NBER WORKING PAPER SERIES

THE ADJUSTMENT PROCESS AND THE TIMING OF TRADE LIBERALIZATION

Michael Mussa

Working Paper No. 1458

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
September 1984

NBER Working Paper #1458
September 1984

The Adjustment Process and the Timing of Trade Liberalization

ABSTRACT

This paper examines the appropriate time path of the tariff rate for a small open economy that has decided to move from protection of import competing industries to free trade. Adjustment costs for moving resources to alternative uses do not provide a rationale for gradual adjustment of the tariff rate because in the absence of distortions, rational optimizing agents will make socially appropriate investment decisions with respect to adjustment when they are given correct price signals. Some distortions of the adjustment process imply the desirability of gradual adjustment of the tariff rate to slow adjustment, but other distortions imply the desirability of subsidizing imports in the short run in order to speed movement of resources out of previously protected industries. Concern with the income redistribution effects of reductions in the tariff rate (which usually injure owners of factors in previously protected industries) does provide a general rationale for a gradual move to free trade. The influence of the unemployment consequences of tariff reduction on the appropriate path of commercial policy depends on the nature and shape of the response of the rate of resource reallocation to the level of unemployment in previously protected industries.

Michael Mussa
Graduate School of Business
University of Chicago
1101 East 58th Street
Chicago, Illinois 60637

(312) 962-7143

The Adjustment Process and the Timing of Trade Liberalization*

by

Michael Mussa

Introduction and Summary

This study is concerned with the appropriate time path of commercial policy for a country that has already determined that a more liberal trade policy is in its long run best interest. In contrast to the question of a country's best static trade policy which has been extensively discussed in the economic literature, the subject of the present study has received scant attention.[1] However, unless one believes that most countries have already achieved their optimum trade policies or that the best time path of policy is always and unquestionably to move immediately to the best long run policy, then the question of the appropriate time path of commercial policy should be regarded as an interesting and important issue.

The approach that will be adopted in examining this issue in the present study is to assume that a country with a high level of protection granted to domestic industries that produce goods competing with imports has decided, for whatever reasons, that a more liberal commercial policy, with a much lower level of protection for import competing domestic industries, is in its long run best

---

* This paper was written while the author was a consultant to the Strategy and Trade Division of the Country Policy Department of the World Bank. The World Bank does not accept responsibility for the views expressed, which are those of the author and should not be attributed to the World Bank or its affiliated organizations. The findings, interpretations and conclusions are the result of research supported by the Bank; they do not necessarily represent official policy of the Bank. The designations employed, the presentation of material and any maps used in this document are solely for the convenience of the reader and do not imply the expression of any opinion whatsoever on the part of the Bank or its affiliates concerning the legal status of any country, territory, city, area, or of its authorities, or concerning the delimitation of its boundaries or national affiliation.

1. Among the papers that do examine the appropriate timing of trade liberalization or closely related issues are Lapan (1976), Leamer (1980), Mussa (1978 and 1982b) Neary (1982) and Martin and Selowsky (1982).

interest. To keep matters as simple as possible, it will usually be assumed that this country is sufficiently small that it has no influence on the world prices of the goods it trades, and that there are no distortions or externalities that make any policy other than complete free trade the optimal long run policy for this country. The issue for policy makers in this country is how to alter commercial policy over time in order to move in an optimal manner from a policy that grants substantial protection to import competing industries to a policy of free trade.

This statement of the issue under study is not meant to suggest that the problem with respect to the optimal path of commercial policy is always how to move optimally to free trade. As is well known, there are circumstances in which a country's best long run commercial policy is not free trade--especially when its economy is infected by distortions that have some relationship to international trade and that are beyond the scope of government policy to eliminate completely. Rather, the suggestion is that by considering a simple and well defined question, in the context of a well specified analytical structure, some principles will emerge that will have relevance in more general situations. Moreover, while the specific issue under study is the optimal path for commercial policy leading from protectionism to free trade, the principles that emerge in the exmination of this issue will presumably have some relevance for related issues concerning domestic policies dealing with taxes, subsidies, price controls and other government interventions into the economic system. No attempt will be made here, however, to draw any conclusions for this broader range of issues from the present analysis.

To limit further the range of the present investigation, it will consider only the optimal path of commercial policy in a program of trade liberalization, and not the appropriate paths of other policies that would normally be used in

conjunction with, and in support of, commercial policy in a sensible and comprehensive program of trade liberalization. Among the policies that will not be considered are the monetary, fiscal, and exchange rate policies that would have to be pursued in conjunction with a more liberal commercial policy in order to insure an adequate level of aggregate demand and to prevent, to the extent possible, the more liberal commercial policy from resulting in an increase in the general level of unemployment. Also not considered are policies of "adjustment assistance" that might be used either to facilitate the movement of resources out of previously protected industries or to compensate the owners of these resources for income lost due to the removal of protection. Further, the only commercial policy that will be considered explicitly is a tariff applied to imported products. No consideration will be given to the interesting and important question of how to move from a complicated system of tariffs, quotas, export taxes and subsidies, content requirements, multiple exchange rates, and other commercial policy interventions to a more uniform and liberal system of commercial policy.

Having described the limitations of this study, it is now appropriate to summarize the specific issues it does investigate and the results of this investigation. First, the study considers the effect of adjustment costs incurred in moving resources out of previously protected industries and into other activities on the appropriate time path of trade liberalization. In the absence of such costs, the economy could, in principle, adjust immediately to the new long run equilibrium position consistent with its optimal long run commercial policy. The question is--When such instantaneous adjustment is not possible because of costs incurred in moving resources, is there a case for moving more gradually from a policy of protectionism to a liberal trade policy? The answer, in general, is no. Specifically, when private economic agents who

control the disposition of productive resources have rational expectations which allow them to calculate correctly the values of locating these resources in alternative activities, and when there are no distortions of the adjustment process that cause these agents to see private adjustment costs that differ from social adjustment costs, then the adjustment process subsequent to an immediate change of commercial policy to its long run optimum will be socially efficient. By implication, a slowing down of the implementation of the policy of trade liberalization, which would reduce the privately perceived incentive to relocate resources outside of previously protected industries, would result in less socially desirable adjustment path for the economy.

Second, when there are distortions that affect the adjustment process, then the strong presumption in favor of an immediate move to the best long run commercial policy as the best time path of policy disappears. Unfortunately, for the variety of distortions that might reasonably be thought to affect the adjustment process, there is no general indication of how the time path of commercial policy should deviate from the policy of an immediate move to the best long run commercial policy. For some distortions, such as the distortion that arises when economic agents hold static expectations concerning the incomes that will be earned by factors located in different activities, adjustment occurs too rapidly following an immediate move to the best long run commercial policy. In these cases, there is an argument for gradualism in reducing the level of protection in order to slow down the adjustment process. For other distortions, such as the distortion created by taxes on factor incomes which affect the privately perceived benefits of factor movements, adjustment occurs too slowly following an immediate move to the best long run commercial policy. In these cases, it is desirable for the level of protection initially to be reduced to below its long run optimal level (imports or exports should be subsidized if

free trade is the best long run policy) in order to increase the speed with which resources are moved out of the previously protected industries. Thus, no general case for gradualism in implementing a policy of trade liberalization emerges from consideration of the implications of distortions that might affect the adjustment process.

Third, a general case for gradualism in trade liberalization can be based on a desire to limit the income and wealth losses sustained by owners of resources initially employed in protected industries. For reasons that will be discussed, limitation of such losses may be a valid and important objective of policy makers even if the owners of these resources are not among the poorer members of society (and even if their private losses do not correspond to any social loss). Under reasonable assumptions about the structure of the economic system including the nature of the adjustment process, it can be shown that a more gradual policy of trade liberalization moderates the income and wealth losses sustained by owners of resources initially employed in protected industries, but at some cost in terms of the efficiency of the economy's adjustment path. The issue for policy makers concerned with limiting the losses of these resource owners is to make the appropriate trade off between limiting these losses and securing reasonable efficiency of the adjustment process. Among the factors that influence the nature of this trade off are the degree to which resources employed in protected industries are specific to those industries and must be allowed to depreciate in order to move them to other activities. When adjustment must occur primarily through wearing out existing plant and equipment and by waiting for skilled workers with specific human capital to retire, little may be gained in terms of the efficiency of the adjustment process by pushing trade liberalization more rapidly than the rate required to induce no new capital to be invested and no new workers to train for skilled jobs in the previously protected industries.

Fourth and finally, the appropriate time path of commercial policy in a program of trade liberalization may be influenced by the possibility that resources employed in protected industries may become unemployed as a consequence of reductions in the level of protection. Because of the difficulty in specifying a completely satisfactory and widely acceptable model of why resources become unemployed (and remain in that state for substantial periods), the analysis of this issue in the present study is based on an assumed reduced form relationship which relates the rate at which resources are moved out of protected industries to the amount of unemployment experienced by resources that continue to seek employment in these industries. Doubts about the existence and stability of this reduced form relationship imply doubts about the validity and generality of conclusions based upon its use. Accepting the general approach as valid, however, the key result that emerges is that the optimal path of commercial policy is the path that balances the marginal social cost of increased unemployment of resources in protected industries (which results in a loss of output) against the marginal social benefit of stimulating more rapid movement of resources out of these industries. The time path of the level of protection that maintains this balance depends critically on the shape of the reduced form relationship between the rate of movement of resources and the level of unemployment. With a proportional relationship, it turns out that the optimal long run commercial policy is not free trade. This is so because when the economy gets sufficiently close to its free trade equilibrium, the marginal social benefit of moving additional resources out of protected industries becomes very small and ultimately becomes smaller than the social cost for the output lost due to unemployment of these resources. Along the path of convergence to this optimal long run commercial policy, however, the level of protection exhibits peculiar "overshooting" behavior. Specifically, in the optimal program of trade liberalization, the level of

protection is initially reduced to below its long run optimal level (and perhaps to below zero) and is subsequently raised back up to this optimal long run level. This peculiarity disappears when the reduced form relationship between the rate of resource reallocation and the level of unemployment is not proportional, but instead has the property that the rate of resource reallocation relative to the level of unemployment becomes large at low levels of unemployment. It is argued that this property is reasonable if decisions about the industries of employment for newly produced capital and new workers entering the labor force are strongly influenced by relatively small differences in expected earnings between industries. If this argument is generally correct, then the time path of commerical policy that trades off appropriately the marginal social cost of increased unemployment against the marginal social benefit of more rapid adjustment will be a path along which the level of protection is gradually reduced to its long run optimal level.

I. Adjustment Costs and the Timing of Trade Liberalization

If productive resources could move costlessly and instantaneously among alternative uses and product and factor prices adjusted immediately to clear markets, there would be no interesting issue concerning the optimal timing for a policy of trade liberalization. The optimal policy would be to move immediately to the stance of commercial policy that is optimal in the long run. For a small country without any monopoly power in trade and without any domestic distortions requiring trade interventions as part of a second-best policy regime, this optimal policy would be an immediate move to complete free trade. For a more complicated economy, the optimal long run policy would not necessarily be free trade, but it would still be optimal to move immediately to this most desirable long run policy.

In real world economies, of course, productive resources cannot be moved instantaneously among alternative uses, and movement of many resources is a costly activity either in terms of direct costs of movement or in terms of foregone output while resources undergo transformations necessary to make them productive in alternative uses. Because of the time and cost involved in moving resources to alternative uses, the adjustment to any sudden change in economic conditions, including a sudden shift to a liberal commercial policy regime, will not occur all at once, but will be spread out over time. Moreover, during the period of adjustment subsequent to a sudden trade liberalization, the value of final output produced in the economy will be reduced to the extent that costs are incurred in the adjustment process. Because these costs tend to be higher, at a moment of time and in total, the more rapidly adjustment takes place, it desirable that the economic system not adjust too rapidly to any change in economic conditions. To some, this might suggest the desirability of slowing

the process of trade liberalization in order to limit the costs that the economy incurs in adjusting to the new, long run commercial policy regime.

The main purpose of this section is to demonstrate that this intuitively plausible notion is not in general correct. Even though adjustment costs rise as the pace of adjustment quickens, it is not generally desirable to slow the pace of trade liberalization in order to limit the cost of adjusting to the new commercial policy regime. Provided that the economic agents who control the allocation of resources perceive a private benefit from resource movements that corresponds to the true social benefit, and provided that they see costs of resource movements that correspond to true social costs, they will make the socially correct decisions concerning the appropriate pace of adjustment subsequent to an immediate trade liberalization. The case for gradualism in implementing a policy of trade liberalization, therefore, depends on the existence of distortions affecting the social efficiency of private decisions about resource movement (discussed in section II), or on concern about the income redistribution effects of a sudden trade liberalization (discussed in section III), or on the unemployment effects of trade liberalization (discussed in section IV), rather than on any general argument based on the existence of adjustment costs.

A. A Two-Sector Economy with Adjustment Costs

To develop the main proposition concerning the influence of adjustment costs on the appropriate timing of trade liberalization, it suffices to consider a relatively simple model of a two-sector economy. It is assumed that the output of the protected sector, X, and the output of the rest of the economy, Z, are produced in accord with standard, neo-classical, constant-returns-to-scale production functions, using two inputs, labor and capital:

(1) $X = F(L_X, K_X)$

(2) $Z = G(L_Z, K_Z)$

Labor is assumed to be freely and instantaneously mobile between X and Z, but capital (which presumably includes human capital) is assumed to be specific, at least at a moment of time, to the industry where it is located. The assumption of free mobility of labor is intended as a convenient simplifying assumption, not as a description of the situation of most workers in a real world economy.

An essential element of the present model is the specification of the technology of the adjustment process for the redistribution of existing capital and for the construction and allocation of new capital. There are many ways in which the technologies of these two adjustment activities might be specified that would be consistent with the assumption that they are resource-using activities with rising marginal costs--the assumption that is crucial for the conclusions of the present analysis. For analytical simplicity, it is convenient to assume that these two adjustment activities are pursued separately and that each utilizes only labor in its production process. Formally, it is assumed that the amounts of labor used in capital movement, L_M, and in investment in new capital, L_I, are determined by

$$L_M = \psi(|M|), \quad \psi(0) = 0, \quad \psi' > 0, \quad \psi'' > 0$$

$$L_I = \phi(|I|), \quad \phi(0) = 0, \quad \phi' > 0, \quad \Phi'' > 0$$

where M is the rate of movement of old capital out of Z and into X, and I is the rate of production of new capital which may be allocated to either industry to replace depreciating old capital or to add to the industry's capital stock. Taking account of movement of old capital, allocation of new capital, and depreciation of old capital, the rules governing the rates of change of the capital stocks in the two industries are given by

$$\dot{K}_X = M + I_X - \delta \cdot K_X \tag{5}$$

$$\dot{K}_Z = -M + I_Z - \delta \cdot K_Z \tag{6}$$

where $I_X \geq 0$ and $I_Z \geq 0$ are the amounts of new capital allocated to X and Z, respectively, subject to the constraint

$$I_X + I_Z = I, \tag{7}$$

and where δ is the depreciation rate of capital which is assumed to be the same for both industries.

Aside from the assumption that capital movement and investment in new capital use only labor as a factor of production, this specification of the technology of the adjustment process captures, in a stylized form, key elements of the processes governing adjustments of physical and human capital in actual economies. Many types of existing plant and equipment can be transferred to alternative uses, but usually only at some cost for restructuring, remodeling, retooling, or relocation. In addition, physical capital may be transferred to alternative uses by allowing existing plant and equipment to depreciate and by locating the new capital that corresponds to such depreciation in some other industry. Similarly, for human capital, it is possible to retrain and relocate workers who have already acquired substantial human capital that is specific to a particular industry. It is also possible to achieve a reallocation of human capital by not replacing retiring workers in one industry and training new entrants to the labor force in the skills required for other industries.

Given the specification of the technology for producing the final outputs X and Z and the technology of the adjustment process, we may address the question of the optimal timing of trade liberalization by considering the considering the policy that would be adopted by a social planner whose objective is to maximize the welfare of a representative consumer in the economy. Assuming for simplicity that the economy is small and takes the world relative price of X in terms of Z, denoted by P, and the world interest, r, as given, the objective of this social planner may be stated as the maximization of the present discounted value of the economy's final output, V, as defined by

$$V = \int_0^{\infty} [P\ F(L_X, K_X) + G(L_Z, K_Z)] \cdot \exp(-r \cdot t)\ dt, \tag{8}$$

subject to the technology of the adjustment process specified in (3) through (7), and subject to the overall employment constraint,

$$L_X + L_Z + L_M + L_I = \bar{L}, \tag{9}$$

where $\bar{L}$ is the fixed supply of freely mobile labor.[1] The initial condition for this dynamic optimization problem is determined by the initial amounts of capital that are located in the X and Z industries, $K_X(0)$ and $K_Z(0)$. Since the initial state of the economy is assumed to be the long run equilibrium position for the economy before trade liberalization when the X industry was protected by an import tariff, it is correct to assume that $K_X(0)$ exceeds the equilibrium size of the capital stock in X that is appropriate under free trade, K_X^*, and that $K_Z(0)$ is less than the equilibrium size of the capital stock in Z that is appropriate under free trade, K_Z^*.[2]

---

1. Since the optimum policy is to move immediately to free trade, we may safely disregard the consumption distortion cost of a tariff. We could treat the case where the interest rate is endogenously determined by equilibrium in the domestic credit market (with no international capital mobility), but this would complicate the analysis without altering its basic conclusions. If the country faced an upward rising foreign borrowing cost schedule, the planner would need to tax

Without going into the formal details of the analysis of the planner's optimization problem (which are discussed in an appendix), it is possible to explain the economic principles that govern the planner's behavior. The world market price of X in terms of Z, P, tells the planner the correct way to value output of X in terms of output of Z. In addition to this price, the planner needs to calculate a shadow price for a unit of capital located in X, denoted by μ_X, and a shadow price for a unit of capital located in Z, denoted by μ_Z, and a shadow wage rate for a unit of mobile labor, denoted by ω. The appropriate shadow prices for units of capital located in the two industries are the present discounted values of the value of the marginal product of capital in the respective industries, adjusted for the rate of depreciation of capital:

$$(10) \qquad \mu_X(t) = \int_t^\infty P \cdot F_L(L_X(s), K_X(s)) \cdot \exp(-(r+\delta)\cdot(s-t))\, ds$$

$$(11) \qquad \mu_Z(t) = \int_t^\infty G_L(L_Z(s), K_Z(s)) \cdot \exp(-(r+\delta)\cdot(s-t))\, ds$$

Given the socially correct prices for output of X and for units of capital located in the two industries, the planner sets the shadow wage rate to achieve the socially appropriate distribution of labor among X production, Z production, movement of existing capital, and production of new capital. The correct amount of labor to employ in X is the amount for which the value of the marginal product of labor in X, $P \cdot F_L(L_X, K_X)$, is equal to the shadow wage rate, ω. Taking account of constant returns to scale in production of X, this amount of labor can be expressed as $K_X \cdot \ell_X^d(\omega/P)$, where $\ell_X^d(\omega/P)$ is the labor demand function of an

---

foreign borrowing at a rate that would make the privately perceived cost of such borrowing correspond to the true social cost. With this tax in place, however, there would be no reason for gradualism in trade policy.

2. In the present model, the long run stock of capital, $K_X + K_Z$, is not fixed. It is possible to show that if X production is relatively labor intensive, the long run stock of capital will rise due to the removal of protection; whereas it will decline if X production is relatively capital intensive.

X producer with one unit of capital. Similarly, the correct amount of labor to employ in Z is determined by the requirement that the value of the marginal product of labor in Z, $G_L(L_Z, K_Z)$, equal ω; and is equal to $K_Z \cdot \ell_Z^d(\omega)$, where $\ell_Z^d(\omega)$ is the labor demand function of a Z producer with one unit of capital.

The correct amount of labor to employ in moving existing capital is determined by the requirement that the marginal social cost of this activity must equal the marginal social benefit. The marginal social cost of capital movement is equal to the shadow wage rate (which measures the social cost of a unit of labor) multiplied by the amount of labor required for a marginal increment in the rate of capital movement, $\psi'(|M|)$. As shown in figure 1, the marginal social cost of capital movement, for a given ω_0, is an increasing function of the rate of capital movement, $|M|$. The marginal benefit of capital movement is equal to the absolute value of the difference between the shadow prices of capital in the two industries, with the sign of the difference determining the appropriate direction of capital movement. Thus, as illustrated in figure 1, when $\mu_X = \mu_{X0} < \mu_{Z0} = \mu_Z$ and $\omega = \omega_0$, the appropriate rate of capital movement is $|M_0|$ and the appropriate direction of capital movement is out of X and into Z. Applying this condition more generally, we determine that the appropriate amount of labor to employ in capital movement is given by

$$(12) \qquad L_M^d(\omega/|\mu_X - \mu_Z|) = \psi[\psi'^{-1}(|\mu_X - \mu_Z|/\omega)].$$

The correct amount of labor to employ in producing new capital is determined by the requirement that the marginal social cost of investment in new capital must equal the marginal social benefit. The marginal social cost of new investment is equal to the shadow wage rate multiplied by the amount of labor required for an increment in investment, $\phi'(I)$. Since it does not make economic sense to locate any new capital in the industry with a lower shadow value of capital,

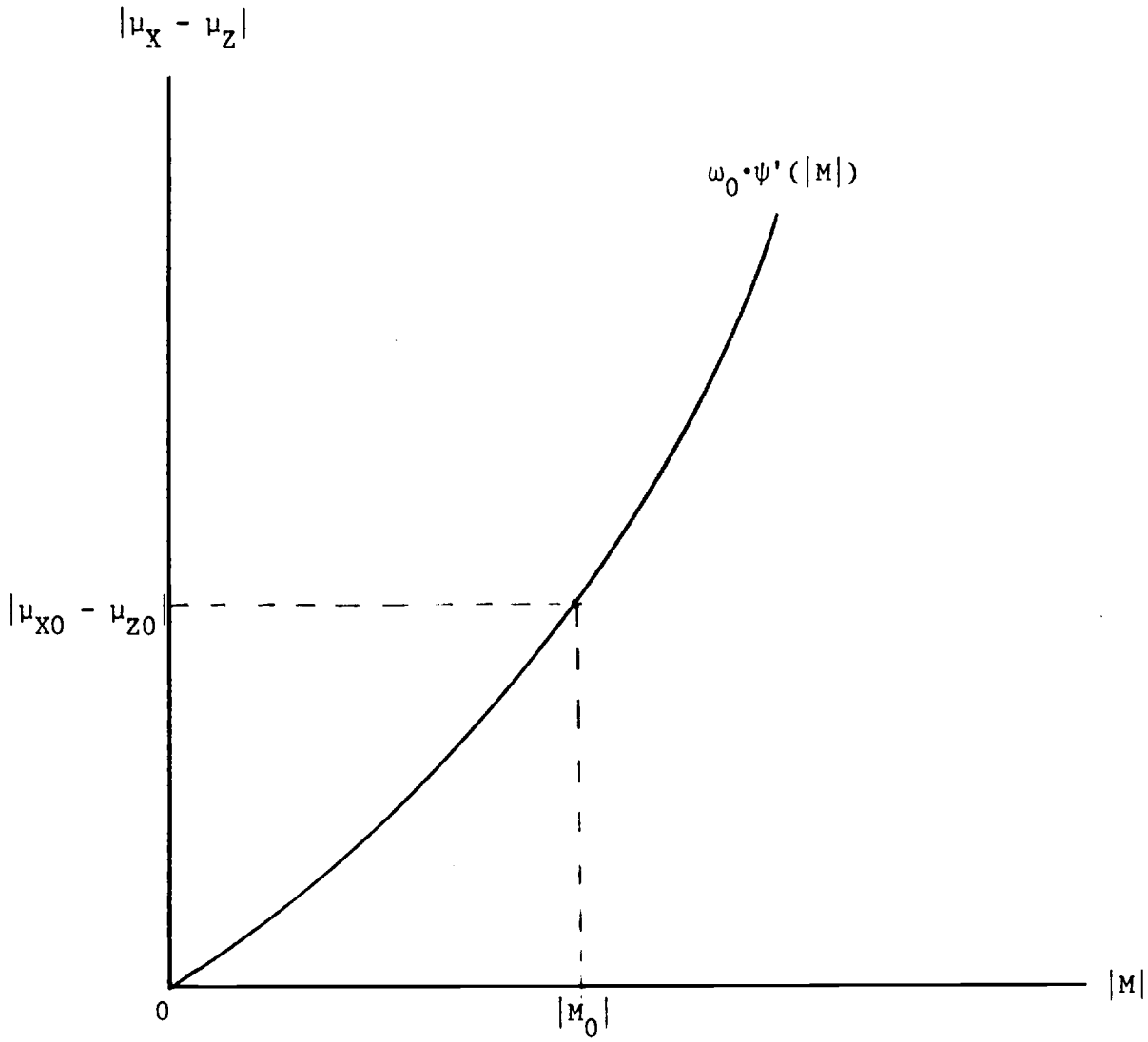


Fig.--1. Determination of the Rate of Capital Movement.

the marginal benefit of investment in new capital is determined by the shadow price of capital for the industry with the higher shadow price of capital; that is, by $\bar{\mu}$ = maximum of μ_X and μ_Z. As illustrated in figure 2, therefore, the correct amount of investment in new capital is determined by the condition that the marginal cost of such investment equal $\bar{\mu}$. From this condition, we determine that the correct amount of labor to employ in producing new capital is given by

$$(13) \qquad L_I^d(\omega/\bar{\mu}) = \phi[\phi'^{-1}(\bar{\mu}/\omega)].$$

Adding together the amounts of labor allocated to its four different uses, it follows that the total amount of labor allocated by the social planner is given by

$$(14) \qquad L^d(\omega, \mu_X, \mu_Z, K_X, K_Z, P) = K_X \cdot \ell_X^d(\omega/P) + K_Z \cdot \ell_Z^d(\omega) + L_M^d(\omega/|\mu_X - \mu_Z|) + L_I^d(\omega/\max(\mu_X, \mu_Z)).$$

The constraint that the total amount of labor allocated must equal the available supply, that is,

$$(15) \qquad L^d(\omega, \mu_X, \mu_Z, K_X, K_Z, P) = \bar{L},$$

determines the appropriate value of the shadow wage rate, given the shadow prices of capital for the two industries, the amounts of capital in the two industries, and the relative output price.

With the determination of the shadow wage rate, every aspect of the planner's optimal behavior at a moment of time is completely determined. Specifically, the allocation of labor among its four uses determines the outputs of X and Z, the rate of movement of existing capital between industries, and the rate of production of new capital. The sign of the difference between μ_X and μ_Z determines the direction of movement of existing capital and the allocation of all new capital to the industry with the higher shadow price of capital.

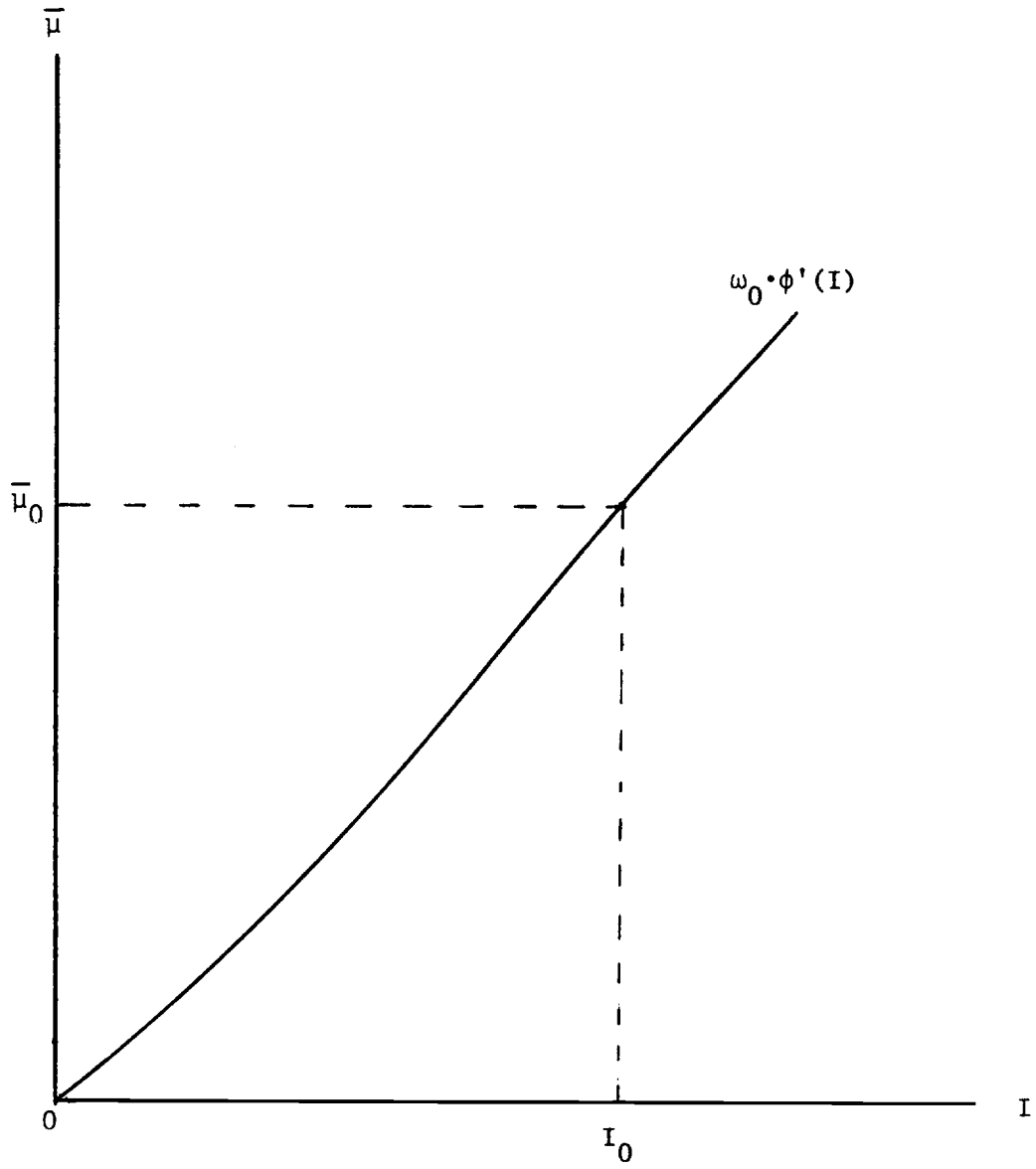


Fig.--2. Determination of the Rate of Investment in New Capital.

Starting from the long run equilibrium position of the economy when the X industry is protected by a tariff, the path that the economy will traverse under the guidance of the social planner may be described as follows. Since at the starting point for the economy, the capital stock in X is too large and the capital stock in Z is too small, relative to their appropriate long run equilibrium levels under free trade, the initial shadow price for a unit of capital in X, $\mu_X(0)$, is less than the initial shadow price for a unit of capital in Z, $\mu_Z(0)$. This implies that at the starting point along the economy's optimal path, the planner allocates a positive amount of labor to the task of moving existing capital out of X and into Z. In addition, the planner directs that all newly produced capital be located in the Z industry. The result is that the stock of capital in X declines through outward movement of existing capital and through depreciation, while the stock of capital in Z grows because of inward movement of existing capital and because the total amount of newly produced capital that is all allocated to this industry exceeds depreciation of existing capital. As K_X declines and K_Z rises, the differential between μ_X and μ_Z narrows and the rate of movement of existing capital out of X and into Z declines. All newly produced capital, however, continues to be allocated to the Z industry. Ultimately, a point is reached where the value of the marginal product of capital in X is equal to the value of the marginal product of capital in Z, and this condition is subsequently maintained so that μ_X thereafter remains equal to μ_Z. When this point is reached, the economy will not, in general, have yet reached the long run equilibrium position appropriate for free trade. Subsequent adjustment does not involve any movement of existing capital out of X and into Z, since devoting resources to this activity is not optimal when μ_X equals μ_Z. Rather, adjustment is achieved by distributing newly produced capital between X and Z in an appropriate manner, with the share

of investment going to X gradually rising (from zero) and the share of investment going to Z gradually declining (from unity) until the level and distribution of the capital stock reaches the long run equilibrium level and distribution of capital appropriate for free trade.

It should be noted that for the planner to move the economy along this optimal adjustment path, he must calculate the appropriate time paths for the shadow prices of units of capital in the two industries. At any given date, these shadow prices depend on the present discounted value of the value of the marginal product of capital in the respective industries. To know what these shadow prices should be, therefore, the planner must know the future course of the amounts of labor and capital that will be employed in the two industries. The future course of these variables, however, depends on the future course of the shadow prices for units of capital in the two industries. Hence, to move the economy along its optimal adjustment path, the planner must solve a complex dynamic optimization problem in which he jointly and simultaneously determines the appropriate paths for the shadow prices of capital in the two industries and the appropriate paths for the amounts of labor and capital employed in these industries and the amounts of labor allocated to movement of existing capital and production of new capital.

B. Optimal Commercial Policy with Private Agents

When decisions about the allocation of resources are made by private economic agents rather than by an all powerful social planner, government policy influences the adjustment path of the economy only indirectly by affecting the economic conditions that influence the decisions of these agents. The issue with respect to the optimal timing of trade liberalization is how the government should vary the level of protection over time in order to induce private economic agents to follow a socially optimal adjustment path. If there are no distortions in the economic system other than the pre-existing protection granted to import competing industries, and if private economic agents have rational expectations about future economic conditions relevant to their current decisions, it can be shown that the optimal policy is to reduce the level of protection immediately to its long run optimum level and to allow private agents to adjust as they see fit to this change in economic circumstances. In particular, for small country that was described analytically in the preceding subsection, the optimal policy is to cut the import tariff rate immediately to zero and hold it there permanently.

To understand why this policy of an immediate move to free trade induces private economic agents to pursue a socially optimal adjustment path, it is useful to consider the way in which such agents, acting exclusively in their own private interest, would determine the adjustment path of the economy. Economic agents who own units of capital in the X and Z industries must decide at each moment of time whether they wish to retain their capital in its present industry or pay the cost of moving it to the other industry. They must also decide on the amount of new capital they wish to purchase to replace capital that is depreciating or to add to their stock of capital and on the industry in which

to locate this new capital. To make these decisions, these agents need to calculate the value (to them) of a unit of capital located in each of the two industries. Since there are no distortions in the economy, these agents face the same interest rate as the social planner and income from each unit of capital that is equal to the value of the marginal product of capital in the industry where the capital is located, adjusted for the physical depreciation of capital at the rate δ. By the assumption of rationality of expectations, the path that these agents will expect the value of the marginal product of capital to follow in each industry will correspond to the path that is calculated by the social planner. Hence, the values that private agents will assign to units of capital located in the two industries will correspond to the shadow prices, μ_X and μ_Z, that are calculated by the social planner, as defined in equations (10) and (11). Indeed, if there were a market in which economic agents could trade claims to units of capital located in the two industries, μ_X and μ_Z would be the market prices of these claims.

Given the values that agents assign to units of capital in the two industries, the benefit that they will see from moving an existing unit of capital out of X and into Z must be the difference between μ_Z and μ_X. This difference determines the price owners of capital will be willing to pay for the service of moving capital out of X and into Z. In figure 1, this fact is represented by showing a horizontal demand curve for the service of movement of capital at a height equal to $|\mu_{X0} - \mu_{Z0}|$. The supply curve of producers of this service must correspond (under the assumed absence of all distortions) to the marginal cost curve for producing this service, as determined by the wage rate that producers of this service must pay for the labor they employ, multiplied by the amount of labor required to produce a marginal increment in this service. It follows that if the wage rate paid by producers of this service is the same as the shadow

wage rate used by the social planner, the amount of capital movement determined by the equilibrium of demand and supply of this service on the part of private agents will correspond exactly to the amount determined by the social planner. Obviously, the direction of movement of existing capital determined by private agents (out of the industry with the lower value of capital and into the industry with the higher value of capital) is the same as that determined by the social planner.

With respect to investment in new capital, it is clear that private agents will direct all such investment into the industry with a higher value of capital, since to do otherwise would imply a loss to the owner of new capital relative to what he could costlessly achieve by making the socially correct decision concerning the distribution of newly produced capital.[1] It follows that the value that private agents will assign to newly produced capital is the value of a unit of capital in the industry where capital has its highest value; that is, the same value $\bar{\mu} = \max[\mu_X, \mu_Z]$ that is used by the social planner to determine the benefit of investment in new capital. This value to capital owners of newly produced capital is the demand price that faces suppliers of such capital, as represented by the horizontal demand curve at height $\bar{\mu}_0$ in figure 2. The supply curve for new capital corresponds to the marginal cost curve for its producers, as determined by the wage rate multiplied by the amount of labor required to increase new capital production by a marginal unit. It follows that if the wage rate facing producers of new capital is the same as the shadow wage rate used by the social planner, then the level of new capital production determined by private agents (as well as its distribution) will be the same as that determined by the social planner.

---

1. When $\mu_X = \mu_Z$, private agents will also behave exactly like the social planner in allocating investment between X and Z so as to keep the economy along its optimal path.

The wage rate that faces suppliers of new capital and of the service of capital movement in the economy controlled by the behavior of private agents must be the same as the shadow wage rate used by the social planner because the condition of labor market equilibrium in the privately controlled economy is the same as the condition (15) that the planner uses to determine the appropriate value of the shadow wage rate. Specifically, since labor is freely mobile between its four productive uses, it is clear that maximizing behavior by workers who supply a fixed amount of labor $\bar{L}$ will compel the wage rate to be the same for all demanders of labor. The demand for labor in each of these uses is determined in the privately controlled economy by the same functional relationship that the planner uses to allocate labor to each use. Producers of X and producers of Z each demand labor up to the point where the value of the marginal product of labor in their respective industries is equal to the market wage rate. Movers of existing capital and producers of new capital demand labor up to the point where the value of its marginal product in their respective activities (using $|\mu_X - \mu_Z|$ as the price of the service of capital movement and $\bar{\mu} = \max[\mu_X, \mu_Z]$ as the price of new capital) is equal to the market wage rate. Since the sum of these four demand functions yields the aggregate labor demand function defined in (13), and since the supply of labor $\bar{L}$ is the same as for the social planner, it follows that the market equilibrium wage rate implied by the behavior of individual economic agents is the same as the shadow wage rate used by the social planner. This, in turn, guarantees that all aspects of the behavior of the economy when it is controlled by the behavior of individual economic agents are the same as when it is under the control of the social planner.

If the tariff imposed on imported units of X were not immediately reduced to zero at the start of the process of trade liberalization, the economy would

not converge to its appropriate long run equilibrium position along the socially optimal adjustment path. This is so because with a positive tariff remaining imports of X, domestic producers of X will see a price for their output that exceeds its true social value.[1] Consequently, they will employ more labor in producing X than is socially desirable, at the expense of other more valuable uses of this labor. Moreover, because the market price of domestically produced X is kept artificially high by a tariff, owners of capital in X will see a value of the marginal product of this capital which exceeds the true social value of its marginal product and will calculate a value for a unit of this capital that exceeds its true social value. This will slow down the rate at which existing capital is moved out of X and into Z to below the socially optimal rate. In addition, because the increased use of labor in X comes partly at the expense of labor that should be used in Z, the value of the marginal product of capital in Z will be reduced to below its socially appropriate level (along the economy's optimal adjustment path), resulting in a reduction in the value assigned to a unit of capital located in Z (relative to its value along the economy's optimal adjustment path). Since the value of a unit of capital in Z is the demand price for new capital that determines the rate of production of new capital, this reduction in the value of a unit of capital in Z implies that adjustment through production of new capital and its location in Z will proceed at less than the socially optimal rate.[2] Thus, any policy of gradually reducing the tariff rate to zero, rather than reducing it all at once, results in a suboptimal adjustment path.

---

1. In addition, so long as any tariff remains in effect, there is a consumption distortion loss that results from this tariff.

2. Even if there is no immediate reduction in the tariff rate but only an announcement of reductions to occur in the future, the value of a unit of capital in X will fall relative to the value of a unit of capital in Z. Thus, the effect of any program of trade liberalization should be to make the value of a unit of capital in Z the effective determinant of the demand price for additions to the capital stock.

If the assumptions about the structure of the economy or about the technology of the adjustment process were modified from those described in the previous subsection, the description of the optimal policy of the social planner and of the behavior of the economy when under the control of private agents would require corresponding modification. The basic conclusion of the present discussion, however, would not be modified. In the absence of distortions in the economy other than protection and with rationality of expectations on the part of private agents, immediate cutting of the level of protection to zero will be the optimal path of commercial policy (for a small country). The reason is that this policy provides private economic agents with the correct price signals upon which to base their individual decisions with respect to the allocation of the economy's scarce resources. These are the signals that make the privately perceived costs and benefits of any action correspond to its true social costs and benefits and, hence, lead individual economic agents to behave in a way that is consistent with the maximization of social welfare.

This proposition, of course, is not new in economics. It dates back to Adam Smith's description of the mechanism of the "invisible hand" through which the forces of competition in an economic system compel individual agents who seek only their own interest to serve the social interest. The main point of the present discussion is that the validity of this proposition is not suspended in an economic system where the movement of resources among alternative uses is a time consuming and costly activity and where the agents who control the disposition of these resources must solve dynamic rather than static optimization problems.

II. Distortions of the Adjustment Process

A key assumption in demonstrating the desirability of free trade as a country's optimal static commercial policy is that its economy is free of distortions other than the distortions that would be introduced by some other commercial policy. When this assumption is invalid because the country has market power in some of its exports or imports or because there are externalities associated with producing or consuming these products or because of other relevant distortions, free trade is not, in general, the best static commercial policy. Similar reasoning suggests that while an immediate move to a country's best long run commercial policy is the best time path for commercial policy in the absence of distortions affecting the adjustment process, it is not necessarily the best path in the presence of such distortions. However, in contrast to the theory of static commercial policy, where we have some understanding of the distortions that would justify specific divergences from free trade, we have as yet little understanding of the distortions of the adjustment process that would justify gradualism in moving commercial policy to its long run optimum. Indeed, nothing rules out the possibility that the optimal path for commercial policy in an economy with excessive protection and with other distortions affecting the adjustment process would be to reduce the level of protection initially to below its long run optimal level in order to speed the movement of resources out of previously protected activities.

The purpose of this section is to examine the implications of a variety of distortions that might affect the adjustment process for the optimal path of commercial policy. For simplicity, we will focus on the case of a small country where the optimal long run commercial policy is free trade, but where imports are initially restricted by a tariff. The analysis is based on the

model presented in the preceding section. No attempt will be made, however, to demonstrate rigorously the conclusions of the present analysis (though such a demonstration is certainly possible). Rather, the discussion will be directed toward explaining the economic rationale for these conclusions and suggesting the generality of their application. To limit somewhat the range of discussion, we will consider only the implications of distortions of the adjustment process for the optimal path of the tariff rate, and we will ignore the importance of other policies that might be used in conjunction with variations in the tariff rate to offset these distortions and obtain a more efficient adjustment path.[1]

A. Distortions Arising from the Tax System

One potentially important cause of distortions in the adjustment process arises from taxes that governments impose on incomes and on products. Consider specifically, a general income tax levied on all factor incomes or on income from capital (the resource that is subject to costly and time consuming adjustment in response to trade liberalization). Such a tax distorts the adjustment process because it reduces the privately perceived benefit of adjustment to below the true social benefit. As discussed in the preceding section, the true social benefit of moving capital out of the previously protected industry, X, and into the other industry, Z, is equal to the difference between the present discounted value of the value of the marginal product of capital in in the two industries. When income from capital is not taxed and private capital owners have rational expectations and face the same interest rate as the social planner, the privately perceived benefit of capital movement will correspond to the true social benefit. However, when the income of capital is

---

1. Some of the policies that might be used to offset distortions affecting the adjustment process are examined in Mussa (1982b).

taxed, private capital owners will see only the present discounted value of the after tax difference in returns to capital in the two industries as the benefit they will receive from costly investments in moving capital out of the previously protected industry. Accordingly, if the tariff is immediately reduced to zero in the program of trade liberalization, adjustment through the movement of existing capital would proceed at less than the socially optimal rate. Moreover, taxation of income from capital which reduces the present discounted value of the after tax return to capital in both industries reduces the aggregate level of investment in new capital and, hence, slows down the process of adjustment through location of new capital in the Z industry. In this situation (if the tax on factor incomes or on income from capital cannot be eliminated or offset by an investment tax credit), it is surely not desirable to slow down the process of trade liberalization since adjustment is already too slow. If anything, it would be desirable to reduce the tariff rate initially to below its optimal long run level (that is, to subsized imports initially) in order to stimulate more rapid adjustment.

The distortionary effect of product taxes on the adjustment process is less clear than for income taxes since the effect clearly depends on the particular products being taxed and on their role in the adjustment process. If products used in moving existing capital among industries are heavily taxed, then the privately perceived cost of adjustment through movement of existing capital will exceed the true social cost, and adjustment will occur too slowly. On the other hand, if these products are subsidized, adjustment will occur too rapidly. The case for gradualism in reducing the tariff rate would be strengthened if the latter form of distortion is more important than the former.

B. Distortions Arising in the Capital Market

Another important source of distortions that might affect the adjustment process and the appropriate path of trade liberalization arises from distortions in the capital market. One such distortion would be a divergence between the discount rate used by private capital owners in valuing future income streams and the appropriate social discount rate used by the social planner. The usual assumption here is that the social discount rate is typically lower than the private discount rate. If so, then the privately perceived benefit of moving existing capital or investing in new capital will be below the true social benefit. This means that adjustment in response to an immediate reduction of the tariff rate to zero will proceed at less than the socially optimal rate. To correct this problem it would clearly not be desirable to slow down the process of trade liberalization. If anything, it would be desirable to spur adjustment by initially subsidizing imports and gradually reducing this subsidy as the economy approaches its long run equilibrium.

In many countries, capital markets are also distorted because credit is not allocated among firms in an efficient manner through freely functioning credit markets. If existing firms in the protected industry receive allocations of cheap credit that they would lose if they shifted their activities to another industry, or if new entrants to industries that should expand as a consequence of a move to free trade do not have adequate access to credit at interest rates that reflect its social cost, then the process of adjustment subsequent to an immediate move to free trade would be impeded. If this situation cannot be remedied by altering the policies that control the allocation of credit, it might be desirable to increase the incentive for more rapid adjustment by initially subsidizing imports. Such a policy could easily backfire, however, if the

financial institutions that have granted credit to the previously protected sector feel compelled to continue to extend credit (or even expand credit) to these enterprises rather than write off bad loans and visibly impair their own financial condition. In this situation, a more gradual reduction in the level of protection might be desirable as a means of allowing credit to be withdrawn from firms in the protected industries and reallocated to firms in expanding industries.

Capital markets would also be distorted if the country as a whole faced an upward rising supply schedule for foreign loans, but individual enterprises believed that they faced a horizontal supply curve for their own foreign borrowings at an interest rate equal to the average interest rate for the country as a whole. To correct this distortion, the government should tax all foreign borrowing at a rate that makes the private cost of such borrowing correspond to its true social cost. In the absence of such a tax, the private discount rate will be less than the social discount rate, implying that the privately perceived benefit of adjustment in response to an immediate move to free trade exceeds the true social benefit. To retard what would otherwise be an overly rapid adjustment to free trade (and an excessive accumulation of foreign debt to finance such adjustment), it would be appropriate to reduce the tariff rate gradually to zero, rather than doing so all at once.

C. Distortions Arising from Errors in Expectations

To determine the benefit of moving capital out of the previously protected industry and of investing new capital in the other industry, private capital owners must calculate calculate the values of units of capital located in these two industries. Such calculations are necessarily based on expectations concerning the future paths of the earnings of units of capital located in these industries.

If these expectations are not correct, then private capital owners will assign incorrect values to units of capital in the two industries and the adjustment process will be distorted. For example, if capital owners had "static expectations" under which they always expected that current returns to capital in each industry would persist into the indefinite future, then the privately calculated value of moving capital out of X and into Z subsequent to an immediate reduction in the tariff rate to zero would exceed the true social value of such a movement of capital. Adjustment through movement of existing capital would proceed more rapidly than is socially optimal. To correct this problem, it would be appropriate to slow down the rate at which the tariff is reduced in order to make the privately perceived benefit of capital movement (for capital owners who have static expectations) correspond more closely to the true social benefit of such capital movement.

There is no good reason to believe, however, that capital owners will always expect that current differences between returns to capital will persist into the indefinite future. They well might recognize that as capital moves out of the previously protected industry and as new investment is concentrated in other industries, the differential between the return to capital in these other industries and the return to capital in the previously protected industry will gradually diminish. If the rate at which they expect this differential to diminish is greater than the rate at which it would diminish (along the socially optimal adjustment path), then private capital owners will calculate too small a benefit from capital movement and adjustment through this process will proceed too slowly. To correct this problem, it would be appropriate to subsize imports initially in order to stimulate more rapid adjustment.

A specific problem concerning errors in expectations arises in regard to expectations concerning the future course of the governments commercial policy.

The government might reduce the tariff rate to zero and announce its commitment to a continuing policy of free trade, but private agents might not believe that the government (or its successors) would actually continue to pursue this policy or at least might perceive a positive probability of a policy reversal. Unless private agents perceive an offsetting possibility that the government might go beyond a policy of free trade and subsidize imports (or subsidize exports), the value that they will assign to moving capital out of the previously protected industry, taking account of the possibility of a policy reversal, will be less than the social value of such capital movement. For this reason, adjustment to the new policy of free trade will proceed at less than the socially optimal rate. To correct this problem the government might wish to subsidize imports initially which will stimulate move rapid adjustment both by its direct effect on the actual returns to capital in the two industries and by its indirect effect of pursuading private capital owners of the possibility of such an action in the future.

The difficulty with this solution to the problem of persuading private agents of the government's commitment to a more liberal commercial policy is that the government might be compelled by political pressures to modify its policy, or might be replaced by another government so inclined. The likelihood that political pressures will compel a policy reversal may well be positively related to the aggressiveness of the liberalization policy. Thus, a policy of an immediate move to free trade or beyond that to the subsidization of imports might be thought so unlikely to survive that it would actually stimulate less rapid adjustment than a policy of more gradual liberalization.[1] On the other

---

1. If a rapid reversal of a policy of trade liberalization is anticipated there may be a surge of imports (particularly of capital goods and consumer durables) as consumers attempt to take advantage of what they regard as a temporary opportunity to buy these goods at low prices. Such an import surge, in turn, makes it more difficult to sustain the policy of trade liberalization.

hand, a policy of very gradual liberalization might be regarded as such a concession of political and weakness and indecision on the part of the government that it would have no credibility with private agents and would stimulate little or no adjustment. A balance must be struck, therefore, between a policy that is so aggressive that reversal is thought highly probable and a policy that is so feeble that it too lacks credibility.

D. Distortions Arising from Monopoly and Monopsony Behavior

The exercise of monopoly or monopsony power distorts the economic system by creating divergences between the effective price or cost of a product or factor to its purchaser and the marginal cost to its supplier. Exercise of such power either by the suppliers of services used in the adjustment process or by the suppliers of factors used in producing such services should normally result in a slowing of the adjustment process to less than its socially optimal rate. If this problem could not be addressed directly, it might provide an argument for a policy of reducing the level of protection initially to less than its optimal steady state level in order to induce more rapid adjustment. However, in the absence of specific evidence of the importance of monopoly and monopsony behavior in the activities involved in the adjustment process, this seems like a rather weak reed upon which to base a general argument for an excessively aggressive path of commercial policy.

Another circumstance in which the exercise of market power would impede the adjustment process in response to a trade liberalization is if firms in the industries benefited by liberalization are able to impede the entry of new firms and new capital into these industries or if workers and labor unions are able to impede the entry of new workers. Suppose, for example, that a labor union in the Z industry of the model described in the preceding section

is able to prevent entry of any new workers into that industry subsequent to a trade liberalization and that all workers not in that industry remain fully employed but at wage rates that are below the wage paid to workers in Z. In this case it can be shown that if there are no other distortions in the economic system, the optimal time path for commercial policy is to move immediately to free trade. This policy does not result in the same adjustment path for the economy (or the same long run equilibrium) as would prevail in the absence of the barrier to the movement of labor into the Z industry. But, taking this barrier as given, this is still the best path for commercial policy.

This conclusion would be altered if the barrier to the movement into the Z industry was not absolute but tended to break down over time at a rate that is positively related to the differential between the wage earned by workers in Z and the wage prevailing elsewhere in the economy. Maintaining the assumption that labor always remains fully employed, it can be shown that there is a social gain from initially reducing the tariff rate to less than zero (subsidizing imports or subsidizing exports) in order to speed the movement of labor into the Z industry. This conclusion might be reversed, however, if labor outside the Z industry became unemployed with the amount of such unemployment depending (as it does in the Harris-Todaro (1970) model) on the differential between the wage rate in Z and the wage rate in other activities.

E. Distortions Arising from Price Rigidities

Failure of prices to adjust immediately (or ever) to market clearing levels due to government controls or rigidities in the operation of price adjustment mechanisms are another source of distortions that might affect the optimal timing of trade liberalization. Consider specifically the case of a minimum wage rate fixed by law that cannot be altered in connection with the policy of trade

liberalization. To eliminate the possibility that monetary and exchange rate policy could be used to neutralize the effects of this minimum wage by raising the general price level, suppose that the minimum wage is indexed to the cost of a consumption basket that includes the economy's two final goods, X and Z.[1] Further, suppose that the wage rate prior to the removal of protection from the X industry is above the legal minimum, that it would fall to less than the legal minimum as an immediate consequence of the removal of all protection from X if all labor remained employed, but that its long run equilibrium level under free trade would exceed both the legal minimum and the level prevailing prior to the removal of protection from the X industry.[2] In these circumstances it may be desirable to cut the tariff rate immediately only to the level at which the equilibrium wage rate with all labor employed is equal to the legal minimum wage. This will be so if the marginal social cost from the unemployment resulting from a further reduction in the tariff rate exceeds the benefit of such a reduction in reducing the consumption distortion cost of the tariff and in speeding the adjustment of the economy toward its optimal steady state position. On the other hand, it is possible that the optimal commercial policy would be to reduce the tariff rate initially to below zero. This can happen because a lower tariff rate creates a greater incentive to move capital out of X and into Z, and the more rapidly capital moves in this direction the more rapidly the wage rate that is consistent with labor market equilibrium with full employment rises above the legally required minimum wage.

This analysis of the effects of a minimum wage can be extended to more realistic descriptions of conditions prevailing in labor markets and more

---

1. See van Wijnbergen (1983) for an interesting analysis of implications of wage indexing for the effectiveness of commercial policy as a means of stimulating employment.

2. In the model of the preceding section, if Z production is labor intensive in long run equilibrium, then the long run effect of a reduction in protection of X should be an increase in the wage rate in terms of both final products.

generally in the economy. It might be assumed, for example, that individual workers differ in the amounts of labor that they can supply in each industry, measured in efficiency units. This would introduce the possibility that workers in the same industry and in different industries could earn different wage rates as an equilibrium phenomenon, and it would allow for the result that a minimum wage would exclude specific workers from employment.[1] The ambiguity would still remain, however, concerning whether it is better to reduce the tariff rate initially by only a fraction of its appropriate long run adjustment in order to limit the unemployment effects of decreased protection, or whether it is better to reduce the level of protection initially to below its long run optimal level in order to stimulate more rapid adjustment of the disposition of the capital stock.

F. Conclusions Concerning the Implications of Distortions

From the consideration of these examples of distortions that might affect the adjustment process, no general presumption appears to emerge that a policy of gradualism in reducing protection is superior to a policy of moving immediately to a country's long run optimum commercial policy or even an "overshooting" policy in which the level of protection is initially reduced to below its long run optimum level. For some types of distortions, gradualism is the best policy. If the circumstances of a particular economy indicate that these types of distortions are especially important, then gradualism in trade liberalization would be justified for that economy. For other types of distortions, however, gradualism is not the best policy; and for economies where these distortions are important, an "overshooting" policy would be justified.

---

1. A model with these characteristics is presented and analyzed in Mussa (1982a).

An explanation for this ambiguity concerning the implications of distortions affecting the adjustment process for the optimal time path of trade liberalization may be given in the following terms. The condition that must be satisfied for the economy to be moving along its optimal adjustment path is that marginal social benefit of more rapid adjustment (which would be stimulated by a small further reduction in the level of protection) must equal the marginal social cost of more rapid adjustment. When there are distortions affecting the adjustment process, the adjustment path induced by an immediate move to the economy's long run optimal commercial policy no longer has an unambiguous claim on optimality because the privately perceived benefits and costs of more rapid adjustment along this path do not necessarily correspond to the true social benefits and costs. There is no strong presumption, however, that the nature of distortions will generally be such that the privately perceived benefit of more rapid adjustment exceeds the true social benefit or that the privately perceived cost of more rapid adjustment is less than the true social cost. Hence, there is no general presumption that pace of adjustment subsequent to an immediate move to the optimum long run commercial policy is too rapid rather than too slow. Only if there were a presumption that the pace of adjustment in response to immediate and complete trade liberalization were too rapid would there be a presumption in favor of gradualism in trade liberalization.

It follows that to build a case for gradualism in the reform of commercial policy on the basis of distortions afflicting the adjustment process, it is necessary either to identify specific distortions in specific cases where the second best policy involves gradual adjustment of commercial policy, or to identify a general class of distortions frequently affecting adjustment processes for which the second best policy involves such gradualism. Obviously, no general conclusion can be stated concerning the outcome of case by case analyses. With

respect to a general class of distortions that might provide a rationale for gradualism, one candidate is the distortions associated with unemployment of resources previously employed in protected sectors of the economy. This issue is examined in section IV. Another candidate is the distortions associated with failures and bankruptcies of enterprises in previously protected industries. Failures and bankruptcies, of course, are a normal part of the functioning of the economic system, and their occurence as a consequence of a trade liberalization does not necessarily imply any distortion of the functioning of the adjustment process. However, if socially valuable capital associated with continued operation of firms as going concerns (such as the organizational capital of such firms) is destroyed as a consequence of failures and bankruptcies, there may be an important distortion of the adjustment process.[1] Gradualism in trade liberalization which would reduce the failure rate of previously protected firms might be justified in this situation as a method for reducing the social losses associated with failures and bankruptcies.

---

1. Failures and bankruptcies almost always involve private losses as individual asset holders are forced to write down the value of their assets. Social losses occur only when socially valuable capital is destroyed as a consequence of a failure or bankruptcy.

III. Income Redistribution and the Case for Gradualism

A policy of trade liberalization will almost inevitably alter the distribution of income and wealth within society. Consumers will gain from reductions in the relative prices of previously restricted imports and their domestic substitutes to the extent that they consume such products; and they will lose from increases in the relative prices of products whose output is stimulated by trade liberalization. On net, consumers should gain from trade liberalization (up to the point of the optimum trade policy) because of the reduction in the consumption distortion loss resulting from excessive protection. But, nothing generally guarantees that each individual consumer will gain as a consequence of the changes in relative prices resulting from trade liberalization. Owners of factors of production specific to or used intensively in previously protected industries are likely to suffer substantial declines in income and wealth as a consequence of trade liberalization; while owners of factors of production specific to or used intensively in industries stimulated by trade liberalization should enjoy gains in income and wealth from this policy. On net, income and wealth should rise due to the reduction in the production distortion loss of excessive protection. But, rarely if ever are the net winners from trade liberalization compelled to compensate the net losers; nor is it clear that they ought to be.

Decisions about commercial policy are necessarily political decisions, and politics is at least as much concerned with the distribution of income as it is with economic efficiency. For this reason, an analysis of the appropriate time path of trade liberalization should consider the effects of

---

1. In the model of section I, if X is relatively labor intensive, then capital of capital initially located in X will suffer a short run decline in their income as a consequence of trade liberalization, but will enjoy a long run increase in their income. Whether these capital owners end up as net winners or net losers from trade liberalization depends on the speed with which the economy moves from the short run to the long run; see Mayer (1974) and Mussa (1974) for further

alternative paths of commercial policy on the income redistribution effects of trade liberalization. For reasons that are intuitively apparent and that will be examined in greater detail in this section, a more gradual policy of trade liberalization should reduce the intensity of the income redistribution effects of the liberalization, but only at the expense of some loss in the efficiency of the adjustment process. The key issue with respect to the design of the policy of trade liberalization, therefore, becomes making the appropriate trade-off between reducing the intensity of the income redistribution effects of the liberalization and maintaining the efficiency of the adjustment process.

A. The Significance of the Income Redistribution Issue

Before examining the analytical issue of the factors that influence this trade-off between income redistribution and efficiency, it is important to discuss significance of income redistribution in the context of a program of trade liberalization. One reason why the income redistribtion effects of trade liberalization might be important is because the poorest members of society are injured (or assisted) as a consequence of liberalization. If the heavily protected industries prior to liberalization are primarily low wage industries whose workers would have difficulty in finding re-employment if protection were substantially reduced, then losses sustained by these workers would be a serious consequence of liberalization. If these losses could be reduced by a more gradual program of liberalization, this would be a valid and important argument in favor of gradualism even at the expense of some loss in efficiency. In the highly developed countries where some heavily protected industries (especially textiles and to some extent agriculture) are low wage industries, this argument may have practical relevance. In many developing countries, however, the heavily protected industries are not typically the low wage industries that employ the poorest members of society. Indeed, in

many developing countries, the poorest workers are employed in agriculture--an industry that is usually disadvantaged by protection that is granted to manufacturing industries. Of course, protected industries in developing countries will usually employ some low wage workers who might experience difficulty in finding other jobs, and the capital employed in these industries might be owned by the less wealthy in society. It is difficult to see, however, that a general case for gradualism in trade liberalization in developing countries could be built on the argument that rapid liberalization would typically benefit the richer members of society at the expense of the poorer.

Even if those who suffer reductions in income and wealth as a consequence of trade liberalization are not typically among the poorest in society, the income redistribution effects of liberalization are likely to be important to policy makers because of their political consequences. Those who are injured as a consequence of trade liberalization are likely to see more liberal trade policies as a cause of their injury and are likely to make use of whatever opportunities the political system provides to seek redress of their grievances. In many instances, the political power of these groups will be substantial--as testified to by their previous success in securing and maintaining protection for their industries. Few governments can afford to ignore completely the complaints of those who are injured as a consequence of trade liberalization, even (or perhaps especially) if these people are not among the poorest in society.

Moreover, apart from political necessity or expediency, there may be good reason for governments to pay special attention to those who are injured as a consequence of trade liberalization. In this circumstance, injury is suffered not as a consequence of unforeseen changes in economic conditions that are under no one's control, but rather as the direct consequence of a deliberate

change in government policy. Among those who suffer the greatest loss from trade liberalization will be those who have made costly investments in physical and human capital that is relatively specific to the previously protected industries, in the expectation that protection would be continued. In many instances, the return that would have been earned on these investments with the continuation of protection would not have exceeded the normal rate of return on other investments in physical and human capital. Hence, the losses these individuals suffer as a consequence of trade liberalization cannot legitimately be regarded as merely a surrender of ill gotten gains. Rather, these are losses sustained as a consequence of pursuing investments that it was the previous objective of government policy to promote. For this reason, it might be argued that the goverment has a responsibility to protect these individuals from inordinately large losses so long as it can do so without exceptionally high cost to the rest of society. Moreover, if a government adopts the general attitude that those who are injured as a consequence of policy changes are entitled to no consideration even if those losses are a consequence of performing in accord with past policies, then it is likely to find that people are less willing to pursue those actions that the government would like to promote with its new policy. In the case of trade liberalization, the incentive to invest in the industries that ought to expand under a more liberal commercial policy will be blunted if potential investors see the possibility of a later policy reversal and fear that they will receive no consideration for the losses they would sustain in the event of such a reversal. Hence, on grounds of promoting more effecient functioning of the economic and political system (broadly conceived), it may be desirable to provide some compensation to those who are injured as a consequence of trade liberalization even if they are not among the poorest in society.

B. The Redistributive Consequences of Alternative Paths of Commercial Policy

In principle, compensation could be paid to those injured by trade liberalization without altering the path of commercial policy from that which yields greatest economic efficiency. In practice such means of paying compensation have occasionally been used. As a general matter, however, it is difficult to design and implement policies that compensate directly those injured by trade liberalization without distorting economic incentives. The practical means of providing compensation that is generally available is simply to slow the pace of liberalization.

The theory of international trade generally identifies two considerations that relevant in determining the extent to which the income of a particular factor of production is raised or lowered as a consequence of variations in relative output prices induced by changes in commercial policy. If all factors are mobile between industries, then the income of each factor tends to be linked positively to the relative prices of the products of the industries in which it is used relatively intensively. In particular, in a two-product, two-factor economy, the Stolper-Samuelson theorem indicates that a factor's income will rise in terms of both products when the relative price of the product in which it is used intensively rises and, corresponding, a factor's income will decline in terms of both products when the relative price of the product in which it is used intensively declines. When all factors are not perfectly and immediately mobile between industries, the incomes of factors that are not immediately mobile tend to be positively linked to the relative prices of the products of the industries where they are presently employed, while the incomes immediately mobile factors tend not to be so strongly linked to the relative prices of particular products.[1] In particular, in a two-product, three-factor model where

---

1. In an economy with many products and many factors used to produce each product, some perfectly mobile and some not, virtually any result is possible if one assumes

labor is assumed to be perfectly mobile between industries and capital is assumed to be specific (at least in the short run) to each industry, an increase in the relative price of one industry's product increases the income of capital specific to that industry in terms of both goods, reduces the income of capital specific to the other industry in terms of both goods, and reduces the wage in terms of that industry's product while raising it in terms of the other industry's product.[1]

In my judgment, the theory that focuses on the short run specificity of factors of production to particular industries as the prime determinant of the income redistribution effects of relative price changes is the most relevant theory for understanding the likely redistributive effects of trade liberalization in most economies. In making use of this theory, however, it should be recognized that "labor" which is assumed to be a perfectly mobile factor of production does not correspond to all labor in actual economies. Much of the labor that is employed in many industries embodies a substantial amount of human capital that is relatively specific, at least in the short run, to the particular industry where it is employed. In the discussion that follows, therefore, "capital located in an industry" should be thought of as including not only physical plant and equipment that is specific, in the short run, to that industry but also human capital that shares this property of short run specificity.

Using the model of section I, it can be shown than a permanent reduction in the level of protection, as measured by the tariff applied to imports of X, implies an immediate reduction of the income of capital located in X relative the income of capital located in Z. Under reasonable additional assumptions,

---

sufficiently wierd complementary and substitution relations among factors. While these possibilities may occasionally have practical relevance, they will not be considered in this discussion.

1. The specific capital model is described in Jones (1971), Mayer (1974), and Mussa (1974). The last of these papers presents specific formulas that indicate the extent to which each factor's income is affected by a relative price change as a function of parameters describing the production processes. It also indicates how these results generalize to an economy that produces many goods using one specific factor in each industry and one mobile factor common to all industries.

it may be shown that the income of capital located in X falls absolutely in terms of both goods while the income of capital located in Z rises absolutely in terms of both goods. The effect of a permanent reduction in the tariff on the values of units of capital located in the two industries, as determined by the present discounted values of their future income streams (μ_X and μ_Z) is less clear, except that μ_X must fall relative to μ_Z. This ambiguity arises because the long run effect of a permanent reduction in the tariff on the income of capital must be the same for both industries and depends on which industry is relatively capital intensive. If X is relatively capital intensive, the long run level of income of capital will fall in terms of both goods; while if Z is relatively capital intensive, the long run level of income of capital will fall in terms of both goods. If adjustment to the economy's long run equilibrium occurs sufficiently rapidly subsequently to a tariff reduction, the long run effect of the tariff reduction on the income of capital in both industries could dominate the short run differential effect on the income of capital in each industry, with the result that the value of a unit of capital could rise in both industries or could fall in both industries. I do not believe that either of these results is a likely consequence of tariff reductions in most instances. Rather, I think it more likely that the adjustment process works sufficiently slowly that the short run effects of capital specificity dominate over the long run effects of capital intensity, with the implication that a tariff reduction initially reduces the value of a unit of capital located in X while raising the value of a unit of capital located in Z. This result will be assumed in the discussion that follows.

It is clear that if a permanent reduction in the tariff rate reduces the income and wealth of owners of capital initially located in the protected industry, then one way to reduce the (private) losses suffered by these capital

owners is diminishing the extent of the reduction in the tariff rate. The disadvantage of this policy is that it leaves the economy with permanent efficiency losses resulting from a tariff that exceeds its optimal level (zero for a small country. An alternative policy that achieves the objective of diminishing the losses sustained by owners of capital located in the protected industry while avoiding permanent efficiency losses from the continuation of protection in excess of its optimal level is a policy of gradually reducing the level of protection to its long run optimal level. There are two important reasons why a gradual reduction in the level of protection diminishes the losses suffered by owners of capital located in the protected industry. First, by delaying the losses of income implied by future scheduled reductions in the tariff rate, the program of gradually reducing the level of protection reduces the magnitude of the initial decline in the present discounted value of the income stream generated by a unit of capital originally located in the protected industry. Second, even a small initial decline in the value of a unit of capital located in X relative to the value of units of capital located elsewhere in the economy (which would be induced by an announced program of very gradual reductions in the tariff rate) induces some capital to move out of the protected industry and, perhaps more important, encourages new investment not to be located in this industry. If the demand curve for the protected industry's product is to any extent downward sloping or the supply curve of other inputs is to any extent upward sloping, the reduction in the industry's capital stock through outward movement of existing capital and non-replacement of depreciating capital should moderate the decline in the income earned by capital that remains in the protected industry.[1]

---

1. In the model of section I, the supply curve of the other input, mobile labor, is upward sloping to the X industry, but the demand curve for the industry's product is horizontal at the world market price multiplied by one plus the tariff rate. In circumstances where domestically produced products are imperfect substitutes for imported products, the demand curve facing the protected domestic industry should be downward sloping.

Formally, the problem of determining the optimal path of trade liberalization in the light of concerns about the losses suffered by owners of factors located in the protected industry could be analyzed in at least two ways. Ignoring for simplicity the consumption distortion loss of protection, the objective of the problem could be stated as the maximization of the present discounted value of the economy's final output, as in section I, but subject to some constraint on the maximim permissible reduction in either income earned by a unit of capital in the protected industry or in the private value of a unit of capital located in that industry. Alternatively, the objective function could be modified by substracting from the value of output at each date some measure of the political and social cost of losses sustained by owners of capital in the protected industry. In the first approach, the trade off between efficiency in the adjustment process and limiting the losses suffered by those injured by trade liberalization is exhibited by considering tighter or looser constraints on the maximum permissible loss of owners of capital located in the protected industry. In the second approach, the appropriate trade off is determined endogenously as part of the solution of the maximization problem (given the function that describes the social and political cost of losses suffered by owners of capital located in the protected industry).

Without going into the details of the formal analysis of either of these formulations of the optimization problem, it is useful to state the following general conclusions that may be derived from such an analysis. First, when the protected industry is labor intensive, there are circumstances (which I believe to be of limited practical relevance) in which there is no conflict between the goal of economic efficiency and the desirability of limiting losses sustained by owners of capital located in the protected industries. In these circumstances, the optimal path for commercial policy is to move

immediately to the long run optimal commercial policy of free trade. Second, when the protected industry is capital intensive, there are circumstances in which concern with the losses suffered by owners of capital in the protected industry can be sufficiently important that it is not optimal to move all of the way to the commercial policy of free trade that is optimal on grounds of economic efficiency. This result might be taken as representative of the situation in which some protection is justified on the grounds of raising the incomes of the poorest in society.[1] Third, in the "normal case" where a greater reduction in the tariff rate implies a greater reduction in the income of capital in the protected industry and in the present discounted value of that income, a tighter constraint on the maximum permissible loss of owners of capital in the protected industry or a greater political and social cost assigned to such losses implies a slower optimal rate of reduction of the level of protection. This result provides a valid argument for gradualism in trade liberalization under "normal" circumstances when a government is concerned, for political or economic reasons, with limiting the losses of income and wealth sustained by owners of factors of production that are initially located in the protected scetor of the economy.

---

1. The analogy here is very weak, reflecting the fundamental weakness of the model of section I in dealing with the issue of the distribution of income among individuals in society, as opposed to the distribution of income among classes of factors. In this model, all capital earns the same income in long run equilibrium. Hence, removal of a tariff that protects the capital intensive industry could reduce the income of capital below some arbitrarily prescribed minimum. It is doubtful, however, that this is what is at issue when one discusses the income of the poorest members of society. To get at this issue, we would need a model in which different individuals own different amounts of human and physical capital perhaps with varying efficiency in different industries. Then we might consider how removal of protection might injure those who own only small amounts of this capital.

C. Factors Affecting the Trade Off between Efficiency and Redistribution

Economic analysis can contribute to an understanding of the path of trade liberalization that balances appropriately the social and political costs of loses imposed on owners of factors located in protected industries against the efficiency gained by rapid reductions in the level of protection by indicating the circumstances in which reducing the loses of these factor owners by slow liberalization will, or will not, have a high cost in terms of the efficiency of the adjustment process. Among the factors that should be considered are the following: (1) the ease with which factors located in protected industries can be moved to alternative activities that should expand as a consequence of trade liberalization; (2) the extent to which factors used in protected industries are specific to those industries and must be worn out (in the case of physical capital) or retire (in the case of human capital) and be replaced by new factors in order to be moved to alternative activities; (3) the likely productive life span of the factors in the previous category: (4) the geographic distribution of factors used in protected industries relative to the likely geographic distribution of factors that would be employed in industries stimulated by a reduction in protection.

First, consider the circumstances in which factors used in protected industries could move relatively easily to activities that should expand as a consequence of trade liberalization. This would be a likely circumstance if the workers employed in protected industries were largely unskilled, had a high level of general skill rather than specific skill (to the extent that this is possible) or had skills that would likely be useful in the industries that would expand as a consequence of trade liberalization. This last circumstance would be more likely if levels of protection differed widely within a sector of the economy such as manufacturing rather than between sectors such as manufacturing and

agricultural. If some manufacturing industries were heavily protected while other manufacturing industries using similar types of labor and capital received negative protection, then factors employed in protected industries probably could move into alternative uses with comparative ease.[1] This would not be likely, however, if all manufacturing industries are heavily protected at the expense of agriculture and mining. With respect to physical capital, movement to alternative uses is likely to be comparatively easy when capital consists largely of office and plant space rather than highly specialized equipment. When circumstances are such that it appears that most factors employed in protected industries could move relatively easily into alternative activities, then incomes and wealth losses that are likely to be sustained by a rapid reduction in levels of protection should not be enormous and the efficiency gain from stimulating rapid adjustment should be substantial.

Second, the circumstances in which factors used in protected industries must be allowed to wear out or retire and be replaced by new capital or new workers are essentially the reverse of the circumstances described in the preceding paragraph. When these circumstances are descriptive of the factors employed in protected industries, then it is likely that these factors will sustain substantial and prolonged income loses as a consequence of a rapid reduction in the level of protection. Aside from reducing the consumption distortion cost of protection, however, little efficiency may be gained by reducing the level of protection more rapidly than is necessary to discourage new workers from acquiring skills specific to the protected industries or new capital from being invested in the protected industries. Hence, in these

---

1. The activities that will expand due to a reduction in protection will depend to some extent on the factors that are available in the economy and on the prices at which these factors make themselves available.

circumstances, a gradual rate of reduction of the level of protection at near the rate that discourages new factors from moving in to the protected industries may be the best policy.

Third, when labor and capital cannot move easily out of protected industries, the expected productive lifespan of these factors may be an important guide for the pace of liberalization. If many of the workers with specific skills in protected industries have only relatively short periods remaining in their likely working lives, they are unlikely to pay the costs and suffer the dislocations associated with moving to other jobs, even if they suffer substantial reductions in income (including reductions due to unemployment) as a consequence of a rapid decline in the level of protection. Hence, little efficiency can be gained by a rapid reduction in the level of protection that imposes substantial loses on these workers. In contrast, if most workers in protected industries have many years remaining in their productive lives, the prospect of many years of lower income if they remain in their present jobs (or unemployed waiting for work in the previously protected industry) may induce them to incur the costs of retraining and relocation in order to find new jobs in expanding industries. In this case a more rapid reduction in the level of protection at least serves some purpose in increasing economic efficiency. The same principles apply to physical capital, though policy makers may be less concerned with losses sustained by capital owners than by workers.

Fourth, the geographic location of protected industries may sometimes be an important factor influencing the appropriate pace of trade liberalization. If these industries are located in larger metropolitan centers where workers employed in them have reasonable prospects for finding re-employment in other expanding industries, then the losses they will suffer due to liberalization should not be too large, and efficiency is likely to be promoted by a relatively

rapid pace of liberalization. On the other hand, if the protected industries are dominant employers in smaller centers that are isolated from the areas where workers might reasonably expect to find re-employment in expanding industries, then a rapid pace of liberalization is likely to generate very substantial losses for these workers and for the owners of capital in the protected industries. In this circumstance, it may be appropriate to reduce the level of protection more gradually in order to limit income losses for workers and capital owners in the protected industries and to allow adjustment to take place through attrition and depreciation.

Finally, it should be emphasized that the general state of economic conditions in a country influences the appropriate pace of trade liberalization. In a rapidly growing, vibrant economy, labor and capital released from protected industries can much more easily be absorbed in other industries than is likely to be the case in a slowly growing or stagnant economy. The implication is that trade liberalization can probably proceed more rapidly and with smaller losses to factors employed in protected industries when liberalization is undertaken in a vibrant and rapidly growing economy. It should be recognized, however, that in an expanding world economy, a policy of trade liberalization (combined with appropriate monetary, fiscal and exchange rate policies) may have some capacity to transform a stagnant of slowly growing national economy into one with a healthier rate of economic progress.

IV. Unemployment and the Path of Trade Liberalization

It is widely believed that the process of adjustment subsequent to a sudden reduction in the level of protection will involve not only a gradual movement of resources out of previously protected activities and into other activities with a higher product value, but also substantial unemployment of some of these resources, perhaps for an extented period of time. Concern with the social cost and political consequences of such unemployment, especially unemployment of labor, is probably an important reason for resistance to the implementation of programs of trade liberalization. Concern with these costs also seemingly provides a rationale for gradual implementation of more liberal trade policies in order to reduce the amount of unemployment they generate, or at least to spread the cost of such unemployment over time.

The purpose of this section is to investigate the influence of unemployment resulting from trade liberalization on the optimal path of liberalization. In this investigation, it is assumed that some amount of unemployment, specifically unemployment of labor, is an inevitable concomitant of any reduction in the level of protection, and that a larger reduction in the level of protection generates both a larger immediate increase in unemployment and a more rapid movement of workers out of the previously protected activity. These assumptions imply that there can be no liberalization without enduring some cost of unemployment and that more rapid liberalization has both a cost, in the form of higher short term unemployment, and a benefit, in the form of more rapid adjustment. The problem, therefore, is to choose the path of liberalization that appropriately balances this cost and benefit.

This investigation is subject to three important limitations that cast some doubt on the validity or generality of its conclusions and that should be

noted at the outset. First, there is no attempt to model or to analyze the details of the economic and institutional arrangements that lead to the assumed reduced form relationship between the level of unemployment of workers in a previously protected industry and the rate at which these workers move to other industries.[1] Presumably this has something to do with arrangements governing the determination of wage rates, but no mention is made of the wage determination process in the discussion that follows. It is certainly possible that conclusions of the subsequent analysis, particularly the conclusions relating to social welfare, might depend in a critical way on the details of the structure that underlies the reduced form relationship between the level of unemployment and the rate of adjustment of the labor force. Second, the only policy tool that is considered in the subsequent analysis is the level of protection, specifically the ad valorem tariff rate applied to imports. It is possible that through the use of other policy tools, such as wage subsidies, retraining programs, or relocation assistance, that the government could reduce the unemployment cost of trade liberalization while facilitating the adjustment process. This possibility, however, is not considered. Third, the subsequent analysis focuses on the effects of unemployment in the previously protected industry on the optimal path of commercial policy. It does not consider the effect of the overall unemployment rate on the path of commercial policy. Rather, the implicit assumption underlying the analysis is that an excess supply of labor in the previously protected industry is always matched by an excess demand for labor in the rest of the economy. In many situations, this assumption may not be valid, and in others its validity may be contingent on pursuit of appropriate monetary, fiscal, and exchange rate policies, in concert with the policy of trade liberalization.

---

1. This relationship might depend on expectations concerning the future course of economic variables including the government's commercial policy. Hence, it might not remain stable in the face of changes in policy.

To clarify further the nature and scope of the present investigation, it is useful to emphasize that "the level of unemployment" that will be referred to in subsequent discussion is always to be interpreted as the level of unemployment in the previously protected industry, in excess of the level of unemployment that would normally prevail in that industry and that is assumed to prevail in the rest of the economy. It is assumed that an increase in the level of unemployment, so defined, increases the rate at which workers move out of the previously protected industry and into other industries. This assumption would probably not be appropriate if "the level of unemployment" were understood to mean the general level of unemployment in the economy as a whole. An increase in the general level of unemployment would presumably have a negative effect, or no effect, on the rate at which workers move out of the previously protected industry, since an increase in the general rate of unemployment (holding the structure of unemployment constant) would presumably decrease, or at best not change, the perceived probability of finding a new job for a worker who decides to shift out of the previously protected industry. For this reason, it would be desirable to keep the general level of unemployment low (by whatever means are available and appropriate) during a period of trade liberalization, while simultaneously raising the level of uemployment in the previously protected industry in order to stimulate a redistribution of workers out of this industry.

A. The Social Cost of Unemployment

Before beginning the formal analysis of the influence of unemployment on the optimal path of commercial policy, it is useful to consider briefly the nature of the social cost of unemployment. By definition, an unemployed worker does not produce anything that is included in the standard measure of the value of national output. The social loss from unemployment of this worker, however, may be less than, equal to, or greater than the value of the output he would produce if employed. Discussion of a few specific cases will serve to illustrate this point.

First, consider a worker formerly employed at a very high wage in a heavily protected industry who would like to continue to work in his old job at his old wage, but who is not willing to accept available work in another job at a much lower wage rate. This worker has suffered an individual economic loss from the removal of protection for the industry that previously employed him. There is not, however, any social loss that is necessarily associated with his unemployment. Certainly the amount he would have earned in his job is not a valid measure of the social loss from the disappearance of that job since the value of the output of that job was raised artificially above its true social value by the previous grant of protection. Moreover, if this worker chooses to remain unemployed and use his time in non-market activities, rather than accept work at a wage that reflects the social value of the marginal product of his labor, then it might be concluded that there is no social loss from his unemployment. If this worker chooses to remain unemployed only because he receives a subsidy (such as unemployment compensation) that is contingent on his unemployment, then the social loss should be measured as the difference between the value of what he would produce

when employed (in a new industry) and the value he assigns to non-market uses of his time.

Second, consider a worker who remains unemployed so that he can search more efficiently for a higher paying job than he could find without search. This is a common assumption is search theory models of unemployment. For this worker, unemployment is a productive activity, even though its output (finding a better job) is not included in the usual measure of the value of the economy's output. If there are no externalities in the search process arising from one worker's search interfering with the search of others when there are a fixed number of jobs, then the private benefits of search should correspond to the social benefits (ignoring some complications arising from taxation). In this case, the technology of the adjustment process for moving workers between industries has the same essential properties as the technology of the adjustment process for moving capital in the model presented in section I. As in that model, the privately perceived cost of adjustment (including the cost of being unemployed) will correspond to the true social cost, and so too will the privately perceived benefit correspond to the true social benefit. Thus, while there is a social cost of unemployment, this cost is appropriately taken into account by the agents responsible for determining the extent of unemployment--leaving no rationale for government intervention. Of course, if there are distortions affecting either the privately perceived cost or benefit of unemployment, then there is a rationale for government intervention along the lines discussed in section II.

Third, the costs of unemployment are not evenly spread across members of society, but tend to be heavily concentrated on the particular individuals who become unemployed and on their families. This concentration is diminished

somewhat by unemployment compensation, provision of public services, and social welfare programs. But, even in societies with extensive social welfare programs (and more so in societies without such programs), there may be legitimate concern that losses that are heavily concentrated on a small part of society have a greater social cost than losses that are evenly spread. This would make the social cost of unemployment exceed the value of lost output.

Fourth, in some cases, heavily protected industries that will be the principal victims of trade liberalization may be geograhically concentrated and may be dominant or very important employers in their locales of operation. In such cases, substantial declines in employment in previously protected industries may have important, concentrated, and negative spillover effects for other enterprises and workers in their locales of operation. Even when macroeconomic and exchange rate policies are successful in maintaining a level of aggregate demand adequate to absorb resources released from previously protected industries, these local economic difficulties are unlikely to be overcome completely. This may add to the social cost of unemployment associated with the removal of protection in these cases.

Fifth, it has been observed that workers who suffer prolonged periods of unemployment also suffer substantial declines in their human capital, at least as measured by the wages they are subsequently able to obtain. To the extent that this phenomenon reflects a loss in the private return to human capital that is socially less valuable, there is no additional social cost of unemployment. However, to the extent that this phenomenon reflects an actual deterioration in general human capital due to unemployment, the social cost of such unemployment may well exceed the value of the output lost during the actual period of unemployment.

B. A Formal Analysis of the Optimal Path of Unemployment

In order to provide a formal basis for analysis of the influence of unemployment on the optimal timing of trade liberalization, it is useful to consider a simple model of the interaction between adjustment to changes in commercial policy and the level of unemployment (especially in the industries directly affected by the commercial policy change).[1] Since the model used earlier in this paper to analyze the optimal timing of trade liberalization treats labor as a perfectly mobile factor, this model cannot be used without modification to analyze the effects and implications of unemployment of labor. Rather than modifying this model to allow for a sensible analysis of unemployment, it is easier to consider a model with a somewhat simpler basic structure.

Suppose that the small economy under investigation has two industries: the X industry that has previously been granted protection be means of a tariff from imports of similar foreign goods; and the Z industry which produces every other good in the economy, including goods for export. Each industry uses only a single factor of production, labor, and the output of each industy is a concave function of the amount of labor employed in that industry;

$$X = F(L_X)$$

$$Z = G(L_Z).$$

The amount of labor employed in each industry is always less than or equal to the number of workers who seek work in that industry, and the number of workers who seek work in each industry is assumed to be a slowly adjusting variable. The number of workers who seek work in X is denoted by N, and the number of workers who seek work in Z is the total work force, $\bar{N}$, less those who seek work in X. Given the world relative price of X in terms of Z, denoted by P, the demand for labor in the two industries is assumed to depend on the ad

valorem tariff rate, τ, that is charged on imported units of X. Specifically, the demand for labor in X, denoted by $L(\tau)$, is assumed to correspond to the equilibrium level of employment in the X industry with free movement of labor when the tariff rate is τ; and the demand for labor in the Z industry is, by the same assumption, given by $\bar{N} - L(\tau)$. When the demand for labor in an industry is greater than the number of workers in that industry (as will typically be the case for the Z industry in subsequent discussion), there is an unsatisfied excess demand for labor in that industry. When the demand for labor in an industry is less than the number of workers in that industry, the excess supply of labor in that industry is unemployed. Since this situation will generally apply to labor in the X industry in subsequent discussion, it is convenient to denote the level of unemployment in this industry (and in the economy) by

$$U = N - L(\tau).$$

Unemployment of workers who seek to work in an industry is assumed to provide the incentive, directly or indirectly, for some of these workers to move out of this industry and seek work in the other industry. Since subsequent analysis will be concerned with unemployment in the X industry (resulting from the removal of tariff protection), this assumption can conveniently be embodied in the specification that

$$\dot{N} = -\beta \cdot U \tag{1}$$

where $\beta > 0$ measures the speed at which workers move out of the X industry in response to unemployment in that industry.

The initial condition of the economy is assumed to correspond to the equilibrium position of the economy with a positive level of protection, τ_0 granted to domestic producers of X, with the number of workers in X equal to $L(\tau_0)$ and the number of workers in Z equal to $\bar{N}(\tau_0)$. The problem for

the social planner who controls commercial policy is to chose the path of the tariff rate that maximizes the present discounted value of the economy's final output, V, as given by

$$V = \int_0^{\infty} [P \cdot F(L(\tau)) + G(\bar{N} - N)] \cdot \exp(-r \cdot t)\, dt$$

subject to the transition law

$$\dot{N} = -\beta \cdot [N - L(\tau)].$$

In this specification of the objective function of the social planner, it should be noted that the cost of unemployment is reflected, one-for-one, in the value of output of X (measured as world market prices) that is lost due to unemployment of labor in that industry. (No unemployment occurs in Z so L_Z is set equal to $\bar{N} - N$.) Thus, no allowance is made either for the excess social cost of unemployment above the value of output lost, or for the value that unemployed workers may derive from alternative uses of their time. Also, in the specification of the objective function, no allowance is made for the consumption distortion loss that results from a non-zero tariff rate on imports of X. The specification of the objective function could be modified to take account of these factors with the cost of increased analytical complexity, but without altering the basic conclusions of the present discussion.

Since the number of workers in the X industry, N, is a state variable of the dynamic optimization problem confronting the social planner, it is possible, using the relationship that $U = N - L(\tau)$, to view the planner's control variable as the level of unemployment, U, rather than the tariff rate, τ. Adopting this view (which no policy maker would publicly admit), the problem for the planner is to maximize

$$V = \int_0^{\infty} [P \cdot F(N - U) + G(\bar{N} - N)] \cdot \exp(-r \cdot t)\, dt \qquad (2)$$

subject to the transition law

$$\dot{N} = - \beta \cdot U,$$

by choice of the time path of U.

To determine the solution of this problem, we form the current value Hamiltonian,

(3) $$H = P \cdot F(N - U) + G(\bar{N} - N) + \lambda\beta \cdot U,$$

where λ represents the shadow price of being a worker seeking work in Z rather than a worker seeking work in X. (λ is defined this way so that λ will positive along the adjustment path associated with trade liberalization.) The first order condition for optimal behavior requires that U be chosen so that

(4) $$\partial H/\partial U = - P \cdot F'(N - U) + \lambda\beta \leq 0$$

with equality holding whenever U is > 0. This condition says that whenever U is > 0, the level of unemployment must be such that marginal benefit of unemployment arising from a more rapid movement of workers from seeking work in X to seeking work in Z, as measured by $\lambda\beta$, must equal the marginal cost of unemployment arising from the value of lost output of X, as measured by $P \cdot F'(N - U)$. When the marginal benefit of unemployment is so low that this condition cannot be satisfied (i.e., $\lambda < P \cdot F'(N)/\beta$), then the level of unemployment is zero. When λ is greater than this minimum value, the level of unemployment is given by

(5) $$U = N - F'^{-1}(\lambda\beta/P).$$

From this result, it is apparent that the level of unemployment is an increasing function of λ when $\lambda > P \cdot F'(N)/\beta$.

Substituting the solution for the level of unemployment into the transition law governing the evolution of N, it follows that

$$(6)\qquad \dot{N} = \begin{cases} 0 & \text{when} \quad \lambda \leq P\,F'(N)/\beta \\ \beta\cdot[F'^{-1}(\lambda\beta/P) - N] < 0 & \text{when} \quad \lambda > P\,F'(N)/\beta \end{cases}$$

This result is represented in the phase diagram shown in figure 1. The negatively sloped line along which $\lambda = P\cdot F'(N)/\beta$ is the upper boundary of the region in which the level of unemployment is zero and accordingly there is no movement of workers from seeking work in X to seeking work in Z; i.e., in this region $\dot{N} = 0$. Above this region, the level of unemployment is positive and N is negative, indicating that workers are shifting from seeking work in X to seeking work in Z.

The transition law for the shadow price λ is given by

$$(7)\qquad \dot{\lambda} = r\cdot\lambda - \partial H/\partial(-N) = r\cdot\lambda + P\cdot F'(N - U) - G'(\bar{N} - N).$$

Taking account of the solution for U implied by (4), it follows that when $\lambda < P\cdot F'(N)/\beta$ (and hence $U = 0$), the rate of change of λ is given by

$$(8)\qquad \dot{\lambda} = r\cdot\lambda + P\cdot F'(N) - G'(\bar{N} - N).$$

Thus, in the region of the phase diagram where $U = 0$ and $\dot{N} = 0$, the combinations of N and λ for which $\dot{\lambda} = 0$ are those for which

$$(9)\qquad \lambda = [G'(\bar{N} - N) - P\cdot F'(N)]/r.$$

These combinations of λ and N are indicated by the section of the $\dot{\lambda} = 0$ locus in figure 1 that lies in the region below the line along which $\lambda = P\cdot F'(N)/\beta$. When $\lambda > P\cdot F'(N)/\beta$ (and hence $U = N - F'^{-1}(\lambda\beta/P)$), the rate of change of λ is given by

$$(10)\qquad \dot{\lambda} = (r + \beta)\cdot\lambda - G'(\bar{N} - N)$$

Thus, in the region of the phase diagram where $U > 0$ and $\dot{N} > 0$, the combinations of N and λ for which $\dot{\lambda} = 0$ are those for which

$$(11)\qquad \lambda = G'(N - N)/(r + \beta).$$

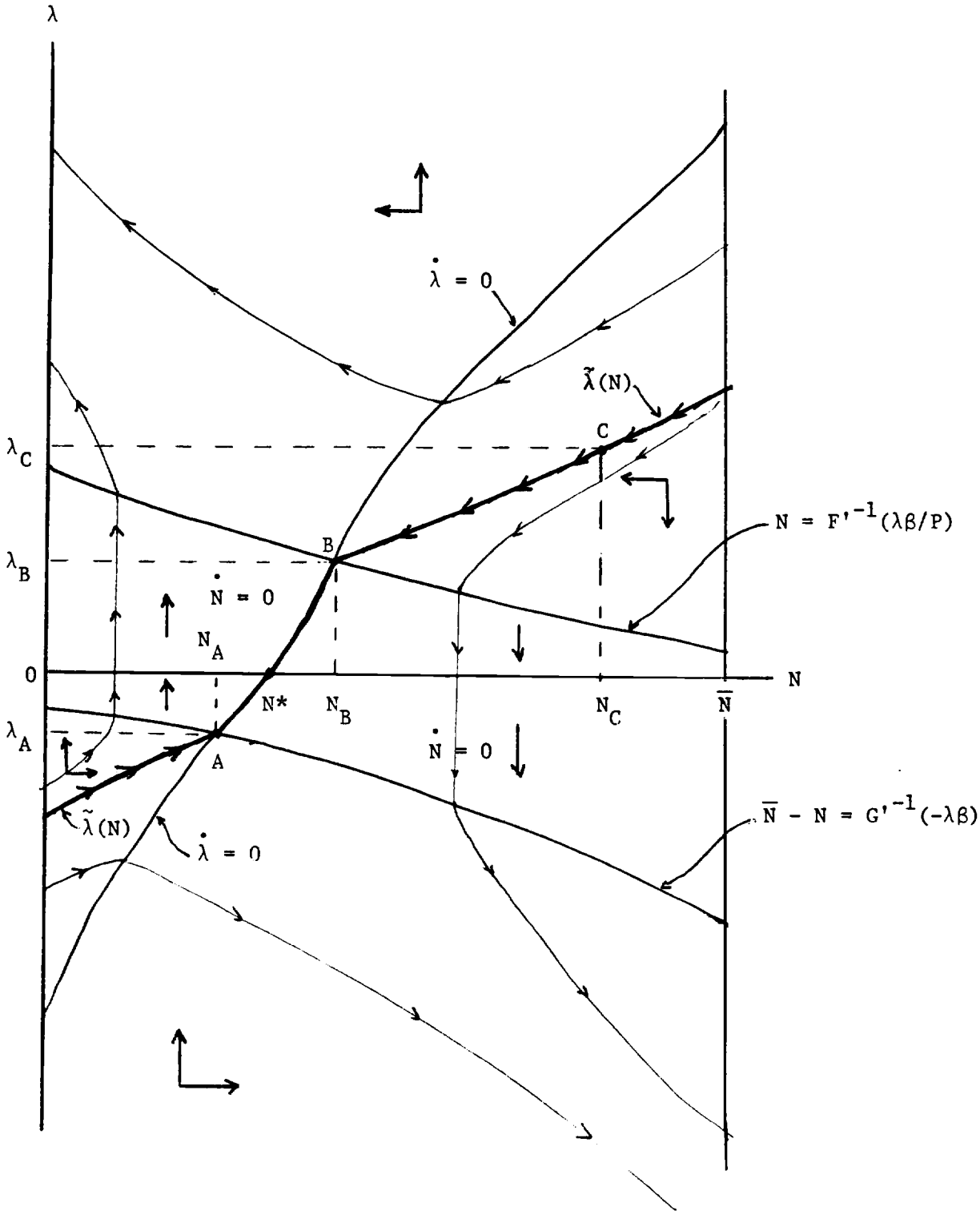


Fig.--1. The Optimal Adjustment Path for the Distribution of Workers between Industries.

These combinations of N and λ are indicated by the section of the $\dot{\lambda} = 0$ locus that lies in the region above the line where $\lambda = P \cdot F'(N)/\beta$. In general, in the region above the $\dot{\lambda} = 0$ locus $\dot{\lambda}$ is > 0 and in the region below the $\dot{\lambda} = 0$ locus, $\dot{\lambda}$ is < 0.

The distribution of workers that corresponds to the free trade equilibrium of the economy, indicated by $N = N^*$, occurs where the value of the marginal product of labor in X, $P \cdot F'(N^*)$, is equal to the value of the marginal product of labor in Z, $G'(N - N^*)$. If the social planner inherited this distribution of workers as the initial distribution at the start of the policy of trade liberalization (which is not possible if the economy was at equilibrium position corresponding to a positive tariff rate), the optimal policy for the social planner would clearly be to set $\lambda = 0$ and have the economy sit at its free trade equilibrium position. In the phase diagram, this policy is indicated by the point where $N = N^*$ along the N axis. Starting with $N = N^*$, any choice of $\lambda(0)$, other than zero, would clearly not be optimal since it would place the economy on a dynamic path that would ultimately lead away from the free trade equilibrium and toward an equilibrium where either $N = \bar{N}$ (if $\lambda(0) < 0$) or $N = 0$ (if $\lambda(0) > 0$).

It must be recognized, however, that the point where $N = N^*$ and $\lambda = 0$ is not the only optimal steady state for the economy. In fact, any point on the $\dot{\lambda} = 0$ locus in the region of the phase diagram where $N = 0$ is an optimal steady state position. In other words, if the economy inherits a distribution of workers with N between the levels N_A and N_B illustrated in figure 1, the optimal policy is to set $\lambda(0) = [G'(\bar{N} - N) - P \cdot F'(N)]/r$ (which makes $\dot{\lambda} = 0$) and to hold the distribution of workers at the inherited distribution. This is the optimal policy because the benefit of shifting a worker from one industry to another, as measured by $\lambda(0)$ which is the present discounted value of the difference

between the value of the marginal product of labor in the two industries, is smaller than the cost of the unemployment that must be created (or tolerated) in order to induce a worker to shift industries.

The largest number of workers in the X industry consistent with an optimal steady state, N_B, and the associated value of λ_B for this optimal steady state satisfy the condition that

$$(12) \qquad P \cdot F'(N_B)/\beta = \lambda_B = [G'(\bar{N} - N_B) - P \cdot F'(N_B)]/r.$$

If the level of protection previously granted to the X industry was substantial, it is likely that the inherited number of workers in the X industry, N_0, will exceed N_B. In this case, the optimal policy for the social planner is to choose $\lambda(0) = \lambda_C$ in order to place the economy at the point C that lies along the stable branch of the dynamic system illustrated in figure 1. With this choice of $\lambda(0)$, the economy moves gradually along the stable branch of that dynamic system until it arrives at the optimal steady state position indicated by the point B. At this point, no further movement is desirable because the social value of shifting additional workers out of X and into Z does not repay the social cost of inducing such movement. Any other choice of $\lambda(0)$ would not be optimal since it would lead to a situation either where N converged to $\bar{N}$ (if $\lambda(0)$ were $< \lambda_C$) or where N converged to 0 (if $\lambda(0)$ were $> \lambda_C$). In either case, the transversality conditions of the planner's optimization problem would be violated.

To move the economy along its optimal path, the social planner does not directly set the unemployment rate. Rather, he sets the path of the tariff rate applied to imports of X. If the level of protection previously granted to the X industry was so low that the planner inherits a number of workers in the X industry that is within the range of optimal steady state levels of N

(i.e., between N_A and N_B), the planner simply holds the tariff rate constant in order to hold the demand for labor in X, $L(\tau)$, at the inherited level of N. (This requires a positive tariff rate if N is between N* and N_B and a negative tariff rate if N is between N_A and N*.) If the level of protection previously granted to the X industry maintained a level of employment $N_0 = L(\tau_0)$ that was greater than N_B, as illustrated in figure 1, then the planner must immediately cut the tariff rate to below its previous level, τ_0, in order to reduce the demand for labor in X to below N_0 and stimulate the optimal rate of movement of workers from seeking work in X to seeking work in Z. Subsequently, the planner must manipulate the tariff rate in order to move the economy along the stable branch in figure 1 until the steady state point B is reached. The path of the tariff rate that moves the economy along the stable branch is determined by the requirement that the demand for labor at each level of N must be consistent with the required level of unemployment at that level of N along the stable branch; formally this requires that

$$L(\tau) = F'^{-1}(\tilde{\lambda}(N)\cdot\beta/P) \tag{13}$$

where $\tilde{\lambda}(N)$ is the value of λ that is associated with N along the stable branch in figure 1. The tariff rate at the optimal steady state position B is the tariff rate τ_B that is determined by this requirement when N is set equal to N_B and $\tilde{\lambda}(N) = \tilde{\lambda}(N_B) = \lambda_B$.

To move the economy along its optimal path from C to B, the tariff rate set by the social planner must be declining. This is implied by the fact that $\tilde{\lambda}(N)$ is declining as we move along the stable branch in figure 1 from the point C to the point B. Thus, the optimal path for commercial policy during the period of trade liberalization requires "overshooting" in the sense that the tariff rate is initially cut below its inherited level τ_0

to a level τ_C (associated with the point C in figure 1) that is <u>below</u> its new steady state value τ_B. Subsequently, the tariff rate is <u>raised</u> in order to move the economy along its optimal path from the point C to the point B. Indeed, if the inherited level of τ_0 was sufficiently high, it is even possible that the optimal policy will be to cut the tariff rate initially to a level that is below the free trade level--that is, the optimal path for commercial policy would involve an initial period during which imports of X would be subsidized in order to stimulate a rapid rate of movement of workers out of the X industry and into the Z industry.

C. Extensions and Modifications

It would be misleading to suggest than any of the specific implications of the model discussed in the preceding subsection have any substantial claim to generality. In particular, the conclusion that the optimal path of commercial policy in a trade liberalization involves "overshooting" in which the level of protection is initially reduced below its optimal steady state level (and perhaps made negative) is a specific implication of that model, and not a general property of reasonably specified models of the influence of unemployment on the optimal timing of trade liberalization. To obtain a better notion of the range of conclusions that are consistent with models that might have some claim to economic sensibility, it is useful to consider variations of the model of the preceding subsection which preserve its simple two-industry, one-factor structure, but allow for modifications in the objective function of the social planner or in the specification of the transition law that relates the rate of redistribution of workers to the level of unemployment.

With respect to the planner's objective function, one important modification would be to take account of the consumption distortion loss resulting from a tariff. Assuming for simplicity that the consumption distortion loss is a function $D(\tau)$ of the tariff rate, the objective of the social planner would become the maximization of

$$(14) \qquad V = \int_0^\infty [P \cdot F(L(\tau)) + G(\bar{N} - N) - D(\tau)] \cdot \exp(-r \cdot t)\, dt$$

by choice of the time path of τ, subject to the transition law

$$\dot{N} = -\beta \cdot (N - L(\tau)).$$

Without going through the details of the formal analysis of this problem, the following modifications of the results of the preceding subsection should be

noted. Since the consumption distortion loss of the tariff is second order of smalls for small values of τ (assuming no other distortions), we retain the earlier result that there is a region of optimal steady positions for the economy surrounding the free trade equilibrium point. The size of this region of optimal steady states, however, is reduced because taking account of the consumption distortion loss of a tariff implies a greater shadow value for shifting workers out of X and into Z at any level of $N > N^*$; specifically, at any steady state position (where $U = 0$ and $\dot{N} = 0$), λ is now given by

$$\lambda = [G'(\bar{N} - N) - P \cdot F'(N) + D'(L^{-1}(N)) \cdot L^{-1}{}'(N)]/r. \tag{15}$$

Comparing this result with (9), the additional term $D'(L^{-1}(N)) \cdot L^{-1}{}'(N)/r$ that appears in (15) represents the present discounted value of the gain from reducing the consumption distortion loss of the tariff by the amount permitted by reducing the number of workers seeking work in the X industry by one unit. More generally, along the stable branch of the dynamic system governing the evolution of N and λ (which corresponds to the optimal path for the economy), the value of λ will now be the present discounted value of $G'(\bar{N} - N) - P \cdot F'(N - U) + D'(L^{-1}(N - U)) \cdot L^{-1}{}'(N - U)$, rather than the present discounted value of $G'(\bar{N} - N) - P \cdot F'(N - U)$. For this reason, for $N > N^*$, the value of λ along the optimal path will be greater than it was when no account was taken of the consumption distortion loss of the tariff. This, in turn, implies that for any value of N above the optimal steady state region the optimum level of unemployment will be higher and the optimum level of the tariff rate will be lower than it was when no account was taken of the consumption distortion loss of the tariff.

Modification of the planner's objective function to allow for social costs of unemployment other than the value of lost output can be dealt with in much the same way as the modification allowing for the consumption distortion loss of the tariff. If the social loss from unemployment is assumed to be less than the value of lost output because unemployed workers derive benefit from alternative uses of their time, to the extent measured by the function $W(U)$ (with $W(U) > 0$, $W'(U) > 0$, and $W''(U) < 0$), then the marginal social cost of unemployment is reduced from $P \cdot F'(N - U)$ to $P \cdot F'(N - U) - W'(U)$. The first order condition determining the optimal level of U, for given values of N and λ becomes

$$P \cdot F'(N - U) - W'(U) \leq \lambda\beta \tag{16}$$

with equality holding whenever $U > 0$. It is apparent that the maximum value of λ consistent with zero unemployment is now smaller than it was when unemployed workers were assumed to derive no benefit from alternative uses of their time. For λ above this maximum, the level of U determined by (16), say $\hat{U}(\lambda\beta, N, P)$, is greater than the corresponding level of U, given by $N - F'^{-1}(\lambda\beta/P)$, determined in the preceding subsection. Since the transition laws determining the evolution of N and λ are still given by (1) and (7), it is relatively easy to establish that the optimal path of trade liberalization is modified in the following ways. The range of optimal steady values of N around N* is reduced because the marginal social cost of unemployment is reduced. For any N above this range, the optimal level of unemployment is increased and the optimal level of the tariff rate is reduced. The long run steady state level of the tariff that is reached starting from such an N is lower and the rate of convergence of the tariff to its steady state level is greater, implying a greater initial reduction in the tariff below the previously granted level of protection.

On the other hand, if the social cost of unemployment is assumed to be greater than the value of output lost, for any of the reasons previously discussed, then the conclusions of the preceding paragraph are reversed. The range of optimal steady state value of N around N* is expanded. For any N above this range, the optimal level of unemployment is reduced and the optimal level of the tariff rate is increased. The long run steady state level of the tariff that is reached starting from such an N is higher and the rate of convergence of the tariff rate to this long run steady state level is slower, implying a smaller initial reduction in the tariff but not an elimination of the "overshooting" of the initial reduction in the tariff to a level below its new steady state level.

Another area in which it is important to consider modifications of the model analyzed in the preceding subsection is in the specification of the transition law that governs the rate at which workers move from seeking work in the X industry to seeking work in the Z industry. This transition law is important because it controls the marginal benefit associated with unemployment by specifying the relationship between the level of unemployment and the rate of redistribution of the work force. In a more complete analysis than will be attempted here, it would be appropriate to consider how this critical transition law arises out of the economic and institutional arrangements that govern wage rates, employment levels, labor migration, and education and training of the work force. For the present, it is desirable at least to consider alternative specifications of the transition law (1), which should be thought of as a reduced form relationship that might be derived from a more detailed investigation.

A more general formulation of the transition law (1) would allow the rate at which workers move from seeking work in X to seeking work in Z to depend upon both the level of unemployment experienced by workers in X and on the number of such workers; say

(17) $\dot{N} = -\phi(U, N), \quad \phi(0, N) = 0$ for all N,

with $\phi_U = \partial\phi/\partial U > 0$ and $\phi_N = \partial\phi/\partial N > 0$. An additional attractive assumption is that ϕ is a linear homogeneous, quasi-concave function, implying that equal proportionate increases in U and N (which would hold the unemployment rate for workers in X constant) would result in a proportionate increase in the rate of movement of workers out of the X industry. A specific form of ϕ that has this property is the Cobb-Douglas form,

(18) $\phi = \beta \cdot U^{\alpha} \cdot N^{\alpha} \quad 0 < \alpha < 1.$

The original form of the transition law (1) may be thought of as the limiting case of this Cobb-Douglas form with $\alpha = 1$.

Given the more general form of the transition law (17), the Hamiltonian for the social planner's optimization problem becomes

(19) $H = P \cdot F(N - U) + G(\bar{N} - N) - \lambda \cdot \phi(U, N).$

The first order condition that determines the optimal value of U, for given values of N and λ becomes

(20) $\partial H/\partial U = -P \cdot F'(N - U) + \lambda \cdot \phi_U(U, N) \leq 0$

with equality whenever $U > 0$. The value of U that satisfies this condition (and maximizes the value of H) may be written as a function of λ and N, say

$$U = \tilde{U}(\lambda, N).$$

When $\tilde{U}(\lambda, N)$ is > 0, its partial derivatives are given by

(21) $\partial\tilde{U}/\partial\lambda = -\phi_U/(P\,F'' + \lambda \cdot \phi_{UU})$

(22) $\partial\tilde{U}/\partial N = (P \cdot F'' - \lambda \cdot \phi_{UN})/(P \cdot F'' + \lambda \cdot \phi_{UU}).$

The second order condition for maximization of H with respect to U,

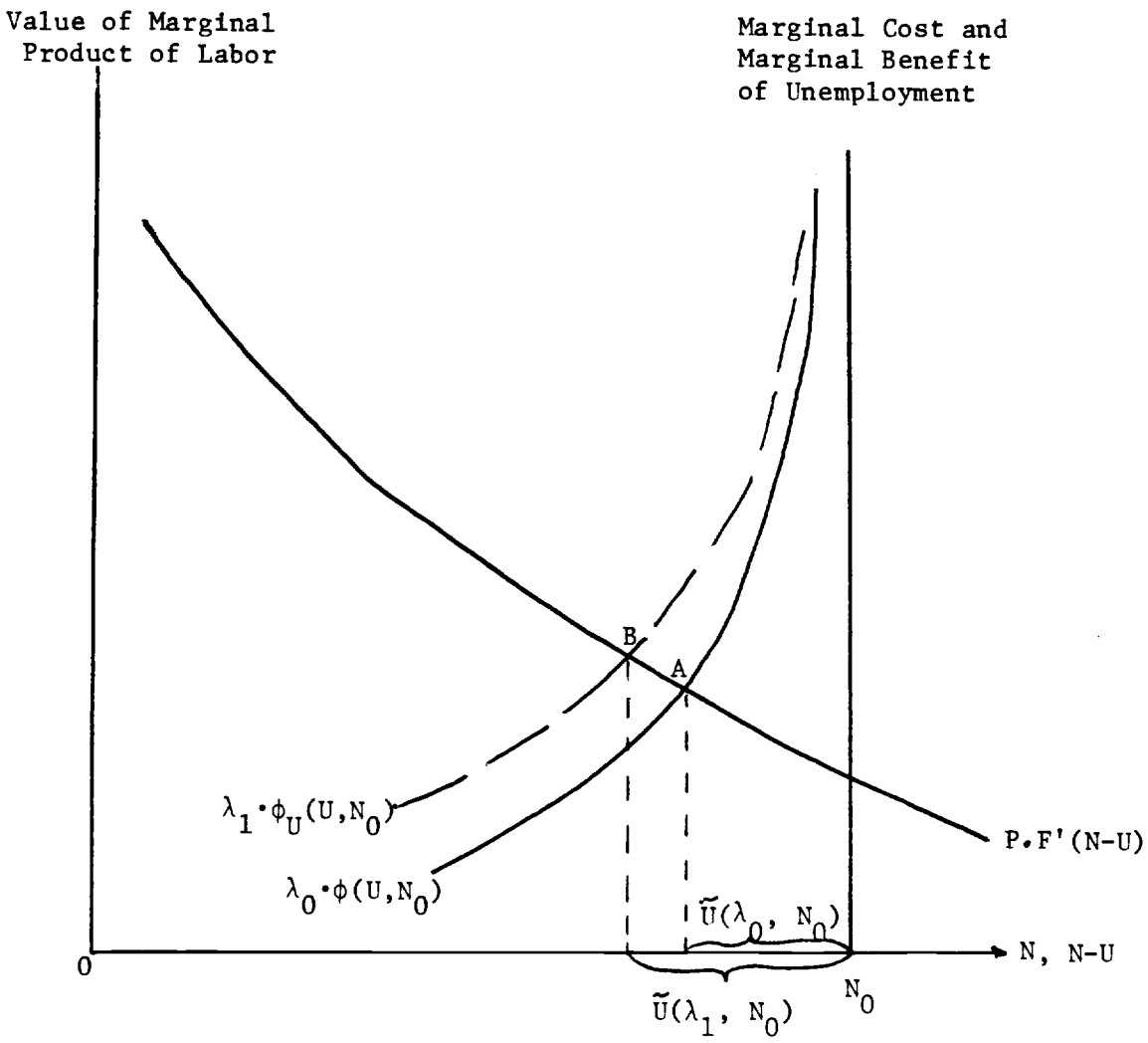
(23) $\partial^2 H/\partial U^2 = P \cdot F'' + \lambda \cdot \phi_{UU} < 0,$

implies that the denomintors in the expressions for $\partial\tilde{U}/\partial\lambda$ and $\partial\tilde{U}/\partial N$ must be negative. Since ϕ_U must be negative at the value of U that satisfies (20) (with equality), it follows that $\partial\tilde{U}/\partial\lambda > 0$. In other words, an increase in the shadow value of moving workers out of X and into Z always justifies an increase in the level of unemployment. In the case where ϕ is a linear homogeneous, quasi-concave function, we also know that

(24) $\phi_{UU} \cdot U + \phi_{UN} \cdot N = 0.$

Since U must be $\leq$ N, it follows that in the linear homogeneous, quasi-concave case, $0 \leq \partial\tilde{U}/\partial N \leq 1$, with $\partial\tilde{U}/\partial N = 0$ only if $\phi_{UU} = \phi_{UN}$ (which is true for the transition law (1)), and with $\partial\tilde{U}/\partial N = 1$ only if U = N (which is true only if all workers in X are unemployed).

The determination of the optimum level of unemployment as a function of and N is illustrated in figure 2. In this figure, the number of workers seeking work in X, N, and the number of workers actually employed in X, N - U, are measured positively along the horizontal axis, starting from the origin 0. Relative to the origin 0, the curve labeled $P \cdot F'(N-U)$ shows the value of the marginal product of labor in X as a function of the number of workers employed in that industry. For a given number of workers seeking work in X, N_0, this same curve, viewed from the perspective of an origin at N_0, shows the marginal cost of unemployment, with the level of unemployment measured negatively along the horizontal axis starting at N_0. When $N = N_0$ and $\lambda = \lambda_0$, the marginal benefit of unemployment is indicated by the curve labeled $\lambda_0 \cdot \phi_U(U, N_0)$ which is also plotted relative to the origin at N_0. The shape of this curve


Value of Marginal
Product of Labor
Marginal Cost and
Marginal Benefit
of Unemployment
B
A
$\lambda_1 \cdot \phi_U(U,N_0)$
$\lambda_0 \cdot \phi(U,N_0)$
P.F'(N-U)
$\tilde{U}(\lambda_0, N_0)$
0
N, N-U
$\tilde{U}(\lambda_1, N_0)$
N_0

reflects the assumption that $\phi_{UU} < 0$; that is, the marginal response of the rate of redistribution of workers to an increase in the level of unemployment is assumed to decline as the level of unemployment rises. The intersection of the marginal cost and marginal benefit curves at the point A determines the optimum level of unemployment $\tilde{U}(\lambda_0, N_0)$. An increase in λ to λ_1 shifts this intersection point to B and increases the optimum level of unemployment to $\tilde{U}(\lambda_1, N_0)$.

With the modification of Hamiltonian for the social planner's optimization problem, the rule governing the evolution of the shadow price λ becomes

$$\dot{\lambda} = r \cdot \lambda - \partial H/\partial(-N) = r \cdot \lambda + P \cdot F'(N-U) - G'(\bar{N}-N) + \lambda \cdot \phi_N(U,N). \tag{25}$$

Setting $U = \tilde{U}(\lambda, N)$ in this differential equation and in the transition law $\dot{N} = -\phi(U, N)$ that determines the evolution of N, we obtain the differential equation system that governs the joint behavior of N and λ.

One important issue concerning the nature of this differential equation system concerns the circumstance under which it will have a range of optimal steady state values of N and λ, where $\dot{N} = 0$ and $\dot{\lambda} = 0$, as was illustrated in figure 1. This situation arises when the "marginal product" of unemployment in increasing the rate of redistribution of workers, $\phi_U(U, N)$, is bounded as the level of unemployment approaches zero. The reason is that with an upper bound on the limiting value $\phi_U(U, N)$ as U approaches 0, the limiting value of the marginal benefit of unemployment, $\lambda \cdot \phi_U(U, N)$, for small values of λ is less than the marginal cost of unemployment, $P \cdot F'(N - U)$. This means that in the neighborhood of the distribution of the work force N* that corresponds to the free trade equilibrium, where the value of λ associated with the stable branch of the dynamic system governing N and λ must be small, we cannot satisfy the first order condition (20) with a positive level of U.

Hence, within a region around N*, $\dot{N}$ will be zero, implying that once we reach this region it is not optimal to incur the costs associated with any positive level of unemployment in order to enjoy the benefits of moving closer to free trade. In contrast, when the limit of $\phi_U(U, N)$ as U approaches zero is unbounded, the only optimal steady state position will be the free trade equilibrium position.

Another important issue concering this differential equation system is the path of the tariff rate along the path of convergence to an optimal steady state position, starting from a level of N that is above the range of optimal steady state levels of N. In this regard, it should be recalled that for the transition law $\dot{N} = -\beta \cdot U$ examined in the preceding subsection, the optimal path of the tariff rate involved "overshooting" in the sense that the tariff rate was initially reduced to below its new steady state level (which was below its inherited level) and then gradually raised to this steady state level. Since the tariff rate is directly related to the actual level of employment in X, through the function $L(\tau)$ described in preceding subsection, the path of the tariff can be inferred from the path of $L = N - U$. Whenever the initial N is above the range of optimal steady state values of N, it follows that the tariff rate must initially be cut to below its inherited level in order to start the economy moving toward its optimal steady state. If $L = N - U$ is rising along the subsequent path of convergence to this steady state, it follows that the tariff rate must be rising along this path, and hence that tariff rate must initially be cut to below its new steady state level--that is, there must be "overshooting" in the optimal behavior of the tariff rate. On, the other hand, if L declines along the path of convergence to the optimal steady state, the tariff rate must be declining along this path and, hence must initially be reduced by only a fraction of its ultimate reduction. This might be described as the case of "gradual adjustment" of the tariff rate.

After some rather tedious manipulations (the details of which are omitted), it is possible to show that the rate of change of employment in X along the path of convergence to the steady state is given by

$$\dot{L} = \Omega \cdot [\lambda \cdot \phi \cdot (\phi_{UU} + \phi_{UN}) + \phi_U \cdot \dot{\lambda}]. \tag{26}$$

where

$$\Omega = 1/(P \cdot F'' + \lambda \cdot \phi_{UU}) < 0 \tag{27}$$

Along this path of convergence, starting from an N above the steady state region, $\phi = -\dot{N}$ will be positive and $\dot{\lambda}$ will be negative. Hence, the prospects for avoiding "overshooting" of the tariff rate as a optimal policy depend on having $\phi_{UU} + \phi_{UN}$ negative and sufficiently large that $\dot{L}$ is positive. For the transition law $\phi(U, N) = \beta \cdot U$ examined in the preceding subsection, this condition cannot possibly be met since ϕ_{UU} and ϕ_{UN} are both zero. In the case where (U, N) is a linear homogeneous, quasi-concave function, we may use the fact that $\phi_{UU} + \phi_{UN} = (1/N) \cdot [(N-U) \cdot \phi_{UU} + U \cdot \phi_{UU} + N \cdot \phi_{UN}] = ((N-U)/N) \cdot \phi_{UU} < 0$ to conclude that term $\lambda \cdot \phi \cdot (\phi_{UU} + \phi_{UN})$ contributes to the possibility that the initial reduction in the tariff rate will not overshoot the ultimate steady state reduction in the tariff rate. More specifically, in the Cobb-Douglas case where $\phi(U, N) = \beta \cdot U^{\alpha} \cdot N^{1-\alpha}$, it can be shown that starting from an $N > N^*$, the tariff rate will ultimately be reduced to a steady state value of zero (free trade equilibrium will be reached) and that the tariff rate will be declining along the optimal path of convergence to free trade at least in the region where

$$G'(\bar{N} - N) < (1/\alpha) \cdot P \cdot F'(N). \tag{28}$$

Since $G'(N^*) = P \cdot F'(N^*)$, it is apparent that this region necessarily includes a range of values of N immediately above N^*. When α is small and when the marginal product of labor in the two industries is not very sensitive to changes

in the levels of employment in the respective industries, the region where gradual convergence of the tariff rate is assured tends to be quite large.

An explanation of the result of gradual convergence to free trade in the Cobb-Douglas case may be given as follows. With the Cobb-Douglas specification of the $\phi(U, N)$ function, the marginal product of unemployment in stimulating workers to move from X to Z, $\phi_U = \beta\alpha(N/U)^{1-\alpha}$, becomes indefinitely large as the level of unemployment is reduced toward zero. This implies that even with a low shadow value for shifting a worker when we are near the free trade distribution of the work force, the value of the marginal product of unemployment, $\lambda \cdot \phi_U$, will be able to equal the marginal cost of unemployment at some positive level of U. Hence, it always pays to tolerate at least a small amount of unemployment to move the economy in the direction of its free trade equilibrium. The marginal product of unemployment in stimulating redistribution of the labor force, however, is a sharply declining function of the level of unemployment, especially at relatively low levels of unemployment (i.e., $\phi_{UU} = -\beta\alpha \cdot (1-\alpha) \cdot N^{1-\alpha} \cdot U^{\alpha-2}$ is large and negative for small values of U). This means that there is an incentive to provide the stimulus reguired to induce workers to move to the free trade distribution of the labor force by having very low levels of unemployment spread over long periods rather than higher levels of unemployment for shorter periods. Hence, the optimal path for the tariff rate does not involve a large initial cut that would generate a high initial level of unemployment and stimulate a rapid initial rate of convergence of N toward N*. Rather, the optimal policy calls for a small initial cut in the tariff rate to stimulate a small amount of unemployment, and then a gradual reduction in the tariff rate to maintain a small but decreasing level of unemployment along the adjustment path to the free trade equilibrium.

D. Suggested Conclusions

As previously noted, concern about the economic and institutional arrangements that underlie the assumed reduced form relationship between the level of unemployment in the previously protected industry and the rate at which workers shift out of this industry casts some doubt on the validity and generality of the analysis based on this reduced form relationship. If, however, we accept the hypothesis that there is such a reduced form relationship that remains stable for variations in the commercial policy regime (and for variations in other related policies), then some general conclusions may be seen to follow from the preceding analysis concerning the influence of unemployment on the appropriate path of commercial policy in a program of trade liberalization.

First, there are circumstances in which it is not optimal, because of the social cost of unemployment, to push trade liberalization all of the way to what would be the first best optimum in the absence of these costs. These circumstances arise when the marginal social cost of unemployment in the previously protected industry is positive and bounded away from zero at low levels of unemployment in that industry and when the "marginal product" of unemployment in stimulating a more rapid movement of workers out of the previously protected industry does not become very large as the level of unemployment becomes small. When these conditions are met, it is not optimal to reduce the level protection below a certain finite level because the social cost of the unemployment generated by further reductions is greater than the present discounted value of the gain in allocative efficiency from inducing workers to shift out of the previously protected industry.

Second, the circumstances under which a finite, permanent level of protection would be justified by the social costs of temporary unemployment resulting from reductions in the level of protection would not arise if it were possible

to maintain a finite rate of redistribution of the work force with a very low level of unemployment in the previously protected industry. In particular, adapting the model of capital redistribution used in section 2 to the present discussion of labor force redistribution, new workers entering the labor force might be assumed to locate outside of the previously protected industry in response to the incentives associated with even a very low level of unemployment in this industry; whereas workers already employed in the protected industry would move (prior to retirement) only in response to a much higher level of unemployment. In this situation, it would be optimal to generate, through reductions in the level of protection, at least the very low level of unemployment necessary to induce new workers not to locate in the protected industry. until the first best equilibrium is achieved.

Third, the behavior of commercial policy along the path of convergence to the optimal steady state depends critically on the shape of the reduced form relationship between the level of unemployment in the protected industry and the rate at which workers are shifting out of this industry. In the case analyzed in subsection B, where we have a proportional response of N to U, we find that it is optimal for the initial reduction in the tariff rate to overshoot the long-run steady state and for the tariff rate to rise (subsequent to this initial reduction) along the optimal path of convergence to its (positive) steady state level. However, in the case of the Cobb-Douglas response function discussed in subsection C, the optimal initial reduction in the tariff rate is smaller than the optimal steady state reduction (to zero), and the tariff rate declines along the optimal path of convergence to its steady state value.

Fourth, it is possible to argue, at least heuristically, that the properties exhibited by the Cobb-Douglas response function $\phi(U, N) = U^{\alpha} \cdot N^{1-\alpha}$ are probably

more reasonable than the properties exhibited by the proportional response function $\phi(U, N) = \beta \cdot U$. The argument is that even with a low level of unemployment in the protected industry (when the level of protection in this industry is not too high), most new workers will see the advantage of seeking jobs outside of this industry, especially if the prospect is for further reductions in the level of protection. Hence, even with a low level of unemployment in the protected industry (relative to the average in the economy), there will be a fairly high net rate of movement of workers out of this industry as older workers retire and few new workers enter this industry. At higher levels of unemployment in the protected industry, even fewer new workers will decide to enter, and some older workers will decide to shift industries before retirement. However, the rate of worker redistribution will rise far less than proportionately with increases in the level of unemployment in the protected industry because most new workers will be affected even at low levels of unemployment and because the number of older workers who decide to shift in response to an increase in unemployment tends to decline as the level of unemployment rises.

Finally, if this heuristic argument about the form of the $\phi(U, N)$ function governing the response of the rate of worker movement to the level of unemployment in the protected industry is accepted, then it follows that concern with controlling the social costs of unemployment arising from reductions in the level of protection provides a valid rationale for a gradual policy of trade liberalization.

APPENDIX

This appendix presents some of the formal details of the analysis of the dynamic process governing the adjustment of the economy for the model described in Section II. We consider an economy that produces two goods, X and Z, in accord with standard, neoclassical, linear homogeneous production functions, using two inputs, capital and labor:

(A1) $X = F(L_X, K_X)$;

(A2) $Z = G(L_Z, K_Z)$.

Labor is assumed to be mobile between X and Z production, but capital is specific, at least at a moment of time, to producing output in the industry where it is located.

There is an adjustment process through which capital can be moved from one industry to another over the course of time. Such capital movement is "costly" in the sense that it requires use of some of the economy's supply of mobile labor, in accord with the labor requirements function for capital movement;

(A3) $L_M = \psi(|M|), \quad \psi(0) = 0 \quad \psi'(0) = 0, \ \psi'' > 0$

where M denotes the rate at which existing capital is being moved out of Z and into X. The specification of ψ as a function of the absolute value of M implies that the cost of moving existing capital is independent of the direction of movement.

In addition to movement of existing capital, adjustment occurs through depreciation of existing capital, at an exponential rate δ common to capital located in both industries, and through investment in new capital

that may be located (initially) in either industry. Investment requires use of some of the economy's supply of mobile labor in accord with the investment labor requirements function;

(A4) $L_I = \phi(I), \quad \phi(0) = 0, \quad \phi'(I) > 0, \quad \phi''(I) > 0,$

where I is the rate of production of new capital.

Taking account of investment in new capital, depreciation of existing capital, and movement of existing capital, the rates of change of the capital stocks in the two industries are given by

(A5) $\dot{K}_X = I_X - \delta \cdot K_X + M,$

(A6) $\dot{K}_Z = I_Z - \delta \cdot K_Z - M;$

where $I_X \geq 0$ and a $I_Z \geq 0$ are, respectively, the amounts of investment allocated to X and Z, which add up to total investment in new capital; i.e.,

(A7) $I_X + I_Z = I.$

The total amount of mobile labor available to produce final goods, to produce new capital, and to produce the service of movement of existing capital is the economy's endowment of labor, $\bar{L}$. Assuming that labor is fully employed, the constraint on the total use of labor is expressed by the requirement

(A8) $L_X + L_Z + L_I + L_M = \bar{L}.$

It is assumed that the behavior of the economy is governed by a social planner whose objective is to maximize the present discounted value of the economy's output of final goods, V, where V is defined by

(A9) $V = \int_0^\infty (P \cdot X + Z) \cdot \exp(-r \cdot t)\, dt.$

It is assumed that the relative price of X in terms of X, denoted by P, and real interest rate measured in terms of units of Z per year, denoted by r, are fixed exogenously (by conditions in world goods and capital markets). This assumption of exogeneously determined values of P and r could be relaxed with some increase in the complexity of the analysis, but without altering any of its basic conclusions. The social planner's behavior is constrained by the relationships expressed in (A1) through (A8).

To determine the solution or the social planner's optimization problem it is convenient to define the current value Hamiltonian

$$(A10) \qquad H = P\cdot F(L_X,K_X) + G(L_Z,K_Z) + \mu_X\cdot(I_X - \delta\cdot K_X + M)$$

$$+ \mu_Z\cdot(I_Z - \delta\cdot K_Z - M) + \omega\cdot(\bar{L} - L_X - L_Z - \phi(I_X + I_Z) - \psi(|M|)).$$

In this Hamiltonian, μ_X represents the shadow price of a unit of capital located in X, μ_Z represents the shadow price of a unit of capital located in Z, and ω represents the shadow wage rate, all measured in terms of units of Z at time t. The first order conditions for optimal behavior at time t require maximization of H by choice of the current control variables L_X, L_X, I_X, I_Z, M, and ω . Assuming an interior solution, the associated first order conditions are for the maximization of H are given by

$$(A11a) \qquad \partial H/\partial L_X = P\cdot F_L - \omega = 0$$

$$(A11b) \qquad \partial H/\partial L_Z = G_L - \omega = 0$$

$$(A11c) \qquad I_X\cdot(\partial H/\partial I_X) = I_X\cdot(\mu_X - \omega\cdot\phi') = 0$$

$$(A11d) \qquad I_Z\cdot(\partial H/\partial I_Z) = I_Z\cdot(\mu_Z - \omega\cdot\phi') = 0$$

$$(A11e) \qquad \partial H/\partial M = \mu_X - \mu_Z - \omega\cdot\text{sign}(M)\cdot\psi' = 0.$$

$$(A11f) \qquad \partial H/\partial\omega = \bar{L} - L_X - L_Z - \phi(I_X + I_Z) - \psi(|M|) = 0.$$

The condition (A11a) determines the amount of labor employed in X through the requirement that the value of the marginal product of labor in X must equal the shadow wage rate. It follows that

$$(A12a) \qquad L_X = K_X \cdot \ell_X(\omega/P), \quad \partial\ell/\partial(\omega/P) < 0$$

where $\ell_X(\omega/P)$ is the labor demand function (the inverse of the marginal product of labor schedule) for a firm with one unit of capital located in X. Similarly, the condition (11b) determines the amount of labor employed in Z through the relationship

$$(A12b) \qquad L_Z = K_Z \cdot \ell_Z(\omega), \quad \partial\ell_Z/\partial\omega < 0$$

where $\ell_Z(\omega)$ is the labor demand function (the inverse of the marginal product of labor schedule) for a firm with one unit of capital located in Z.

The conditions (A11c) and (A11d) jointly determine the level of investment in new capital and its distribution between X and Z. Except in the special case where $\mu_X = \mu_Z$, satisfaction of these two conditions requires that all newly produced capital be allocated to the industry which has the higher shadow price of capital, and that no new capital be allocated to the industry with the lower shadow price of capital; that is

$$(A12c) \qquad I_X = \begin{cases} \phi'^{-1}(\mu_X/\omega) & \text{if } \mu_X > \mu_Z \\ 0 & \text{if } \mu_X > \mu_Z \end{cases}$$

$$(A12d) \qquad I_Z = \begin{cases} 0 & \text{if } \mu_X > \mu_Z \\ \phi'^{-1}(\mu_Z/\omega) & \text{if } \mu_X > \mu_Z. \end{cases}$$

In the special case where $\mu_X = \mu_Z$, the aggregate level of investment is determined by $I = \phi'^{-1}(\mu_X) = \phi'^{-1}(\mu_Z)$, and the distribution of investment

between X and Z is determined by conditions other than the first order conditions for maximization of the current value Hamiltonian.

The rate and direction of movement of existing capital between industries is determined by the condition (Alle) which says that the marginal cost of moving capital from Z into X, $\omega \cdot \text{sign}(M) \cdot \psi'(M)$, should equal the marginal benefit of such movement, as measured by the difference between the shadow price of a unit of capital located in X and the shadow price of a unit of capital located in Z. Solving this condition to determine M, we find that

$$\text{(A12e)} \qquad M = \text{sign}(\mu_X - \mu_Z) \cdot \psi'^{-1}(|\mu_X - \mu_Z|/\omega).$$

Thus, $|\mu_X - \mu_Z|/\omega$ determines the rate at which existing capital is moved between industries, and the sign of $\mu_X - \mu_Z$ determines the direction of that movement.

The appropriate value of the shadow wage rate is determined by the condition (A12f) which is simply the labor market clearing condition. Using (A12a) through (A12e) to substitute into (A11f), it follows that this value of the shadow wage rate must satisfy

$$\text{(A12f)} \qquad K_X \cdot \ell_X(\omega/P) + K_Z \cdot \ell_Z(\omega) + \phi(\phi'^{-1}(\max(\mu_X, \mu_Z)/\omega)))$$

$$+ \psi(\psi'^{-1}(|\mu_X - \mu_Z|/\omega)) = \bar{L}.$$

This condition can be solved for the optimum value of ω as a function of the state variables K_X and K_Z and the co-state variables μ_X and μ_Z (with the aggregate labor supply suppressed as a argument); viz

(A13) $\omega = \tilde{\omega}(K_X, K_Z, \mu_X, \mu_Z)$,

where the partial derivatives of $\tilde{\omega}$ with respect to each of its arguments is positive. Using the function $\tilde{\omega}(K_X, K_Z, \mu_X, \mu_Z)$ to substitute for the variable ω that appears in (A12a) through (A12e), we may determine the values of the other current control variables, L_X, L_X, I_X, I_Z and M, as functions of the state variables K_X and K_Z and the co-state variables μ_X and μ_Z. These functional relationships, which are implied by the first order conditions for maximization of the current value Hamiltonian, are indicated by a "tilda" appearing above the respective variable; e.g. $\tilde{L}_X(K_X, K_Z, \mu_X, \mu_Z)$ denotes the level of labor employed in X as a function of the state and co-state variables of the social planner's maximization problem.

Optimal behavior by the social planner also requires that the state variables K_X and K_Z and the co-state variables μ_X AND μ_Z evolve in accord with the appropriate transition laws. Specifically, for K_X and K_Z, we require that

(A14a) $\dot{K}_X = \partial H/\partial \mu_X = \tilde{I}_X(K_X, K_X, \mu_X, \mu_Z) - \delta \cdot K_X + \tilde{M}(K_X, K_Z, \mu_X, \mu_Z)$

(A14b) $\dot{K}_Z = \partial H/\partial \mu_Z = \tilde{I}_Z(K_X, K_Z, \mu_X\ \mu_Z) - \delta \cdot K_Z - \tilde{M}(K_X, K_Z, \mu_X\ \mu_Z)$.

For the co-state variables, μ_X and μ_Z, we require that

(A14c) $\dot{\mu}_X = r \cdot \mu_X - \partial H/\partial K_X = (r + \delta) \cdot \mu_X - P \cdot F_K(\tilde{L}_X(K_X, K_Z, \mu_X, \mu_X), K_X)$

(A14d) $\dot{\mu}_Z = r \cdot \mu_Z - \partial H/\partial K_Z = (r + \delta) \cdot \mu_Z - G_K(\tilde{L}_Z(K_X, K_Z, \mu_X, \mu_Z), K_Z)$

In addition, for the social planner to have chosen the optimal path for the economy, K_X and K_Z must have the initial values determined by the initial levels of capital in the two industries, and the paths of the state and co-state variables must satisfy the non-negativity constraints and the relevant transversality conditions.

Since the dynamic system that characterizes the evolution of the state and co-state variables is a (nonlinear) fourth order system, the usual graphical techniques (phase diagrams) that are applied for systems with one state variable and one co-state variable cannot be applied in the present case. There are, however, three important features of the present system that can be described relatively easily.

First, taking the forward looking solutions of the differential equations (A14c) and (A14d) that characterize the evolution of the shadow prices of capital in the two industries, we find that

$$\text{(A15c)} \quad \mu_X(t) = \int_t^{\infty} P \cdot F_K(s) \cdot \exp(-(r+\delta) \cdot (s-t)) ds + B_X \cdot \exp((r+\delta) \cdot t)$$

$$\text{(A15d)} \quad \mu_Z(t) = \int_t^{\infty} G_K(s) \cdot \exp(-(r+\delta) \cdot (s-t)) ds \cdot + B_Z \cdot \exp((r+\delta) \cdot t)$$

The transversality conditions for the social planner's optimization imply that the constants B_X and B_Z in (A15c) and (A15d) must both be zero. Thus, the shadow price of capital located in each industry at time t is equal to the present discounted value of the future return to a unit of capital in that industry, as determined by the value of the marginal product of capital in that industry, discounted at a rate equal to the market interest rate plus the depreciation rate. When the economy is controlled by private agents, these shadow prices calculated by the social planner are replaced

by the prices of units of capital located in the two industries which are calculated by private agents.

Second, at the steady state position of the economy for a given (constant) relative price of X in terms of Z, the value of the marginal product of capital must be the same in the two industries. Assuming that production is non-specialized, it follows that steady state wage rate, $\omega^*(P)$, and the steady state rental rate on capital, $R^*(P)$, (both measured in terms of the numeraire Z) correspond to the equilibrium wage rate and rental rate determined in the standard two-sector (Heckscher-Ohlin-Samuelson) model in which labor and capital are assumed to be perfectly mobile between industries. The steady state wage rate and rental rate, therefore, depend only on the relative commodity price, P. In the present model, however, the size of the capital stock is not fixed, and its steady state level depends on the relative commodity price. Specifically, the steady state size of the capital stock, K^*, is determined by the requirement that

$$\omega^*(P)\cdot\phi'(\delta\cdot K^*) = R^*(P)/(r+\delta) = \mu^* \tag{A16}$$

where $R^*/(r+\delta)$ corresponds to the common steady state value of μ_X and μ_Z, denoted by μ^*. From the properties of the standard two-sector model, it is known that if X production is relatively capital intensive, $R^*(P)/\omega^*(P)$ is an increasing function of P. It follows that in the present model if X production is relatively capital intensive, then the steady state capital stock will be an increasing function of P. The converse obviously holds if X is relatively labor intensive. The steady state distribution of the capital stock also depends on P: specifically, it can be shown that $K_X^*(P)$ is an increasing function of P and $K_Z^*(P)$ is a decreasing function of P.

Third, with respect to the adjustment process, it is important to note the difference between the factors that determine the rate of investment in new capital (and the distribution of that investment between industries) and the factors that determine the rate of movement of existing capital between industries. For the rate of investment, what matters is the maximum of μ_X and μ_Z, and any small difference between μ_X and μ_Z leads all new capital to be located in the industry with the higher shadow price of capital. Changes in the shadow price of capital for capital with the lower shadow price have no effect on the rate of investment in new capital or on its distribution between industries, so long as this shadow price remains the lower of the two shadow prices of capital. In contrast, the rate of movement of existing capital depends on the difference between the shadow prices of capital in the two industries. Common changes in the levels of μ_X and μ_Z, therefore, have no effect on the rate of movement of existing capital.

The nature of the adjustment process subsequent to a permanent reduction in the level of protection (which reduces the relative price of X in terms of Z seen by domestic producers and consumers) may be understood with the aid for figure A1. This figure is constructed for the case where the protected industry, X, is relatively capital intensive. Since only relative commodity prices matter, it is clear that this analysis applies equally well to a permanent increase in the level of protection of the Z industry which is assumed to be relatively labor intensive.

In figure A1, the line labeled L*L* shows the combinations of K_X and K_Z for which the long run level of labor demand is equal to the available labor supply, as expressed by the requirement that

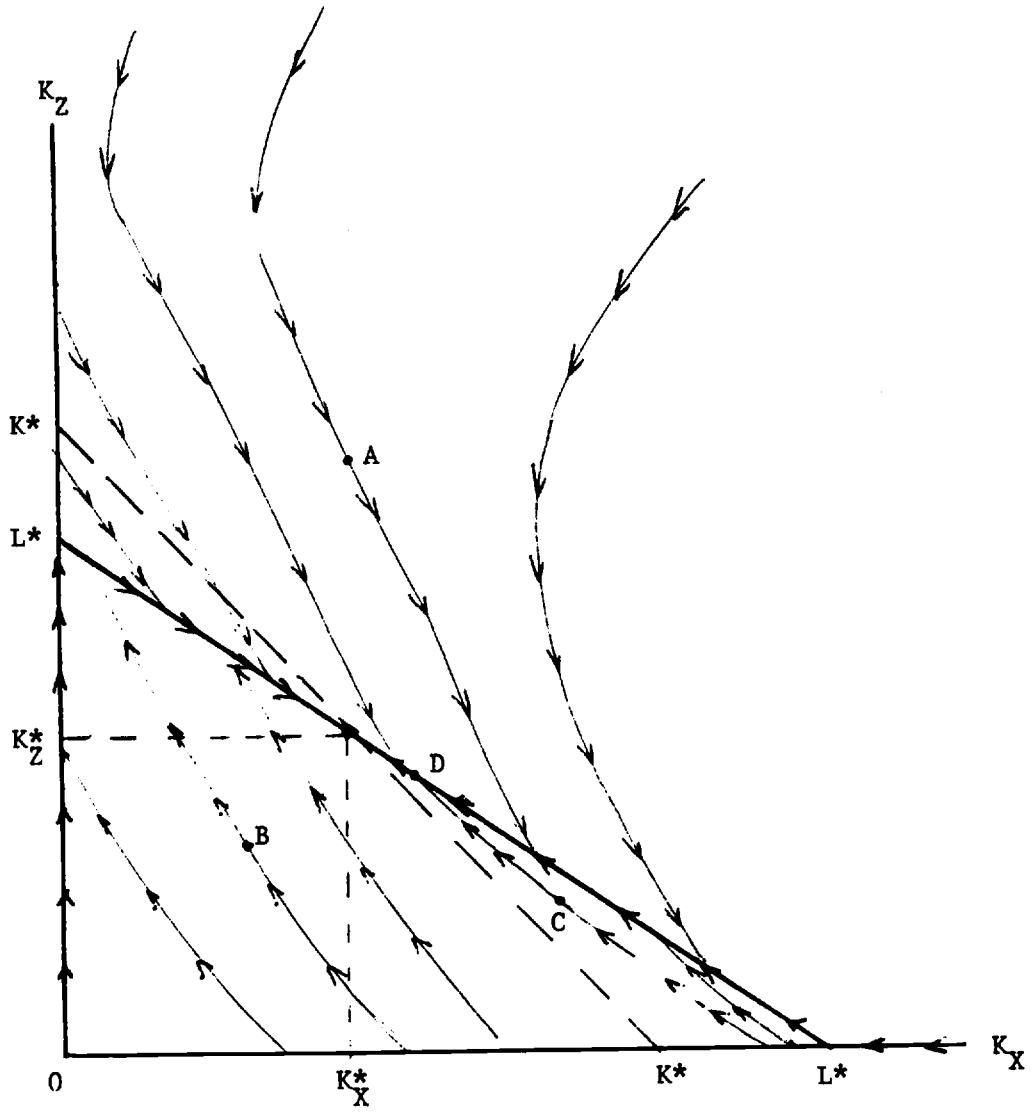


Fig.--A1: The paths of adjustment of capital in the two final goods industries.

(A17) $\quad K_X \cdot \ell_X^* + K_Z \cdot \ell_Z^* + L_I^* = \bar{L}$

where $\ell_X^* = \ell_X(\omega^*(P)/P)$, $\ell_Z^* = \ell_Z(\omega^*(P))$, and $L_I^* = \phi(\phi'^{-1}(\mu^*/\omega^*(P)))$. The nature of the solution of the social planner's optimization problem is such that the economy reaches this line precisely when μ_X and μ_Z are equal to each other and equal to μ^*. Once this line is reached, μ_X and μ_Z remain equal to μ^* ($\dot{\mu}_X$ and $\dot{\mu}_Z$ are both equal to zero), the amount of labor devoted to investment remains constant at L_I^*, the shadow wage rate remains constant at $\omega^*(P)$, and aggregate investment remains constant at $I^* = \phi(L_I^*)$. The distribution of aggregate investment changes in order to keep (A17) satisfied; that is, $\dot{K}_X$ and $\dot{K}_Z$ jointly satisfy the conditions

(A18a) $\quad \dot{K}_X \cdot \ell_X^* + \dot{K}_Z \cdot \ell_Z^* = 0$

(A18b) $\quad \dot{K}_X + \dot{K}_Z = I^* - \delta \cdot (K_X + K_Z).$

From these conditions, it follows that when the economy is at a point along the L*L* line above and to the left of the optimum steady state point (K_X^*, K_Z^*), K_X is rising, K_Z is falling, and the aggregate capital stock $K_X + K_Z$ is rising (since the rate of increase of K_X is greater than the rate of decrease of K_Z). This process continues until the economy reaches the optimum steady state position (K_X^*, K_Z^*) which depends on the given value of the domestic relative price of X in terms of Z. At this optimum steady state position, aggregate investment is just sufficient to cover aggregate capital depreciation and the distribution of investment is such as to keep the capital stock in each industry constant. Conversely, if the economy starts at a point on the L*L* line that is below and to the right of the optimum steady state point, then K_X will be falling and K_Z will be rising,

and the aggregate capital stock will be falling (since rate of decrease of K_X exceeds the rate of increase of K_Z). This process also continues until the optimum steady state point (K_X^*, K_Z^*) is reached.

If the initial levels of capital in the two final goods industries place the economy at a point off of the L*L* line defined by (A17), the optimum initial value of μ_X will necessarily differ from the optimum initial value of μ_Z determined by the solutions to the social planner's optimization problem. In particular, if the point corresponding to the initial levels of capital in the two industries lies above the L*L* line, like the point $A = (K_X^A, K_Z^A)$, the optimum initial values of μ_X and μ_Z, denoted by $\mu_X^A(0)$ and $\mu_Z^A(0)$, must be less than μ^* with $\mu_X^A(0) > \mu_Z^A(0)$. At this initial point, K_Z will be falling and K_X will be rising because all new investment will be devoted to the X industry and some existing capital will be moving from Z to X.[1/] The point describing the position of the economy in figure A1, therefore, will be moving downward and to the right along a path leading to point on the L*L* line (or on the K_X axis). As the economy moves along this path, both μ_X and μ_Z will be rising, and μ_Z rising more rapidly than μ_Z. When the L*L* line is reached, μ_Z will equal μ_X and both will equal μ^*. Henceforth, the economy will move along the L*L* line in the manner previously described.

If the initial levels of capital in the two industries place the economy at a point such as $B = (K_X^B, K_Z^B)$ that is below the L*L* line, the

---

1/ If the capital stock in both industries is large, the initial level of aggregate investment together with the rate of capital movement may not be sufficient to compensate for depreciation of capital in X. In this case, both K_X and K_Z will be declining at the economy's initial point.

optimum initial values of μ_X and μ_Z, denoted by $\mu_X^B(0)$ and $\mu_Z^B(0)$, will be greater than μ^*, with $\mu_X^B(0) < \mu_Z^B(0)$. At this initial point, K_X will be falling and K_Z will be rising because all new investment will be devoted to the Z industry and some existing capital will be moving out of X and into Z. The point describing the position of the economy, therefore, will be moving upward and to the left along a path leading to the L*L* line (or to the K_Z axis). As the economy moves along this path, both μ_X and μ_Z will be falling, with μ_Z falling more rapidly than μ_X. When the L*L* is reached, μ_X will equal μ_Z and both will equal μ^*. Henceforth, the economy will move along the L*L* line in the manner previously described.

If the initial position of the economy is the steady state equilibrium position corresponding to a higher relative price of X (sustained by the previous tariff protection granted to the X industry), then this position must be at a point like $C = (K_X^C, K_Z^C)$ that lies below the L*L* line and below and to the right of the new steady state equilibrium point (K_X^*, K_Z^*).[1/] At this initial point C, the total capital stock, $K^C = K_X^C + K_Z^C$, must be greater than the new steady state equilibrium capital stock, $K^* = K_X^* + K_Z^*$. This is indicated in figure A1 by the position of the point C above the K*K* line which shows the combinations of K_X and K_Z for which the total capital stock is equal to K*. Starting at C, the rules governing the adjustment of the economy are those described in the preceding paragraph: K_X falls and K_Z rises, and both μ_X and μ_Z fall until L*L* line is reached at which time

---

1/ The old steady state equilibrium position must lie along the line described by (A17) for a higher value of P. Using the properties of the standard two-sector model, it may be shown that this old L*L* line must lie below the L*L* line in figure A1 which is drawn for a lower value of P.

$\mu_X = \mu_Z = \mu^*$. The point D at which the L*L* line is reached (starting from C) must lie below and to the right of the new steady state equilibrium point (K_X^*, K_Z^*). Subsequent adjustment along the L*L* line, therefore, involves a positive $\dot{K}_Z$ and a negative $\dot{K}_X$, with these levels of net investment converging to zero as the steady state equilibrium position is reached. The path of adjustment from the point C to the new steady state equilibrium position at (K_X^*, K_Z^*) is the path of adjustment in response to an immediate trade liberalization that is discussed in the main text.

References

Jones, R. W., 1971, "A Three Factor Model in Theory, Trade, and History," in Bhagwati, J. N. and Jones, R. W. (eds.), Trade, the Balance of Payments, and Growth. Amsterdam: North Holland.

Lapan, H. E., 1976, "International Trade, Factor Market Distortions, and the Optimal Dynamic Subsidy," American Economic Review, 66, no. 3., (June), pp. 335-46.

Leamer, E. E., 1980, "Welfare Computations and the Optimal Staging of Tariff Reductions in Models with Adjustment Costs," Journal of International Economics, 10, no. 1., (February), pp. 21-36.

Martin, R. and Selowsky, M., 1982, "On the Optimal Phasing of Consumer Price Subsidies," unpublished manuscript, June.

Mayer, W., 1974, "Short-run and Long-run Equilibrium for a Small Open Economy," Journal of Political Economy, 82, no. 5., (September), pp. 955-67.

Mussa, M. L., 1974, "Tariffs and the Distribution of Income: The Importance of Factor Specificity, Substitutability, and Intensity in the Short and Long Run," Journal of Political Economy, 82, no. 6., (November), pp. 1191-1203.

Mussa, M. L., 1978, "Dynamic Adjustment in the Heckscher-Ohlin-Samuelson Model," Journal of Political Economy, 86, no. 5., (September), pp. 775-91.

Mussa, M. L., 1982a, "Imperfect Factor Mobility and the Distribution of Income," Journal of International Economics, 12, no. 1., (February).

Mussa, M. L., 1982b, "Government Policy and the Adjustment Process," in Bhagwati, J. N. (ed.), Import Competition and Response. Chicago: Univ. of Chicago Press.

Neary, J. P., 1982, "Intersectoral Capital Mobility, Wage Stickiness, and the Case for Adjustment Assistance," in Bhagwati, J. N. (ed.), Import Competition and Response. Chicago: Univ. of Chicago Press.

van Wijnbergen, S., 1983, "Tariffs, Employment and the Current Account: The Role of Real Wage Resistance." unpublished manuscript, July.