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CREDIBILITY, REAL INTEREST RATES, AND THE OPTIMAL SPEED OF TRADE LIBERALIZATION

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This paper investigates the effects of imperfectly credible trade liberalization programs on welfare and the allocation of resources. We present a rational expectations model in which a government with limited access to international borrowing will abort a liberalization program if hard-currency reserves are depleted too quickly. The liberalization's lack of perfect credibility acts as a distortion which becomes (rationally) intensified under the typical first-best policy of immediate liberalization. A more gradual lowering of trade barriers leads to higher welfare and a greater probability that the program succeeds. We derive the optimal speed of liberalization, and the endogenous level of credibility.

1. Introduction

Given the unpopularity of tariffs among economists, it should come as no surprise that so many countries have been counselled to embark upon ambitious trade liberalization programs over the past decade. In return for large reductions in trade barriers, conventional neoclassical models and newer models using an intertemporal approach to commercial policy offer the prospect of improvements in welfare and efficiency. To the extent that these models are realistic, they make a strong case for the viability and profitability of immediate and complete trade liberalization.

In an uncertain world, however, there is less cause for optimism than many such models would suggests. Recent attempts at trade liberalization in the southern cone of Latin America, like many earlier programs in these and other countries, have been completely or partially abandoned. Argentina and Uruguay, for example, had plans to establish a lower, more uniform tariff structure with a maximum rate of 35 percent (down from several hundred

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percent) and a minimum rate of about 10 percent. The Argentinean package, announced in December 1978, was abandoned in 1981 and the progress that had been made was soon reversed. The Uruguayan plan never succeeded in reducing trade barriers. Chile was by far the most successful in bringing down tariffs, which reached a uniform level of 10 percent (excluding autos) by the end of 1979. Since then, however, tariffs have been raised substantially.

With this kind of experience as the rule, it seems our models should address the possibility that agents will take the government's stated intention of permanently liberalizing trade with a (rational) grain of salt. Several authors have in fact argued that recent trade liberalization programs in the southern cone were not fully credible. Edwards (1983, 1985a, b), Pastore (1983), Sjaasted (1983), and Dornbusch (1983, 1985), for example, all point toward blatant domestic policy inconsistencies as being partly responsible for the programs' failures. Calvo (1985, 1986) studies the costs of such temporary liberalizations in the absence of uncertainty. Rodrick (1987) focuses on the role of commercial policy in signaling the government's preferences, about which the private sector is uncertain.

This paper injects the issue of incompletely credible policy into the discussion of tariff reduction in a very simple way. It considers a government whose commitment to free trade is infeasible in some future states of the world. Private agents are assumed to be fully informed: when the liberalization first takes place they recognize the possibility of time-inconsistency, and behave in a way that makes a retrenchment from free trade more likely. We concentrate on the intertemporal incentives in consumption and the distortions in output which are generated by fears that the liberalization program will be short lived. The analysis intentionally focuses on countries (such as many LDCs today) that have limited access to international financial markets, in the sense that unanticipated current account deficits must be financed by reserve depletion instead of by borrowing. The credibility of trade reform is perhaps most important in these countries because of their dual histories of policy reversals and severe trade restrictions.

Our interest lies not just in how doubts about the permanence of trade reforms contribute to the eventual reinstatement of trade barriers. We also consider the effects of alternative, slower speeds of liberalization on the equilibrium level of credibility. Even though such slower rates of reform are second best in that they represent clear deviations from the neoclassical optimum, they are desirable here because they turn out to lessen the distortion generated by the lack of perfect credibility. Indeed, it turns out that in the model below, governments with credibility problems should not pursue policies that eliminate tariffs right away. Such a finding is particularly surprising in the context of our optimizing two-period framework, which tends to bias the results toward complete and instantaneous liberalization

even as compared with more standard macro-economic treatments.[1] In the modern intertemporal approach, for example, a permanent tariff reduction is painless in the sense that it does not result in a trade deficit.

After describing the model in section 2, section 3 goes on to derive a rational expectations equilibrium in which the current account deficit, level of welfare, and the probability of collapse are endogenous. Next, we consider a more gradual liberalization program which employs positive first-period tariffs. It is possible to show that gradualism improves welfare, lowers the current account deficit, and raises the probability that free trade will ultimately prevail. There is a unique, positive first-period tariff which is welfare optimal. For many developing countries today, particularly those with large external debts, binding restrictions on international borrowing fix current accounts more or less exogenously. In section 4, the effects of imperfect credibility are investigated when agents cannot substitute toward current consumption by running a larger current account deficit.[2] In these circumstances, the shadow value of saving must increase to equilibrate the expected marginal utility of real consumption in both periods. High real interest rates have in fact been a common feature of many recent liberalization attempts. Here we find that more gradual speeds of liberalization will help bring down interest rates and shift production toward the export sector. Section 5 concludes.

2. The model

We employ a two-period model of a small country similar to that of Svensson and Razin (1983), and Edwards and van Wijnbergen (1983). There are two goods, exports (x) and imports (m), both of which are consumed and produced. The small country is represented by a single consumer, who maximizes expected welfare, $W = W(\gamma, \Gamma)$, where $\gamma = \gamma(c_m, c_x)$ denotes subutility in period 1 of the consumption of imports, c_m, and exports, c_x. Period 2 subutility is expressed as $\Gamma = \Gamma(C_m, C_x)$.[3] γ and Γ are assumed to have the expected utility property and are homothetic. Without loss of generality, γ and Γ can be chosen to be linearly homogeneous. Each period's expected subutility has an associated unit expenditure function, π and Π, which yields the minimum expenditure required to reach the unit level of expected subutility in that period, given current prices of imports and exports:

[1] Examples of the approach used in this paper include Dixit and Norman (1980), Svensson and Razin (1983), Edwards and van Wijnbergen (1983), and van Wijnbergen (1983).

[2] In a similar two-period model, Edwards and van Wijnbergen (1983) investigate the optimal speed of liberalization for the case in which a binding external financing constraint falls entirely on investment and second-period tariffs are zero with certainty.

[3] Throughout the paper we use lower-case letters for period-1 variables and upper-case letters for period-2 variables.

$$\pi(p_m, p_x, 1) = \min\{p_m c_m + p_x c_x : 1 \leqq \gamma(c_m, c_x)\},$$

$$\Pi(P_m, P_x, 1) = \min\{P_m C_m + P_x C_x : 1 \leqq \Gamma(C_m, C_x)\}. \quad \text{(i)}$$

Expressions for nominal spending are therefore $\pi\gamma$ and $\Pi\Gamma$, the price index times the measure of real consumption in that period.

The analogous intertemporal expenditure function, $E(\pi, D\Pi, W)$, gives the minimum present discounted expenditure required to achieve a fixed level of expected welfare, for given levels of the price indexes, π and Π:

$$E(\pi, D\Pi, W) = \min\{\pi(p_m, p_x)\gamma + D\Pi(P_m, P_x)\Gamma : \bar{W} \leqq W(\gamma, \Gamma)\}, \quad \text{(ii)}$$

where $D = (1+i)^{-1}$ is the discount factor and i is the domestic nominal interest rate. Overall welfare, W, is the expected utility of real consumption over both periods. From the Slutsky equation, the marginal propensity to spend times the change in expenditure with respect to welfare is equal to the second derivative of the expenditure function with with respect to price and welfare:

$$\frac{E_{1W}}{E_W} = \frac{\partial \gamma}{\partial E} = c_W, \quad \text{(iii)}$$

where c_W is the marginal propensity to spend in period 1 out of a change in expenditure.

On the production side we define first- and second-period composite revenue functions (over exports and imports), q and Q, which are homogeneous of degree one in each period's prices:

$$q(p_m, p_x; K, L) = \max\{p_m q_1 + p_x q_2 : q_1, q_2 \text{ are feasible}\}, \quad \text{(iv)}$$

where the own derivatives with respect to prices, $q_1 = q_1(p_m, p_x; K, L)$ and $q_2 = q_2(p_m, p_x; K, L)$ are the first-period functions for imports and exports, respectively (and similarly for period 2).[4]

3. Expected collapse of a liberalization program when reserves are not rationed

With this model in mind consider a country that has just liberalized its trade account by eliminating tariffs on imports. We assume that the country

[4]This model could be extended to include investment by adding a specific factor such as land. In an effort to keep the model as simple as possible, however, we abstract from investment since it provides no important new insights. In addition, we wish to distinguish the results in section 4 from related results in Edwards and van Wijnbergen (1983), which depend on the assumption that the external financing falls entirely on investment.

is credit constrained in that the private sector does not have direct access to suppliers of foreign exchange. Instead, all borrowing in international capital markets is conducted by the government at the beginning of period 1. The initial level of hard-currency reserves held by the government, R, includes any external financing the government has been able to arrange, and is treated here as exogenously determined (though in reality it is the outcome of a quasi-market bargaining process between the government and its creditors). These reserves may be interpreted as a buffer stock of the two goods, whose prices are fixed exogenously in world markets.

In this section, the government must finance any current account deficit from its stock of reserves. The government's reserves are also used to shield the private sector from unanticipated shocks to export revenues or import expenditures that occur during period 1. Thus the ex post current account deficit, or the total reduction in government reserves, is the sum of the current account deficit the private sector chooses plus a random shock component:

$$\tilde{z}=z+\mu, \tag{1}$$

where μ is distributed normally with mean 0 and variance σ_μ^2. At the end of the first period, reserves are $R-\tilde{z}$.

To focus on the possibility that the liberalization program will be abandoned, we assume the government follows a rule-of-thumb policy in deciding whether to levy second-period tariffs. The rule is that tariffs will be reimposed at an arbitrary fixed level, τ_p, in period 2 if reserves at the end of the first period fall below some critical floor, $R_{\min}$, and otherwise, period-2 tariffs remain at zero. The probability that the liberalization program will be reversed is just the probability that end-of-period reserves are less than $R_{\min}$:

$$\lambda=P(R_{\min},\sigma_\mu^2,z)=\text{probability}\{\mu>R-R_{\min}-z\}. \tag{2}$$

To keep matters simple and to avoid ambiguities, we assume that $R_{\min}$ is set equal to the difference between the initial level of reserves and the maximum current account deficit, i.e. the deficit the private sector would choose if tariffs were to be reinstated with probability one:[5]

$$R_{\min}\equiv z(\lambda=1). \tag{3}$$

Notice that even with a balanced current account, $z=0$, there is still a

[5]This assumption turns out to guarantee uniqueness of the rational expectations equilibrium below.

nonzero probability of reversal. The government's decision rule therefore implies that the price of imports in period 2 is distributed binomially:

$$\tilde{P}_m = \begin{cases} P_m^*, & \text{if } \mu \leqq R - R_{\min} - z, \\ P_m^* + \tau_p, & \text{if } \mu > R - R_{\min} - z. \end{cases} \tag{4}$$

Before we proceed, two other aspects of the model require elaboration. First, in this type of welfare-based general equilibrium model, it is often useful to limit the absolute magnitude of distortions (in our case, τ_p). Large distortions result in large reductions in real income, and these income effects eventually swamp the more subtle substitution effects we wish to study. So, for example, in attempting to offset the negative first-period welfare effects of a large temporary first-period tariff, agents shift real expenditure toward the first period. When the tariff is big enough, expenditure in the first period is sufficient to swing the current account into *deficit*. Although one could question the importance of such perverse Marshallian effects on the basis of their doubtful realism, we rule them out here simply because tariffs are imposed by governments with the intention of *improving* the current account. Therefore, in the spirit of the small-but-positive tariff assumption, we frequently express sufficient conditions for the paper's results in terms of upper bounds on the size of the tariff.

A second aspect of the model that requires additional explanation is the treatment of uncertainty. Random prices are not usually added to intertemporal general equilibrium models because of the additional complexity they bring. The standard results from duality theory do not generally hold when prices are random; for example, there is no guarantee that the matrix of Hicksian substitution terms is negative semidefinite. In the present paper, however, we are able to invoke a kind of weak-form certainty equivalence by exploiting the binomial distribution of import prices and the limitations imposed on the magnitude of the tariff by our small-but-positive tariff assumption. Notice that the nth moment of the second-period tariff, $\tilde{\tau}$, can be written as $M_n(\tilde{\tau}) = \tau_p^n \lambda(1-\lambda^{n-1})$. For a small, but *positive* tariff and any given finite probability that the liberalization will collapse, the higher-order moments of $\tilde{\tau}$ can be made insignificantly small relative to the expected tariff, $\lambda\tau_p$. More precisely:

$$\lim_{\tau_p \to 0} \frac{M_n(\tilde{\tau})}{E(\tilde{\tau})} = (1-\lambda^{n-1})\tau_p^{n-1} = 0, \quad \forall n \geqq 2. \tag{5}$$

The effects of a change in the *probability* that tariffs will be levied in period 2 can be made arbitrarily close to the effects of a known change in the future tariff. For small but *strictly positive* values of τ_p, the signs of the substitution

and income effects remain the same as in the certainty case, even though the optimal choice variables become vastly more complex functions of the underlying utility and production functions.[6] Since we make no attempt in the paper to specify the various elasticities of consumption and production beyond their respective signs, all of the results remain general enough to apply to a variety of utility and production functions. Indeed, such a treatment of uncertainty seems particularly natural in this case, since, as we have already noted, it is desirable to restrict our attention to small positive values of τ_p, regardless of whether uncertainty is present.

We can now apply the model of the previous section, and derive the rationally expected level of credibility, the current account, and the level of welfare under complete liberalization. The intertemporal budget constraint of the country is:

$$E(\pi(p_m, p_x), D\Pi(P_m, P_x), W) = q(p_m, p_x) + DQ(P_m, P_x) + T. \tag{6}$$

Eq. (6) requires that total expenditure is equal to the present discounted value of income plus tax revenues. Revenues generated by a future tariff will be returned to the private sector in the form of a lump-sum transfer, T, where

$$T = D\bar{\tau}(E_2\Pi_1 - Q_1) = D\bar{\tau}(C_m - Q_1). \tag{7}$$

$C_m - Q_1$ represents net imports, or consumption minus domestic production of the imported good, and $\bar{\tau} = \lambda\tau_p$, the expected future tariff. We assume that the country has no prior debt to the rest of the world (this could easily be added). Consequently, the current account deficit is equal to consumption expenditure minus total revenues from production:

$$z = E_1\pi - q. \tag{8}$$

To see that an imperfectly credible commitment to free trade leads to a suboptimal allocation of resources, we take the derivative of eq. (6) with respect to λ and use eq. (7) to get:

$$E_W\,\mathrm{d}W = \lambda\alpha_0\,\mathrm{d}\lambda, \tag{9}$$

where

[6]See Proposition A.1 of Appendix 1 in the NBER Working Paper version of this paper for a proof of this statement. There we show that, for example, the own, pure substitution effect has the usual (negative) sign provided that $\tau_p < (\Gamma_2\Psi^{-1})^{1/2}$, where Γ_2 is the marginal utility of future consumption evaluated at the positive expected tariff, $\lambda\tau_p$, and Ψ is a complicated expression which is $O(0)$ in τ_p.

$$\alpha_0 = \frac{\tau_p D(E_2\Pi_{11} + \Pi_1 E_{22}\Pi_1 D - Q_1)}{1 - \bar{\tau} D \Pi_1 C_W} < 0.$$

Eq. (9) gives the loss in welfare attributable to a nonzero probability that strictly positive future tariffs will be levied. Welfare declines proportionally in the probability of a policy reversal; indeed, integration of eq. (9) gives the familiar Harberger result that the loss in welfare is proportional to the square of the distortion (i.e. the lack of perfect credibility).

The welfare effects of the misallocation of resources are summarized in α_0. The numerator is proportional to the discounted substitution effect in consumption and production, holding welfare constant. The first term in the numerator, $E_2\Pi_{11} = \partial C_m/\partial P_m$, is the change in the compensated demand for period-2 imports from a change in price holding real period-2 expenditure constant. This captures the *intratemporal* substitution in consumption of exports for imports. The second term, $\Pi_1 E_{22}\Pi_1 D = (C_m/\Gamma)(\partial\Gamma/\partial P_m)$, is the change in period-2 real spending from a change in the price of imports, weighted by the share of imports in spending. This term represents the transfer of real income across periods in response to price changes. The third term, $-Q_1$, is the negative valuation effect on imports realized as a result of the distortion. Taken together these three terms comprise the compensated substitution effects of the expected future tariff; all represent welfare losses.[7]

It is worth mentioning the effects on production as well. On the margin, output of the imported good is expected to rise by $P_m Q_{11}$ while output of exports is expected to fall by an equivalent amount,[8] $P_x Q_{21}$. The standard mechanism linking the output of imports and exports is the wage–rental ratio, ω, which decreases with higher import prices. The effect of expected price changes on the composition of output can be seen in fig. 1, the familiar Samuelson diagram. With zero expected future tariffs, the terms of trade stand at p, corresponding to an output mix at point B (where A represents complete specialization in exports and D represents complete specialization in imports), given the capital–labor ratio of the economy, k. An increase in tariffs lowers the expected terms of trade to p', lowers ω and moves the output mix to point C, where more imports and fewer exports are produced than before.

To see the effects of a change in the probability of a policy reversal on the current account we differentiate eq. (8) and use eq. (9) to get:

[7]The overall effect of the expected future tariff on welfare will be negative providing the stability condition $1 - \bar{\tau} D \Pi_1 C_W > 0$ is satisfied. An unnecessarily strong but sufficient condition for this is if the marginal propensity to spend in both periods is positive, that is, if $D\Pi C_W < 1$.

[8]These two terms cancel exactly only for infinitesimal changes in relative prices. For discrete changes, the change in total output is zero only for first-order approximations.

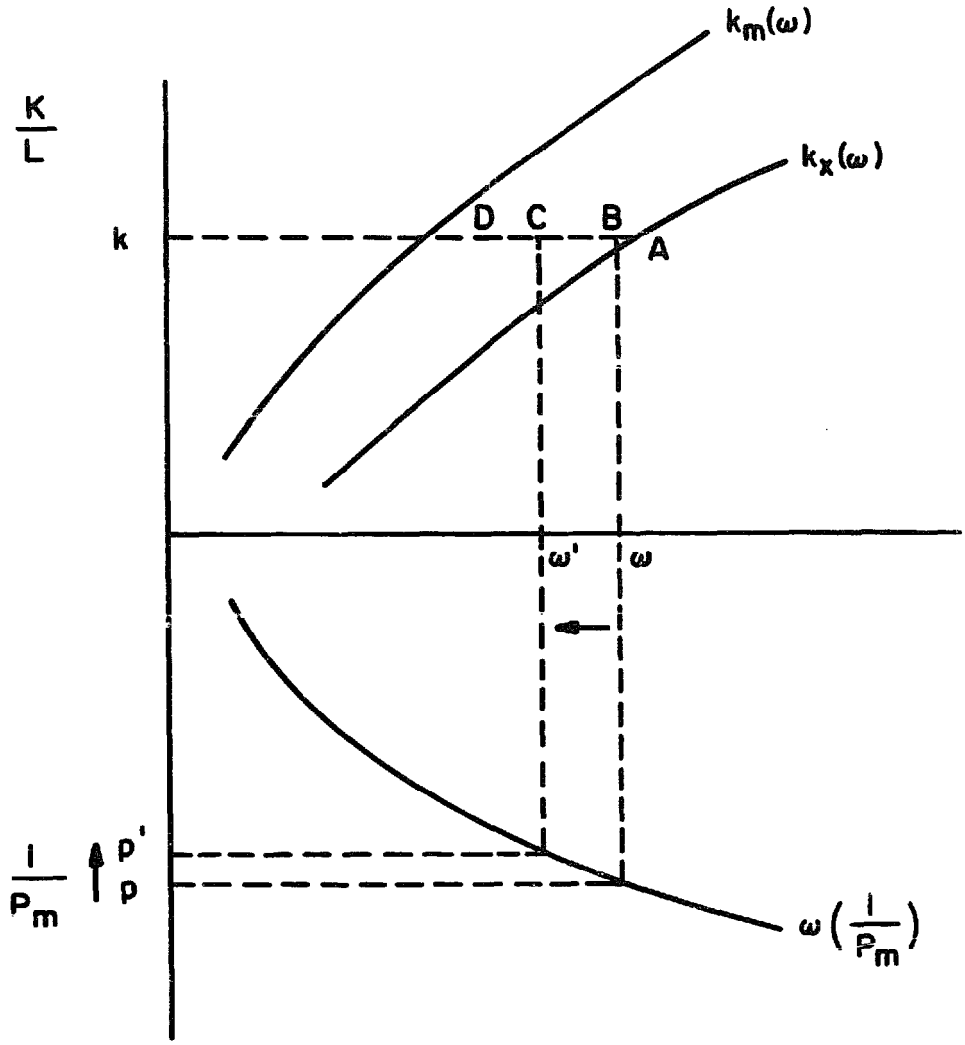

Fig. 1. The effects of expected future tariffs on the expected period-2 output mix.

$$\frac{dz}{d\lambda}=\alpha_1-\alpha_2\lambda, \tag{10}$$

where $\alpha_1=\pi E_{12}\Pi_1 D>0$, and $\alpha_2=-\pi c_W\alpha_0>0$.

The first term in eq. (10), α_1, is the sum of the compensated intertemporal substitution effects in consumption; it tends to increase unambiguously the current account deficit. The intuition is that higher expected tariffs raise the aggregate level of prices in the second period and lower the real consumption rate of interest, $1+r=\pi/D\Pi$. The incentive to save is therefore reduced and consumption is transferred toward the first period. Also, the lower the credibility of the liberalization program, the greater the misallocation of real resources toward the inefficient import sector.

The second term in eq. (10), $-\alpha_2\lambda$, which is negative, reflects the decrease in total income from the distortion weighted by the marginal propensity to spend in period 1 and the expected tariff. A decrease in total income reduces

real spending in every period,[9] and improves the first-period current account. Notice that if the tariff becomes too large, the second term will dominate, and the expected future tariff will *improve* the first-period current account. We therefore use as an upper bound on the size of the tariff the point at which the substitution effects are just cancelled out by the income effects: $0<\tau_p \leq \alpha_1/\alpha_2$. Note that at the margin $\lambda=0$, the intertemporal substitution effects, α_1, induce a marginal current account deficit regardless of the size of τ_p.

To find the approximate deviation in the level of the current account from the zero expected tariff equilibrium, we integrate eq. (10) to get an expression which is once again approximately a quadratic:[10]

$$z(\lambda)=\alpha_1\lambda-(1/2)\alpha_2\lambda^2. \tag{11}$$

Given our restriction on τ_p, the current account deficit is an increasing function of the probability that the liberalization program will fail.

We can now solve for the rational expectations equilibrium of the model by combining eqs. (2) and (11). A linear approximation to λ in eq. (2), is used to give a simple algebraic solution (in any case, the cumulative normal distribution is not tractable analytically):

$$\lambda=P(\chi,\sigma_\mu^2,z)=\alpha_3+\alpha_4 z, \tag{12}$$

$$\alpha_3=\alpha_3(R_{\min},\sigma_\mu^2)\colon \frac{\partial\alpha_3}{\partial R_{\min}}<0,\ \frac{\partial\alpha_3}{\partial\sigma_\mu^2}>0$$

$$\alpha_4=\alpha_4(R_{\min},\sigma_\mu^2)\colon \frac{\partial\alpha_4}{\partial R_{\min}}>0,\ \frac{\partial\alpha_4}{\partial\sigma_\mu^2}>0.$$

Eqs. (2) and (11) now give equilibrium levels of credibility, λ^*, and the current account deficit, z^*:

$$\lambda^*=\alpha_3+\frac{-1-\alpha_4(\alpha_2\alpha_3-\alpha_1)+((\alpha_1\alpha_4-1)^2+2\alpha_2\alpha_3\alpha_4)^{1/2}}{\alpha_2\alpha_4}, \tag{13}$$

$$z^*=\frac{-1-\alpha_4(\alpha_2\alpha_3-\alpha_1)+((\alpha_1\alpha_4-1)^2+2\alpha_2\alpha_3\alpha_4)^{1/2}}{\alpha_2\alpha_4^2}. \tag{14}$$

[9]Nominal spending will rise less than proportionately in the period with the tariff, and fall absolutely in the other period.

[10]The integration performed in eq. (11) holds α_1 and α_2 fixed (while in fact they may vary with λ), and therefore yields an approximation to the current account. See the NBER Working Paper version (especially footnote 9) for more details.

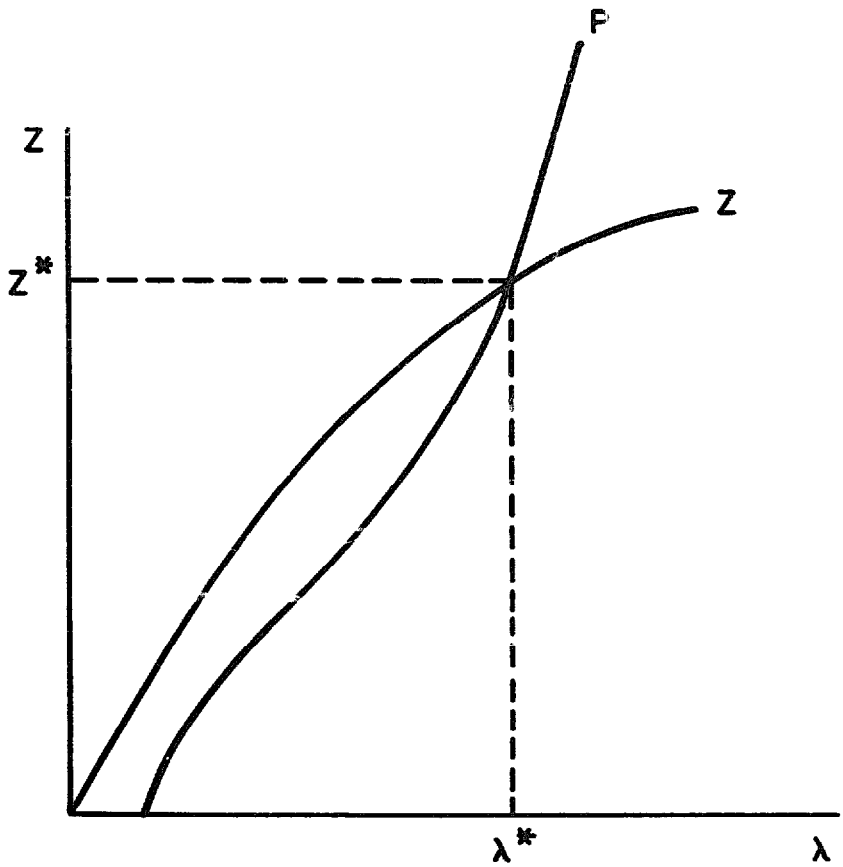

Fig. 2. The current account and the probability that liberalization is reversed.

The scaling restriction in eq. (3) is sufficient to imply that $\alpha_1\alpha_4<1$, $\alpha_1>\alpha_2$, and $\alpha_3<1$, so that λ^* and z^* are both positive. Also, from eqs. (9) and (11), we have that the loss in welfare due to the imperfect credibility is

$$\Delta W^* = \frac{\alpha_3}{2E_W}\lambda^{*2}. \tag{15}$$

More intuition about the equilibrium can be gained from a graph than from the algebraic solution. Fig. 2 displays the current account and probability of collapse given in eqs. (11) and (2). As one might expect, greater intertemporal substitutability in consumption raises the equilibrium current account and probability of collapse. From eq. (15), the lack of credibility imposes larger welfare losses when these intertemporal transfers are more readily made. An increase in the world interest rate predictably reduces the current account deficit (since any given future surplus finances a smaller current deficit) and lowers λ^* and ΔW^*. Finally, increases in uncertainty about the future level of reserves [which raise the intercept and the slope of the P curve in eq. (12)] yield a higher probability of collapse, a greater current account deficit, and a lower level of welfare.

A second-best argument for a slower rate of trade liberalization

The model above can now be used to investigate the justification for positive first-period tariffs as a second-best tool for reducing the distortion introduced by a lack of perfect credibility. Such temporary tariffs may be added to the foregoing analysis by rewriting eqs. (6), (7), and (8) as follows:

$$E(\pi, D\Pi, W) = q(p_m, p_x) + DQ(P_m, P_x) + t + T, \tag{16}$$

$$t = \tau_1(E_1\pi_1 - q_1), \tag{17}$$

$$T = D\tilde{\tau}(E_2\Pi_1 - Q_1),$$

$$z = -\hat{q} + E_1\hat{\pi}, \tag{18}$$

where t represents the lump-sum transfer of revenues from the first-period tariff. Eq. (18) is similar to (8), the hats indicate that the trade deficit is evaluated at international prices instead of at distorted domestic prices.[11] Differentiating eq. (16) and using (17) we have the change in welfare resulting from a change in τ_1:

$$\frac{E_W \, dW}{d\tau_1} = \frac{\tau_p DJ\lambda + \tau_1 c}{1 - A - O}, \tag{19}$$

where $J = \Pi_1 E_{21}\pi_1 > 0$, $c = E_1\pi_{11} + \pi_1 E_{11}\pi_1 - q_{11} < 0$, $A = \tilde{\tau}D\Pi_1 C_W > 0$, and $O = \tau_1\pi_1 c_W > 0$.

The variable J on the right-hand side of eq. (19) captures the intertemporal substitution effect. Although it arises from the introduction of a new first-period tariff, it acts to *raise* welfare. Welfare improves because the real consumption rate of interest, $\pi/\Pi D$ (which is 'too' low due to the anticipation of future tariffs), rises with τ_1. Consumption is then shifted toward the future and the current account improves. Though the intertemporal distortion created by low credibility is mitigated by the imposition of τ_1, there are obvious costs: a new distortion in the first period is introduced. The second term in eq. (19) captures the reduction in welfare attributable to the intratemporal distortions produced by the first-period tariff. This term is proportional to τ_1, so that, overall a marginal first-period tariff tends unambiguously to improve welfare.

[11] This complicates matters since the usual duality expressions must be amended. For example, on the production side first-period production in international prices is $q = p_m^* q_1 + q_2$. A change in the tariff alters domestic production decisions, but international prices remain fixed, $q_1 = p_m^* q_{11} + q_{21}$. The domestic marginal rate of transformation satisfies $(p_m + \tau_1)q_{11} + q_{21} = 0$. The change in the value of domestically produced goods is therefore given by $q_1 = -\tau_1 q_{11}$.

Eq. (19) also implies that there is a unique first-period tariff that maximizes welfare. Setting $dW=0$, we have:

$$\tau_1^*(\lambda)=\alpha_8\lambda, \tag{20}$$

where $\alpha_8=-\tau_p DJ/c>0$. The welfare maximizing temporary tariff, τ_1^*, is strictly positive for all non-zero λ. The reason τ_1^* is increasing in λ is that the higher is the probability of failure, the greater is the distortion in the consumption rate of interest, and the more it is worth the cost of incurring a second distortion (in the form of a tariff in period 1) which will reduce the distortion in the real consumption rate of interest. For any given level of credibility, the government can raise welfare by liberalizing more slowly.

We now turn to the effects of temporary tariffs on the current account deficit. By differentiating eq. (18) with respect to τ_1, we have:

$$\frac{dz}{d\tau_1}=-\alpha_6-\alpha_7\tau_1, \tag{21}$$

where

$$\alpha_6=(\tau_1\pi_1-\pi)\left(E_{11}\pi_1+\frac{\bar{\tau}Dc_W\Pi_1E_{12}\pi_1}{1-\tau_1\pi_1c_W-\bar{\tau}\Pi_1C_W}\right)>0$$

and

$$\alpha_7=-\frac{c_W(\pi-\tau_1\pi_1)(E_1\pi_{11}+\pi_1E_{11}\pi_1-q_{11})}{1-\tau_1\pi_1c_W-\bar{\tau}\Pi_1C_W}+E_1\pi_{11}-q_{11}.$$

The term α_6 captures the intertemporal effects of the first-period tariff on expenditure and welfare. The tariff shifts spending toward the second period as the real consumption rate of interest rises; α_6 will be positive as long as τ_1 is not too large. Tariffs today will therefore offset the suboptimal reduction in the real consumption rate of interest caused by positive expected tariffs tomorrow. The incentive to save increases and the current account improves.[12]

If we evaluate eq. (21) at the optimal tariff as defined in eq. (20), it can be shown that the current account improves for all $\tau_1\leq\tau_1^*$. From this fact, it follows that the level of the temporary tariff which maximizes the current account, call it $\check{\tau}_1$, is greater than the level of the optimal temporary tariff, τ_1^*. This makes sense intuitively because for $\tau_1\geq\hat{\tau}_1$, expenditure is transferred on the margin toward the first period. Welfare must already be declining.

[12]The sign of α_7 is ambiguous, but will be positive as long as the intertemporal substitution effects are 'large' in comparison with the first-period intratemporal substitution effects. To make this precise, α_7 will be positive if

$$-\pi c_W\pi_1E_{11}\pi_1>(1-\pi c_W)(q_{11}-E_1\pi_{11}).$$

The approximate improvement in the current account deficit from posiitive first-period tariffs can be obtained by integrating eq. (21) over τ_1:

$$\Delta z(\tau_1) = -\alpha_6\tau_1 - (1/2)\alpha_7\tau_1^2. \tag{22}$$

It is also convenient to define a function which allows us to see how changes in first-period tariffs affect the current account as λ varies:

$$z(\tau_1, \lambda) = z(\lambda) + \Delta z(\tau_1) = \alpha_1\lambda - (1/2)\alpha_2\lambda^2 - \alpha_6\tau_1 - (1/2)\alpha_7\tau_1^2. \tag{23}$$

We now have three equations in three unknowns: the current account deficit, z, the probability of collapse of the liberalization program, λ, and the optimal temporary tariff, τ_1^*:

$$z(\tau_1, \lambda) = \alpha_1\lambda - (1/2)\alpha_2\lambda^2 - \alpha_6\tau_1 - (1/2)\alpha_7\tau_1^2, \tag{24}$$

$$\tau_1^*(\lambda) = \alpha_8\lambda, \tag{25}$$

$$\lambda = P(R_{\min}, \sigma_\mu^2, z) = \alpha_3 + \alpha_4 z. \tag{26}$$

Fig. 3 characterizes the welfare maximizing solution. In the upper right-hand quadrant are the P [eq. (26)] and z [eq. (24)] curves. They intersect initially at the instantaneous liberalization equilibrium, point A. In the lower-right quadrant is a 45 degree line, mapping λ into itself. The third quadrant contains the τ_1^* curve [eq.. (25)], which translates a given level of credibility into an implied optimal first-period tariff. Finally, in the upper left is the z curve in z-, τ_1-space [eq. (24)], which reports the current account deficit associated with different first-period tariffs, given values of λ generated by intersections of the P and z curves in the first quadrant.

Consider now what happens if the liberalization proceeds more slowly. Positive tariffs in period 1 shift the z curve in the first quadrant down. This defines a new intersection of the P and z curves at a lower current account deficit and lower λ, marked by point B. Moving in a clockwise direction into the third quadrant, the τ_1^* curve gives the optimal temporary tariff. In the upper left quadrant, the value of the optimal tariff is translated into a corresponding current account deficit. If the deficit is the same as that generated by the intersection of the z and P curves, we have found the fixed point B. If it is not, we try a higher τ_1, shifting the z curve further down. The fixed-point values, τ_1^{**}, z^{**}, λ^{**}, give the optimal speed of liberalization, the optimal current account deficit, and the resulting degree of credibility, given the underlying parameters R, σ_μ^2, $R_{\min}$.[13] It is straightforward to show that

[13] Because the algebraic solutions for λ^{**}, z^{**}, and τ_1^{**} are cumbersome and yield no additional insights, they are omitted here.

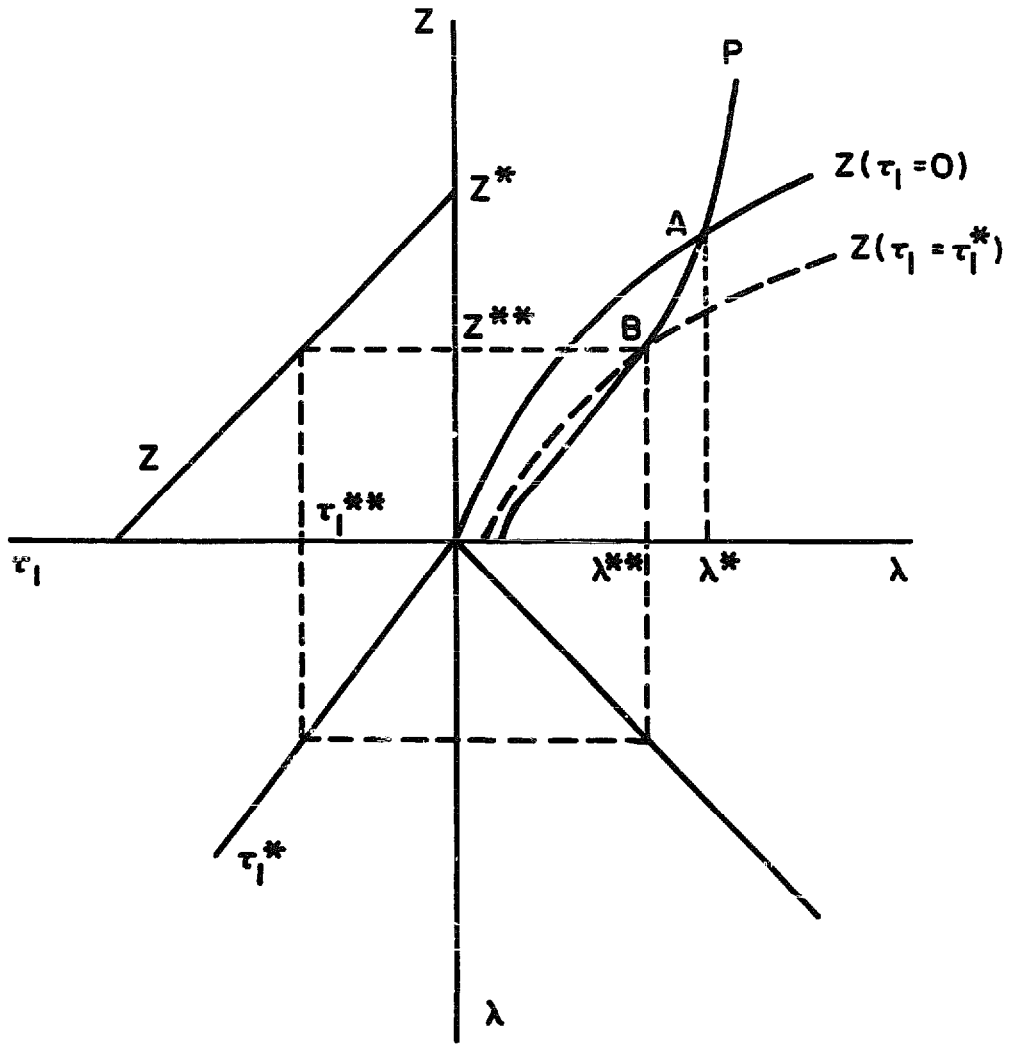

Fig. 3. Simultaneous determination of the rational-expectations equilibrium current account, probability that liberalization is reversed, and the optimal first-period tariff.

$0<z^{**}<z^{*}$, $0<\lambda^{**}<\lambda^{*}$, and $0<\tau_1^{**}$. A liberalization program which removes tariffs directly and has less than perfect credibility can be improved upon by slowing the speed at which tariffs are reduced.

It is also possible to do some comparative statics with this model. An increase in the minimum level of reserves, R_{min}, lowers z^{**}, λ^{**}, τ_1^{**}, as shown in fig. 4. Here the P curve shifts left (its slope decreases as well) and the z curve in z-, τ_1-space shifts down, since the improvement in credibility implies that at any given level of τ_1, the current account deficit will be lower. The initial optimum is given by λ^{**}, τ_1^{**} and z^{**} and the new optimum by λ^{***}, τ_1^{***} and z^{***}. Greater international liquidity, evidenced by a lower level of R_{min}, will have the same qualitative effect on the equilibrium: the P curve shifts to the left as the program's susceptibility to trade balance shocks improves. The higher the level of reserves, and the easier it is to negotiate additional international lending, the greater the optimal speed of liberaliza-

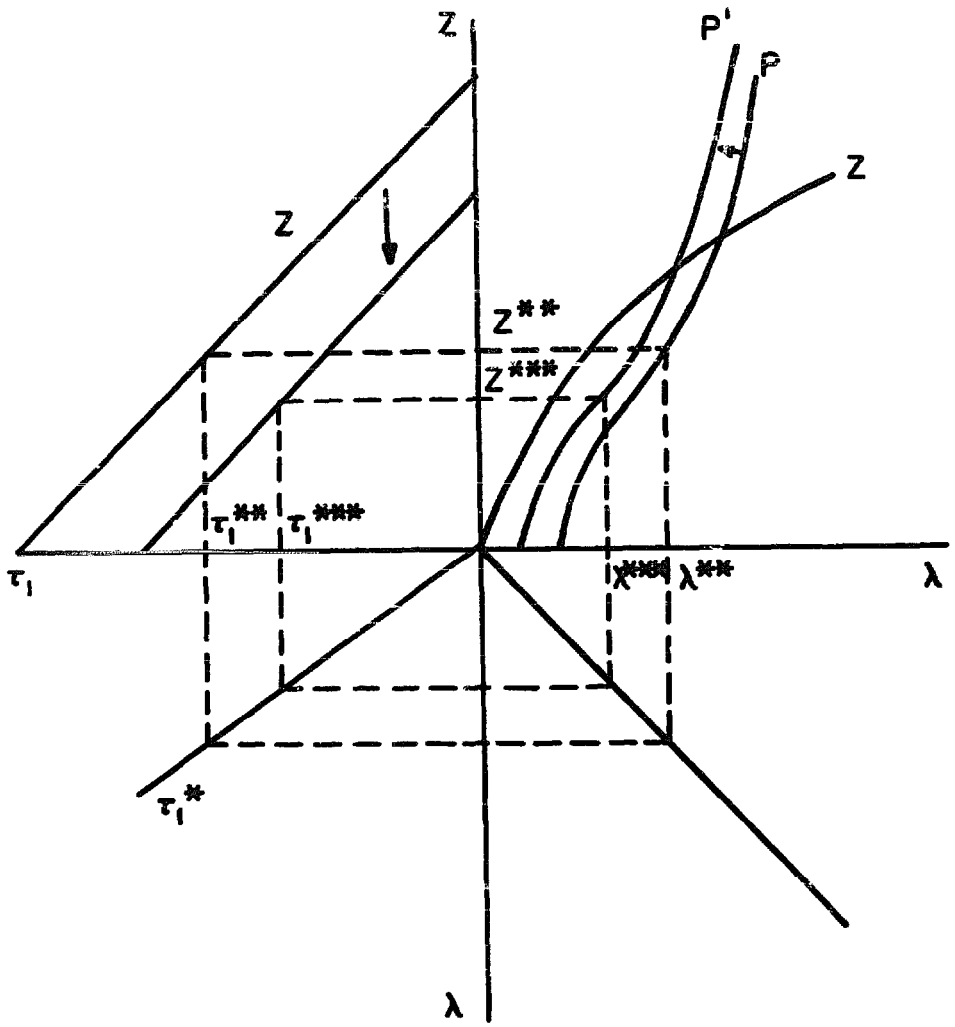

Fig. 4. An increase in reserves or a decrease in uncertainty in international markets.

tion. A decrease in the variance of unexpected shocks to reserves, σ_μ^2, shifts the P curve in a similar manner. The result is that z^{**}, λ^{**}, τ_1^{**} all decrease: the optimal rate of liberalization rises.

4. Expected collapse of a liberalization program when reserves are rationed

The previous section explored the kind of difficulties that confront a less-than-fully credible removal of tariffs when domestic reserves are made available to finance the private sector's current account deficit. Frequently, however, reserves are rationed by the government, so that only limited borrowing by the private sector is possible. In this section we look at the effects of an incredible liberalization when the current account is fixed by the authorities. The private sector's excess demand for loans in the initial period is vitiated in the model below by a rise in the domestic interest rate, which

compensates individuals who would otherwise want to consume more in the first period. The budget constraint now becomes:

$$E(\pi, D\Pi, W) = q + DQ + T + (D^* - D)(Q - E_2\Pi), \tag{27}$$

$$T = D\bar{\tau}(E_2\Pi_2 - Q_2), \tag{28}$$

where $D^* = (1+i^*)^{-1}$ and i^* is the nominal world rate of interest. In eq. (27), we treat the higher domestic interest rate as a tax on first-period borrowing. The term $(D^* - D)(Q - E_2\Pi)$ represents the redistribution of the revenues from the tax. We assume that these taxes are calculated in terms of real goods, evaluated at period-2 domestic prices. The current account constraint is given by

$$\bar{Z} = D^*(\hat{Q} - E_2\hat{\Pi}), \tag{29}$$

where the hats indicate that the current account is fixed in terms of international currency. To see how the domestic discount rate varies in response to positive expected future tariffs we differentiate eqs. (27) and (28) using (29), and apply Cramer's rule to get:

$$E_W \mathrm{d}W = \Delta^{-1}((F - \bar{\tau}B)(D - D^*)V + \bar{\tau}(D^* - 2D)(GB - FC) + \bar{\tau}V(\bar{\tau}C - G))\,\mathrm{d}\lambda, \tag{30}$$

$$\mathrm{d}D = \Delta^{-1}(\bar{\tau}C(1 - (2D - D^*)N) - G(1 - Da\lambda) - (D^* - D)a\lambda G - (a\lambda - N)(D^* - D)V)\,\mathrm{d}\lambda, \tag{31}$$

where $a = \tau_p \Pi_1 C_W > 0$, $B = \Pi_1 E_{22}\Pi < 0$, $C = \Pi_1 E_{22}\Pi_1 D + E_2\Pi_{11} - Q_{11} < 0$, $F = \Pi E_{22}\Pi < 0$, $G = \Pi E_{22}\Pi_1 D < 0$, $N = \Pi C_W > 0$, and $V = E_2\Pi_1 - Q_1 > 0$.

The factor Δ, which is the determinant of the matrix of coefficients for the endogenous variables, is negative. For small permanent tariffs it is easy to show that $E_W \mathrm{d}W/\mathrm{d}\lambda < 0$ in eq. (30).[14] Welfare must fall because, as individuals' expectations of future tariffs increase, the expected second-period distortion rises. This seemingly obvious result is complicated in the above equation because the domestic interest rate is free to fluctuate in response to pressure on the current account, and will presumably do so in a way that tends to raise welfare above what it would have been if it were fixed.

Eq. (31) gives the response of the interest rate to changes in expected

[14]See the NBER Working Paper version for more detail on these points, especially Appendices 2 and 3.

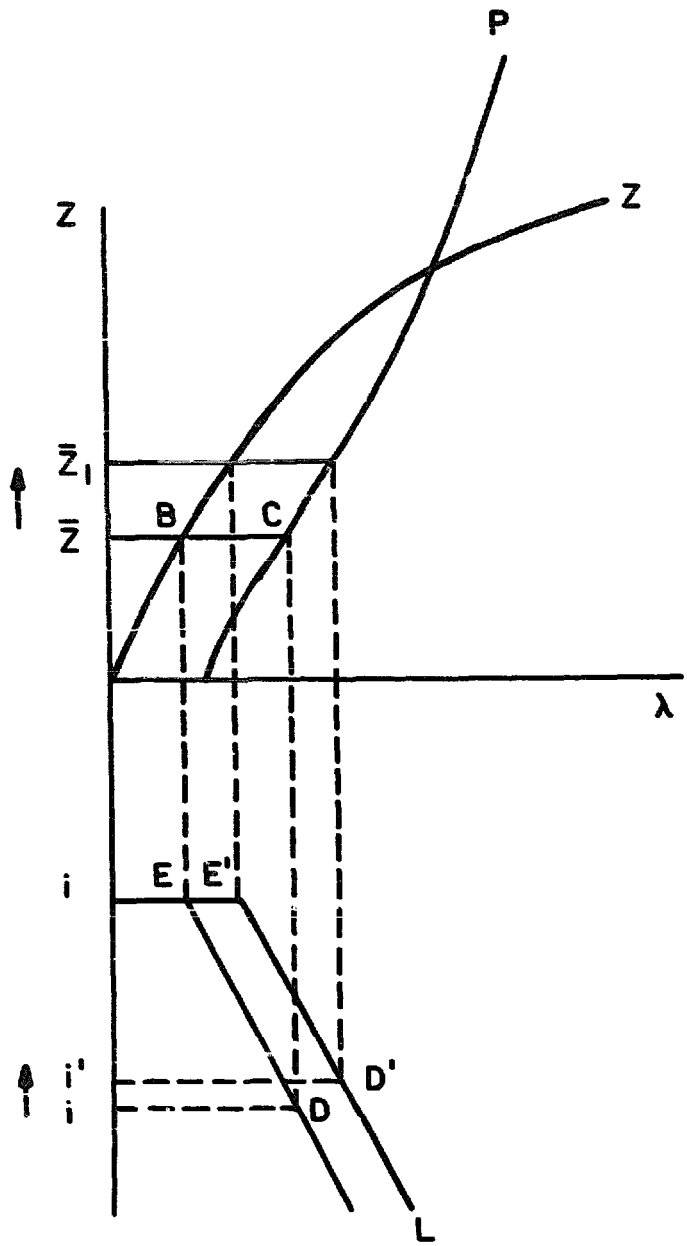

Fig. 5. Domestic interest rates and the closed capital account: simultaneous determination of the probability that liberalization is reversed, and the domestic interest rate.

future tariffs. The lack of perfect credibility lowers the consumption rate of interest and encourages consumption, causing the current account constraint to bind more severely. Consequently, interest rates must rise in order to compensate individuals for the immediate consumption they otherwise would desire.

Fig. 5 demonstrates this mechanism using the P and z curves from the previous section. Now, however, the ex ante current account is pegged at $\bar{Z}$. At point B the current account constraint is just binding, so that $D=D^*$, and, from eq. (10), $\bar{\lambda}\approx\bar{Z}/\alpha_1$. The equilibrium, $\lambda=\lambda^*$ (point C), has associated

with it a domestic interest rate which exceeds the world rate (point D). It is possible to integrate (31) from $\bar{\lambda} \approx \bar{Z}/\alpha_1$ to λ^* to get the domestic differential, $D^* - D$:

$$L(\bar{Z}, \lambda) = \int_{\bar{Z}/\alpha_1}^{\lambda^*} \mathrm{d}D(\lambda)\,\mathrm{d}\lambda. \tag{32}$$

From eq. (32), $\partial L(\bar{Z}, \lambda)/\partial Z < 0$ and $\partial L(\bar{Z}, \lambda)/\partial \lambda > 0$. Fig. 5 also shows the effect on the domestic interest rate of a change in the borrowing constraint from $\bar{Z}$ to $\bar{Z}'$. When the current account is fixed at $\bar{Z}'$, interest rates begin to rise at point E' instead of point E. At a given level of credibility, the equilibrium domestic interest rate falls when the capital constraint is loosened: point D' implies a lower interest rate than D. Welfare improves unambiguously.

A slower rate of liberalization when reserves are rationed

Now we can analyze the optimal speed of liberalization when reserves are rationed. The budget constraint is similar to eq. (31):

$$E(\pi, D\Pi, W) = q + DQ + t + T + (D^* - D)(Q - E_2\Pi), \tag{33}$$

$$T = D\tilde{\tau}(E_2\Pi_1 - Q_1), \tag{34}$$

$$t = \tau_1(E_1\pi_1 - q_1), \tag{35}$$

with t representing first-period tariff revenues. The current account is given by eq. (29):

$$\bar{Z} = D^*(\hat{Q} - E_2\hat{\Pi}). \tag{36}$$

Taking the derivative of eqs. (33) and (36), and using eqs. (34) and (35) we can solve to get:

$$\frac{E_W\,\mathrm{d}W}{\mathrm{d}\tau_1} = \Delta^{-1}(\tau_1(c(F - \tilde{\tau}B) + H(J\tilde{\tau} - H)) + \tilde{\tau}V(J\tilde{\tau} - H)), \tag{37}$$

$$\frac{dD}{d\tau_1}=\Delta^{-1}(J\bar{\tau}-H+\tau_1(c(a-N)-O(J\bar{\tau}-H))), \tag{38}$$

where $H=\pi_1 E_{12} II>0$. Setting (37) equal to zero and solving for the optimal tariff in period 1, we obtain:

$$\tau_1^*(\lambda)=(\alpha_9/\alpha_{10})\lambda>0, \tag{39}$$

where $\alpha_9=-\tau_p V(J\bar{\tau}-H)>0$, and $\alpha_{10}=c(F-\bar{\tau}B)+H(J\bar{\tau}-H)>0$. The optimal tariff is once again increasing and approximately linear in λ: when credibility is low, more can be gained from instituting larger first-period tariffs.[15]

Next we consider the behavior of interest rates when tariffs are imposed in the initial period. From eq. (38) we have:

$$\frac{dD}{d\tau_1}=\alpha_{11}-\alpha_{12}\tau_1, \tag{40}$$

where

$$\alpha_{11}=\Delta^{-1}(\bar{\tau}\Pi_1-\Pi)\pi_1 E_{21}>0,$$

and

$$\alpha_{12}=\Delta^{-1}(\bar{\tau}\Pi_1-\Pi)(\pi_1 E_{21}\pi_1 c_W-cC_W)>0.$$

Eq. (40) implies that interest rates will fall as a result of higher temporary tariffs provided that $\tau_1<\alpha_{11}/\alpha_{12}$. A simple intuitive argument serves to demonstrate that the domestic interest rate remains above the world rate at the optimal tariff, τ_1^{**}. The only benefit to raising τ_1 comes from a decline in the interest rate (λ is fixed). The cost of such a policy is the temporary distortion that tariffs induce. At the point where $\tau_1=\alpha_{11}/\alpha_{12}$, the benefits of raising tariffs further are zero, but the costs of the added distortion are positive. It follows that welfare can be at a maximum only when the benefits are still positive, i.e. that $\tau_1<\alpha_{11}/\alpha_{12}$.

From eq. (40) we can integrate over τ_1 to obtain:

$$L(\bar{Z},\lambda,\tau_1)=L(\bar{Z},\lambda)-\alpha_{11}\tau_1+(1/2)\alpha_{12}\tau_1^2, \tag{41}$$

which gives the level of the interest rate for given values of λ, τ_1, and $\bar{Z}$.

We can now solve for the optimal first-period tariff and the equilibrium level of credibility and domestic interest rate. There are three equations and three unknowns:

[15]The parameter α_{10} is guaranteed to be positive for small first-period tariffs.

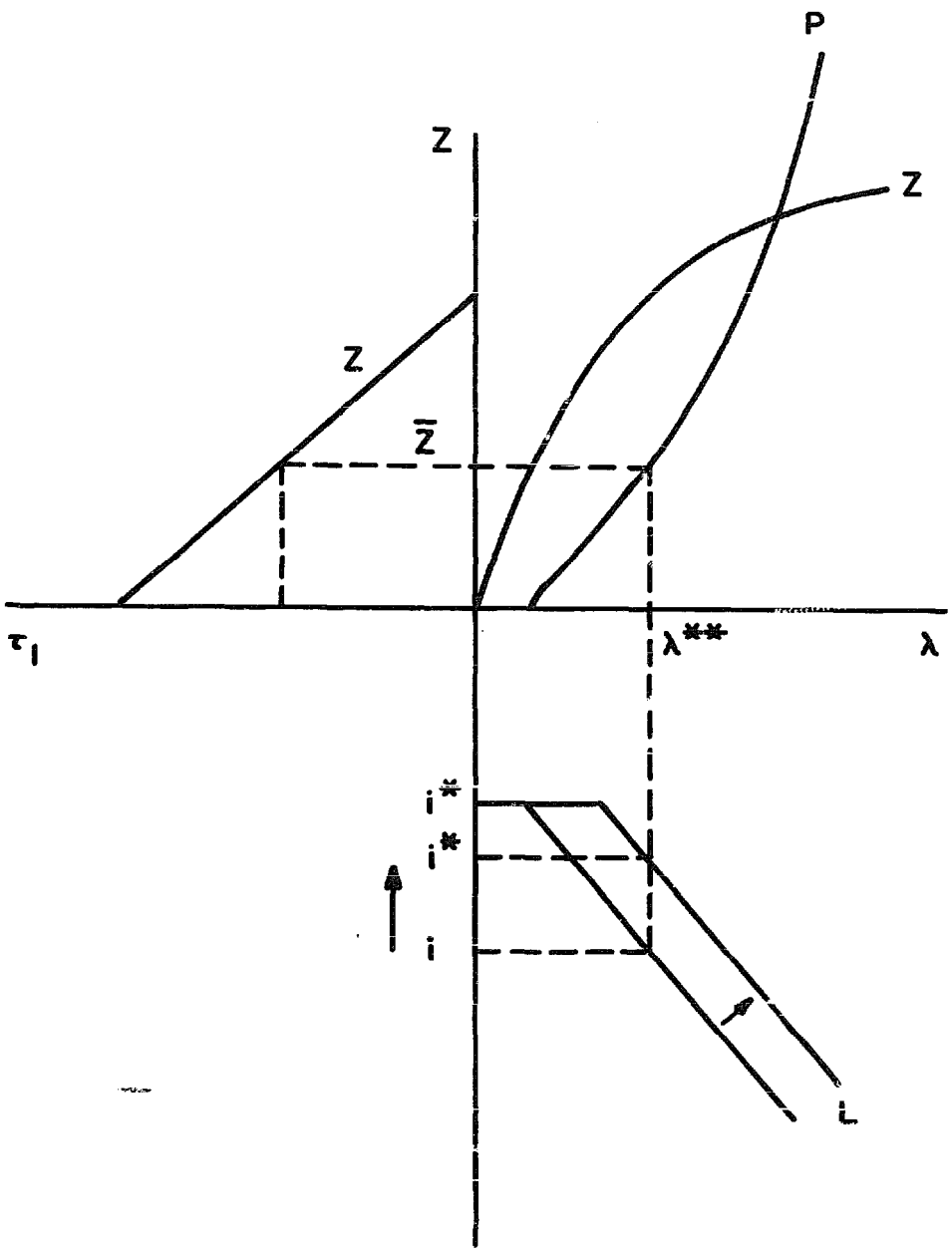

Fig. 6. The closed capital account: simultaneous determination of the rational expectations equilibrium current account, probability that liberalization is reversed, domestic interest rate, and the optimal first-period tariff.

$$\lambda = P(R_{\min}, \sigma_\mu^2, \bar{Z}) = \alpha_3 + \alpha_4 \bar{Z}, \tag{42}$$

$$\tau_1^*(\lambda) = (\alpha_9/\alpha_{10})\lambda, \tag{43}$$

$$L(\bar{Z}, \lambda, \tau_1) = I(\bar{Z}, \lambda) - \alpha_{11}\tau_1 + \alpha_{12}\tau_1^2. \tag{44}$$

The solution is displayed in fig. 6. Note that λ^* is determined by $\bar{Z}$ and eq.

(42), so that the above system is recursive. Given λ^*, eq. (43) yields the optimal tariff, τ_1^{**}. Eq. (44) then gives the equilibrium domestic interest rate, i^{**}. When the current account is fixed by government fiat and domestic interest rates are consequently driven above world rates, gradual liberalization appears to be the optimal policy in the face of imperfect credibility.

In many cases, a reduction in the speed of liberalization will ease pressure on the current account constraint, and in some cases the constraint will no longer bind. If this occurs, we are in the situation described in section 3, and the tendency for temporary tariffs to improve welfare and the efficiency of resource allocation is strengthened over and above the arguments presented in this section, since first-period tariffs purchase both reductions in the domestic interest rate and improvements in credibility.

5. Conclusions

When the private sector can obtain hard currency to finance its desired current account deficit, an imperfectly credible and immediate attempt to liberalize trade results in a positive current account deficit and rational positive probability that the liberalization will ultimately fail. Positive expected future tariffs tend to increase future production opportunities in the import sector relative to the export sector. The imperfect credibility built into our model thus tends to undermine one important motivation for removing tariffs to begin with: to shift productive resources out of the protected import sector and into the efficient export sector.

By slowing the rate of trade liberalization, welfare can be improved as long as temporary first-period tariffs are not too large. This equilibrium dominates that of the instantaneous liberalization in that the current account deficit is smaller, $z^{**} < z^*$, the probability of the program's failure is lower, $\lambda^{**} < \lambda^*$, and welfare is greater. There is a unique (positive) first-period tariff which maximizes intertemporal welfare. Second-period production in the import sector is on average lower with such temporary tariffs. Thus, a more gradual speed of liberalization may actually help encourage a shift of resources from the import into the export sectors.

For cases in which the current account is constrained by rationing of reserves, imperfect credibility translates into domestic interest rates that are above those in the rest of the world. We show that in such circumstances, an immediate and complete tariff reduction is inferior to a more gradual approach. When such temporary tariffs are imposed, the domestic interest rate is lower than it would be under instantaneous liberalization. The behavior of the interest rate in this instance indicates that successful liberalization is particularly problematic for countries with foreign exchange constraints. When high interest rates force down the capital stock in the export sector, it becomes all the more difficult to obtain fresh loans. Thus, in

the common case in which a current account constraint is a consequence of a low level of reserves and too little international liquidity, an incredible liberalization program may push further into the future the day when voluntary lending can be resumed.

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