Transition and Compensation in Efficient Trade Agreements

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Abstract

This paper examines efficient paths of trade liberalization in a symmetric two country model where countries choose a (cooperative) trade agreement that maximizes national welfare, subject to the constraint that capital initially located in the import-competing sector receive some compensation for losses from liberalization. If lump sum transfers are available to compensate capital owners, free trade is reached immediately. In the absence of lump sum transfers, the efficient agreement will have a tariff rate and subsidy to the movement of capital located outside the import-competing sector that decline at the rate of depreciation of capital. This policy results in a non-monotonic path for capital in the import-competing sector that is everywhere below that in the first best agreement. If the government’s only policy instrument is the tariff, the efficient tariff will decline at a rate that exceeds the rate of depreciation of capital. The steeper decline in the tariff rate in the third best case results from the desire to compensate capital while still encouraging capital to move out of the import-competing sector. The path of capital stock in the import-competing sector will be monotonic in this case, and will exceed that under the first best trade agreement.

1 Introduction

One of the roles of trade agreements is to solve the prisoner’s dilemma that arises when countries set trade policies unilaterally. By signing a trade agreement, governments promise to lower tariffs on imported goods in return for reduced tariffs on its exports to the partner country. These reciprocal tariff reductions, if designed properly, will raise national welfare of the respective countries. Despite the availability of gains in national welfare, trade agreements
are usually a source of considerable domestic controversy because of their distributional consequences, since tariff reduction will typically result in losses to owners of factors of production whose incomes are tied to the import-competing sector.

The purpose of this paper is to characterize the efficient trade agreement between two countries when the government in each country cares both about the income level of factor owners in the import-competing sector as well as aggregate national welfare. This distributional concern will be modeled by assuming that governments maximize national welfare subject to a constraint that factors in the import-competing sector receive a specified level of compensation following trade liberalization. We take an eclectic view of the reason for this promise of compensation: it could reflect either a government that maximizes a weighted social welfare function or a government responding to political pressure from an organized lobby in the importable sector. It will be assumed that governments can commit to the promises it makes concerning market access to the foreign government as well as to its promises of compensation to factor owners.

In examining the promise of compensation by the government, it is important to distinguish losses to factors of production that are permanent from those that are temporary. The epitome of permanent losses is provided by the Stolper-Samuelson theorem, in which the incomes of the factor used intensively in the importable sector are reduced as a result of tariff protection, regardless of whether the factor owners happen to be located in the importable or exportable sectors. Transitory losses, on the other hand, arise when a factor owner locates in the import-competing sector prior to a tariff reduction, and then finds it costly to move to pursue better opportunities in another sector when an unanticipated tariff reduction occurs. In this paper the focus is on transitory losses, so that the government is concerned about compensating factor owners for losses that are not incurred by those with similar endowments who chose to locate in a different sector. This is modeled by assuming that some factors are quasi-fixed - they are immobile between sectors in the short run but mobile in the long run. We simplify by aggregating these quasi-fixed factors into a single factor, which will be referred to as capital. The movement of capital between sectors in response to an adverse shock can arise either through incurring adjustment costs to move existing capital or by allowing the existing stock of factor in the importable sector to depreciate and to make new investments in the other sector. This model does allow for permanent changes in income of factor owners as a result of a change in trade policy, so that we can examine how the permanence of the effects of the policy change affects the way in which compensation is paid.

The path following the implementation of this agreement will have two phases. In the first phase the tariff reduction in the trade agreement has the effect of creating a gap between the return to capital in the importable sector and that available elsewhere, so that no new investment will be located in the importable sector. In the second phase, the capital in the importable sector has fallen sufficiently that returns to the two sectors are equalized, and investment takes place in both sectors. A major focus of the analysis is how the transitional path, as reflected in the speed of reallocation of capital between sectors and the
level of the tariff, is affected by the instruments that are available to the government for providing compensation. Three cases are considered, depending on the instruments that are available to the governments. The benchmark case is one in which the government can use tariffs, sector specific capita taxes, and lump sum transfers. The availability of lump sum transfers allows the government to satisfy the compensation constraint in a non-distorting way, so that tariff and factor market policies such as trade adjustment assistance can be used to allocate resources between sectors in the most efficient way. In this case an immediate move to free trade will be the optimal policy, and there will be no intervention in factor markets unless there is a divergence between the private cost and social cost of adjustment. This result is consistent with those obtained by Lapan (1976) and Mussa (1978, 1982) for the small country case. The result continues to hold in the case of an efficient trade agreement between large countries because the planner neutralizes all terms of trade effects in designing the agreement.

The second case is one in which lump sum transfers are not available. The government must rely on the use of tariff and factor market instruments to achieve its goal of compensating workers in the import-competing sector, while minimizing the loss in national income. In this case the tariff under the agreement will start at a positive level, but will gradually decline over time at the rate equal to the depreciation rate of capital in the importable sector. With exponential depreciation, free trade is reached asymptotically. The other feature of this path is that subsidies to capital usage in the non-traded goods sector are used to encourage capital to leave the importable sector. This subsidy to capital movement is used to offset the distorting effect of the tariff on output, which leads to overproduction of the importable. In this case the speed of transition will exceed that under the first best agreement. Interestingly, the stock of capital in the importable sector actually overshoots its steady state value in the short run.

The final case considered is one where the government has access only to trade instruments as part of the agreement, so that the time path of tariffs must serve to both compensate workers in the importable sector and to induce movement out of the sector. In this case the tariff will decline at a rate that exceeds the depreciation rate of capital in the importable sector. This occurs because a tariff put in place at time $s$ has the effect of discouraging movement of capital out of the importable sector for all $s' < s$. Thus, the efficient agreement will tend to load protection in the early periods of the agreement, when it has the least effect on discouraging the outflow of capital from the protected sector. If the tariff has no permanent effect on the return to capital, then the efficient agreement will reach free trade in finite time. If there is a permanent effect of the tariff on the return to capital, the tariff will decline at a rate equal to the depreciation rate of capital once the returns to capital have been equalized between sectors. In this case the rate of transition is slower than that in the first best agreement because of the necessity of using the tariff to compensate capital owners.

The gradual tariff reductions derived from this model are a common feature
of trade agreements. The North American Free Trade Agreement (NAFTA) provides a prominent example of this structure. Under NAFTA, goods were divided into 4 categories. The tariffs on goods in category A were eliminated immediately. Goods in categories B, C, and C+ had tariffs removed in annual stages spread over periods of 5, 10, and 15 years, respectively. A similar pattern of gradual liberalization was built into the WTO Agreement on Textiles and Clothing. The purpose of this agreement was to integrate textile and clothing products, whose trade had previously been restricted by a system of bilateral country quotas that had been set up under the Multifibre Arrangement, into the GATT system. The agreement specified that an increasing fraction of the products should be integrated into the GATT system over the period of the agreement (1995-2005). In addition, the agreement specified minimum growth rates for imports of products that were still under MFA restriction. Although this agreement was specified in terms of quantities rather than prices, it certainly suggests a gradual reduction in the tariff-equivalents of these quotas, with all of the restrictions to be eliminated by the end of the agreement.

It is important to emphasize that the analysis in this paper assumes that the parties to the trade agreements are able to commit to their promises to factor owners as well as to the trading partner. This approach contrasts with the literature, initiated by Staiger ([9]), which examines how the requirement that trade agreements be self-enforcing can lead to gradual tariff reduction. In this literature, the incentives to deviate are larger the greater the stock of factors employed in the import-competing sector. As resources leave the sector, the no deviation constraint is relaxed, making further trade liberalization sustainable. Furusawa and Lai (1997) examine a model with adjustment costs of moving sectors between sectors, and show that the efficient trade agreement between welfare maximizing governments will involve gradual tariff reduction. Bond (2008) considers a model with multiple sectors in each country, and shows that the minimum discount factor for supporting simultaneous liberalization of all sectors is higher than that for liberalizing sectors sequentially in the presence of sectoral adjustment costs.

A second type of commitment issue is addressed by Maggi and Rodriguez-Clare ([6]), who assume that the government is able to commit to tariffs in its trade agreement with the foreign country, but is unable to commit in its deal with a domestic special interest group. They highlight the role of tariff ceilings under a trade agreement, because negotiated tariff ceilings act as a constraint on the negotiation between the government and the interest group over the setting of the tariff. They also show that tariffs will be gradually reduced in an infinite horizon version of the model when the government can commit to tariff rates.

Section II of the paper presents the basic model in the case where labor is fully mobile between sectors, and characterizes the non-cooperative equilibrium that exists prior to the signing of the trade agreement. Section III derives the features of the efficient trade agreements for the first best, second best, and third best cases. Section IV offers some concluding remarks.
2 The Model

We consider an infinite horizon two country trade model in which each country produces a non-traded good (N) and two traded goods. The exportable good (2 in the home country and good 1 in foreign) is produced using a sector specific factor of production that is in fixed supply, yielding an exogenously given output of the exportable, $y_X$, at each point in time. The importable good is produced using a quasi-fixed factor, referred to as capital, that can also be used to produce the non-traded good. Normalizing the stock of capital to 1 and letting $z$ be the quantity of capital located in the importable sector, the output of the importable is $y_M = z$ and the output of the non-traded good is $y_N = (1 - z) - .5\alpha(1 - z)^2$.

The quasi-fixed nature of the factor comes from the fact that although a new unit of capital can be costlessly located in either sector, an adjustment cost will be incurred if an existing unit of capital is moved to the other sector. Thus, an unanticipated change in price will impose a capital loss on existing capital that is located in the sector whose relative price has declined. To formalize this notion, assume that in each period a fraction $\delta$ of the existing capital stock depreciates and is replaced by new capital.\footnote{Capital can be interpreted either as physical capital or human capital. In the latter case the depreciation can be thought of as an exogenously given probability of exit from the labor force. We abstract from the investment/population growth decision by assuming that there is no net accumulation of capital over time.}

Letting $z_s$ denote the stock of capital located in the importable sector and $i_s$ the gross investment in the importable sector at time $s$, we have $z_{s+1} = (1 - \delta)z_s + i_s$. Adjustment costs will be incurred if gross investment in either sector is negative, (i.e. $i_s < 0$ or $i_s > \delta$). The aggregate costs of adjustment (measured in units of the non-traded good) will be assumed to take the following form:

$$G(i) = \begin{cases} 
(i - \delta)\theta + \frac{\gamma(i - \delta)^2}{2} & i > \delta \\
0 & 0 \leq i \leq \delta \\
-\theta i + \frac{\gamma i^2}{2} & i < 0
\end{cases} \quad (1)$$

where $\theta, \gamma \geq 0$. For $i > \delta$ [$i < 0$], marginal adjustment costs are $\theta + \gamma(i - \delta)$ [$-\theta + \gamma i$]. This formulation allows for the possibility of increasing marginal costs of adjustment ($\gamma > 0$) at a point in time as well as a case in which the marginal adjustment costs is constant at all times ($\theta > 0, \gamma = 0$). Since the the adjustment cost function is not differentiable at $i \in \{0, \delta\}$ if $\theta > 0$, the subdifferential of $G$ will be a non-empty interval $\partial G(\delta) = [0, \theta]$ and $\partial G(0) = [-\theta, 0]$ at these values.

We assume that preferences for the goods at a point in time are identical across countries and are given by the quasi-linear function $u(d_1, d_2, d_N) = \sum_{i=1}^{2} (Ad_i - .5d_i^2) + d_N$, where $d_i$ is consumption of traded good $i$ and $d_N$ is the consumption of the non-traded good. Letting $\beta$ denote the discount factor, consumption is chosen to maximize $\sum_{s=0}^{\infty} u(d_{1s}, d_{2s}, d_N)\beta^s$. This optimization problem yields demand functions for the traded goods at each point in time of
\[ d(p_i) = A - p_i \]

Substituting these demand functions into the utility function yields the indirect utility function,

\[
V = \sum_{s=0}^{\infty} \sum_{i=1,2} s(p_{is})\beta^s + Y, \tag{2}
\]

where \( s(p_i) = .5(A - p_i)^2 \) is the consumer surplus from consuming good \( i \) and \( Y \) is the present value of national income.

The home government is assumed to choose a tariff (if it is not committed to a tariff under an existing trade agreement) at the beginning of each period \( s \), and then consumers make purchase decisions and capital owners make investment/capital reallocation decisions. The capital stock in place at the beginning of period \( s \), \( z_s \), is predetermined by investment/reallocation decisions made in the previous period. Letting \( t \) denote the specific tariff chosen by the government and \( p_1^* \) the world price of good 1, home excess demand for good 1 is

\[
m_1 = A - p_1^* - t - z \text{ and foreign excess demand is } m_1^* = A - p_1^* - yX. \]

The market clearing world price of the home importable is

\[
p_1^*(t, z) = A - (z + yX + t)/2, \]

with the domestic price \( p_1(t, z) = p_1^*(t, z) + t \) and home imports \( m_1(t, z) = (yX - z - t)/2. \) It will be assumed that \( yX \geq 1 \), which ensures that the home country does not export good 1 for any feasible allocation of capital to that sector. We can similarly solve for the market clearing conditions for good 2, which by the symmetry of the production and demand structure will satisfy \( p_2(a, b) = p_1^*(a, b). \)

Figure 1 illustrates the return to capital in the importable sector, \( p_1^*(t, z) \), and the return to capital in the non-traded goods sector, \( r_N(z) = 1 - \alpha(1 - z) \), as a function of \( z \). Since the capital locations are given at the beginning of the period, returns to capital will not necessarily be equalized at a given point in time. We denote the differential in returns to capital between the importable and non-traded goods sectors as

\[
\Delta(t, z) = p_1(t, z) - 1 + \alpha(1 - z) \tag{3}
\]

which is increasing in \( t \) and decreasing in \( z \). If the level of tariff is set permanently and \( \Delta(t, z) \neq 0 \) at the initial allocation of capital, the allocation of new capital and movement of existing capital over time will result in a long run capital stock satisfying \( \Delta(t, z) = 0 \), as will be established below. The following assumptions will be imposed on the parameter values to ensure that this long run equilibrium has an interior solution for the allocation of capital in which the home country imports good 1

**Assumption 1:** (i) \( A \in (1 - \alpha + yX/2, (yX + 3)/2) \), (ii) \( yX \geq 1 \)

Condition (i) guarantees that \( z \in (0, 1) \) in a steady state with \( t = 0 \), and (ii) is sufficient to ensure that the home country imports good 1.

National income will be the sum of production income (net of adjustment costs) and tariff revenue, which using (2) yields national welfare to be

\[
V = \sum_{s=0}^{\infty} \left[ W^M(t_s, z_s)z_s + W^X(t^*_s, z^*_s) - G(i_s) \right] \beta^s \tag{4}
\]
where

\[ W^M(t, z) = s(p_1(t, z)) + p_1(t, z)z + y_N(z) + tm(t, x) \]

\[ W^X(t^*, z^*) = s(p_2(t^*, z^*)) + p_2(t^*, z^*)y_N \] (5)

\( W^M \) is the surplus obtained from the importable and non-traded good sectors, and \( W^X \) is the surplus obtained from the exportable sector. This model exhibits the property that international externalities from a country’s choice of tariffs and employment levels operate solely through the terms of trade, as is clear from (5).

2.1 Non-Cooperative Equilibrium

We model the non-cooperative equilibrium as one in which each country chooses the path of tariffs and employment of capital in the importable sector to maximize (4), given the tariff and employment policies of the other country. The assumption that policymakers can choose employment levels is equivalent to the assumption that they have sector specific tax/subsidy policies that allow them to induce a particular allocation of capital across sectors. Since the objective here is to model the transition from the steady state of a non-cooperative equilibrium to the steady state under a free trade agreement, the focus in this section will be on characterizing the steady state of the noncooperative equilibrium.

The value of \( t_s \) will be chosen to maximize \( W^M(t_s, z_s) \) yielding

\[ t^N(z_s) = \frac{y_N - z_s}{3} \] (6)

The optimal tariff in (6) reflects the usual trade-off of an improvement in the terms of trade against the loss due to a decline in trade volume. Since foreign excess supply is linear, a larger quantity of capital located in the import-competing sector will raise the elasticity of supply of imports and lower the optimal tariff. Taking the derivative of national welfare with respect to \( i_s \) and using the fact that \( \partial z_s + u = \partial i_s \) yields

\[ \sum_{u=1}^{\infty} \Delta(t^N(z_{s+u}), z_{s+u})(1 - \delta)^{u-1} \beta^u \in \partial G(i_s) \] (7)

The left hand side of this expression is the difference in the discounted social return to a unit of capital between the importable sector and the non-traded goods sector. The right hand side of (7) is the cost of moving a unit of capital, so that this condition requires that the marginal social benefit of moving a unit of capital equal the marginal social cost of moving a unit of capital at points where the adjustment cost function is differentiable. If \( \theta > 0 \) and all of the new capital is being allocated to one sector with no adjustment costs being incurred (i.e. \( i_s \in \{0, \delta\} \)), this condition requires that the differential in returns between the two sectors not exceed \( \theta \).

A steady state is a value \( \bar{z} \) satisfying (6) and (7) with \( i_s = \delta \bar{z} \) for all \( s \). Solving these two conditions for the the steady state tariff and employment levels gives the following result.

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Proposition 1 When countries set tariffs to maximize national welfare and Assumption 1 holds, the steady state level of tariff and capital allocation is given by

\[ t^N = \frac{yX(1 + \alpha) - (A + \alpha - 1)}{2 + 3\alpha} > 0; \quad z^N = \frac{3(A + \alpha - 1) - yX}{2 + 3\alpha} \in (0, 1). \] (8)

In order to decentralize the optimal path for investment implied by the optimal path for \( z_s \) the government can choose a subsidy \( \sigma_s \) (which could be negative) to capital located in the non-traded goods sector at time \( s \) such that capitalists choose the value of \( i_s \) that satisfies (7). Assuming that the private cost of moving a unit of capital between sectors equals the marginal social cost, the path \( \{t_s, z_s\} \) will be an equilibrium if ²

\[ \sum_{u=1}^{\infty} (\Delta(t_{s+u}, z_{s+u}) - \sigma_s)(1 - \delta)^{v-1} \beta^v \leq G_s'(i_s), \text{ with equality for } i_s \neq 0, \delta (9) \]

The non-cooperative equilibrium will be achieved by the sequence of subsidies \( \{\sigma_s\} \) such that (9) is satisfied at all points on the path \( \{t^N(z^N_{s}), z^N_{s}\} \).³ It is clear by comparison with (7) that the equilibrium path is obtained with \( \sigma_s = 0 \), so that no intervention in factor markets is required when the objective is to maximize national welfare. This is the result that has been obtained in the small country case studied by Lapan [5] and Karp and Thierry [4] when private costs and social costs of moving are equal. It should be emphasized, however, that in the two country case this result follows from the fact that the government achieves no terms of trade benefits from moving capital between sectors that it cannot attain by altering the tariff. Specifically, the specification of the current model implies that capital movements have identical effects on the terms of trade and trade volumes to those of tariffs (i.e. \( (\partial p_1/\partial t) / (\partial m/\partial t) = -(\partial p_1/\partial z) / (\partial m/\partial z) \)). Similarly, these policies also have the identical (i.e. zero) effects on the optimal tariff chosen by the other government. Alternative production structures which do not share this feature would generate an additional role for interventions in factor mobility between sectors.

3 Trade Agreements

We now turn to the case in which the two countries sign a trade agreement that commits them to a time path for tariffs and capital allocation. It will

²The result that it will be desirable to subsidize (tax) movements of capital when the marginal social cost of moving is less (greater) than the private cost will also hold in this model. We simplify the discussion by abstracting from this motive for intervening in factor markets.

³This can equivalently be accomplished by a policy of adjustment assistance that makes a one time payment of \( \sum_{u=0}^{\infty} \sigma_{s+u} \) (\( \sum_{u=0}^{\infty} \sigma_{s+u} \)) to the owner of a unit of capital moving into (out of) the non-traded good sector at time \( s \).
be assumed that the governments care about both the total level of national welfare and the income received by the factors that are initially in the sector at the time that the trade agreement is signed. Specifically, it will be assumed that the countries choose the policies under the trade agreement to maximize world welfare subject to the constraint that owners of capital initially in the import-competing sector earn an income of at least $\Pi_0$.

The impact of home tariff and employment choices on world welfare can be expressed

$$V^W = \sum_{s=0}^{\infty} [W^W(t_s, z_s) - G(i_s)] \beta^s$$  \hspace{1cm} (10)$$

where $W^W(t, z) = W^M(t, z) + s(p^*_1(t, z_s)) + p^*_1(t, z)y_X$

is the sum of surplus in the home and foreign countries in good 1 plus home country surplus in the non-traded goods sector. Due to the symmetry and separability of the model, the home country policy choices will be independent of foreign country policies and the problem for the foreign country’s policy choice is identical to that of the home country. The payoff constraint is

$$\sum_{s=0}^{\infty} \rho(t_s, z_s)(1 - \delta)^s \beta^s + S \geq \Pi_0,$$  \hspace{1cm} (11)$$

where $S$ is the present value of lump sum transfers to capital owners in the import-competing sector at the time the agreement is signed. We will consider first best, second best, and third best cases. In the first best case, the government can choose a lump sum transfer in addition to the paths for employment and tariffs. In the second best case, the government is assumed not to be able to use the lump sum instrument. Finally, the third best case is one in which the government’s only instrument is the tariff.

One interpretation of this exercise is that the government is bargaining with the capital owners initially in the import-competing sector over the payoff that they will receive under the trade agreement, with the government being able to commit to any promise that is made at $s = 0$. The efficient frontier between national welfare and compensation to capital in the importable sector (subject to the allowed instruments) can be obtained by varying the value of $\Pi$, with the point on this frontier being chosen as part of an efficient bargaining process between the government and factor owners. Alternatively, this problem can be thought of as one in which the government has a weighted social welfare function, with the Lagrange multiplier from the optimization problem representing the additional weight placed on welfare of these capital owners. Since the primary concern in this analysis is how the desire to compensate factor owners affects the terms of the contract, rather than how a particular level of compensation is chosen, the value $\Pi_0$ will be treated as exogenous.
3.1 First Best Agreements

In order to provide a benchmark for the following discussion, we begin with the case where lump sum transfers are available as a policy tool for the government. The availability of lump sum transfers allows the governments to choose the trade and employment levels to maximizes world welfare, with (11) satisfied by the use of a lump sum transfer of the appropriate amount.

The necessary conditions for choice of tariffs and employment levels yield the following conditions:

\[ t_s^{W1} = 0. \sum_{v=1}^{\infty} \Delta(0, z_s^{W1})(1 - \delta)^{u-1} \beta^v \in \partial G(i_s) \text{ for all } s \]  

The world welfare criterion internalizes the terms of trade effects between countries, so the efficient trade agreement will call for free trade in all periods. Factor market interventions will not be required during the adjustment process in the absence of external effects, as in the small country case, because goods prices reflect social opportunity costs in each country.

The impact effect of the tariff reduction is illustrated in Figure 1, where the initial long run equilibrium is at \( z^N \), which equalizes the returns to capital in the two sectors at the optimal steady state tariff, \( t^N \). The elimination of the tariff results in a differential between sectors of \( \Delta(0, z^N) \). The existence of this differential creates an incentive to allocate all new investment to the non-traded goods sector, and to incur adjustment costs to move existing capital out of the importable sector. The following proposition establishes that this adjustment process reach the free trade steady state, \( z^{W1} \), which eliminates the sectoral differential at \( t = 0 \), in finite time.

**Proposition 2** The efficient first best trade agreement will involve free trade and no factor market intervention. The capital stock in the importable sector will follow a non-increasing path that reaches the steady state level in finite time. The steady state capital stock is,

\[ z^{W1} = \frac{2(A + \alpha - 1) - yX}{1 + 2\alpha} < z^N \]  

at which the returns to capital are equalized across sectors. There exists a critical value \( z^{R1} \) such that

(i) If \( z^N \leq z^{R1} \), the adjustment to the steady state occurs with all new investment being allocated to the non-traded goods sector and no capital being moved from the importable sector.

(ii) If \( z^N > z^{R1} \), all new investment will be allocated to the non-traded goods sector and capital will be moved from the importable sector to the non-traded goods sector for all \( s \) such that \( z_s > z^{R1} \).

The steady state can be reached in finite time by simply allowing the capital stock in the importable sector to depreciate and allocating all new investment to the non-traded goods sector. If the discounted differential in returns (evaluated
at $\hat{z}^N$) earned by moving a unit of capital to the non-traded goods sector exceeds $\theta$, then adjustment costs will be incurred to move some existing capital out of the importable sector. The critical value $z^{R1}$ is the capital stock at which the sectoral differential equals $\theta$, and once the capital stock reaches that level the steady state will be reached by replacement investment only, so that $i_s \in [0, \delta)$. In the case where $\theta = 0, z^{A1} = \hat{z}^{W1}/(1 - \delta)$, which is the largest value of $z$ at which the steady state can be reached in the following period by allocating all new investment to the non-traded goods sector. Note that if $\delta$ is sufficiently high the new steady state can be reached in the first period following the signing of the agreement without incurring adjustment costs.

Figure 2 illustrates the transition path for parameter values such that $z = .75$ in the steady state of the non-cooperative equilibrium and $z = .5$ at free trade. A depreciation rate of $\delta = .1$ is assumed, which would result in an adjustment along the dotted path if there was no movement of existing capital out of the importable sector. The path with no movement of capital reaches the free trade steady state at $s = 4$. The dashed path shows the optimal adjustment path assuming $\theta = .0$ and $\gamma = 2$. In this case the optimization problem yields $T^{W1} = 3$. Adjustment costs are incurred to move capital out of the importable sector for $s = 0, 1, 2$. At $s = 3$, the capital in the importable sector is at $=.01$, which is sufficiently close to the steady state level that the remaining gap is eliminated without disinvestment from the importable sector. The importable sector capital stock is at the steady state level for $s > 3$, with $i_s = .05$ in the steady state. The optimal path results in a substantially smaller capital stock for $s < 4$ than in the case where there is only replacement investment, although it reaches the steady state level at the same time as does the replacement path.\textsuperscript{4}

### 3.2 A Second Best Trade Agreement

We next consider the case in which the government is not able to use lump sum taxes to compensate capital in the import-competing sector. The absence of the lump sum transfer means that the government will choose to use both trade policy and subsidies to capital movement in an efficient agreement. The optimization problem for the government is to choose the sequence of pairs \{$z_s, t_s$\} to maximize (10), subject to (11) and given $z_0$. Since the set of feasible pairs $(t_s, z_s)$ is compact and $p(t_s, z_s)$ is linear in its argument, the set of sequences \{$z_s$\} satisfying (11) will be compact and convex. The second best optimization problem will thus involve maximizing a continuous, concave function on a compact set, so a maximum will be attained.

The second best optimal policy can be by forming the Lagrangean,

$$V^{2W}(z_0, \Pi_0) = \max_{t_s, z_s} \sum_{s=0}^{\infty} \left[ W^W(t_s, z_s) - G(i_s) + \lambda^{W2} p_1(t_s, z_s)(1 - \delta)^s \right] \beta^s - \lambda^{W2} \Pi_0. \quad (14)$$

The value function, $V^{2W}(z_0, \Pi_0)$, yields the trade-off between national welfare and the compensation to capital initially located in the importable sector. It is

\textsuperscript{4}The parameter values for this case were $y_X = 1.5, \alpha = 0, \beta = .95, and A = 2.$
straightforward to show that the value function will be decreasing and strictly concave in $\Pi_0$ for values of $\Pi_0$ for which (11) is binding.5

The introduction of the compensation constraint has the effect of giving capital in the importable sector a weight of $1 + W^2(1 - \delta)s$ in the social welfare function at each point in time. The optimal tariff for this case will satisfy

$$\partial W^W(t_s, z_s)/\partial t + \lambda(1 - \delta)^s\partial p_1/\partial t,$$

which yields

$$t^W_s = \lambda^W(1 - \delta)s.$$ (15)

The optimal tariff is positive when the compensation constraint is binding because it transfers income to the capital located in the importable sector, which carries a greater weight in the social welfare function. This weight will diminish over time, however, because of the declining amount of capital that was promised compensation. Therefore, this model generates a tariff reduction that declines at a rate equal to the depreciation rate of capital,

$$(t^W_{s+1} - t^W_s)/t^W_s = -\delta,$$ because future tariff reductions are less valuable to capital owners as the rate of depreciation increases.

The condition for the optimal choice of capital allocation at time $s$ is

$$\sum_{v=1}^{\infty} [\Delta(t^W_{s+v}, z_{s+v}) - t^W_s] (1 - \delta)^v - 1 \beta^v \in \partial G(i_s).$$ (16)

Since $\Delta(t, z) - t = p(t, z) - (1 - \alpha(1 - z))$, (16) requires that the discounted differential in returns between sectors evaluated at world prices be contained in the subderivative of the adjustment cost function. This result is consistent with the literature on the second best, which notes that it is world prices that are relevant for determining the values of goods. Implementing the optimal path will require a subsidy to capital located in the non-traded goods sector of $t^W_s$, because private agents will compare the differential in returns between sectors at domestic prices in making decisions to relocate capital.

Since the tariff will be declining over time, the economy will not reach a steady state in the sense that the capital stock remains constant in each sector. However, the economy can reach a point where the differential between sectors is eliminated, so that new investment will be taking place in both sectors.

$$z^W_s \equiv z^W_1 - \frac{\lambda^W(1 - \delta)s}{1 + 2\alpha}.$$ (17)

The following result establishes that there will be a finite time $T^W$ such that $z_s = z^W_s$ for $s > T^W$. For $s < T^W$, all new investment will be allocated to the non-traded goods sector and some capital may be moved from the importable sector. Once the path described by (17) is reached, the capital stock

---

5Suppose (11) holds with equality for $\Pi^1$ and $\Pi^2$, with $\{z^i, t^i\}$ for $i = 1, 2$ denoting the corresponding optimal paths with $z^0 = z^0$. The sequence $t^\lambda = t^1 + (1 - \lambda)t^2$ and $z^\lambda = z^1 + (1 - \lambda)z^2$ will yield a payoff to capital in the importable sector of $V^\lambda = \lambda V^1 + (1 - \lambda)V^2$ due to the linearity of the payoff constraint in its arguments. Since $W^W$ is strictly concave in its arguments and $G$ is convex, we must have $V(z_0, \Pi^1) > \lambda V(z_0, \Pi^1) + (1 - \lambda)V(z_0, \Pi^2)$.
in the importable sector will be increasing over time and will approach $z^{W1}$ asymptotically.  

**Proposition 3** The second best trade agreement, when government does not have access to lump sum taxes, has the following properties:

(a) The tariff at time $s$ will be $t^W_s = \lambda^W (1 - \delta)^s$, and the government will provide a subsidy to a unit of capital in the non-traded goods sector of the same amount.

(b) The time path of capital in the importable sector will be non-monotonic. There will be a finite time $T^{W2}$ such that the capital stock in the importable sector will be increasing as given by (17) for $s > T^{W2}$. For $s \leq T^{W2}$, the capital stock will follow a decreasing path that reduces the capital stock from $z^N$ to $z^{W2}_{T^{W2}}$. There will exist critical values $z^{R2}_s$ such that:

(i) If $z^N \leq z^{R2}_0$, $i_s = 0$ for $s \leq T^{W2}$. Adjustment is achieved without moving any existing capital from the importable sector.

(ii) If $z^N > z^{A2}_0$, $i_s = 0$ all new investment will be allocated to the non-traded goods sector and capital will be moved from the importable sector to the non-traded goods sector for all $s$ such that $z_s > z^{A2}_s$.

The second best trade agreement uses both the tariff and the factor market subsidy to raise the return to capital initially located in the importable sector. The factor market policy raises the sectoral return differential, which accelerates the movement of capital out of the importable sector as long as $\theta$ is not too large. These two forces, the tariff protection of the importable and the more rapid exit of capital from the exportable sector, both have the effect of raising the return to capital in the importable sector and thus serving to satisfy the compensation constraint. The increased exit from the manufacturing sector overshoots the steady state level from the first best agreement, $z^{W1}$. However, the outflow will be reversed after $T^{W2}$. The reversal occurs because the level of protection declines over time as the quantity of original capital in the importable sector declines.

If $\theta = 0$, the adjustment cost function will be differentiable everywhere, and we can utilize (17) at $s$ and $s + 1$ to obtain the arbitrage condition $G'(i_s)/\beta - G'(i_{s+1})(1 - \delta) = \Delta(t^W_{s+1}, z^{W2}_{s+1}) - t^W_{s+1}$. For $s \geq T^{W2}$, both sides of the equation will equal 0 because the sectoral return differential is eliminated (i.e. $z_s = z^{W2}_{s+1}$) and no adjustment costs are incurred ($i_s = i_{s+1} \in (0, \delta)$). For $s < T^{W2}$, the return differential is sufficiently high that adjustment costs are incurred. The arbitrage condition makes the capital owner indifferent between moving at $s$ and $s + 1$, because the loss in earnings from remaining in the importable sector for another period exactly equals the saving in adjustment costs from waiting an additional period to move. This yields the following system of $T^{W2}$ equations,

\[
-\gamma(1 - \delta)z_{s+2} + \left(0.5 + \alpha + \frac{\gamma}{\beta} + \gamma(1 - \delta)^2\right)z_s - \frac{\gamma(1 - \delta)}{\beta}z_s = A - 1 + \alpha - \frac{yX + \lambda(1 - \delta)s + 1}{2}
\]

Note that this path is feasible, since $i_s = z^{W2}_{s+1} - (1 - \delta)z^{W2}_s = \delta z^{W1}_s \in (0, 1)$ for $s > T^{W2}$.
\[
(5 + \alpha + \frac{\gamma}{\beta}) z_{T^W_2} - \frac{\gamma(1 - \delta)}{\beta} z_{T^W_{2-1}} = A - 1 + \alpha - \frac{yX + \lambda(1 - \delta)T^{-1}}{2}
\]

The system (18) will determine \(z_1, \ldots, z_T\), given \(z_0 = \tilde{Z}^N\) and \(T^W_2\). The arbitrage condition differs at time \(T^W_2 - 1\) because \(i_{T^W_2} \in (0, \delta)\). In order for this system to be consistent with reaching no adjustment costs at \(T^W_2\), the solution must yield \(z_{T^W_2} \in [\tilde{z}_{T^W_{2+1}}/(1 - \delta), \tilde{z}_{T^W_{2+1}}]\).

These results can be used to derive the impact of a tightening of the compensation constraint on the efficient path under the trade agreement, which will have the effect of increasing \(\lambda\). It is clear from (15) and (3) that a larger weight on capital in the importable sector will reduce \(\Delta(t_s^{WC}, z_s) - t_s^{WC}\) for a given \(z\), which makes moving capital out of the importable sector more attractive. An increase in the tariff and the subsidy to capital in the non-traded capital sector of the same amount will reduce the relative return to capital in the importable sector, because the price of the imported good does not rise by the full amount of the tariff. It is clear from (17) that this results in a lower value of \(\tilde{z}_s\) and hence a lower level of capital in the importable sector for \(s > T^W_2\). The effect on the capital stock for \(s \leq T^W_2\) is obtained by differentiation of the system (18). It is shown in the Appendix that since the Jacobean of this system has a dominant diagonal, an increase in \(\lambda\) will also reduce \(z_s\) for \(0 < s \leq T^W_2\) in the second best agreement. Since \(\lim_{\lambda \to 0} z_s^{W_2} = z_s^{W_1}\) for all \(s\), this also means that the level of \(\lambda\) in the second best trade agreement will be everywhere below that in the first best agreement when the compensation constraint is binding.

**Proposition 4** If \(\theta = 0\) and the compensation constraint is binding, the capital stock in the importable sector under the second best policy will be less than that in the first best policy and will be decreasing in \(\lambda\) for all \(s\). For given \(z_0\), the level of capital in the importable sector will be decreasing in \(\lambda\) for all \(s > 0\).

It might seem surprising that an increased desire to compensate capital initially in the importable sector will lead to the sector shrinking more rapidly than in the first best agreement. This results from the fact that the factor market policy leads to a more rapid exit of capital in order to mitigate the distorting effects of the tariff.

If \(\theta > 0\), the system in (18) can be used to characterize the adjustment process over the time period during which adjustment costs are being incurred if the marginal adjustment cost is modified to include \(\theta\). The primary difference is that with \(\theta > 0\), there may be some values of \(s < T^W_2\) for which \(i_s = 0\) because of the discontinuity in the marginal adjustment cost function at \(i = 0\). This is illustrated most clearly in the case of constant marginal cost of adjustment (i.e. \(\theta > 0, \gamma = 0\)), where no adjustment costs will be incurred after period 0. Optimal adjustment will result in a discounted return differential at time 0 that is less than or equal to \(-\theta\), and the fact that the return differential is decreasing over time will ensure that it is strictly less than \(-\theta\) for \(s > 0\). The optimal policy will be to choose \(i_s = 0\) for \(1 \leq s < T^W_2\) with constant marginal adjustment costs.
Figure 2 illustrates the effect of adding the compensation constraint to the adjustment process. The solid line shows the adjustment path for the second best agreement with \( \{\theta = 0, \gamma = 1\} \), with the value of \( \lambda^{W2} \) chosen such that the owners of capital initially located in the importable sector are compensated for 60% of their loss resulting from the trade agreement. Adjustment costs are incurred to move capital out of the importable sector for \( s = 0, 1, 2 \), since \( T^{W2} = 3 \). At \( s = 3 \), the gap between the capital stock in that period (\( z_{3} = .483 \)) and the solution that equalizes returns between sectors for \( s = 4 \) (\( z_{4}^{W2} = .474 \)) is sufficiently small that it can be reached without incurring additional adjustment costs. For \( s > 4 \) the path is given by (17), which is increasing in \( s \). This adjustment path for the second best case illustrates the non-monotonicity described by Proposition 3, as it declines to reach a minimum at \( s = 4 \) and is then increasing thereafter. The adjustment path for the first best case, illustrated by the dashed line, is shown for comparison. The first best path also incurs adjustment costs for \( s = 0, 1, 2 \) and reaches the steady state at \( s = 4 \). The first best is non-increasing for all \( s \), and is everywhere above the second best path as indicated by Propositions 3 and 4.

### 3.3 Trade Agreements without Capital Market Interventions

We conclude by considering the third best case, in which the governments only specify a path for tariffs as part of the trade agreement. Relaxing this assumption is not restrictive in the case where governments maximize national welfare and private adjustment costs equal social costs of adjustment, as established in Proposition 3. However, capital market instruments played a significant role in inducing movement of capital out of the import-competing sector in Proposition 4, where tariffs were used to compensate capital owners in the import-competing sector. In the third best case, the path for tariffs must be chosen so that it plays the dual role of compensating factor owners and inducing movement of resources to the more efficient production location. In this section we examine the effect of eliminating the use of factor market interventions under the assumptions that the private cost of moving for workers equals the marginal social adjustment cost.

The constraint on capital market movement requires that owners of capital in place receive a return that is no lower than that which can be earned by incurring the adjustment costs of moving to the other sector. In order to simplify the presentation, we begin with the case where the adjustment cost function is differentiable for all \( i \) (i.e. where \( \theta = 0 \)) so that the capital mobility constraint can be written as

\[
\sum_{u=1}^{\infty} \Delta(t_{s+u}, z_{s+u})(1 - \delta)^{u-1} \beta^{u} - G'(i_{s}) = 0 \quad \text{for all } s
\]

(19)

The efficient contract in the third best case is obtained by (10), subject to (11), (19) and given \( z_{0} \). The Langrangean for this third best optimization problem
will be

\[ L^{W3} = \sum_{s=0}^{\infty} \left[ W^W(t_s, z_s) - G(i_s) + \lambda^{W3} p_1(t_s, z_s)(1 - \delta)^s \right] \beta^s - \lambda^{W3}\Pi_0 + \sum_{s=1}^{\infty} \mu_s \left( \sum_{u=1}^{\infty} \Delta(t_{s+u}, z_{s+u})(1 - \delta)^{u-1} \beta^u - G'(z_s - (1 - z_{s-1})) \right) \beta^{s-1} \]

where \( \mu_s \) is the current value multiplier associated with the adjustment constraint at time \( s \). If \( \mu_s < 0 \ (> 0) \), the payoff under the agreement can be raised by inducing more capital to move to the non-traded goods sector (importable goods sector), so an increase in the differential for \( s' > s \) will tighten (relax) the capital mobility constraint at time \( s \).

It is convenient to rewrite the Lagrangean problem as

\[ L^{W3} = \sum_{s=0}^{\infty} \left[ W^W(t_s, z_s) - G(i_s) + \lambda^{W3} p_1(t_s, z_s)(1 - \delta)^s + M_s \Delta(t_s, z_s) \right] \beta^s - \lambda^{W3}\Pi_0 \]

(20)

where \( M_s = \sum_{u=0}^{s-1} \mu_u(1 - \delta)^{s-1-u} \) summarizes the effect of an increase in \( \Delta_s \) on the capital mobility constraint for all \( s' < s \). \( M_s < 0 \ (> 0) \) indicates that an increase in \( \Delta_s \) will be to tighten (relax) the capital mobility constraint for \( s' < s \). The definition of \( M_s \) then implies

\[ M_{s+1} = (1 - \delta)M_s + \mu_s \quad M_0 = 0 \quad (21) \]

The multiplier \( M_s \) reflects the presence of commitment in the trade agreement, because it shows that the planner’s decisions at time \( s \) incorporate the effects of these decisions on agent decisions at \( s' < s \).

The necessary condition for choice of \( t \) in the third best case is

\[ t^{W3}_s = \lambda^{W3}(1 - \delta)^s + M_s \tag{22} \]

An increase in the tariff will relax the compensation constraint, as in the second best problem. However, it will also make moving to the non-traded goods sector less attractive, which tightens the capital mobility constraint when \( M_s < 0 \). The time path of the tariff will thus reflect the tension between these two effects. Utilizing (21), it can be seen that the rate of decline of the tariff along the optimal path will be \( (t^{W3}_{s+1} - t^{W3}_s)/t^{W3}_s = -\delta + \mu_s/t^{W3}_s \). The tariff rate will decline at a rate greater than \( \delta \) if \( \mu < 0 \) and \( t^{W3}_s > 0 \), because the decline in the tariff is being used to relax the capital mobility constraint by encouraging capital to move out of the importable sector.

The necessary condition for location of capital is obtained by differentiating the Lagrangean with respect to \( i_s \), and then substituting using (19) to obtain

\[ \sum_{u=1}^{\infty} \left[ \lambda^{W3}(1 - \delta)^{s+u} + M_{s+u}(1 + \alpha) \right] (1 - \delta)^{u-1} \beta^u \in -\mu_s \partial G'(i_s). \tag{23} \]
Owners of capital evaluate the benefit of moving to the non-traded goods sector as the discounted difference in marginal products between sectors, whereas the government evaluates the benefit of moving as the discounted difference in marginal social products across sectors. The left hand side of (23) is the difference between these two measures, which includes the difference between domestic and world prices of outputs as well as the impact of capital movements on the constraints. Similarly, the right hand side is the difference between the social cost and the private cost of moving capital between sectors, which results from the fact that capital owners do not take into account the impact of their moving on the marginal cost of adjustment, which affects the mobility constraint. The necessary condition (23) thus requires that the divergence between social benefits and private benefits equal the difference between social costs and private costs. Note that the marginal cost of adjustment function has a discontinuity at \( i_s \in \{0, \delta\} \), since \( G'(i_s) = 0 \) for \( i \in (0, \delta) \) and \( G'(i_s) = \gamma \) for \( i_s > \delta \) and \( i_s < 0 \).

As in the previous cases, we can establish that there will be finite time, denoted \( T^{W3} \), such that \( i_s \in (0, \delta) \) for \( s \geq T^{W3} \). The fact that replacement of capital is taking place in each sector will imply \( G'(i_s) = 0 \) and \( G''(i_s) = 0 \) for \( s \geq T^{W3} \) from (1). The former condition implies \( \Delta(t_s, z_s) = 0 \) for \( s > T^{W3} \) from (19), and the latter yields \( \lambda W^3 (1 - \delta)^s + M_s (1 + \alpha) \) for \( s > T^{W3} \) from (23). These two conditions yield the following characterization of the optimal path of tariffs and employment of capital once the sectoral differential has been eliminated.

**Proposition 5** When the tariff is the only instrument available to the government in the trade agreement, there will be finite time \( T^{W3} \) such that returns to capital will be equalized in both sectors for \( s \geq T^{W3} \). The terms of the efficient agreement will be

\[
\begin{align*}
t_s &= \frac{\alpha \lambda W^3 (1 - \delta)^s}{(1 + \alpha)}; \\
M_s &= \frac{\lambda W^3 (1 - \delta)^s}{(1 + \alpha)}; \\
\tilde{z}_s^{W3} &= \tilde{z}_s^{W1} + \frac{\alpha \lambda W^2 (1 - \delta)^s}{(1 + 2 \alpha) (1 + \alpha)} \quad \text{for } s > T^{W3}
\end{align*}
\]

Since \( M_s \) increases at rate \( \delta \), we also have the result that \( \mu_s = 0 \) for \( s > T^{W3} \).

The result that for \( \tilde{M}_s < 0 \) indicates that the capital mobility constraint must be binding with \( \mu_s < 0 \) for some \( s < T^{W3} \). Thus, tariff policy in the long run in the third best case is determined by the trade-off between the desire to compensate capital initially in the importable sector with the desire to move capital out of that sector. If \( \alpha = 0 \), then the marginal product of capital in the non-traded sector will be constant, so trade policy has no effect on the return to capital in the long run. The tariff will be eliminated in finite time if \( \alpha = 0 \), because it cannot be used to relax the compensation constraint once returns have been equalized across sectors. If \( \alpha > 0 \), the marginal product of capital in the non-traded goods sector is decreasing in the quantity of capital, so a positive tariff can be used to raise the return to capital in the long run. The benefit of
an increase in the tariff must be weighed against its deterrent to the movement of capital. The optimal tariff will be increasing in $\lambda$, which reflects the tightness of the compensation constraint, and also increasing in $\alpha$. The optimal tariff will decrease at rate $\delta$ in this region, as in the second best case, because the mobility constraint is not binding for $s > T_{W^3}$. The quantity of capital in the importable sector will exceed the first best level when the compensation constraint is binding if $\alpha > 0$, because the sector is still being protected in order to satisfy the compensation constraint. This contrasts with the second best case, where the employment of capital was less than the first best level due to the use of the subsidy to capital in the non-traded goods sector.

In order to analyze the evolution of tariff and capital allocation for $s \leq T_{W^3}$, we must also solve for the evolution of the costate variable $M_s$. Substituting the optimal tariff (22) into the necessary condition for choice of investment (23) and then differencing yields the arbitrage condition $\lambda^{W^3}(1-\delta)^s + M_s(1+\alpha) = -\mu_s G''(i_s)/\beta + \mu_{s+1}(1-\delta)G''(i_{s+1})$ that must hold at each time $s$. Using (21), the arbitrage condition yields the following set of $T_{W^3}$ equations that must hold for periods $s = 0, ..., T_{W^3} - 1$,

$$-\beta(1-\delta)M_{s+2}G''(i_{s+1}) + (\beta(1+\alpha) + G''(i_s) + \beta(1-\delta)^2G''(i_{s+1})$$

$$-(1-\delta)G''(i_s)M_s = -\frac{\beta\lambda^{W^3}(1-\delta)^s+1}{1+\alpha}$$

If there are no corner solutions during the transition (i.e. $i_s \neq 0$), the system in (25) will be a system of linear equations that can then be used to solve for the unknowns $\{M_1, ..., M_{T_{W^3}}\}$ using $G''(i_s) = \gamma$ for $s = 0, ..., T_{W^3} - 1$ and $G''(i_{T_{W^3}}) = 0$. It can be shown using arguments similar to those in the proof of Proposition 3 that $M_s < 0$ for $s = 1, ..., T_{W^3}$ when $\lambda^{W^3} > 0$, which means that increasing the tariff at time $s$ has the effect of tightening the capital mobility constraint for $s' < s \leq T_{W^3}$. The same arguments also ensure that an increase in $\lambda$ will result in a decline in $M_s$ for all $s$. The requirement that the capital mobility constraint bind at time $s$ and $s+1$ yields the arbitrage condition $G'(i_s)/\beta - G'(i_{s+1})(1-\delta) = \Delta(i_{s+1}, z_{s+1})$ that must hold for periods $s = 0, ..., T_{W^3} - 1$. If there are no corner solutions during the transition, the solutions for the $M_s$ from (25) can be used in these arbitrage conditions to give a system of $T_{W^3}$ linear equations analogous to (18) that can be solved for $\{z_1, ..., z_{T_{W^3}}\}$.

If the system does have a corner solution with $i_s = 0$, then the system of equations (25) also contains unknown values $\theta_s \in [0, \gamma]$ representing the shadow value of $G''(i_s)$ for each period in which $i_s = 0$. Note however that this eliminates one unknown for the capital stock in each period in which $i_s = 0$, since $z_{s+1} = z_s(1-\delta)$. In this case the system of $2T_{W^3}$ equations from (25) and

\footnote{This system of equations in (25) can be expressed in matrix form as $BM = -\Lambda$, where $M$ is the column vector with elements $M_s$, $\Lambda$ is the column vector with elements $\lambda(1-\delta)^s$ and $B$ is the coefficient matrix with positive diagonal elements and non-positive off diagonal elements. Since $B$ has a dominant diagonal and the elements of $\Lambda$ are all positive when the compensation constraint is binding, we must have $M < 0$. This establishes that when the compensation constraint binds, the multiplier on the sectoral differential on returns to capital will be negative.}
the capital mobility constraint must be solved simultaneously to determine the characteristics of the transition path.

These results can be summarized as:

**Proposition 6** The capital mobility constraint must bind for some \( s < T^{W3} \) in the third best case, and the tariff rate will fall at a rate exceeding \( \delta \) over the transition period from period 0 to period \( T^{W3} \).

Figure 3 shows a comparison of the adjustment path under the efficient agreement for the third best case (solid line) with that under the replacement path (dotted line) and the first best adjustment path. The parameter values \( \{A, \alpha, \beta, \gamma, \delta\} \) are the same as in Figure 2, with the value \( \lambda^{W3} \) chosen to yield the same level of compensation as was obtained in the second best case. In the third best case, adjustment costs are incurred at \( s = 0, 1 \). The replacement path is then followed for \( s = 2, 3 \), with the factor price differential between sectors being eliminated at \( s = 4 \). Due to the assumption of \( \alpha = 0 \) in this example, the policy from period 4 onward is one of free trade with \( z_s = \delta^{W1} \). The third best path lies below the replacement path due to the fact that adjustment costs are incurred to speed the adjustment in the first two periods. The third best path lies above the first best path for \( s < 4 \) due to the use of the tariff to compensate capital owners in the importable sector. Increases in the level of compensation promised to capital in the importable sector will raise \( \lambda^{W3} \), which increases the tariff, slows the rate of adjustment, and moves the third best path closer to the replacement path.

Figure 4 shows a comparison of the second best and third best tariff policies for the \( \lambda \) values used in Figures 2 and 3, which yield the same amount of protection to the capital owners. The non-cooperative tariff in this case is \( .25 \). In the second best case, the tariff under the agreement tariff starts at \( .035 \) and declines at a constant rate \( \delta \) thereafter. In the third best case, the tariff starts at a substantially higher level (\( .174 \)) and declines rapidly to reach 0 at \( s = 4 \). The fact that the tariff is higher at \( s = 0 \) when capital taxes are not available is a general result for comparisons of second and third best tariff rates that generate the same compensation to capital owners in the importable sector. The initial period tariffs are equal to \( \lambda^{W2} \) and \( \lambda^{W3} \) for the second and third best cases. Since \( \lambda \) is the marginal cost of the compensation constraint for each problem, \( \lambda^{W2} < \lambda^{W3} \) because the marginal cost of compensating the losing capital owners is lower when the government has more policy instruments available. In the subsequent periods, the tariff in the third best case will decline at a rate exceeding \( \delta \) because of its impact on the capital mobility constraint. This is illustrated by the dotted \( M_s \) line in Figure 4, which shows the impact of the tariff in period \( s \) on the mobility constraint in the preceding periods. \( M_0 = 0 \) because the initial tariff has no impact on capital that has already been located. The impact of the mobility constraint on the tariff reaches its maximum at \( s = 4 \), because the mobility constraint is binding for periods 0 to 4. In the following periods, the mobility constraint is slack so the relative importance of the mobility constraint is declining.
4 Conclusions

This paper has shown how the form of the efficient trade agreement varies with the type of policy instruments that are available when there is a motive to compensate factors initially located in the import-competing sectors. One point that applies to both of the second best and third best cases, where lump sum instruments are not available, is the central role played by the rate of depreciation of the mobile factors. The higher the rate of depreciation, the less value that is placed on future returns by the owners of capital initially in the importable sector, and the less valuable is future protection. The depreciation rate would not play such a role if the objective were to permanently raise the return to capital in the importable sector, because in that case the returns to future generations of capital owners would be considered. This prediction of the model is potentially testable, as it provides a cross-sectional prediction that sectors with higher rates of turnover of physical and human capital will have more rapid rates of tariff adjustment under a free trade agreement.

The second emphasis was on the interaction between the use of the tariff and the use of sectoral factor tax/adjustment policies that could also be used to speed adjustment. When two instruments are available, the cost of compensation is much lower because the government can compensate factors in the importable sector while simultaneously providing an incentive for resources to leave the sector. In fact, this leads to an exit of factors at a rate exceeding that under the first best agreement because of the output market distortion. In contrast, when only a tariff instrument is available the tariff must be used both to compensate capital owners and to encourage exit from the industry. These results on the relationship between the instruments included in the trade agreement and the rate of tariff reduction would also be potentially testable.

The introduction of stochastic shocks into the analysis remains an area for future work. The impact of uncertainty about future prices, and its impact on promises of compensation to factor owners, could provide a potential role explanation for the introduction of safeguards into trade agreements.
5 Appendix

Proof of Proposition 2: It is convenient to solve the optimization problem using the functional equation, \( V(z) = \max_x W^W(0, z) - G(x - (1 - \delta)z) + \beta V(x) \). The period payoff function is a bounded, continuous function defined on \([0, 1] \times [0, 1]\). Furthermore, it is concave in \((x, z)\) and strictly concave in \(z\). It then follows using standard arguments (e.g. (10)) that the value function, \( V(z) \), is a strictly concave function and the optimal policy, denoted \( \tilde{x}(z) \), is a continuous, single-valued function. If \( \theta = 0 \), the value function will also be differentiable on the interior of its domain. Since \( G_{xx} \leq 0 \) and the functional equation is strictly concave in \( z \), the policy function will be non-decreasing in \( z \). This establishes that the path from \( \tilde{z}^N \) to \( \tilde{z}^W_1 \) will be non-increasing.

In order to establish some properties of the optimal path, it is convenient to define the "replacement path" that shrinks the importable sector by allowing its capital to depreciate until the steady state is reached. From an initial stock at time \( z > \tilde{z}^W_1 \) at time \( s \), the attrition path will yield a stock \( u \) periods later of \( z^R_1(z) = \max[(1 - \delta)^u z, \tilde{z}^W_1] \). The gain of moving a unit of capital to the non-traded goods sector at time \( s \), given that the current stock is \( z \) and the replacement path will be followed thereafter, is \( v^R_1(z) = \sum_{u=1}^{\infty} \Delta(0, z^R_1(z))(1 - \delta)^{u-1} \beta^u \). Since \( v^A_1(z) \) is non-increasing in \( z \), the attrition path will satisfy the necessary conditions from time \( s \) onward if \( v^R_1(z_s) > -\theta \). Defining \( z^1_{\max} \) as the maximum value of \( z \) satisfying \( v^R_1(z) = -\theta \), \( z^R_1 \equiv -1 \) if \( v^R_1(1) \geq -\theta \). The replacement path will be optimal for any \( z_s \in [z^1_{\max}, \tilde{z}^W_1] \). For \( z_s > z^1_{\max} \), the sectoral return differential will be sufficiently large that it will be worthwhile incurring the adjustment costs of moving capital to the non-traded goods sector and (??) will be satisfied with \( i_s < 0 \).

Define \( T^R_1(z) \) as the maximum value of \( s \) satisfying \((1 - \delta)^s z > \tilde{z}^W_1 \) for \( z > \tilde{z}^W_1 \), which must be finite since \( \delta \in (0, 1) \). If the replacement path is followed from time \( 0 \), it will reach the steady state at time \( T^R_1(\tilde{z}^N) + 1 \). Since the optimal path will result in an exit of capital from the importable sector that is at least as fast as the attrition path, there will be a finite time \( T^W_1 \leq T^R_1(\tilde{z}^N) \) such that \( z_s = \tilde{z}^W_1 \) for \( s > T^W_1 \) in the optimal policy.

Proof of Proposition 3: The discussion in the text established that the maximum in (14) will exist if the feasible set is non-empty.

As in the first best case, we begin by characterizing the replacement path, which will reach the path of capital given by (17) in finite time. If \( z > \tilde{z}^W_2 \), let \( u^R(z, s) \) be the smallest value of \( u \) such that \( \max[(1 - \delta)^u z, \tilde{z}^W_2] = \tilde{z}^W_2 \) at time \( s + u \). This value is finite for \( \delta > 0 \), and is decreasing in \( z \) and \( s \). The replacement path is feasible since it satisfies \( i_s \in [0, \delta] \) for all \( s \). Note that this path is non-monotonic, since it will be decreasing at time \( s \) if \( z_s > \tilde{z}^W_2 \) and increasing if \( z_s = \tilde{z}^W_2 \). The gain of moving a unit of capital to the non-traded goods sector at time \( s \), given that the replacement path is followed from \( s \) onward, is \( v^R_2(z, s) = \sum_{u=1}^{\infty} [\Delta(t^W_2, \max[(1 - \delta)^u z, \tilde{z}^W_2]) - t^W_2] (1 - \delta)^{u-1} \beta^u \).
Following the attrition path from time $s$ will satisfy (16) if $v^{A2}(z, s) > -\theta$. It is then possible to define a critical value $z_s^{R2}$ satisfying $v^{R2}(z) = -\theta$ (i.e., $z_s^{R2} = -1$ if $v^{A2}(1) \geq -\theta$) such that the replacement path will be optimal for $z_s \in [z_s^{R2}, z_s^{W2}]$.

Note that since the tariff and capital subsidy in the non-traded goods sector depend on calendar time, the critical value will depend on calendar time as well. Movement of capital out of the importable sector will occur at time $s$ if $z > z_s^{R2}$. Thus, the optimal path will satisfy $z_s \leq z_s^{R2}$, which yields $T^{W2} \leq u^{R}(z^{N}, 0)$.

Proof of Proposition 4: By differentiating the system of equations in (18) and expressing in matrix form, we can obtain the effect can be written in matrix form as $Bdz = dt$, where $dz$ is the $T^{W2}$ element vector whose $s^{th}$ element is $dz_s$, and $dt$ is the $T^{W2}$ vector whose $s^{th}$ element is $-\frac{(1-\delta)^s}{2} d\lambda$. $M$ is a $T^{W2}$ by $T^{W2}$ matrix whose diagonal entries are by $b_{ss} = \left(\frac{5 + \alpha + \frac{\gamma}{\beta}}{\beta}\right)$ for $s = 1, ..., T^{W2} - 1$ and $b_{T^{W2}T^{W2}} = \left(\frac{5 + \alpha + \gamma(1 - \delta)^2}{\beta}\right)$. The off-diagonal elements are $b_{s,s+1} = -\gamma(1 - \delta)$ for $i = 1, ..., T^{W2} - 1$, $b_{s,s-1} = -\gamma/\beta$ for $i = 2, ..., T^{W2}$, and 0 for all other elements. The column sums are positive for each row, so this matrix has a dominant diagonal. It then follows from Theorem 4.C.3 in Takayama [11] that $dt < 0$ implies $dz \leq 0$. To show that $dz < 0$ in this case, suppose that $dz_s = 0$ for some $s$. Then the $s^{th}$ element of $Bdz$ will be $\sum b_{sj}dz_j \geq 0$, since $b_{sj} \leq 0$ for $j \neq s$ and $dz_j \leq 0$. However, this cannot be a solution because it contradicts $dt_s < 0$. Therefore, we have $dz_s < 0$ for all $s$. 

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References


Figure 1: Capital Market Allocation Between Importable and Non-Traded Sectors
Figure 2: First best and second best employment paths
Figure 3: First best and third best paths for capital stock
Figure 4: Second and third best tariff paths