders are sometimes hesitant about trade reform. Those who lose may lose a great deal and are likely to remember who is at fault when the next election nears. The gains are delayed, perhaps significantly, and are spread out over many so that, on average, those who do gain probably gain much less than the few who lose.

Nevertheless, there is probably no other position in economics that has as much widespread support as the belief in the benefits from freer trade. Academic economists typically respond to public concerns about the personal losses to dislocated workers by explaining that such concerns are misplaced and misguided. This view was summarized and, we feel,

appropriately criticized by Baldwin, Mutti, and Richardson (1980) in their article on adjustment costs:

> Economists have sometimes dismissed such adjustment costs with the comment that the displaced factors become reemployed "in the long run." But this is bad economics, since in discounting streams of costs and benefits for welfare calculations, the near-present counts more heavily than "the long-run."

In this paper, we have tried to take a serious look at the possible magnitude of the adjustment costs that are likely to arise from trade reform. The novelty of our approach is that we have modeled the training and search proccesses that workers must go through in order to find jobs. This allows us to take into account the time and resource costs of retraining and job search. We have tried to be modest in our assumptions concerning these costs. We have assumed away the resource costs associated with job search and low-tech training. We have also assumed that the time costs involved in low-tech training are very small (one week). Finally, we have looked at a wide variety of assumptions concerning the cost of training in the high-tech sector.

Our results are surprising. Even with our most modest assumption concerning the cost of high-tech training (that they equal one month of the average high tech worker's annual earnings), we find that adjustment costs are a significant fraction of the gross benefits from trade reform. Our lowest estimate is that roughly 30% of the gross benefits will be eaten away by adjustment. At the other extreme, we find that when high-tech training is costly (15 months of the average worker's annual salary) as much as 90% of the gross benefits may disappear during the transition period. Even when we focus attention on gross output (so all that matters are the time costs of training and job search) we find that our estimates of adjustment costs are at least twice as high as previous estimates in the literature (Magee 1972 and Bladwin et al 1980). We also find that the tranistion period may be substantial, taking anywhere from 2 to 5 years for net output to get back to its prereform level. Therefore, it is not surprising that politicians may be

reluctant to agree to trade liberalization – by the time their economy begins to reap the benefits they may have already been voted out of office!

In the latter part of the paper we investigate the relationship between labor market flexibility, the gains from trade reform and aggregate adjustment costs. It is well documented that turnover rates vary significantly across countries (Freeman 1994). Part of the reason for this is that countries vary in generousity of the social safety nets they provide for the poor and the jobless. Firing costs and generous unemployment insurance programs contribute to long term unemployment and low turnover throughout Europe (Ljungqvist and Sargent 1998). In addition, the wide-spread influence of unions in Europe contrasts sharply with their role in the US, resulting in more rigid wages in European labor markets. Labor and macroeconomists have recognized that this difference in labor market structure has important implications for issues such as job training and macroeconomic performance (see, for example, Layard, Nickell, and Lackman 1991). As far as we know, we are the first to investigate the implications for the net gains from trade liberalization.

Again, our results could not have been anticipated. We find that tariffs create the biggest distortions in economies with slothful or highly flexible labor markets. As a result, when trade is liberalized these economies have the most to gain. This is true inspite of the fact that adjustment costs are high when there is very low turnover. It follows that economies with sluggish labor markets should be the most reluctant to reduce trade barriers – they have the least to gain. Finally, all of our simulations suggest that the turnover rates in U.S. labor markets are high enough to characterize it as a highly flexible economy. This suggests that the U.S. probably has more to gain from trade reform than there European allies.

Appendix A

In this Appendix we show how to solve the differential equations in (1)-(5) and obtain a closed form solution for the transition path to the new steady-state equilibrium. We begin by noting that workers with ability levels in the intervals (a_L, a_{HN}) and (a_H, 1) do not change their behavior after liberalization. Those in the former interval remain attached to sector 1 while those in the latter interval remain attached to sector 2. It follows that the measure of workers in these intervals that are training, searching, or employed are given by (16)-(20) with the term a_H term in (16) and (17) replaced by a_{HN}.

The remaining workers, those with ability levels in the interval (a_{HN}, a_H), want to switch from sector 1 to sector 2, but will only do so while training. We refer to these workers as the "switchers." To figure out how many switchers are in each labor market state at time t, we begin by introducing some new notation. We define $S_{12}^{T}(t)$ as the measure of workers who switch from sector 1 to sector 2 following liberalization and are training at time *t.* Similarly define $S_{12}^{S}(t)$ as the measure of workers who switch from sector 1 to sector 2 and are searching at time *t*. Finally, we use $S_{12}^{E_j}(t)$ to denote the measure of switchers who are employed in sector j at time t. The system of differential equations for these workers can be written as in (A.1) - (A.4):

$$(A.1) \qquad \dot{S}_{12}^{E_1} = -b_2 S_{12}^{E_1}$$

$$(A.2) \qquad \dot{S}_{12}^{E_2} = eS_{12}^{S_2} - b_2 S_{12}^{E_2}$$

$$(A.3) \qquad \dot{S}_{12}^{S} = b_2 \mathsf{f}_2 S_{12}^{E_2} + \mathsf{t}_2 S_{12}^{T} - eS_{12}^{S}$$

$$(A.4) \qquad (a_H - a_{HN})L = S_{12}^{E_1} + S_{12}^{E_2} + S_{12}^{S} + S_{12}^{T}$$

where, for notational convenience, we have suppressed the time argument.

Equation (A.4) is a simple differential equation, which has the following solution

$$(A.5) \qquad S_{12}^{E_1}(t) = \frac{\mathsf{t}_1}{\mathsf{t}_1 + b_1}(a_H - a_{HN})Le^{-b_1 t}.$$

In solving (A.1), we make use of the initial condition that $S_{12}^{E_1}(0) = \frac{\tau_1}{\tau_1 + b_1}(a_H - a_{HN})L$.

To solve (A.2) - (A.4), substitute (A.5) into (A.4), solve for S_{12}^T in terms of $S_{12}^{E_2}$ and S_{12}^S and then substitute the result into (A.3). This leaves us with (A.2) and (A.3) which form a system of two differential equations that can be written in matrix form:

$$(A.6) \qquad \begin{bmatrix} \dot{S}_{12}^{E_2} \\ \dot{S}_{12}^{S} \end{bmatrix} = \begin{bmatrix} -b_2 & e \\ b_2\phi_2 - \tau_2 & -(e+\tau_2) \end{bmatrix} \begin{bmatrix} S_{12}^{E_2} \\ S_{12}^{S} \end{bmatrix} + \begin{bmatrix} 0 \\ h(t) \end{bmatrix}$$

where $h(t) \equiv \tau_2(a_H - a_{HN})L\left(1 - \frac{\tau_1}{\tau_1 + b_1}e^{-b_1 t}\right)$. The method for solving a system of this form can be found in Boyce and DiPrima (1977), pp. 329-331. Using the initial conditions that $S_{12}^{E_2}(0) = S_{12}^{S}(0) = 0$, the solutions are

$$(A.7) \qquad S_{12}^{E_2}(t) = \frac{e\tau_2(a_H - a_{HN})L}{\lambda_1\lambda_2} + \frac{e\tau_1\tau_2(a_H - a_{HN})L}{(\tau_1 + b_1)(\lambda_2 - \lambda_1)}\left[\frac{e^{\lambda_1 t}}{\lambda_1 + b_1} - \frac{e^{\lambda_2 t}}{\lambda_2 + b_1}\right] -$$

$$\frac{e\tau_2(a_H - a_{HN})L}{\lambda_2 - \lambda_1}\left[\frac{e^{\lambda_1 t}}{\lambda_1} - \frac{e^{\lambda_2 t}}{\lambda_2}\right] - \frac{e\tau_1\tau_2(a_H - a_{HN})L}{(\tau_1 + b_1)(\lambda_1 + b_1)(\lambda_2 + b_1)}e^{-b_1 t}$$

$$(A.8) \qquad S_{12}^{S}(t) = \frac{\tau_2 b_2(a_H - a_{HN})L}{\lambda_1\lambda_2} + \frac{\tau_1\tau_2(a_H - a_{HN})L}{(\tau_1 + b_1)(\lambda_2 - \lambda_1)}\left[\frac{b_2 + \lambda_1}{b_1 + \lambda_1}e^{\lambda_1 t} - \frac{b_2 + \lambda_2}{b_1 + \lambda_2}e^{\lambda_2 t}\right] -$$

$$\frac{\tau_2(a_H - a_{HN})L}{(\lambda_2 - \lambda_1)}\left[\frac{b_2 + \lambda_1}{\lambda_1}e^{\lambda_1 t} - \frac{b_2 + \lambda_2}{\lambda_2}e^{\lambda_2 t}\right] -$$

$$\frac{\tau_1\tau_2(b_2 - b_1)(a_H - a_{HN})L}{(\tau_1 + b_1)(\lambda_1 + b_1)(\lambda_2 + b_1)}e^{-b_1 t}$$

where λ_1 and λ_2, the eigenvalues of the coefficient matrix in (A.6), are given by:

$$(A.9.a) \qquad \mathsf{l}_1 = \frac{-(b_2 + e + \mathsf{t}_2) - \sqrt{(b_2 + e + \mathsf{t}_2)^2 - 4b_2 e(1 - \mathsf{f}_2)}}{2}$$

$$(A.9.b) \qquad \mathsf{l}_1 = \frac{-(b_2 + e + \mathsf{t}_2) + \sqrt{(b_2 + e + \mathsf{t}_2)^2 - 4b_2 e(1 - \mathsf{f}_2)}}{2}.$$

The measure of workers training in sector 1 at time t is then given by (16) (with a_H replaced by a_{HN}). The total measure of workers employed in sector 1 at time t is then given by the sum of $S_{12}^{E_1}(t)$ and (17) (with the a_H term replaced by a_{HN}). The total measure of workers training in sector 2 is given by the sum of (18) and $S_{12}^{T}(t)$ and the total measure of workers searching in the high-tech sector is the sum of (19) and $S_{12}^{S}(t)$. Finally, the total measure of workers employed in sector 2 at time t is given by the sum of (20) and $S_{12}^{E_2}(t)$. These values are used in (22) to solve for output net of training costs along the adjustment path.

Appendix B

In this appendix we show that the laissez-faire equilibrium in our model is efficient. To do so, we calculate the dynamic marginal product of labor in each sector and show that these values are equal in the market equilibrium.

The dynamic marginal product of sector j labor measures the increase in net output that occurs if the steady state is disturbed by adding an additional worker to that sector taking into account the adjustment path to the new steady state. To calculate the dynamic marginal products we follow the method developed in Diamond (1980).

We begin by defining $c_i(\theta)$ as the present discounted value of output net of training costs produced in sector i when a (small) measure θ of new workers is added to that sector. These workers are assumed to have ability level a_H. Equilibrium is efficient if $c_1'(\theta) = c_2'(\theta)$.

Start with sector 1. We have[20]

$$c_1(\theta) \equiv \int_0^\infty e^{-rt}\{a_H q_1 p_1 \theta I(t) - \theta p_1 c_1[1 - I(t)]\}dt$$

where $\dot{\theta}_1^E = \tau_1 \theta - (\tau_1 + b_1)\theta_1^E$ and $I(t)$ is an indicator function that takes on the value of 1 when the worker is employed and equals zero at all other times. To find $c_1'(\theta)$ we start by using the fundamental equation of dynamic programming which states that

$$rc_1(\theta) = a_H q_1 p_1 \theta I(t) - \theta p_1 c_1[1 - I(t)] + \frac{\partial c_1}{\partial \theta_1^E}\dot{\theta}_1^E$$

Substituting for $\dot{\theta}_1^E$ from above allows us to write this as

$$(B.1) \qquad rc_1(\theta) = a_H q_1 p_1 \theta I(t) - \theta p_1 c_1[1 - I(t)] + \frac{\partial c_1}{\partial \theta_1^E}\{\tau_1 \theta - (\tau_1 + b_1)\theta_1^E\}$$

[20] The equation of motion for $\dot{\theta}_1^E$ is obtained in the following manner. Since search is not required to find employment in sector 1, we have $\dot{\theta}_1^E = \tau_1 \theta_1^T - b_1 \theta_1^E$. Now, we know that the total measure of trainers

Differentiating with respect to q yields

$$r c_1'(q) = a_H q_1 p_1 I(t) - p_1 c_1 \{1 - I(t)\} + t_1 \frac{\partial c_1}{\partial q_1^E}$$

but, at t = 0, $I(a_H, 0) = 0$ so that we have

$$(B.2) \qquad r c_1'(q) = -p_1 c_1 + t_1 \frac{\partial c_1}{\partial q_1^E}$$

To complete our derivation, we must now calculate $\frac{\partial c_1}{\partial q_1^E}$. To do so, we solve (B.1) for $\frac{\partial c_1}{\partial q_1^E}$. We obtain

$$\frac{\partial c_1}{\partial q_1^E} = \frac{r c_1 - a_H q_1 p_1 q I(t) + q p_1 c_1 [1 - I(t)]}{t_1 q - (t_1 + b_1) q_1^E}$$

In the initial steady state, the right-hand side of this equation equals 0/0. Applying L'Hopital's Rule, we have (note that we are differentiating with respect to q_1^E, which is the same as $q I(t)$)

$$\frac{\partial c_1}{\partial q_1^E} = \frac{r \frac{\partial c_1}{\partial q_1^E} - a_H q_1 p_1 - p_1 c_1}{-(t_1 + b_1)}$$

or

$$\frac{\partial c_1}{\partial q_1^E} = \frac{a_H q_1 p_1 + p_1 c_1}{r + t_1 + b_1}$$

We can now substitute this value into (B.2) to obtain the dynamic marginal product of labor in sector 1:

$$(B.3) \qquad r c_1'(q) = \frac{t_1 a_H q_1 p_1 - (r + b_1) p_1 c_1}{r + t_1 + b_1}$$

Note that this dynamic marginal product equals $r V_1^E(a_H)$.

(out of the q) in sector 1 is equal to the difference between q and the measure of employed

We now turn next to sector 2. We have

$$\gamma_2(\theta) \equiv \int_0^\infty e^{-rt}\{a_H p_2 q_2 \theta I(t) - c_2 p_2 \theta [1 - I(t) - H(t)]\}dt$$

where $\dot{\theta}_2^E = e\theta_2^S - b_2\theta_2^E$, $\dot{\theta}_2^S = \tau_2\theta + (b_2\phi - \tau_2)\theta_2^E - (\tau_2 + e)\theta_2^S$, I(t) is an indicator function that equals one when the worker is employed and zero otherwise and H(t) is an indicator function which equals one when the worker is searching and zero otherwise.

As above, we start by applying the fundamental equation of dynamic programming which implies that

$$r\gamma_2(\theta) = a_H p_2 q_2 \theta I(t) - c_2 p_2 \theta [1 - I(t) - H(t)] + \frac{\partial \gamma_2}{\partial \theta_2^E}\dot{\theta}_2^E + \frac{\partial \gamma_2}{\partial \theta_2^S}\dot{\theta}_2^S$$

If we now use the equations of motion to substitute for $\dot{\theta}_2^E$ and $\dot{\theta}_2^S$ and then differentiate with respect to θ we obtain

$$r\gamma_2'(\theta) = a_H p_2 q_2 I(t) - c_2 p_2 [1 - I(t) - H(t)] + \frac{\partial \gamma_2}{\partial \theta_2^S}\tau_2$$

But, in the initial steady state (at $t = 0$), we know that $I(0) = H(0) = 0$; so that

$$(B.4) \qquad r\gamma_2'(\theta) = -c_2 p_2 + \tau_2 \frac{\partial \gamma_2}{\partial \theta_2^S}$$

The final step requires us to solve for $\frac{\partial \gamma_2}{\partial \theta_2^S}$ and then substitute that value into (B.4). Again following Diamond (1980), we differentiate the fundamental equation of dynamic programming with respect to θ_2^E and θ_2^S. We obtain

$$\begin{bmatrix} \frac{\partial \gamma_2}{\partial \theta_2^E} \\ \frac{\partial \gamma_2}{\partial \theta_2^S} \end{bmatrix} = \begin{bmatrix} (a_H p_2 q_2 + c_2 p_2) & c_2 p_2 \end{bmatrix} \begin{bmatrix} r + b_2 & -(b_2\phi - \tau_2) \\ -e_2 & (r + \tau_2 + e_2) \end{bmatrix}^{-1}$$

---

workers in that sector. Substituting for θ_1^T yields the desired result.

Solving this system of equations for $\frac{\partial c_2}{\partial q_2^S}$ yields

$$(B.5) \qquad \frac{\partial c_2}{\partial q_2^S} = \frac{p_2\{a_H q_2 e_2 + c_2(e_2 + r + b_2)\}}{(r+b_2)(r+t_2+e_2) + e_2 t_2 - e f\, b_2}$$

Substituting (B.5) into (B.4) and collecting terms results in

$$(B.6) \qquad r c_2'(q) = \frac{p_2\{a_H q_2 e - [(r+b_2)(r+e_2) - e_2 f\, b_2] c_2\}}{(r+b_2)(r+t_2+e) + e_2 t_2 - e_2 f\, b_2}$$

Note that (B.6) is also equal to $rV_2^T(a_H)$. Thus, since the dynamic marginal products both equal the expected lifetime income for a worker training in that sector, and, since workers are allocated so that the expected lifetime income from training is the same in both sectors, the dynamic marginal products are equal in equilibrium. As a result, equilibrium is efficient.

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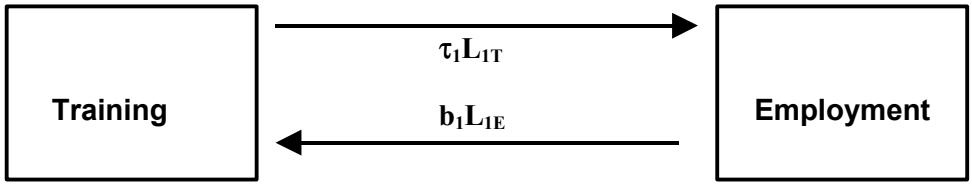

Figure 1: Labor Market Dynamics in Sector 1

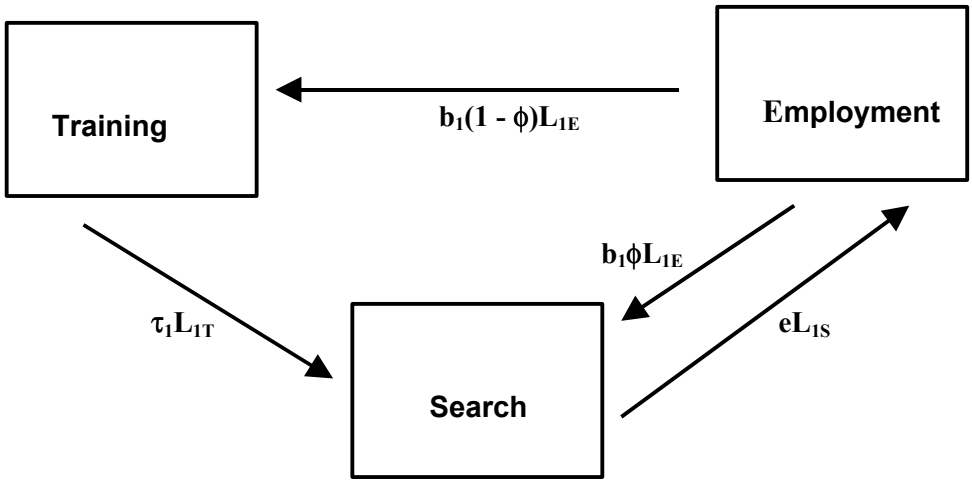

Figure 2: Labor Market Dynamics in Sector 2

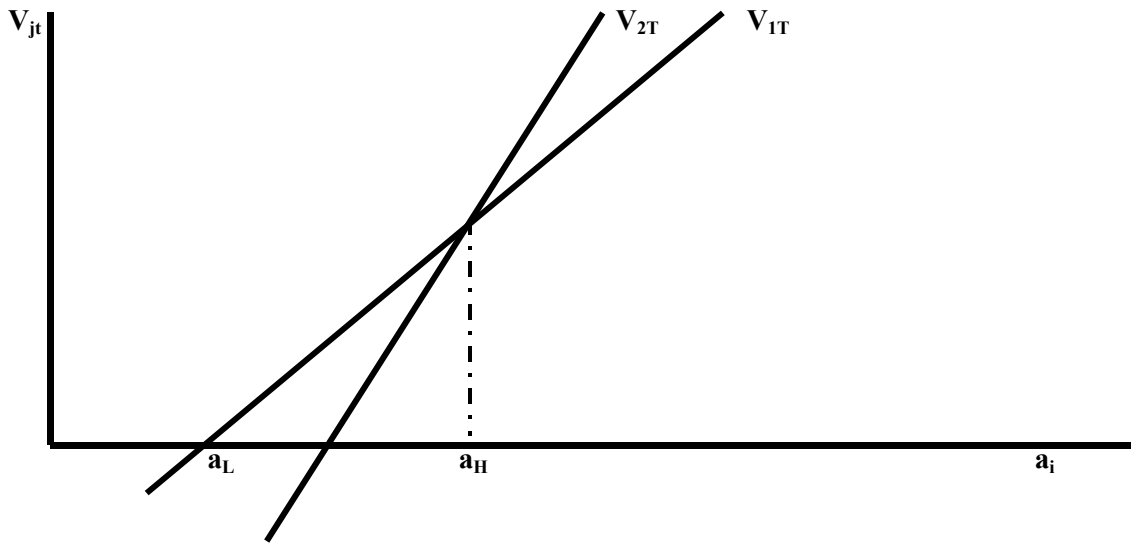

Figure 3: The Equilibrium Allocation of Workers

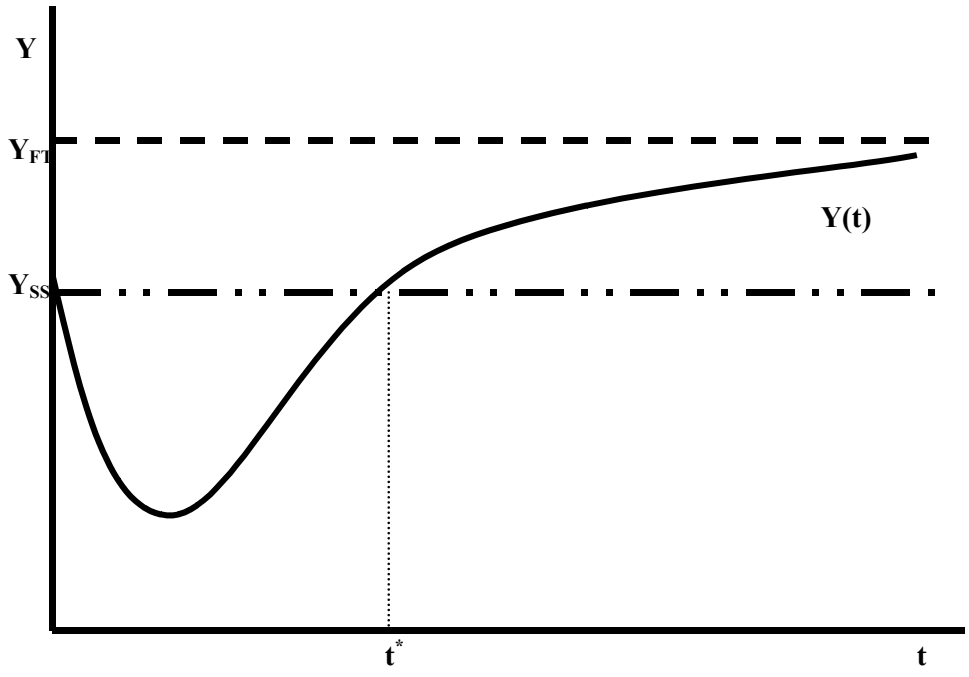

Figure 4: The Value of Ouput Net of Training Costs over Time

R* as a Function of s

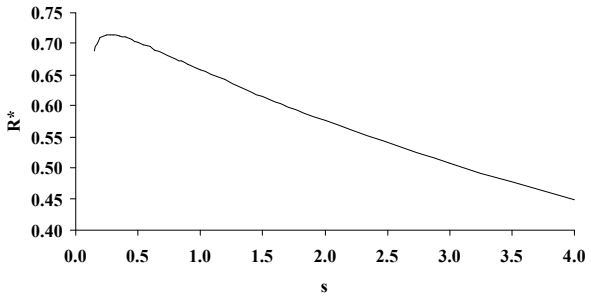

Figure 5a

NB as a Function of s

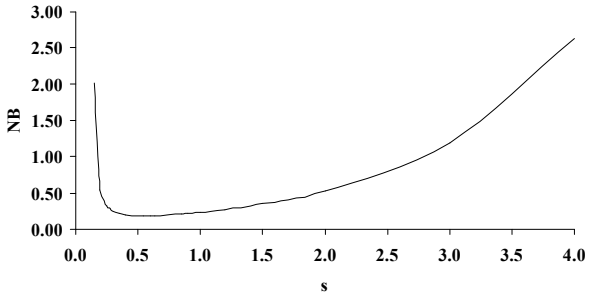

Figure 5b

a_H Training Costs	.20	.33	.50	.66	.80
b_1=.5 b_2=.1					
1 month	.49	.43	.39	.37	.36
5 months	.75	.67	.60	.55	.52
10 months	.86	.78	.71	.67	.64
15 months	.90	.84	.78	.73	.70
b_1=.5 b_2=.167					
1 month	.50	.44	.40	.38	.36
5 months	.76	.67	.60	.56	.53
10 months	.86	.79	.72	.67	.64
15 months	.91	.85	.79	.74	.71
b_1=1 b_2=.1					
1 month	.48	.41	.38	.36	.34
5 months	.74	.66	.59	.54	.51
10 months	.85	.78	.71	.66	.62
15 months	.90	.84	.78	.73	.70
b_1=1 b_2=.167					
1 month	.48	.42	.38	.36	.35
5 months	.75	.66	.59	.54	.52
10 months	.86	.78	.71	.66	.63
15 months	.91	.85	.78	.73	.70

Table 1

Aggregate Adjustment Costs as a Fraction of the Gross Benefits from Trade Reform

a_H Training Costs	.20	.33	.50	.66	.80
b_1=.5 b_2=.1					
1 month	4.7	4.5	4.3	4.2	4.1
5 months	5.5	5.3	5.1	4.9	4.8
10 months	5.8	5.6	5.4	5.3	5.2
15 months	5.9	5.8	5.6	5.5	5.4
b_1=.5 b_2=.167					
1 month	4.7	4.5	4.3	4.2	4.1
5 months	5.6	5.3	5.1	4.9	4.8
10 months	5.8	5.6	5.5	5.3	5.2
15 months	5.9	5.8	5.6	5.5	5.4
b_1=1 b_2=.1					
1 month	3.2	3.1	3.0	3.0	2.9
5 months	3.6	3.5	3.4	3.4	3.3
10 months	3.8	3.7	3.6	3.5	3.5
15 months	3.8	3.8	3.7	3.6	3.6
b_1=1 b_2=.167					
1 month	3.2	3.1	3.0	3.0	2.9
5 months	3.7	3.5	3.4	3.4	3.3
10 months	3.8	3.7	3.6	3.5	3.5
15 months	3.8	3.8	3.7	3.6	3.6

Table 2

The Length of Time it Takes for Output (Net of Training Costs)
To Return to its Pre-Reform Level

a_H Training Costs	.20	.33	.50	.66	.80
b_1=.5 b_2=.1					
1 month	.26	.27	.28	.29	.29
5 months	.17	.20	.22	.24	.25
10 months	.13	.16	.18	.20	.21
15 months	.11	.14	.16	.18	.19
b_1=.5 b_2=.167					
1 month	.24	.26	.27	.28	.28
5 months	.15	.18	.21	.22	.23
10 months	.12	.14	.17	.18	.19
15 months	.10	.12	.14	.16	.17
b_1=1 b_2=.1					
1 month	.23	.25	.26	.27	.27
5 months	.14	.18	.20	.21	.22
10 months	.10	.13	.16	.18	.19
15 months	.09	.12	.13	.16	.16
b_1=1 b_2=.167					
1 month	.22	.24	.25	.26	.26
5 months	.13	.16	.19	.20	.21
10 months	.09	.12	.14	.16	.17
15 months	.07	.10	.12	.14	.15

Table 3

Aggregate Adjustment Costs as a Fraction of the Gross Benefits from Trade Reform Ignoring the Resource Costs From High-Tech Training

a_H Training Costs	.20	.33	.50	.66	.80
b_1=.5 b_2=.1					
1 month	3.4	3.5	3.6	3.6	3.7
5 months	2.5	2.9	3.1	3.3	3.3
10 months	1.9	2.4	2.7	2.9	3.0
15 months	1.6	2.0	2.4	2.6	2.7
b_1=.5 b_2=.167					
1 month	3.3	3.5	3.5	3.6	3.6
5 months	2.3	2.7	3.0	3.1	3.2
10 months	1.7	2.2	2.5	2.7	2.8
15 months	1.3	1.8	2.2	2.4	2.5
b_1=1 b_2=.1					
1 month	2.5	2.6	2.7	2.7	2.7
5 months	2.0	2.2	2.4	2.5	2.5
10 months	1.6	1.9	2.1	2.2	2.3
15 months	1.4	1.6	1.9	2.0	2.2
b_1=1 b_2=.167					
1 month	2.5	2.6	2.6	2.7	2.7
5 months	1.9	2.1	2.3	2.4	2.4
10 months	1.5	1.8	2.0	2.1	2.2
15 months	1.2	1.5	1.8	1.9	2.2

Table 4
The Length of Time it Takes for Gross Output
To Return to its Pre-Reform Level

a_H Training Costs	.20	.33	.50	.66	.80
b_1=1 b_2=.1					
1 month	.48	.55	.60	.63	.64
5 months	.20	.28	.35	.40	.44
10 months	.11	.17	.23	.29	.32
15 months	.07	.13	.17	.21	.25

Table 5a
Values of s (speed) that maximize R*

a_H Training Costs	.20	.33	.50	.66	.80
b_1=1 b_2=.1					
1 month	.80	.85	.91	.94	.96
5 months	.45	.55	.63	.67	.70
10 months	.33	.42	.49	.55	.59
15 months	.27	.35	.42	.48	.51

Table 5b
Values of s (speed) that minimize NB

s	GB	AC	NB	GB	AC	NB
.15	6.454	4.438	2.016	7.319	4.740	2.579
.20	1.853	1.313	.540	3.474	2.002	1.472
.25	1.134	.809	.325	2.595	1.472	1.123
.30	.876	.626	.250	2.239	1.302	.937
.35	.752	.536	.216	2.063	1.248	.815
.40	.684	.485	.199	1.971	1.246	.725
.45	.645	.455	.190	1.924	1.270	.654
.50	.622	.437	.185	1.905	1.309	.596
.55	.610	.426	.184	1.903	1.357	.546
.60	.605	.420	.185	1.914	1.411	.503
.65	.604	.417	.187	1.930	1.457	.473
.85	.635	.426	.209	2.071	1.716	.355
1.00	.679	.447	.232	2.208	1.904	.304
1.20	.756	.484	.272	2.420	2.153	.267
1.50	.906	.558	.348	2.782	2.511	.271
2.00	1.247	.718	.529	3.486	3.064	.422
3.00	2.409	1.221	1.188	5.291	4.028	1.263
	Panel A			Panel B		

Table 6
The gross benefits (GB), adjustment costs (AC) and net benefits (NB) Associated with Trade Reform
($b_1 = 1$, $b_2 = .1$, $a_H = .33$)