

# Trade Liberalization and Compensation

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Abstract: Liberalization harms some groups while generating aggregate benefits. We consider various labor market policies that might be used to compensate those who lose from freer trade. Our goal is to find the policy that compensates each group of losers at the lowest cost to the economy. We argue that wage subsidies should be used to compensate those who bear the adjustment costs triggered by liberalization while employment subsidies should be used to compensate those who remain trapped in the previously protected sector. Our analysis indicates that the cost of compensation is low, provided that the right policy is used.

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## 1. Introduction

Two of the most generally accepted propositions in economics are that trade liberalization harms some groups but that it also generates aggregate net benefits. In fact, there are large literatures devoted to identifying the winners and losers from freer trade and measuring their gains and losses. Yet, there has been surprisingly little research aimed at investigating the best way to go about compensating those who lose. Using a traditional, full employment model of trade Dixit and Norman (1980, 1986) have argued that it is possible to use commodity taxes to compensate the losers without exhausting the benefits from freer trade. This is an important finding since it indicates that with such a compensation scheme in place, trade liberalization would always lead to a Pareto improvement. Brecher and Choudhri (1994) have raised concerns about this result by showing that in the presence of unemployment this scheme may not work. They show that in such a setting, under reasonable conditions, fully compensating the losers may eat away all of the gains from trade. Feenstra and Lewis (1994) argue that similar problems arise when factors of production are imperfectly mobile. However, they demonstrate that the situation can be remedied by augmenting the Dixit-Norman scheme with policies aimed at enhancing factor mobility. In particular, they show that the use of commodity taxes *coupled* with trade adjustment assistance may be adequate to achieve true Pareto gains from liberalization. Feenstra and Lewis do not ask whether there is a superior way to achieve this goal.<sup>1</sup>

In contrast, the policy community has been interested in this question for quite some time. Much of the recent policy debate may have been triggered by findings that the *personal* cost of worker dislocation may be quite high. For example, Jacobson, LaLonde, and Sullivan

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<sup>1</sup> In fact, the only other paper (that we know of) that addresses the issue of optimal compensation is Brander and Spencer (1994). See footnote 7 for a brief discussion of their approach and how it differs from ours.

(1993a, b) find that the average dislocated worker suffers a loss in lifetime earnings of \$80,000! Kletzer (2001) also finds that the losses are non-trivial, but her estimates are less dramatic. Focusing on the reduction in wages that these workers eventually accept in order to find new jobs, she finds that the average dislocated worker accepts a 12% pay cut. The policy debate has centered on labor market policies that could be used to alleviate the burden placed on such workers.<sup>2</sup> Among the policies that have been considered are wage subsidies, employment subsidies (sometimes referred to as “reemployment bonuses”), trade adjustment assistance (usually in the guise of unemployment insurance) and training subsidies.<sup>3</sup> Many of the recent contributors to this debate have focused attention on wage subsidies largely because of their incentive effects – wage subsidies reward work and encourage dislocated workers to return to work quickly. In contrast, trade adjustment assistance lowers the opportunity cost of unemployment, resulting in longer spells of unemployment.

In this paper we compare a variety of labor market policies to determine the best way to compensate the groups that are harmed by liberalization.<sup>4</sup> We consider this to be an important

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<sup>2</sup> For contributions to the debate, see Baily, Burtless and Litan (1993), Burtless, Lawrence, Litan, and Shapiro (1998), Parsons (2000), Kletzer and Litan (2001), and Hufbauer and Goodrich (2001).

<sup>3</sup> In a recent policy brief that has generated much discussion, Kletzer and Litan (2001) argue that the best way to compensate dislocated workers is with “wage insurance” which is essentially a wage subsidy. See also Hufbauer and Goodrich (2001) who suggest a similar but more generous policy

<sup>4</sup> We do not allow the government to redistribute income via commodity or income taxes. Thus, we rule out the type of compensation scheme envisioned by Dixit and Norman (1980, 1986). There are at least two reasons for this. First and foremost, we know of no government that has ever considered such a scheme to compensate workers harmed by changes in trade policies. In contrast, the labor market policies that we consider are at the center of the policy debate on dislocated workers. Second, some authors have raised concerns about the practicality of the Dixit-Norman scheme. As we mentioned above, Brecher and Choudhri (1994) argue that the scheme may not work in the

question. The objections of those who will be harmed if trade barriers are removed create roadblocks that make freer trade difficult to achieve. Coupling liberalization with an adequate compensation scheme is one way to secure general agreement about trade policy.<sup>5</sup> However, compensating the losers distorts the economy and reduces welfare. Our goal is to find the labor market policy that fully compensates each group while imposing the smallest distortion on the economy.

To compare these policies, we develop a model of trade in which workers seeking employment must first complete costly training and search processes. The government can reduce the costs imposed on these workers by subsidizing training and/or offering unemployment benefits to searching workers. Alternatively, the government can augment the compensation received by employed workers through wage or employment subsidies.

There are two types of jobs in our economy. First, there are low-tech jobs that require few skills, are easy to find, pay low wages, and are not very durable. Second, there are high-tech jobs that require significant skills, are relatively difficult to obtain, pay high wages, and last for a long time. Workers differ in terms of ability with higher-ability workers producing more output in a given sector than their lower-ability counterparts. In equilibrium, workers separate with low-ability workers attracted to the low-tech sector and high-ability workers attracted to the high-tech sector. If we refer to the worker who is just indifferent between training for high and low-tech jobs as the “marginal worker,” then this implies that the average low-tech worker has

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presence of unemployment. Spector (2001) argues that the scheme may not work when borders are open. See also Kemp and Wan (1986, 1995) who raise concerns about the assumptions required to prove the Dixit-Norman result.

<sup>5</sup> This argument for compensation programs has been made by Lawrence and Litan (1986). We also note that recent survey evidence by Scheve and Slaughter (2001) indicates that a majority of American workers would be in favor of further liberalization *provided* that those who are harmed receive some sort of compensation or assistance.

lower ability than the marginal worker while the average high-tech worker has higher ability than the marginal worker. This distinction plays an important role in our policy analysis.

We assume that in the initial equilibrium the low-tech sector is protected by a tariff. As a result, some workers who, in terms of economic efficiency, should be employed in the high-tech sector are attracted to the low-tech sector instead. We then assume that the tariff is removed and allow the economy to move to the new equilibrium. The model is simple enough that we are able to solve for the adjustment path across steady states. This allows us to take the transition period into account when calculating welfare. We find that there are two groups of workers who are harmed by liberalization. First, there are the “stayers” – those workers who remain trapped in the low-tech sector because it would be too costly for them to acquire the skills required for high-tech jobs. Second, there are the “movers” – those workers who switch sectors after the tariff is removed. While the movers eventually gain by securing higher wages, they bear the burden of the adjustment costs imposed on the economy by liberalization. They must go through a costly training process to acquire high-tech skills and then engage in costly search in order to find new jobs. We find that for reasonable parameter values, these costs outweigh the long-term gains so that, as a group, the movers lose.

Removing the tariff and allowing the economy to adjust to the free-trade equilibrium leads to the highest level of aggregate welfare. However, we assume instead that the government wants to compensate these two groups for their losses. Any attempt to do so creates a distortion, reducing welfare. We compare wage subsidies, employment subsidies, trade adjustment assistance (i.e., unemployment benefits) and training subsidies to see which policy achieves full compensation at the lowest cost to the economy. We find that there are two rules that a compensation scheme should satisfy. The first rule is simple -- any policy should be targeted.

For example, if a wage subsidy is to be used to compensate the movers, then it should be offered only to those who switch sectors after the tariff is removed.

The second rule is more subtle and focuses on how the policies affect the average and marginal workers in the targeted group. The policy's impact on the average targeted worker is important because it determines the size of the program needed to compensate the group. If the average targeted worker's lifetime utility is highly sensitive to the policy parameter, then only a modest sized program will be required to fully compensate the group. The impact of a policy on the marginal worker determines the size of the distortion that the compensation scheme imposes on the economy. If the marginal worker's lifetime utility is highly sensitive to the policy parameter, then even a modest sized program may trigger a great deal of inefficient relocation by workers resulting in a large distortion. It follows that the best policy will be one that has a large impact on the average worker in the targeted group and a small impact on the marginal worker.

Applying these rules, we find that the best way to compensate the movers is with a targeted wage subsidy. The subsidy is paid only to those who switch sectors after liberalization. Under such a policy, high-ability movers (who earn a higher wage) collect more compensation than their low-ability counter-parts. When compensating the movers, this is a desirable feature -- since the average mover has higher ability than the marginal worker, a wage subsidy has a relatively larger impact on the welfare of the average mover. As a result, it is possible to fully compensate the movers with a modest sized program that creates only a small distortion.

In contrast, the best way to compensate the stayers is with a targeted employment subsidy. This subsidy, which would be independent of the worker's wage, would be paid to workers holding low-tech jobs at the time of liberalization and to any worker who obtains a job in that sector shortly thereafter. This policy works better than a wage subsidy because the

average low-tech worker earns a lower wage than the marginal worker. Thus, while the wage subsidy would be relatively more valuable to the marginal worker, an employment subsidy affects the average stayer and the marginal worker equally. It follows a wage subsidy would generate a larger distortion than an employment subsidy.<sup>6</sup>

The paper divides into four additional sections. In Section 2, we introduce a simple two-sector full employment model and use it to show that an optimal compensation scheme should be valued highly by the average worker in the targeted group while having a small impact on the welfare of the marginal worker. In section 3 we extend the model to allow for training and search generated unemployment and show that a wage subsidy is the best way to compensate the movers while an employment subsidy works best for the stayers. In section 4, we calibrate the model and show that for reasonable parameter values, the cost of compensating either group is small relative to the gains from trade, provided that the right policy is used. However, if the wrong policy is used, particularly when trying to compensate the stayers, it is possible to almost completely wipe out all of the benefits from freer trade. We conclude the paper in Section 5.

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<sup>6</sup> As far as we know, the only other paper that directly addresses the issue of optimal compensation is Brander and Spencer (1994). However, their focus is much narrower than ours. To begin with, they are concerned only with the issue of how to compensate workers who lose their jobs and suffer wage losses due to changes in trade patterns and the only policy that they consider is a wage subsidy. To be precise, their goal is to determine whether the wage subsidy should be a decreasing, increasing or constant function of the difference between the worker's old wage and his/her new wage. Moreover, since Brander and Spencer treat the wage offer distribution as fixed and exogenous, they do not use an equilibrium approach. This is not meant as a criticism - their paper is aimed at investigating a theory put forth by Lawrence and Litan (1986) that a tapered wage subsidy would be a good way to compensate dislocated workers. Brander and Spencer show that if a wage subsidy is to be used, then it should be tapered.

## 2. Compensation with Full Employment and without Dynamics

In this section, we build and analyze a parsimonious two-sector, full-employment model to highlight the fundamental differences between wage and employment subsidies. The central features of this model form the foundation for the more textured analysis that follows in the subsequent section.

We assume that labor is the only input. However, workers differ by ability, which we index by  $a$ . For simplicity, we assume that ability is uniformly distributed with  $a \in [0,1]$ .

Each worker is paid the value of her marginal product, which we assume is non-decreasing in ability and define  $w_j(a)$  as the real wage rate earned by a worker with ability  $a$  employed in sector  $j = 1,2$ .

We wish to identify sector 1 as the “low-tech” sector, attracting relatively low-ability workers, and sector 2 as the “high-tech” sector, attracting relatively high-ability workers. To do so, we need to add a bit of structure to the wage functions. In particular, we assume that ability is more important in the high-tech (knowledge-intensive) sector than in the low-tech sector – that is,  $w_1'(a) < w_2'(a)$  with  $w_1(0) > w_2(0)$  and  $w_1(1) < w_2(1)$ . If ability refers to intellectual capacity, then there is not much difference in the number of trucks that can be unloaded by a low-ability worker versus a high-ability worker, since this activity depends more on physical strength and endurance than on mental acuity. By contrast, a low-ability worker is unlikely to contribute much value to the development of software compared with her high-ability counterpart.

Two wage functions that satisfy these properties are illustrated by the curves  $w_1^{TD}(a)$  and  $w_2^{TD}(a)$  in Figure 1, where the superscripts indicate the presence of a tariff distortion.<sup>7</sup> We follow Mayer (1984) by assuming that tariff revenue is distributed in lump-sum fashion in a way that leaves the overall distribution of income unchanged. As such, the *distribution* of tariff revenue does not distort decisions, and the two wage functions in Figure 1 define a critical ability ( $a^{TD}$ ) such that workers with  $a < a^{TD}$  maximize their income by choosing to work in sector 1, and those with  $a > a^{TD}$  maximize their income by choosing to work in sector 2.

With labor as the only input, the removal of import barriers reduces the real wage in the import-competing sector while increasing the real wage in the export sector. Assuming that this country imports the low-tech good, the real wage function for workers in this sector shifts down to  $w_1^{FT}(a)$  and the real wage function for the high-tech sector shifts up to  $w_2^{FT}(a)$ , where the superscript now represents free trade. The intersection of  $w_1^{FT}(a)$  and  $w_2^{FT}(a)$  defines a new critical value of ability  $a^{FT} < a^{TD}$ .

Workers with  $a < a^{FT}$  remain in the import-competing sector. For these “stayers,” trade reform unambiguously reduces their real wage. Workers with  $a > a^{TD}$  are employed in the export sector both before and after trade is liberalized. All of the “incumbents” benefit from liberalization. Workers with  $a \in [a^{FT}, a^{TD}]$  move from sector 1 to sector 2 as a consequence of trade liberalization. Within this group of “movers,” those with relatively high ability (with  $a > \tilde{a}$ ) find jobs in the export sector that pay a higher real wage than the job they leave behind, while those with relatively low ability face a decline in their real wage.

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<sup>7</sup> We have drawn these curves such that  $w_1''(a) = w_2''(a) = 0$ . This is for simplicity only; we discuss the general case below.

Suppose now that we wish to compensate some of the workers who are harmed by liberalization. We must first identify the target group, and then identify the policy that provides the desired level of compensation at the smallest cost.

We begin by assuming that we wish to compensate the movers for their losses. To minimize the cost of this program, it is obviously vital that compensation be offered to only those workers who actually switch sectors in response to trade reform. Even though we are interested in providing compensation to a group, it is analytically convenient to think about compensating a representative worker within that group. In the case of movers, we wish to design a policy that fully compensates the worker identified by  $\hat{a} \in [a^{FT}, a^{TD}]$ . It will shortly become evident that this choice implies that all movers with  $a > \hat{a}$  are over compensated, whereas those with  $a < \hat{a}$  are under compensated.

Focusing on a representative worker allows a wide range of possibilities. For example, if  $\hat{a}$  corresponds to the average mover, then the scheme compensates the group of movers as a whole, with some overcompensated and others under compensated. By contrast, all displaced workers are at least fully compensated if  $\hat{a} = a^{FT}$ . While we restrict attention to these two specific cases in Sections 3 and 4, for now we allow  $\hat{a}$  to take on any value between  $a^{FT}$  and  $a^{TD}$ .

Having identified the target worker, we illustrate in Figure 2 the effects of two alternative compensation plans.<sup>8</sup> In one plan, compensation takes the form of an employment subsidy ( $\eta$ ), which is independent of the wage rate. The other plan calls for a wage subsidy ( $\omega$ ) so that the amount of compensation received by any particular worker is increasing in the wage, which is

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<sup>8</sup> In order to keep the diagram simple, we do not show the tariff-distorted curve for the high-tech sector.

itself increasing in ability. In this figure, the subsidies  $\eta$  and  $\omega$  are chosen to satisfy  $w_1^{TD}(\hat{a}) = w_2^{FT}(\hat{a}) + \eta = w_2^{FT}(\hat{a})(1 + \omega)$ .<sup>9</sup>

In Figure 2,  $a_\eta$  and  $a_\omega$  identify the worker who is just indifferent between remaining in sector 1 and moving to sector 2 if compensated by an employment subsidy or wage subsidy, respectively. These values are found as the solutions to  $w_1^{FT}(a_\eta) = w_2^{FT}(a_\eta) + \eta$  and  $w_1^{FT}(a_\omega) = w_2^{FT}(a_\omega)(1 + \omega)$ . From the figure, it is clear that it will always be true that  $a_\eta < a_\omega$ . In turn, both of these values are less than  $a^{FT}$  since the subsidy induces workers to move who would have remained in sector 1 absent the compensation. Since allocative efficiency requires that all workers for whom  $a < a^{FT}$  remain in sector 1, we conclude that the wage subsidy given only to displaced workers, by enticing a smaller magnitude of inefficient labor movement, generates a higher level of social welfare than does the equivalent employment subsidy.<sup>10</sup>

Suppose now that we wish to compensate the group of stayers, so that  $\hat{a}$  identifies a representative stayer who is targeted for compensation. Now the relative efficiency of the two policy instruments is reversed. We illustrate this result with the aid of Figure 3. In this figure, the relevant subsidies affect the real wages of workers who stay in sector 1. We note that the curve labeled  $w_1^{FT}(a)(1 + \omega)$  coincides with the curve labeled  $w_1^{TD}(a)$  since liberalization reduces the real wage for all stayers by the same percentage.

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<sup>9</sup> Lurking in the background is a constant marginal tax rate on all income (including subsidies) that is used to generate the revenues necessary to fund the subsidies. Since tax payments do not depend on choice of sector, they do not distort decisions and can be omitted from this diagram.

<sup>10</sup> By “equivalent,” we mean that the two policies target the same subset of movers for compensation.

Since the employment subsidy is independent of the wage, it is relatively inconsequential for workers with higher ability, and therefore does not induce too many workers to forego the higher earnings that can be had in sector 2. By contrast, the wage subsidy provides the same proportional benefit to high- and low-wage workers, and therefore leads to a larger number of workers who choose to remain in sector 1. We conclude that the employment subsidy is the preferred instrument when targeting those who are trapped in the import-competing sector.

Both of the examples illustrated here point to two simple rules for determining the welfare-maximizing compensation program. First, as we have already noted, compensation must be targeted. For example, in trying to compensate the movers, the program would be larger than necessary if the government were to subsidize all workers in sector 2. Rather, the government should only subsidize those workers who were employed in sector 1 prior to liberalization, and in sector 2 subsequently. Second, for a given targeted group, the welfare-maximizing compensation program is the one that generates the largest ratio of benefits for the average member of that group relative to the marginal worker, where the marginal worker is defined as the one who would be just indifferent between working in sector 1 or in sector 2 under a regime of free trade. Since all movers have higher abilities than the marginal worker, applying this latter rule implies that the program used to compensate the movers should provide a benefit that is increasing with ability – this is why a wage subsidy works better than an employment subsidy. In contrast, all stayers have lower ability than the marginal worker. It follows that when we are trying to compensate the stayers, an employment subsidy, which is valued equally by all stayers, is superior to a wage subsidy, which provides more compensation to the marginal worker than it provides to the average stayer in the targeted group. In each case, the welfare-maximizing

program provides the desired amount of compensation while minimizing the amount of inefficient policy-induced labor misallocation.<sup>11</sup>

### 3. Unemployment and Training

#### 3.1 The Assumptions and the Initial Steady-State

We continue to assume that the wage earned by an employed worker depends on his ability, but we now extend the model to allow for training and unemployment. We do so in a relatively simple way so that we may keep the analysis tractable. As should be clear from what follows, our results should easily extend to more complex settings.<sup>12</sup>

In order to obtain a job we now assume that a worker must first acquire the appropriate skills and then search for suitable employment. Workers who are training for sector  $j$  jobs exit the training process at rate  $\tau_j$  and the sector  $j$  job acquisition rate is  $e_j$ . While training, each sector  $j$  worker incurs a nominal flow training cost of  $c_j p_j (1 - \gamma_j)$  where  $p_j$  is the domestic (tariff-inclusive) price of the sector  $j$  good (so that sector  $j$  training costs are measured in terms of the sector  $j$  good) and  $\gamma_j$  denotes the sector- $j$  training subsidy (if there is one). Once suitable employment is found, a sector  $j$  worker with ability  $a$  produces a flow of  $q_j(a)$  units of output as long as the job lasts; and, since the worker is paid the value of her marginal product, the sector  $j$

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<sup>11</sup> Note that we only consider the case in which the low-tech good is imported. If, instead, a country that imports the high-tech good liberalizes trade, then our logic suggests that a wage subsidy should be used to compensate those who choose to remain in the high-tech sector, whereas an employment subsidy should be used to compensate those who move to the low-tech sector.

<sup>12</sup> We provide greater detail in Davidson and Matusz (2004b), where we derive solutions for the relevant differential equations and subject our calibration results to sensitivity analysis. This paper is available at [www.msu.edu/~davidso4/currentnew.html](http://www.msu.edu/~davidso4/currentnew.html).

nominal wage is  $p_j q_j(a)$ . In addition to this wage, the worker may also receive an employment subsidy, denoted by  $\eta_j$ , or a wage subsidy, denoted by  $\omega_j$ , so that total nominal compensation is given by  $p_j q_j(a)(1 + \omega_j) + \eta_j$ . Sector  $j$  jobs break up at rate  $b_j$ , and, once they do, workers must retrain if their skills are firm specific. If, however, their skills are sector specific, then the worker may immediately reenter the search process (provided that she does not switch sectors). We use  $\phi_j$  to denote the probability that a sector  $j$  worker's skills transfer across sector  $j$  jobs after termination and we use  $\mu_j(a)$  to denote the unemployment insurance (UI) benefit offered to sector  $j$  workers ( $\mu_j$  varies with ability due to the fact that UI-benefits are tied to the wage that the worker earned on her previous job). Given our assumptions about transitions across labor market states, it follows that the sector  $j$  expected duration of training in sector  $j$  is  $1/\tau_j$ , the expected duration of unemployment is  $1/e_j$ , the expected duration of employment is  $1/b_j$  and the probability that a worker will have to retrain after losing her job is  $1 - \phi_j$ .

In order to turn nominal terms into real values, we now specify a particular set of preferences. This is necessary because we want our compensation scheme to restore the lost welfare of the targeted group, and we cannot be precise about this magnitude without knowing preferences. Toward that end, we assume that all individuals have Cobb-Douglas preferences and that each individual spends half of her income on each good, so that real income is simply nominal income divided by  $\sqrt{p_1 p_2}$ .

If we now assume that the compensation scheme is financed by taxing all earned income at a constant marginal rate of  $m$  and use  $y_{ij}(a)$  to represent the flow of real income (inclusive of all subsidies and net of all taxes) earned by a sector- $j$  worker who is currently in state  $i$ , where

$i \in \{T, S, E\}$  represents training, searching, or employed, respectively; then we have

$$y_{Ej}(a) = \frac{\{p_j q_j(a)(1 + \omega_j) + \eta_j\}(1 - m)}{\sqrt{p_1 p_2}}; \quad y_{Sj}(a) = \frac{\mu_j(a)}{\sqrt{p_1 p_2}}; \quad \text{and } y_{Tj} = \frac{c_j p_j(1 - \gamma_j)}{\sqrt{p_1 p_2}}.$$

Workers choose an occupation based on expected income. If we represent the real expected lifetime income for a worker who is training, searching, or employed by  $V_{Tj}$ ,  $V_{Sj}$ , and  $V_{Ej}$ ,

then we can derive these values by solving the following system of Bellman equations:

$$\begin{aligned} (1) \quad & rV_{Tj}(a) = y_{Tj} + \tau_j \{V_{Sj}(a) - V_{Tj}(a)\} + \dot{V}_{Tj}(a) \\ (2) \quad & rV_{Sj}(a) = y_{Sj}(a) + e_j \{V_{Ej}(a) - V_{Sj}(a)\} + \dot{V}_{Sj}(a) \\ (3) \quad & rV_{Ej}(a) = y_{Ej}(a) + b_j \{\phi_j V_{Sj}(a) + (1 - \phi_j)V_{Tj}(a) - V_{Ej}(a)\} + \dot{V}_{Ej}(a) \end{aligned}$$

In these equations,  $r$  represents the discount rate and a dot over top of a variable represents the derivative of that variable with respect to time.<sup>13</sup> In each equation, the first term on the right hand side represents current income. The second term on the right hand side 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  $j$  is  $e_j$  while the capital gain associated with obtaining employment is  $V_{Ej} - V_{Sj}$ . Note that for employed workers there are two possibilities when they lose their job. Either they retain their skills and can begin to search for a new job immediately (this occurs with probability  $\phi_j$ ) or they must retrain before they can seek a new job. The last term on the right hand side is the asset's rate of appreciation at time  $t$ . We include this term for completeness, but the structure of our

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<sup>13</sup> In order to lighten the notation, we have not explicitly written expected lifetime incomes as functions time, though it should be clear that they are.

model ensures that all changes in asset values that occur do so instantly; so that this term is always zero.

Jobless workers without skills train in the low-tech sector if  $V_{T1}(a) \geq \max\{V_{T2}(a), 0\}$  and they choose to train in the high-tech sector if  $V_{T2}(a) \geq \max\{V_{T1}(a), 0\}$ . Workers with ability such that  $0 \geq \max\{V_{T1}(a), V_{T2}(a)\}$  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 since their training costs exceed any income that they could expect to earn after finding employment. A sector- $j$  searcher continues to search for a job if  $V_{jS}(a) \geq V_{kT}(a)$ ; otherwise, she quits searching, switches sectors and starts training in sector  $k$ . Finally, a sector- $j$  worker quits her job and enters the sector  $k$  training process if  $V_{kT}(a) \geq V_{jE}(a)$ ; otherwise, she continues to work until an exogenous shock causes her job to dissolve.

This completes the description of the model. To characterize equilibrium we must place restrictions on the parameters. While we will be much more precise about the values of the parameters in the next section, it is useful to sketch out the ideas that we are trying to capture in our model. We continue to characterize sector 1 as a low-tech sector that attracts low-ability workers and sector 2 as a high-tech sector that absorbs high-ability workers. What we have in mind is an economy in which high ability workers are better suited to produce the high-tech good. We imagine that workers with high enough ability to choose between the two types of jobs know that they can find low-tech jobs without much effort and can master the skills they require rather easily.<sup>14</sup> However, they also know that these jobs do not pay well, do not last long

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<sup>14</sup> Many low-ability workers face difficulties finding *any* job and therefore experience long spells of unemployment whenever they lose their job. We believe that this is largely due to their work history and overall lack of ability. By

and require skills that are largely job-specific.<sup>15</sup> In contrast, we want high-tech jobs to require significant training and be relatively hard to find (because the matching problem is harder to solve) but durable. Moreover, high-tech skills are much more likely to transfer across jobs than low-tech skills.<sup>16</sup> We capture these ideas assuming that  $\tau_1$  is higher than  $\tau_2$ ,  $b_1$  is higher than  $b_2$  (low-tech training is quicker than high-tech training and low-tech jobs do not last as long as high-tech jobs), and by setting  $e_1 = \infty$  and  $c_1 = \phi_1 = 0$ . Thus, low-tech jobs are obtained immediately after training, there is no resource cost to acquiring low-tech skills and low-tech workers must always retrain after losing their jobs. The assumption that  $c_1 = 0$  implies that  $y_{T1} \geq 0$  so that  $V_{T1}(a) \geq 0$  for all  $a$ , and therefore all workers enter the labor force. These assumptions, while admittedly extreme, greatly simplify our analysis.

Our final two assumptions are related to the relative importance of ability in the two sectors. To ensure that workers are properly sorted into sectors, we require that  $V_{T1}^{TD}(a)$  and  $V_{T2}^{TD}(a)$  have the qualitative properties represented in Figure 4, which is analogous to Figure 1,

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assuming that low-tech jobs are plentiful, we are trying to capture the idea that the *marginal* worker (who has the ability to train for a high-tech job) would be able to find menial employment easily if she chooses to do so.

<sup>15</sup> Consider, for example, a worker who moves from one low-tech job (working as a clerk in a department store) to a new one (working for a fast food restaurant). While training as a clerk, the worker may need to learn the layout of the store, the procedures for opening and closing the store, how to handle the cash register, and so on. However, acquiring these skills will not shorten the time it takes to learn how to prepare fast food.

<sup>16</sup> High-tech workers (e.g., managers, accountants, lawyers) are often required to complete college and some may have a post-graduate education. If they lose their jobs, most of these workers will be able to find reemployment without retraining in the same field. Moreover, even if these workers change occupations, they will have acquired some general skills along the way that may help them land new jobs without acquiring new skills.

where the superscripts again denote the initial tariff-distorted equilibrium. If we set all time derivatives to zero and then solve (1)-(3) for  $V_{Tj}$ , we obtain

$$(4) \quad V_{Tj}(a) = \frac{(r+e_j)(r+b_j) - \phi_j b_j e_j}{\Delta_j} y_{Tj} + \frac{\tau_j(r+b_j)}{\Delta_j} y_{Sj}(a) + \frac{\tau_j e_j}{\Delta_j} y_{Ej}(a)$$

where  $\Delta_j = (r+b_j)(r+e_j)(r+\tau_j) - b_j e_j \tau_j$ . Substituting our parametric assumptions into (4), the  $V_{Tj}$  curves will be consistent with Figure 4 if  $\tau_1 \Delta_2 y'_{E1}(a) < \tau_2 e_2 \Delta_1 y'_{E2}(a) + \tau_2 (r+b_2) \Delta_1 y'_{S2}(a)$ .

Second, we want to assume that ability is more important in determining output in the high-tech sector than it is in the low-tech sector. The easiest way to capture this notion is to assume that if there are diminishing returns to ability, then returns diminish faster in the low-tech sector. In other words, if  $q_j(a)$  is a concave function in both sectors, then we want to assume that  $q_1(a)$  is more concave than  $q_2(a)$  in the usual Rothschild-Stiglitz sense.

Returning to Figure 1, the critical level of ability ( $a^{TD}$ ) solves  $V_{T1}^{TD}(a) = V_{T2}^{TD}(a)$ . Thus, in the initial tariff-distorted steady-state, all workers for with  $a < a^{TD}$  are attracted to the low-tech sector, whereas the remainder are attracted to the high-tech sector.

### 3.2 Compensated Trade Liberalization

As in Section 2, we assume that the low-tech sector is the beneficiary of import restraints. The removal of these restrictions results in higher real wages for high-tech workers and lower real wages for low-tech workers. Both of these changes alter the values of  $V_{T1}(a)$  and  $V_{T2}(a)$ , as depicted in Figure 4. In the new steady-state equilibrium, the ability that identifies the marginal

worker now becomes  $a^{FT} < a^{TD}$ , where  $a^{FT}$  is the solution to  $V_{T1}^{FT}(a) = V_{T2}^{FT}(a)$  (the superscript now indicates free trade).<sup>17</sup>

There are two groups harmed by trade reform. Those who remain in the low-tech sector are clearly worse off after reform, and some of the movers are worse off as well. Unfortunately, compensating the losers results in an inefficient allocation of labor.<sup>18</sup> In particular, some workers who are better suited for low-tech jobs would be induced to move to the high-tech sector if the government subsidized such movement.<sup>19</sup> By the same token, too many workers remain in the low-tech sector if the government attempts to compensate the stayers. In both cases, these losses can be minimized by appropriate design of the compensation program. The principles that we elucidated in Section 2 apply here as well. The optimal compensation package is the targeted one that generates the largest ratio of benefits for the average member of the targeted group relative to the marginal worker.

Now, suppose that the government wants to compensate those who are harmed by liberalization. In addition, let us assume, for now, that the movers lose as a whole when the tariff is removed. Then our first goal is to pin down the government's objective. As we pointed out in Section 2, this is made non-trivial by the fact that ability varies across workers so that (1) the losses are not uniform within a group, and (2) different workers in the same group may differ in the values they place on the various compensation policies. We consider two alternatives. In the first, the government's goal is to fully compensate the group (i.e., the movers or the stayers) as a

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<sup>17</sup> A detailed analysis of how the economy moves from the initial tariff-distorted steady-state equilibrium to the new, free trade steady-state equilibrium can be found in Davidson and Matusz (2004b).

<sup>18</sup> Because turnover rates are exogenous and there are no other distortions in our model, the *laissez-faire* equilibrium is efficient. See Davidson and Matusz (2004a).

<sup>19</sup> As always, we use world prices to value output and therefore gauge productivity.

whole so that the average worker in the group is just indifferent between free trade with compensation and the original tariff-distorted outcome. In the second, the government fully compensates the worker in the group who suffers the largest losses (which, for both the movers and the stayers, is the worker with ability level  $a^{FT}$ ). Note that in the first case, there will be some workers in the group who are undercompensated and these workers will therefore still prefer the tariff, whereas in the second case, *all* workers in the compensated group are at least as well off after liberalization. Of course, compensation by the second criterion is more costly.

We begin by focusing on the movers and we assume that the government's objective is to fully compensate these workers as a group (the arguments easily generalize to the case in which the objective is to compensate the mover who suffers the largest loss). These workers can be compensated by offering wage or employment subsidies to those employed in the high-tech sector, or by offering training subsidies to those training for high-tech jobs, or by providing unemployment benefits to any one searching for employment. Our first result is fairly obvious – any compensation offered should be targeted at only those workers who switch sectors as a result of liberalization. That is, if a wage subsidy is used, workers who were already employed in the high-tech sector at the time of liberalization should not be eligible for it. The reason is that the incumbents already gain as a result of liberalization and providing them with an additional benefit would needlessly add to the cost of the compensation program.

Turn next to the type of compensation that should be used. All four policies increase the expected lifetime for a worker who switches sectors and starts to train for high-tech employment. Thus, the use of any one of these policies to compensate the movers would cause the  $V_{T2}$  curve in Figure 4 to shift up, resulting in too much labor reallocation and deadweight loss. As we showed in Section 2, the policy that allows the government to achieve its objective while

generating the smallest deadweight loss is the one that is highly valued by the average worker in the targeted group relative to the value placed on that policy by the marginal worker. To see which policy works best, all that we need to do is compare the payments that the movers would receive from the government in each case. When the government uses a wage subsidy or unemployment insurance, the movers receive a payment that is increasing in ability. This follows from the fact that both payments are tied to the worker's wage (since unemployment benefits are always paid out as a fraction of the workers previous wage) and wages are increasing in ability. This means that compensating the movers with a wage subsidy or unemployment benefits shifts up the  $V_{T2}$  curve in a *non-parallel* fashion, with high-ability movers receiving larger payments than low-ability movers. In contrast, when the government uses employment or training subsidies, the payment received by the movers is independent of ability. As a result, the  $V_{T2}$  curve shifts up in *parallel* fashion.<sup>20</sup> This difference is important because the average mover has higher ability than the marginal worker. This means that wage subsidies or UI both benefit the average mover more than the marginal worker, whereas training and employment subsidies both benefit the average mover and the marginal worker equally. As a result, wage subsidies and unemployment insurance programs are superior to training and employment subsidies – since the average mover benefits a great deal from these programs, a relatively small program can be used to compensate the movers as a group, and since the marginal worker does not benefit that greatly from these programs, a relatively small distortion will be imposed on the economy.

Finally, to distinguish between wage subsidies and UI, note that the former is tied to the mover's *new* wage,  $w_2$ , whereas the latter is tied to the mover's *previous* wage,  $w_1$ . And, if high-

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<sup>20</sup> Note that if training costs decrease with ability, the  $V_{2T}$  curve would shift up in non-parallel fashion but in a way so that the average mover benefits *less* than the marginal worker. This would make training subsidies even worse.

tech wages are more sensitive to ability than low-tech wages (i.e.,  $q_1(a)$  is more concave than  $q_2(a)$ ), then the spread between the benefit paid to the average mover and the marginal worker is greater with the wage subsidy. As a result, the wage subsidy is the best policy.

Turn now to the stayers. Since there is no low-tech unemployment in our model and since we have assumed away any resource cost associated with low-tech training, we cannot use UI or training subsidies to offset the stayers' losses. We therefore restrict attention to wage and employment subsidies. Comparing these programs, we again note that both increase expected lifetime incomes for trainers, shifting up the  $V_{T1}$  curve. However, as described earlier, an employment subsidy shifts this curve upward in a *parallel* fashion, whereas a wage subsidy increases the slope of the  $V_{T1}$  curve. In this case, the employment subsidy is worth the same to the average stayer as it is to the marginal worker, whereas the wage subsidy is worth relatively more to the marginal worker. Applying our earlier logic, a wage subsidy will therefore generate a larger misallocation of resources than the equivalent employment subsidy.<sup>21</sup> We conclude that the optimal policy for compensating stayers is a targeted employment subsidy.<sup>22</sup>

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<sup>21</sup> If we were to allow for low-tech unemployment, the same argument would imply that employment subsidies dominate UI.

<sup>22</sup> It is worth noting that there are no current programs in the US targeted at compensating those who remain in sectors that have been liberalized. There are programs designed to augment the incomes of low-wage workers with the most prominent one 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 payments to high-wage workers than it provides to their low-wage counterparts. It should be clear that using such a program 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 larger 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-

## 4. Quantifying the Costs of Compensation

How costly is compensation? Would a well-designed compensation program be nearly as distortive as the trade barrier that it replaces? In order to address these questions, we first describe how we measure welfare, and then we parameterize the model presented in Section 3 to numerically compute this measure under the tariff-distorted steady state, the free-trade equilibrium, and an equilibrium in which trade reform is accompanied by compensation.<sup>23</sup>

### 4.1 Measuring Welfare

As noted above, we assume that all workers have identical Cobb-Douglas utility functions, which implies that we can aggregate over groups of agents. In particular, if we define  $C_j(t)$  as the aggregate consumption by a group of agents of good  $j$  at time  $t$ , then the instantaneous utility obtained by that group is  $U(t) = \sqrt{C_1(t)C_2(t)}$ . We measure the welfare for this group as the present discounted value of  $U(t)$ :

$$(5) \quad W = \int_0^{\infty} e^{-rt} U(t) dt.$$

When the group includes all agents in the economy,  $W$  represents social welfare.

We normalize quantities so that the world prices of both goods are unity. As before, good 1 is taken to be the import good, so that  $p_1 \geq 1$ , with equality under a regime of free trade.

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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 indicates that it might be the best way to compensate the stayers.

<sup>23</sup> The exercise carried out in this section is not intended as a serious calibration exercise (e.g., our assumption that ability is uniformly distributed is not realistic). Instead, it should be viewed as an expositional device that helps us understand and illustrate the effects at work in the model.

If we define  $Q_j(t)$  as the quantity of good  $j$  produced at time  $t$ , then balanced trade then implies that  $Q_1(t) + Q_2(t) = C_1(t) + C_2(t)$ . Moreover, preferences imply that  $p_1 C_1(t) = C_2(t)$ . From these two equations, we find that

$$(6a) \quad C_1(t) = \frac{1}{1+p_1} \{Q_1(t) + Q_2(t)\}$$

$$(6b) \quad C_2(t) = \frac{p_1}{1+p_1} \{Q_1(t) + Q_2(t)\}.$$

Output and prices differ across equilibria. Again, letting superscripts  $TD$  represent the tariff-distorted equilibrium,  $FT$  the free-trade equilibrium, and  $CFT$  the compensated free-trade equilibrium; we have social welfare in each case:

$$(7a) \quad W^{TD} = \frac{\sqrt{p_1}}{1+p_1} \int_0^\infty e^{-rt} \{Q_1^{TD}(t) + Q_2^{TD}(t)\}$$

$$(7b) \quad W^{FT} = \frac{1}{2} \int_0^\infty e^{-rt} \{Q_1^{FT}(t) + Q_2^{FT}(t)\}$$

$$(7c) \quad W^{CFT} = \frac{1}{2} \int_0^\infty e^{-rt} \{Q_1^{CFT}(t) + Q_2^{CFT}(t)\}$$

Using (7), the welfare gain from uncompensated trade reform is measured as  $W^{FT} - W^{TD}$ . Compensating workers for their losses misallocates resources, generating a cost. We can compute  $\Theta$ , the economic cost of the compensation policy as a percent of the gains from trade:

$$(8) \quad \Theta = \frac{W^{FT} - W^{CFT}}{W^{FT} - W^{TD}} \times 100.$$

## 4.2 Parametric Assumptions

As noted above, we assume that jobs in the low-tech sector are available for the asking, meaning that duration of search in this sector ( $1/e_1$ ) is zero. In turn, this implies setting  $e_1 = \infty$ .

By contrast, jobs in the high-tech sector do require search. For the United States, the average duration of unemployment fluctuates with the business cycle, but is usually close to one quarter, rarely straying from that value by more than two weeks.<sup>24</sup> We assume that this is the average duration of unemployment in the high-tech sector in our model and correspondingly set  $e_2 = 4$ .

Data on the average duration of employment in US manufacturing is available and can be used to pin down  $b_2$ . Davis, Haltiwanger, and Schuh (1996) provide data on annual rates of job destruction in U.S. manufacturing industries and report that the average annual rate was roughly 10% for the period 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% (implying an average duration of employment of 6 years).<sup>25</sup> 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 jobs that require few skills. While many of these jobs may be found in manufacturing, it is hard to know how to draw conclusions about the average length of the worst jobs in a sector from industry-wide 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 lifetime indicate that up to the age of 24 workers start (roughly) one new job every two years.<sup>26</sup> Based on this evidence, we consider two cases – one in which low-tech jobs last one year ( $b_1 = 1$ ) and one in which they last two years ( $b_1 = 0.5$ ).

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<sup>24</sup> See, for example, Table B-44 of *The Economic Report of the President* (2001).

<sup>25</sup> See Table 2.1 on p. 19 in Davis, Haltiwanger, and Schuh (1996).

<sup>26</sup> See Table 8.1 on p. 210 in Hamermesh and Rees (1998).

We assume that skills in the low-tech sector are relatively job specific, and therefore assume that  $\phi_1 = 0$ . From previous work with this model, we know that results are fairly insensitive to changes in  $r$  and  $\phi_2$ .<sup>27</sup> For all empirically relevant values for the interest rate (below 20%) and for values of  $\phi_2 \in [.5, .9]$ , our estimates of the adjustment costs triggered by trade reform vary only at the third decimal place. Since our results are also so insensitive to changes in these parameters, the only values that we consider are  $r = .03$  and  $\phi_2 = .8$ .

The remaining parameters are tied 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 a value for  $\tau_l$  that is consistent with the idea that low-tech skills are easy to master. Thus, we assume that the time costs are small by setting  $\tau_l = 52$  (so 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) provides a survey of this evidence where the costs are assumed to include the costs of recruiting and training newly hired workers. He concludes 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.<sup>28</sup> Similar estimates can be found in Acemoglu and Pischke's (1999) study of the German apprenticeship training system. They report estimates of training costs that

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<sup>27</sup> See Davidson and Matusz (2002, 2004a).

<sup>28</sup> 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.

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 four months  $\tau_2 = 4$  and then vary the value of  $c_2$  so that total training costs vary from a low of 1 month of pay for an average high-tech worker to a high of 15 months of pay. We also consider two intermediate values in which these costs are equal to 5 and 10 months of high-tech income.

This leaves only a description of the production process. We assume simple production functions, defining the marginal product of a sector- $j$  worker as  $q_j a$ . We normalize  $q_2$  and then vary  $q_1$ , which varies the attractiveness of sector 1. In particular, as  $q_1$  increases, holding  $q_2$  constant, sector 1 becomes more attractive relative to sector 2 and the ability index of the marginal worker ( $a^{TD}$  in the tariff-distorted equilibrium) increases. We consider three different values of  $q_1$  for each combination of turnover rates. These values correspond to values of  $a^{TD}$  equal to 0.1, 0.2 and 0.33. Thus, we consider parameter values that imply that initially 10%, 20%, or 33% of the workforce is employed in the low-tech sector.

### 4.3 Methodology

We assume that this country initially protects the low-tech sector with a 5 percent ad valorem tariff. In addition, we maintain the assumption adopted in Section 2 that tariff revenue is distributed to all agents in proportion to their income, therefore leaving the overall distribution of income unchanged. We solve for the equilibrium under these assumptions and calculate social welfare ( $W^{TD}$ ). We then remove the import tariff and calculate social welfare under free trade ( $W^{FT}$ ).

Finally, we turn to the issue central to this paper and calculate social welfare when we compensate the groups for their losses ( $W^{CFT}$ ).<sup>29</sup> In order to do this, we choose the policy that minimizes the policy-induced labor misallocation, using a wage subsidy to compensate the movers and an employment subsidy to compensate the stayers. Moreover, we choose two different degrees of compensation. We first examine the effects of compensating the targeted group as a whole, implying that some members of that group are over compensated while others are under-compensated. We then look at compensating the marginal worker, which effectively over-compensates every other member of the group.

In conducting our experiment, we take care to implement a constant marginal income tax that generates enough revenue to balance the present discounted value of the cost of the compensation plans.

#### **4.4 Results**

For each set of parameters, the impact of liberalization varies across the groups with the low-ability movers and the high-ability stayers suffering the biggest losses (relative to the other s in their group). In Davidson and Matusz (2004b), we examined the impact of trade reform on the movers as a group in some detail and found that, for all of the parameters discussed above, the group as a whole always loses when the tariff is removed. 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 always outweigh their long-term gains from higher wages and lower consumer prices. These losses vary from

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<sup>29</sup> The detailed calculations of welfare in each of the three situations, along with a description of the transition path across steady-states can be found in Davidson and Matusz (2004b).

between one and a half percent to two and a half percent. Of course, the lowest ability movers suffer a much larger loss, usually around 4.5%, which is roughly the size of the loss suffered by the stayers. In each of our experiments, we solve for the value of the policy parameters required to offset these losses and then calculate the distortion imposed on the economy.

We report our results in Tables 1 – 4. Since our main qualitative results are fairly insensitive to the turnover rates, we report them only for the two extreme cases – one in which the average high-tech job lasts 10 years while the average low-tech job lasts 1 year and one in which the average high-tech job lasts 6 years while the average low-tech job lasts 2 years. Tables 1 and 2 show the percent of the net gain from trade reform that would be eaten away by a compensation plan targeted at the movers, while Tables 3 and 4 do the same for the stayers. Tables 1 and 3 provide the results when the government uses correct policy, whereas Tables 2 and 4 provide the results when the government compensates the groups with an inferior policy.

The main entry in each cell refers to  $\Theta$ , as defined in (8) above, when the government targets the average member of the group. The entries in parentheses show the same measure if the government targets the worker who suffers the largest losses (the worker with ability  $a^{FT}$ ). For example, the efficient policy for compensating the movers is a wage subsidy. If we calibrate the policy based on the average mover, if training costs are 10 months of the average high-tech worker's income, if high-tech jobs last an average of 6 years, low-tech jobs last an average of 2 years and if the initial equilibrium has 10 percent of the population in the low-tech sector, then Table 1 indicates that using a wage subsidy to compensate the movers costs approximately 1.15% of the net gains from trade. However, the cost rises to 4.63% when the policy is

calibrated based on the marginal worker. Table 2 shows that these costs would increase to 1.30% and 5.24%, respectively, if an employment subsidy were used instead.<sup>30</sup>

Table 1 indicates that in all cases, the distortion created when compensating the the average mover is modest – generally less than 6% of the net gains from trade. There are two factors that contribute to this outcome. First, the movers in our model do not suffer huge losses from liberalization (as we noted above, the losses tend to be less than 2%). Second, liberalization does not trigger that much movement in our model. In the case in which 20% of the labor force is initially employed in the low-tech sector, only 4% of the labor force switches to the high-tech sector when the tariff is removed.<sup>31</sup> The fact that the cost imposed on the rest of the economy is so modest makes these redistributive policies considerably attractive.

Not surprisingly, Table 1 also indicates that the distortion created when fully compensating the marginal mover imposes a much greater burden on the economy. While there are many cases in which the cost remains small (below 10% of the net gains from trade), there are also cases in which up to 30% of the net gains from trade are eaten away by the compensation scheme.

The one curious result evident in Table 1 is that the deadweight loss is often non-monotonic in both the size of high-tech training costs and the size of the low-tech sector. This counter-intuitive outcome emerges because of the manner in which we calibrate the model. First, hold constant the percent of the labor force initially attached to the low-tech sector while reducing the training costs in the high-tech sector. The reduction in training costs makes the

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<sup>30</sup> Bear in mind that in our model, unemployment compensation would generate the same costs as a wage subsidy while a training subsidy would generate the same cost as an employment subsidy.

<sup>31</sup> This fraction grows to 10% for the case in which 33% of the labor force starts out attached to sector 1 and shrinks to less than one half of a percent for the case in which 10% begin in that sector.

high-tech sector more appealing, putting downward pressure on the percentage of the workforce attracted to the low-tech sector. To hold this percentage constant, we must increase  $q_1$ , the sector 1 productivity parameter, thereby increasing the low-tech wage for all workers in that sector. This means that when a worker moves to the high-tech sector, the amount of output foregone (and the corresponding wage) is larger than it would be if high-tech training costs were higher (and  $q_1$  lower). Thus, when training costs are low the movers should require *more* compensation than when the training costs are high. On the other hand, the direct loss suffered by the movers due to the higher training costs increases with the magnitude of those costs. This suggests that when training costs are low the movers should require *less* compensation than when training costs are high. As a result of these two conflicting forces, this relationship can go in either direction. A similar argument explains the non-monotonicity with respect to the initial size of the low-tech sector.<sup>32</sup>

Turn next to Table 2, which shows how much the cost of compensation increases if the wrong policy is used. As the table clearly indicates, such a mistake can be quite costly. For

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<sup>32</sup> When calibrating the model, to make the low-tech sector larger we must increase  $q_1$ . This increases the low-tech wage for all workers in that sector and means that when a worker moves to the high-tech sector, the amount of output foregone is larger than it would be if initial sector size were lower (and  $q_1$  lower). Thus, when the low-tech sector is large the movers should require *more* compensation than when the low-tech sector is small. On the other hand, when the low-tech sector is large, the country produces more of the low-tech good domestically and imports less from the rest of the world. This means that the tariff is less distortionary and that the losses from removing the tariff will be smaller than they would be had the sector been smaller. As a consequence, when the low-tech sector is large the movers should require *less* compensation than when the low-tech sector is small. Since these two effects work in opposite directions, the relationship between the initial size of the low-tech sector and the level of compensation required can be non-monotonic.

example, when training costs are very low, choosing the wrong policy more than doubles the deadweight loss. At the other extreme, when training costs are high and the low-tech sector is small, such a policy mistake results in only a small increase in the cost of the program.

Turn now to Tables 3 and 4, which report the cost of compensating the stayers. The employment subsidy that fully compensates the stayers 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. This is clearly reflected by the main entries in Table 3 where the deadweight loss as a fraction of the net gains from trade is given for each of the parameter values when stayers are compensated as a group. With a single exception, this loss is well under 1 percent of the net gain from trade.

The second entry in each cell of Table 3 shows the results when the policy is designed to fully compensate the stayer who is harmed the most by liberalization, therefore over compensating all other stayers. In this case, deadweight loss due to compensation is higher, but it stills remains below 2% for almost all parameter values (rising to around 5% only when the low-tech sector initially accounts for one-third of all employment *and* training costs are high). This makes for a compelling argument in favor of providing such compensation.

We noted above that attempts to compensate the movers with the wrong policy could increase the deadweight loss by a large percentage. 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 a level slightly below the tariff in order to compensate the stayers. But, such a high wage subsidy will cause almost as many low-tech workers to move to the high-tech sector as the tariff. As a result, the deadweight loss associated with a wage subsidy is quite high. These values are reported in 4.<sup>33</sup> These results are striking for two reasons. First, the numbers can get quite high (in some cases the loss amounted to about 60 percent of the net gains from trade reform!). But, perhaps more important, they are striking when compared to the losses associated with the employment subsidy. Thus, if the government's goal is to compensate the stayers, choosing the right policy is vitally important.

## 5. Conclusions

This paper has been devoted to an important issue – what is the best way to compensate those who are harmed by trade liberalization? In addressing this question, we use a model that takes into account the training and search processes that workers must go through in order to find jobs. In the context of our model, we have argued that the optimal way to compensate the

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<sup>33</sup> Note that when using a wage subsidy to compensate the stayers it does not matter whether the government attempts to fully compensate the group or the marginal stayer. This is evident from the fact that there is only one entry in each cell of Table 4. This follows from the fact that a wage subsidy and the tariff both cause shift  $V_{t1}$  to shift up in the same manner.

movers (who bear 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.

In order to keep our model tractable, we were required to make a number of simplifying assumptions. For example, we have assumed that labor is the only input, we have treated the steady-state 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. The first assumption is particularly important since it gives us a model with a Specific Factors flavor in that trade preferences split along industry lines. This has simplified our problem considerably by allowing us to design policies targeted at workers in previously protected industries. In a more complex model in which Stolper-Samuelson forces play a role, the problem will become more complex since the policies will have to be targeted, at least to some degree, towards factors as opposed to industries. In the future it will be vitally important to relax this and all other simplifying 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.

We close by pointing out that we take some comfort in our belief that our results should survive when the steady-state turnover rates are endogenized. The reason for this is that our optimal policies, wage and employment subsidies, should be even more appealing in such a setting. After all, they encourage workers to search harder for employment, resulting in lower average spells of unemployment. In contrast, if we compensate the losers by increasing unemployment benefits or by offering training subsidies, we would expect to see an increase in

the average length of jobless spells. This follows from the fact that these two policies decrease the opportunity cost of unemployment.

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**Table 1**

**Deadweight Loss as a Percent of the Net Gains from Trade  
When Compensating the Average (Marginal) Mover Using a Wage Subsidy**

Percent of labor initially in the low-tech sector

High-tech Training Costs	10%	20%	33%	10%	20%	33%
1 month	0.75 (4.34)	0.25 (2.69)	0.02 (1.27)	0.51 (3.29)	0.14 (1.85)	0.01 (0.85)
5 months	2.18 (9.00)	3.91 (18.79)	1.97 (14.42)	2.27 (9.52)	3.08 (25.59)	1.30 (10.80)
10 months	1.15 (4.63)	5.40 (23.80)	4.71 (27.26)	1.58 (6.38)	5.13 (23.09)	3.68 (22.66)
15 months	0.43 (1.72)	4.90 (20.93)	6.27 (33.60)	0.83 (3.34)	5.30 (22.96)	5.40 (30.09)

Avg. duration of low-tech job = 2 yrs.  
Avg. duration of high-tech job = 6 yrs.

Avg. duration of low-tech job = 1 yr.  
Avg. duration of high-tech job = 10 yrs.

**Table 2**

**Deadweight Loss as a Percent of the Net Gains from Trade  
When Compensating the Average (Marginal) Mover Using an Employment Subsidy**

Percent of labor initially in the low-tech sector

High-tech Training Costs	10%	20%	33%	10%	20%	33%
1 month	2.49 (10.08)	1.52 (7.43)	0.21 (3.53)	2.02 (8.18)	1.05 (5.36)	0.07 (2.40)
5 months	2.99 (12.00)	7.14 (31.40)	4.71 (28.43)	3.39 (13.66)	6.41 (28.37)	3.63 (22.90)
10 months	1.30 (5.24)	7.38 (32.10)	7.73 (43.43)	1.90 (7.63)	7.65 (33.14)	6.79 (38.29)
15 months	0.47 (1.82)	5.94 (25.10)	8.76 (46.31)	0.92 (3.68)	6.83 (29.31)	8.26 (44.33)

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Avg. duration of low-tech job = 2 yrs.  
Avg. duration of high-tech job = 6 yrs.

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Avg. duration of low-tech job = 1 yr.  
Avg. duration of high-tech job = 10 yrs.

**Table 3**

**Deadweight Loss as a Percent of the Net Gains from Trade  
When Compensating the Average (Marginal) Stayer Using an Employment Subsidy**

High-tech Training Costs	Percent of labor initially in the low-tech sector					
	10%	20%	33%	10%	20%	33%
1 month	0.16 (0.64)	0.12 (0.49)	0.06 (0.23)	0.08 (0.31)	0.05 (0.22)	0.03 (0.10)
5 months	0.19 (0.71)	0.60 (2.43)	0.61 (2.52)	0.13 (0.35)	0.34 (1.32)	0.33 (1.37)
10 months	0.09 (0.27)	0.70 (2.67)	1.22 (5.06)	0.07 (0.17)	0.48 (1.53)	0.78 (3.15)
15 months	0.03 (0.09)	0.60 (2.17)	1.60 (6.61)	0.04 (0.08)	0.47 (1.46)	1.12 (4.28)
	Avg. duration of low-tech job = 2 yrs. Avg. duration of high-tech job = 6 yrs.			Avg. duration of low-tech job = 1 yr. Avg. duration of high-tech job = 10 yrs.		

**Table 4**

**Deadweight Loss as a Percent of the Net Gains from Trade  
When Compensating the Average (Marginal) Stayer Using a Wage Subsidy**

High-tech Training Costs	Percent of labor initially in the low-tech sector					
	10%	20%	33%	10%	20%	33%
1 month	41.49	61.82	37.79	43.15	72.43	31.01
5 months	16.09	56.50	61.40	20.45	59.56)	58.90
10 months	5.78	41.73	62.35	8.90	47.57	62.30
15 months	1.87	29.66	59.36	3.93	36.64	61.13

Avg. duration of low-tech job = 2 yrs. Avg. duration of high-tech job = 6 yrs.	Avg. duration of low-tech job = 1 yr. Avg. duration of high-tech job = 10 yrs.
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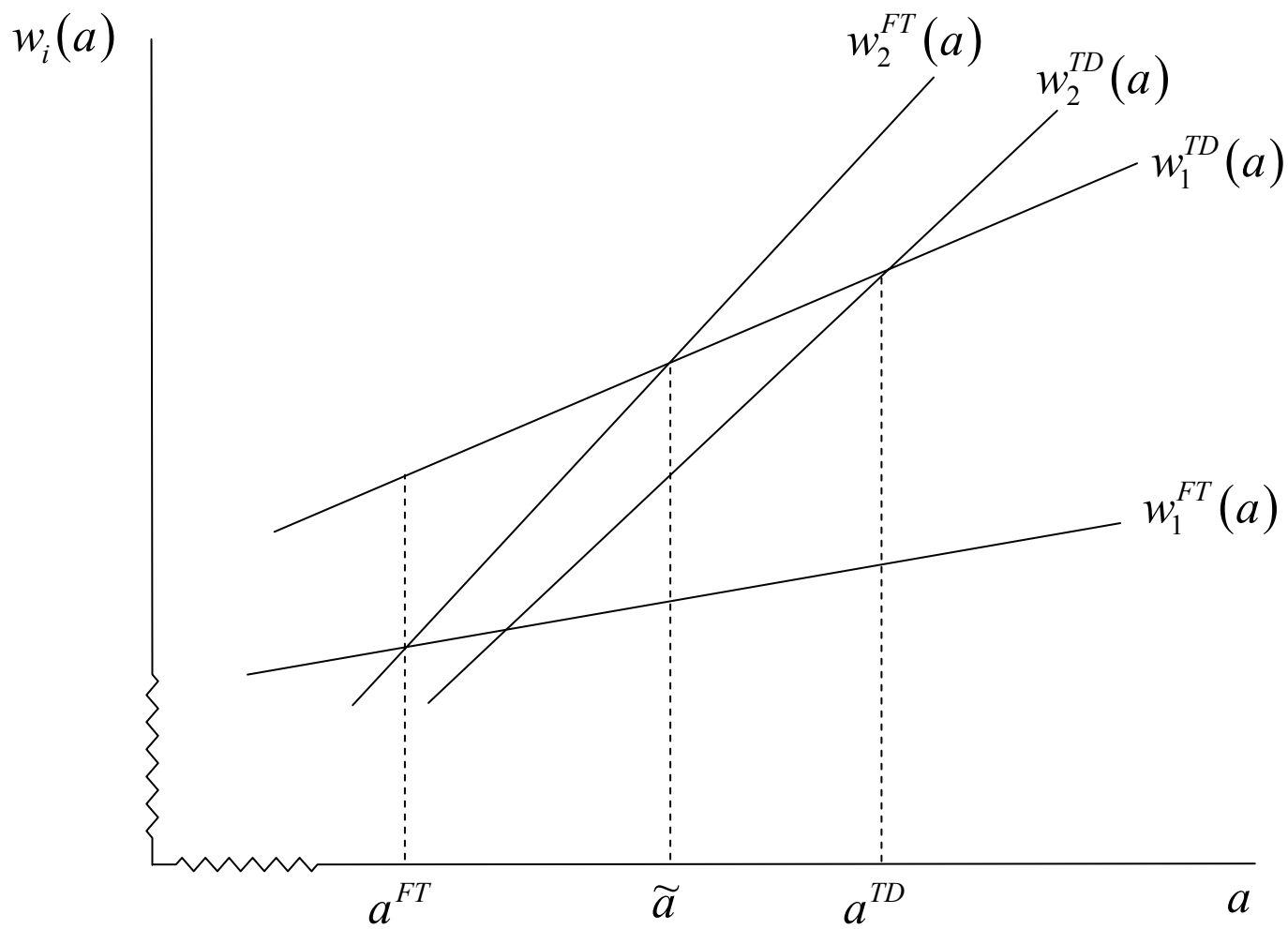


Figure 1

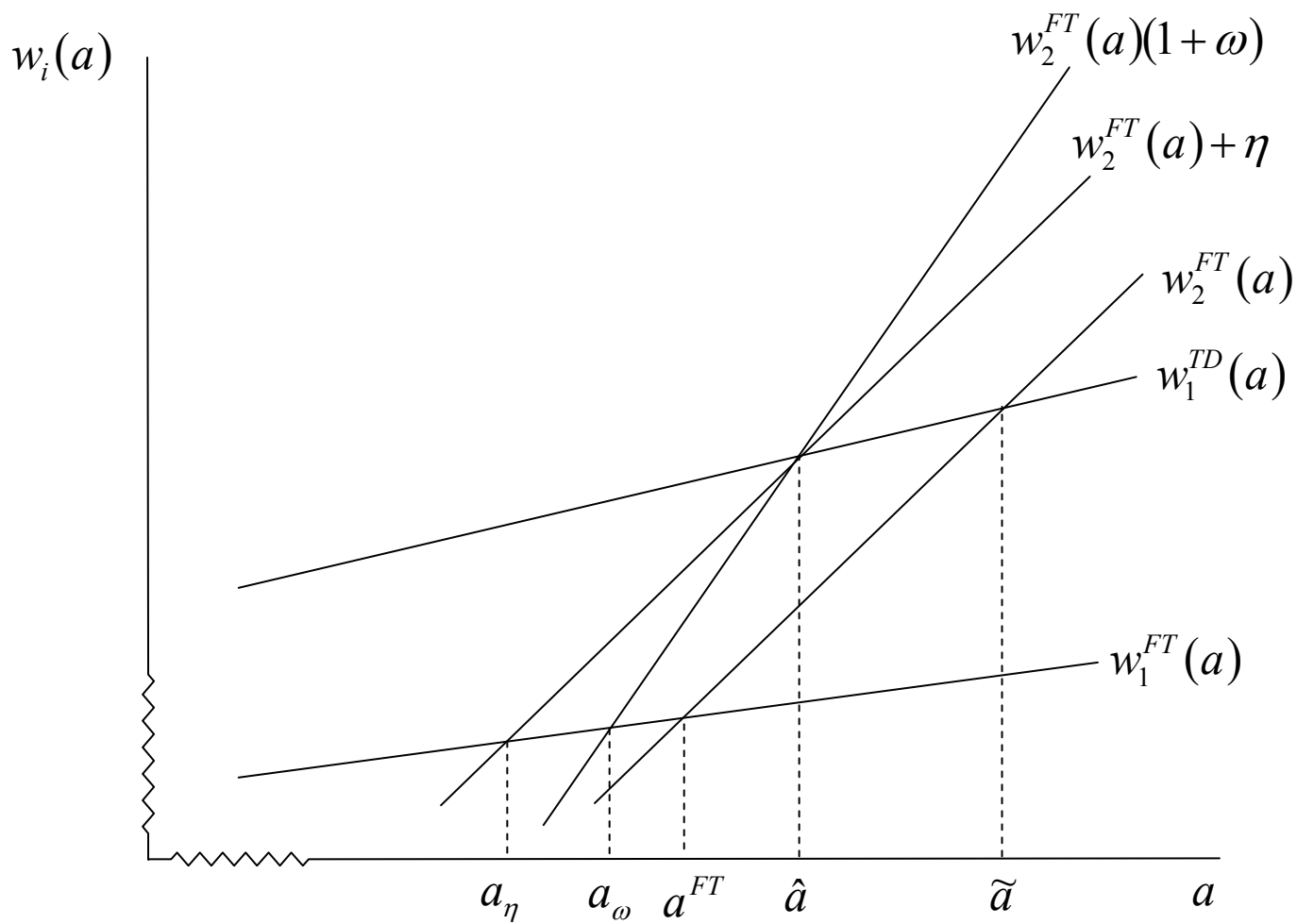


Figure 2

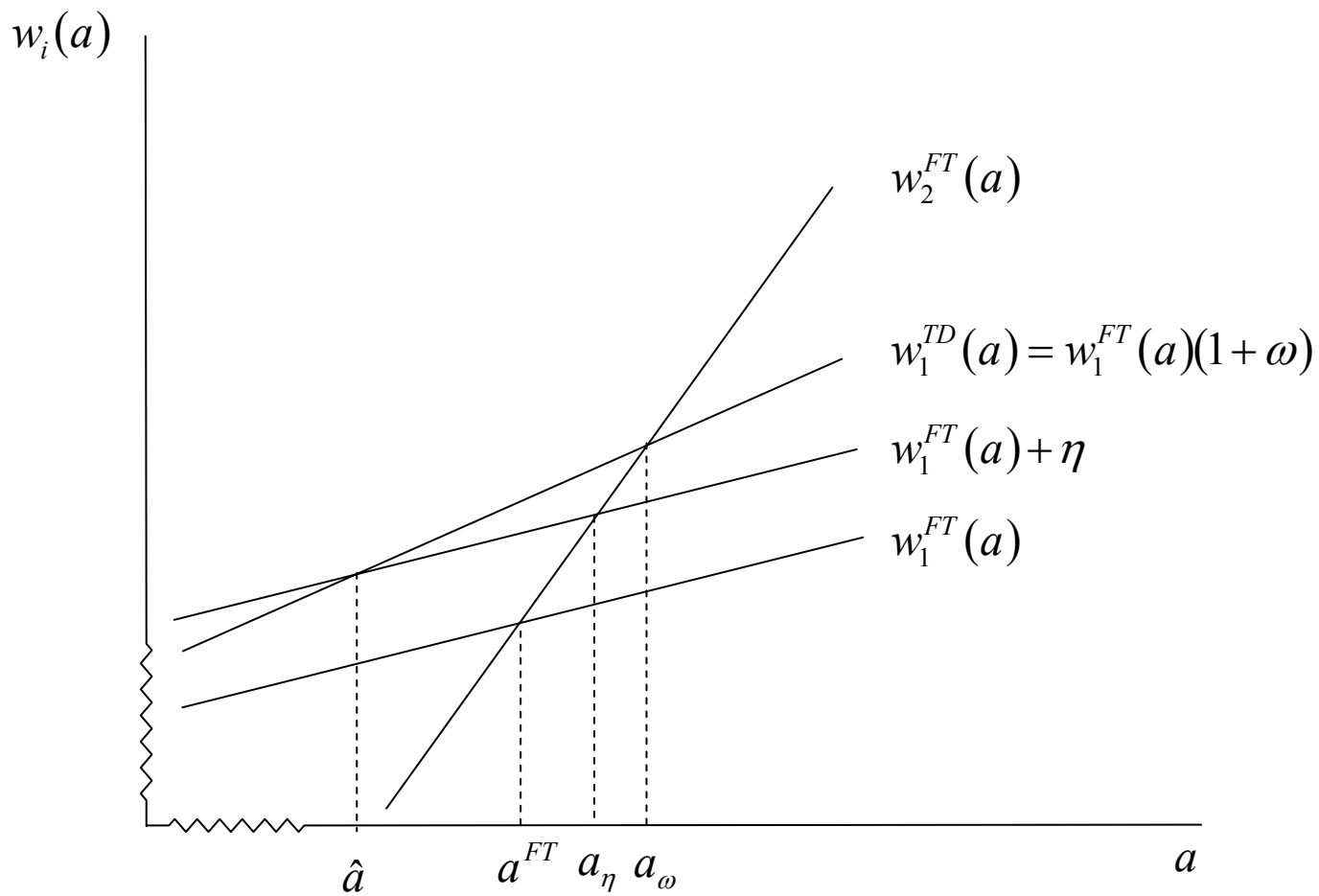


Figure 3

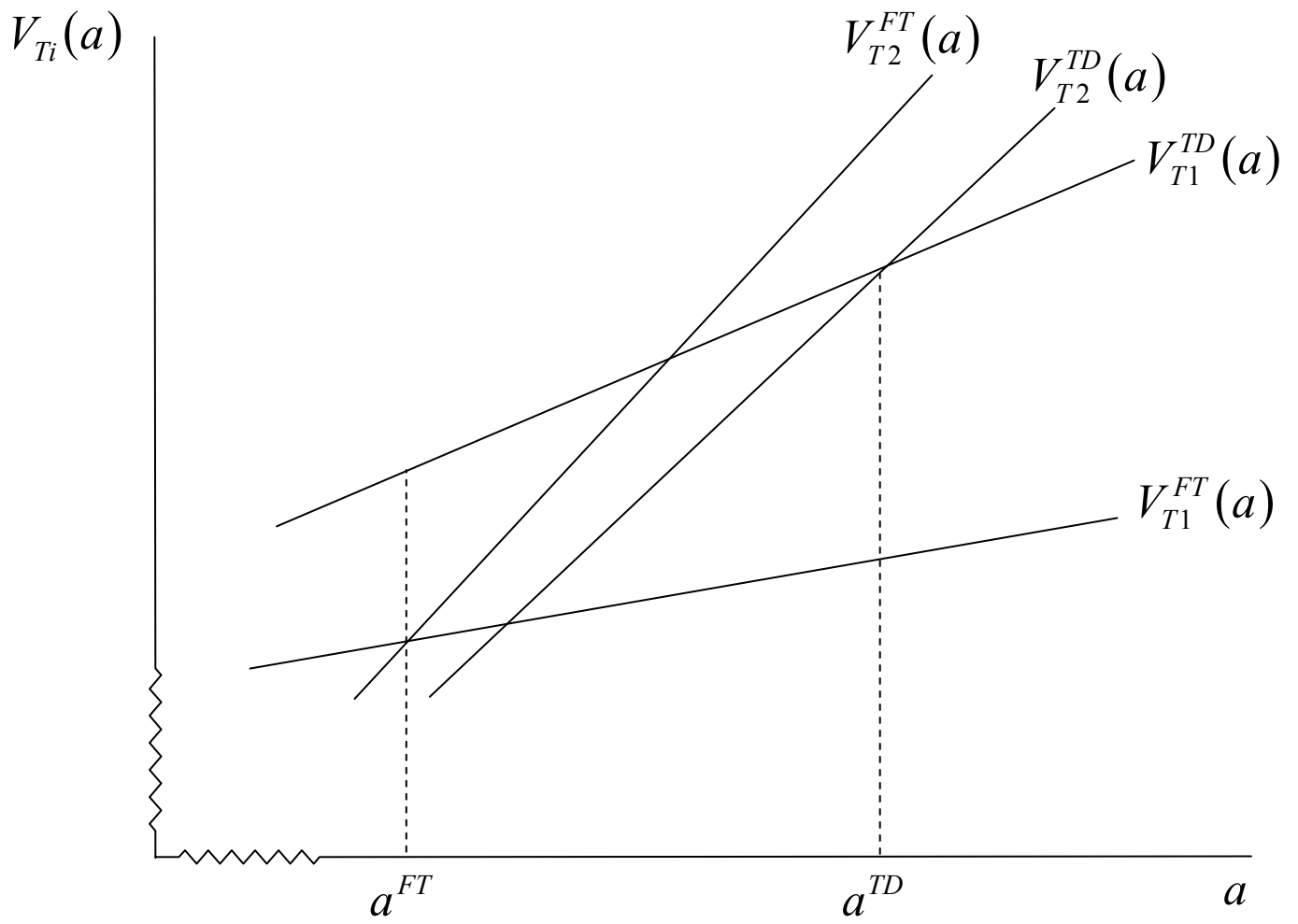


Figure 4