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Optimal Trade Policies and Mutual Tariff Reductions under Factor-Market Distortions

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The mutual tariff reductions from a Nash equilibrium of the tariff retaliation game, i.e., the movement toward free trade has been shown to be beneficial for all nations in the distortion-free world. However, if a country has a distorted factor-market, its optimal trade policy may be an export subsidy rather than a tariff. Furthermore, it has not been shown in the literature that the proposition of mutually beneficial tariff reductions survive the assumption of factor-market distortions present in one of nations. This paper extends the proposition to the case of factor-market distortions and shows that no perverse output response is sufficient for the movement toward free trade to be beneficial.

I. Introduction

A Nash equilibrium of the tariff retaliation game considered by Johnson [10] has been shown to be simultaneously individually rational but collectively irrational in a distortion-free two-country two-commodity world in the sense that mutual (differential) tariff reductions starting from the initial Nash equilibrium make participating nations better off if both commodities are normal in every nation, while neither country can gain by unilateral action. (See, for example, Mayer [13] and McMillan [14]). However, it has not been shown in the literature whether the proposition of mutually beneficial tariff reductions remains valid under the assumption of factor-

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market distortions present in either one of trading countries. The question of how much vulnerable the proposition is to the presence of factor-market distortions is particularly of interest when the negotiation for tariff reduction takes place between the nations with asymmetric factor-market conditions (for instance, between the distortion-free country and the country plagued by an intersectoral wage differential).

In the absence of any other (first and second-best) policies, an import tariff or an export subsidy can be considered for practical purposes as the optimal trade policy for a country with factor-market distortions, depending upon the nature of the distortions. (See, for example, Johnson [11] and Parai [16]). If an import tariff is the optimal trade policy for both the distortion-free country and the country with factor-market distortions at the Nash equilibrium of the tariff retaliation game, will mutual (differential) tariff reductions starting from the initial Nash equilibrium benefit both countries as in the case of the distortion-free world? Furthermore, suppose that the country with factor-market imperfections takes an export subsidy as its optimal trade policy while the distortion-free country imposes an import tariff at the Nash equilibrium. Then, can the distortion-free country gain from its tariff concession in exchange for the reduction of export subsidy on the part of the country with factor-market distortions? These questions are important but remain to be answered.

This paper shows that the proposition of mutually beneficial (differential) tariff reductions remains valid if there is no paradoxical price-output response at the Nash equilibrium (The presence of factor-market distortions may make the output response to price changes paradoxical. See, for example, Bhagwati and Srinivasan [2]).

If both countries impose an import tariff as their optimal trade poicy at the Nash equilibrium with no paradoxical price-output response, mutual tariff reductions benefit both countries. And if the country with the distortions subsidizes its exports at the Nash equilibrium without the paradoxical price-output response, an increase in export subsidy (i.e., a reduction in negative tariff) should be combined with a decrease in tariff of the distortion-free country in order for both countries to gain.

Section 2 presents the neo-classical $2 \times 2 \times 2$ trade model with one nation being under factor-market distortions and the other distortion-free. Section 3 derives explicitly the generalized optimal tariff formula for the country under factor-market distortions and discusses the conditions under which an import tariff or an export subsidy is optimal for the country. Some results obtained in Section 3 will be used in Section 4. Section 4 investigates the welfare effects of the mutual tariff reductions starting from the initial Nash equilibrium of the tariff retaliation game. Concluding remarks are provided in Section 5.

II. The Model

We consider a world economy consisting of two countries, home and foreign, whose production structure is of the Heckscher-Ohlin-Samuelson trade model with one exception: there exist factor-market distortions in the home country.

Each country makes strategic use of tariffs to maximize its national welfare and plays a Nash game with each other in imposing its optimum tariff. The optimal tariff rate may be negative, in which case it is an export subsidy. Each country's tariff revenue is assumed to be redistributed to its consumers in a lump-sum fashion. We assume that there exists a Nash equilibrium and the home country exports commodity 1 in exchange for commodity 2 at the Nash equilibrium.

The home country's production possibility curve is specified by $Y_1 = F(Y_2)$, where Y_i is the production level of commodity i. The presence of factor-market distortions in the home country makes the marginal rate of transformation deviate from the domestic relative price of commodity 2:

$$\frac{\partial F}{\partial Y_2} = -\beta P, \qquad \beta > 0 \tag{1}$$

where P is the domestic relative price of commodity 2 and β is the factor of proportionality between P and the marginal rate of transformation.

We normalize the commodity prices by setting the home country's price of commodity 1 at unity and distinguish the foreign country's variables and functions by asterisks. The relationships between home and foreign commodity prices are:

$$P_1 = 1, \quad P_1^* = 1 + \tau^*, \quad P_2 = (1+\tau)P^* \equiv P, \quad P_2^* \equiv P^*$$

where τ and τ^* are the home and foreign tariff rates respectively. The home country's GNP function is defined as:

$$G(1, P) = Y_1(1, P) + PY_2(1, P) \tag{2}$$

Since the factor-market distortions are present in the home economy, the envelope properties of the GNP function as in Dixit and Norman [5] or Woodland [18] do not hold for the home country's GNP function. For example, the derivative of $G(1, P)$ with respect to P is no longer output supply of commodity 2:

$$\frac{\partial G}{\partial P}=\frac{\partial Y_1}{\partial P}+P\frac{\partial Y_2}{\partial P}+Y_2=(1-\beta)P\frac{\partial Y_2}{\partial P}+Y_2 \tag{3}$$

With no distortions (i.e., $\beta=1$) the usual derivative property of the GNP function holds. The home country's import demand function for commodity 2, $Z_2(P^*, \tau)$, is implicitly defined by the equation:

$$Z_2=X_2[1,\ P,\ G(1,\ P)+\tau P^*\ Z_2]-Y_2(1,\ P) \tag{4}$$

where X_2 is the home country's Marshallian demand for commodity 2 and ($\tau\ P^*\ Z_2$) is the tariff revenue. Similarly, one can implicitly define the foreign country's import demand function for commodity 2, $Z_2^*(P^*, \tau^*)$, by the equation:

$$Z_2^*=X_2^*[1+\tau^*,\ P^*,\ G^*(1+\tau^*,\ P^*)-\tau^* P^* Z_2^*]-Y_2^*(1+\tau^*,\ P^*) \tag{5}$$

where it should be noted that the tariff revenue ($\tau^*\ Z_1^*$) of the foreign country is equal to ($-\tau^*\ P^*\ Z_2^*$) from the trade balance condition, $Z_1^*+P^*\ Z_2^*=0$. Since the foreign country is assumed to be distortion-free, its GNP function exhibits the useful derivative property, for example, $\partial G^*/\partial P^*=Y_2^*$.

The world market clearing condition requires that:

$$Z_2(P^*,\ \tau)+Z^*_2(P^*,\ \tau^*)=0 \tag{6}$$

The equation (6) implicitly defines the foreign price of commodity 2 equilibrating the world commodity markets as a function of τ and τ^*:

$$P^*=P^*(\tau,\ \tau^*) \tag{7}$$

Each country is assumed to maximize its indirect utility function, given the other country's tariff rate. Using the market clearing condition, $Z_2=-Z_2^*$, and the trade balance condition, $Z_1^*=-P^*\ Z_2^*$, we can define each country's indirect utility as a function of tariff rates, τ and τ^*: for the home country,

$$V(\tau,\ \tau^*)\equiv U\{1,\ (1+\tau)P^*,\ G[1,\ (1+\tau)P^*]-\tau P^*\ Z_2^*(P^*,\ \tau^*)\} \tag{8}$$

and for the foreign country,

$$V^*(\tau, \tau^*) \equiv U^*[1+\tau^*, P^*, G^*(1+\tau^*, P^*)+\tau^* P^* Z_2(P^*, \tau)] \qquad (9)$$

The Nash-equilibrium strategies τ_0 and τ_0^*, if any, solve the following two first order conditions (10) and (11) simultaneously. We assume for simplicity but without loss of generality that each country's marginal utility of income is equal to unity at the Nash equilibrium (i.e., $\partial U/\partial I = \partial U^*/\partial I^* = 1$, where I is the national income). Defining $S_{22} \equiv \partial Y_2/\partial P$, we obtain the first-order condition for each country:

$\partial V/\partial \tau = 0$ or

$$(1-\beta)PP^* S_{22} + \left[Z_2^* + (1+\tau)(1-\beta)PS_{22} - \tau P^* \frac{\partial Z^*_2}{\partial P^*}\right] \frac{\partial P^*}{\partial \tau} = 0 \qquad (10)$$

and

$\partial V^*/\partial \tau^* = 0$ or

$$\left[(1+\tau^*)Z_2 + \tau^* P^* \frac{\partial Z_2}{\partial P^*}\right] \frac{\partial P^*}{\partial \tau^*} = 0 \qquad (11)$$

(In deriving (10) and (11), we use Roy's identity, $\partial U/\partial P = -X_2\ \partial U/\partial I$ and $\partial U^*/\partial P^* = -X_2^*\ \partial U^*/\partial I^*$, and the envelope property of the foreign country's GNP function, $\partial G^*/\partial P^* = Y_2^*$)

III. The Optimal Tariff Formula: A Clarification

For our main purpose of investigating the welfare effects of mutual tariff reductions under asymmetric factor-market conditions, we need the explicit generalized optimal tariff formula for the home country under factor-market distortions. (Parai [16]) attempted to derive the generalized optimal tariff formula in an implicit form in the presence of factor-market distortions. In fact, he provides an equation from which the optimal tariff may be derived. However, his implicit form of optimaltariff does not help us in examining the welfare effects of mutual tariff reductions.)

The optimal tariff formula for the home country can be obtained by solving the first order condition (10) for τ. Differentiating (6) with respect to τ after substituting (7) into (6), and solving for $\partial P^*/\partial\tau$, we have:

$$\frac{\partial P^*}{\partial\tau} = -\frac{\partial Z_2/\partial\tau}{\Delta} \tag{12}$$

where $\Delta \equiv (\partial Z_2/\partial P^*) + (\partial Z_2^*/\partial P^*)$. Multiplying both sides of (10) by Δ after substituting (12) into (10) yields:

$$(1-\beta)PP^* S_{22} + \frac{\partial Z^*_2}{\partial P^*} - \left[Z_2^* + (1+\tau)(1-\beta)P\, S_{22}\right]\frac{\partial Z_2}{\partial\tau} +$$
$$\left[(1-\beta)PS_{22} + \frac{\partial Z_2}{\partial\tau}\right]P^*\frac{\partial Z^*_2}{\partial P^*} = 0 \tag{13}$$

The expressions for $\partial Z_2/\partial\tau$ and $\partial Z_2/\partial P^*$ can be obtained by partially differentiating both sides of (4) with respect to τ and P^* respectively after substituting $Z_2 = Z_2(P^*, \tau)$ into (4):

$$\frac{\partial Z_2}{\partial\tau} = \frac{P^*\{H_{22} + [m_2(1-\beta)-1]\, S_{22}\}}{M} \tag{14}$$

$$\frac{\partial Z_2}{\partial P^*} = \frac{(1+\tau)}{P^*}\frac{\partial Z_2}{\partial\tau} - \frac{Z_2\, m_2}{PM} \tag{15}$$

where $H_{22} \equiv (\partial X_2/\partial P) + (\partial X_2/\partial I)X_2$, the own price derivative of Hicksian demand function for commodity 2, which is negative,

$m_2 \equiv P(\partial X_2/\partial I)$, the marginal propensity to consume commodity 2 in the home country,

$$M = 1 - \frac{m_2\tau}{1+\tau}$$

The substitution of (14) and (15) into (13) further simplifies (13) into:

$$\left[(1-\beta)P\, S_{22} + \tau\frac{\partial Z_2}{\partial\tau}\right]\alpha^* + \frac{P^*(S_{22} - H_{22})}{M} = 0 \tag{16}$$

where $\alpha^* \equiv (P^*/Z_2^*)(\partial Z_2^*/\partial P^*)$, the elasticity of the foreign country's export supply. The elasticity of the foreign country's export supply is related to the elasticity of its offer curve, ε^*, by $\varepsilon^* = 1 + (1/\alpha^*)$. (See, for example, Chacoliades [3], p. 171). The optimal tariff formula is obtained by solving (16) for τ.

Theorem. The generalized optimal tariff rate for the country under factor-market distortions is given by: $\tau_0 = \varepsilon^*\,\theta - 1$ (17)

where $\theta \equiv (S_{22}-H_{22})\ (\beta\ S_{22}-H_{22})$.

Proof. See appendix A.

It is easy to show, as is well known, that under no factor-market distortions (i.e., $\beta=1$) the optimal tariff rate is the inverse of the elasticity of the foreign country's export supply (i.e., $\tau_0=\varepsilon^*-1=1/\alpha^*$). Since τ_0 is greater than (-1), ε^* is positive and greater than unity if θ is positive. That is, the optimal trade for the home country occurs on the elastic part of the foreign offer curve if θ is positive. Since H_{22} is negative and β is positive, θ is negative only if S_{22} is negative. If the price-output response is perverse (i.e., $S_{22}<0$), the optimal trade for the home country may occur on the backward-bending part of the foreign offer curve. In the case of intersectoral wage differentials, the perverse price-output response does not arise if and only if the ranking of industries by the physical factor intensity coincides with that by the value factor intensity at equilibrium. (See Jones [12] and Hazari [8]). Herberg and Kemp [9] have shown in their response to Neary [15] that the perverse price-output relationship is compatible with the stability of dynamic extensions of a static model. Thus, one cannot exclude the possibility of this paradoxical price-output response on the ground of stability. For our later use, we formally establish the following lemma which shows that the optimal trade occurs on the elastic part of the foreign offer curve if the output response to price change is normal.

Lemma. If $S_{22}>0$ at the Nash equilibrium and both commodities are normal in the home country's consumption, then $\alpha^*>0$ and $[(1-\beta)\ P\ S_{22}+\tau_0(\partial Z_2/\partial\tau)]<0$.

Proof. See appendix B.

The optimal tariff formula (17) also tells us the sufficient conditions under which the optimal tariff rate is positive. If $S_{22}>0$ and $\beta<1$, then $\varepsilon^*>1$ by lemma and $\theta>1$ so that $\varepsilon^*\ \theta>1$ and thus, $\tau_0>0$. For example, if the import-competing sector (commodity 2) of the home country is physically labor intensive and pays a premium to labor, the physical factor intensity coincides with the value factor intensity so that there is no perverse price-output relationship and $\beta<1$. (See Batra and Pattanaik [1] or Hazari [8]). In this case, an import tariff will be the optimal trade policy in the absence of any other policies. The first-best policy is a factor tax-cum-subsidy correcting the domestic factor-market distortions in combination with an import tariff exploiting monopoly power in international trade(and, so, correcting the foreign' distortion). However, if $\beta > 1$, an export subsidy may be optimal even if there is no paradoxical price-output response.

The foreign country's optimal tariff rate can be derived by solving the equation (18) obtained from (11) for τ^*.

$$(1+\tau^*)Z_2 + \tau^* P^* \frac{\partial Z_2}{\partial P^*} - 0 \tag{18}$$

If $S_{22} > 0$ and both commodities are normal in the home country's consumption, $\partial Z_2/\partial \tau < 0$ since $[m_2(1-\beta)-1] < 0$, $H_{22} < 0$ and $M > 0$ in (14). This implies that $\partial Z_2/\partial P^* < 0$ in (15). Thus, the normality of commodities and no perverse price-output response in the home country require that the optimal trade policy for the distortion-free foreign country be an import tariff since $Z_2 > 0$ by assumption and $(1+\tau^*)$ is greater than zero.

IV. Mutual Tariff Reductions and Welfare

We assume that the world economy is initially at a Nash equilibrium of the tariff retaliation game. As has been shown in the previous section, if there is no perverse price-output relationship at the Nash equilibrium and both commodities are normal in every country's consumption, then the optimal trade policy for the foreign country with no domestic distortions is an import tariff while the home country with factor-market distortions may take an import tariff or an export subsidy as its optimal policy. We take the following assumptions formally.

Assumption 1. There is no perverse price-output response at the initial Nash equilibrium (i.e., $S_{22} > 0$).

Assumption 2. Both commodities are normal in every country's consumption.

We assume that both nations agree to change their tariff rates simultaneously according to some formula summarized by the derivative $d\tau/d\tau^*$. The change of the foreign country's indirect utility due to the agreement is:

$$\frac{dV^*}{d\tau^*} = \frac{\partial V^*}{\partial \tau^*} + \frac{\partial V^*}{\partial \tau}\frac{\partial \tau}{\partial \tau^*} = \frac{\partial V^*}{\partial \tau}\frac{d\tau}{d\tau^*} \quad (19)$$

In (19), $\partial V^*/\partial \tau^*=0$ since the system is initially at a Nash equilibrium. Differentiating (9) with respect to τ and using the envelope property of the GNP function, $\partial G^*/\partial P^* = Y_2^*$, and from (11), we have the expression for $\partial V^*/\partial \tau$:

$$\frac{\partial V^*}{\partial \tau} = \tau^*_0 P^* \frac{\partial Z_2}{\partial \tau} \quad (20)$$

Under assumptions 1 and 2, $\partial Z_2/\partial \tau<0$, $\tau_0^*>0$ and thus, $\partial V^*/\partial \tau<0$. So, if both countries agree to reduce their tariff rates simultaneously (i.e., $d\tau/d\tau^*>0$), then $dV^*/d\tau^*<0$, i.e., the distortion-free foreign country will gain from the agreement.

Similarly, the change of the home country's indirect utility due to the tariff agreement is, nothing again that $\partial V/\partial \tau= 0$ at the initial Nash equilibrium,

$$\frac{dV}{d\tau} = \frac{\partial V}{d\tau^*} = \frac{\partial \tau^*}{d\tau} \quad (21)$$

The expression for $(\partial V/\partial \tau^*)$ can be obtained by differentiating (8) with respect to τ^*:

$$\frac{\partial V}{d\tau^*} = \left[Z^*_2+(1+\tau_0)(1-\beta)P\,S_{22}-\tau_0\,P^*\frac{\partial Z^*_2}{\partial P^*}\right]\frac{\partial P^*}{\partial \tau^*} - \tau_0\,P^*\frac{\partial Z^*_2}{\partial \tau^*} \quad (22)$$

Noting that the coefficient term of $\partial P^*/\partial \tau^*$ of the right-hand side of (22) is equal to $[-(1-\beta)\,P\,P^*\,S_{22}/(\partial P^*/\partial \tau)]$ from the first order condition (10), We have:

$$\begin{aligned}\frac{\partial V}{\partial \tau^*} &= -P^*\left[(1-\beta)\,P\,S_{22}\frac{\partial P^*/\partial \tau^*}{\partial P^*/\partial \tau} + \tau_0\frac{\partial Z^*_2}{\partial \tau^*}\right]\\ &= -P^*\frac{\partial Z^*_2/\partial \tau^*}{\partial Z_2/\partial \tau}\left[(1-\beta)\,P\,S_{22}+\tau_0\frac{\partial Z_2}{\partial \tau}\right]\end{aligned} \quad (23)$$

since $(\partial P^*/\partial \tau) = -(\partial Z_2/\partial \tau)/\Delta$ and $(\partial P^*/\partial \tau^*) = -(\partial Z_2^*/\partial \tau^*)/\Delta$ by differentiating (6) with respect to τ and τ^* respectively. Under our assumptions 1 and 2, $\partial Z_2/\partial \tau <0$ but $\partial Z_2^*/\partial \tau^*$ turns out to be positive. Differentiating both sides of (5) with respect to τ^* and rearranging the terms, we have:

$$\frac{\partial Z^*_2}{\partial \tau^*} = \frac{H^*_{21} - S^*_{21}}{1+m^*_2\,\tau^*_0} \quad (24)$$

where $H_{21}^* \equiv (\partial X_2^*/\partial P_1^*) + (\partial X_2^*/\partial I^*)\,X_1^*$, $S_{21}^* \equiv \partial Y_2^*/\partial P_1^*$ and $m_2^* \equiv P^*\,(\partial X_2^*/\partial I^*)$.

From the basic microeconomic results, $H_{21}^* > 0$ and $S_{21}^* < 0$ in the two-commodity world so that $(\partial Z_2^*/\partial\tau^*) > 0$ under our assumptions. By lemma, the bracket of the right-hand side of (23) is negative. Thus, $\partial V/\partial\tau^* < 0$. This means that the home country with factor-market distortions also gains from the agreement of mutual tariff reductions $(d\tau^*/d\tau > 0)$. The following proposition summarizes what we have obtained thus far about the welfare effects of mutual tariff reductions.

Proposition. Suppose that Assumption 1 and 2 hold. Then, the optimal trade policy for the country with no domestic distortions is an import tariff. If the optimal trade policy for the country with factor-market distortions is an import tariff at the Nash equilibrium, the mutual tariff reduction benefits both countries. On the other hand, if the country with factor-market distortions subsidizes its exports at the Nash equilibrium, then an increase in export subsidy of the country in combination with a decrease in the distortion-free country's tariff is beneficial for both countries.

The proposition shows that mutually beneficial (differential) tariff reductions do not occur only if there exists the perverse price-output relationship at the Nash equilibrium of the tariff retaliation game. If the country with factor-market distortions takes an export subsidy (i.e., $\tau_0 < 0$) as the optimal trade policy at the Nash equilibrium, a decrease in export subsidy of the country with the distortions $(d\tau > 0)$ in combination with the tariff concession of the distortion-free country $(d\tau^* < 0)$ benefits the country with the distortions and immiserizes the distortion-free country. The country with factor-market distortions gains from the terms-of-trade improvement due to the tariff concession of the distortion-free country while the differential reduction of export subsidy does not affect its welfare. On the other hand, the distortion-free country suffers from the terms-of-trade deterioration due to the decrease in export subsidy of the country with the distortions while its small tariff concession at the initial Nash equilibrium does not affect its welfare.

V. Concluding Remarks

This paper extends the proposition of mutually beneficial tariff reductions to the case of factor-market distortions present in one of trading partners and shows that the proposition does not hold only if there is the paradoxical price-output relation ship at the initial Nash equilibrium. Unfortunately, as was mentioned earlier, it has been shown in the literature that we cannot exclude the possibility of the perverse price-output response on the ground of stability. Without the perverse price-output relationship at the Nash equilibrium, the movement toward free trade would benefit the country subsidizing its exports under factor-market distortions and immiserize the country with no domestic distortions. This implies that in the tariff negotiation the distortion-free country should ask the country with the distortions to raise rather than reduce export subsidy in return for its tariff concession.

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⟨Appendix⟩

A. *Proof of the theorem*: Substituting (14) into (16) and multiplying both sides of (16) by M yields:

$$[(1-\beta)\ P\ S_{22}\ M+\tau_0\ P^*\{H_{22}+[m_2\ (1-\beta)-1]\ S_{22}\}]\alpha^*\ +P^*(S_{22}-H_{22})=0.$$

Substituting $M\equiv 1-[m_2\ \tau_0/(1+\tau_0)]$ and nothing that $P=(1+\tau_0)P^*$, we have:

$$[(1-\beta)S_{22}\ (1+\tau_0)-(1-\beta)\ S_{22}\ \tau_0\ m_2+\tau_0(H_{22}-S_{22})+\tau_0 m_2\ (1-\beta)\ S_{22}]\ \alpha^*$$
$$=-(S_{22}-H_{22}).$$

Rearranging and simplifying the terms of the first bracket gives us:

$$[(1-\beta)\ S_{22}-\tau_0(\beta\ S_{22}-H_{22})]\alpha^* = -(S_{22}-H_{22}).$$

Utilizing the fact that $(1/\alpha^*) = \varepsilon^*-1$, we have:

$$\tau_0\ (\beta\ S_{22}-H_{22}) = (1/\alpha^*)\ (S_{22}-H_{22}) + (1-\beta)\ S_{22}$$
$$= \varepsilon^*\ (S_{22}-H_{22}) - (\beta\ S_{22}-H_{22}).$$

Thus, the optimal tariff rate is given by:

$$\tau_0 = \varepsilon^*\ (S_{22}-H_{22})/(\beta\ S_{22}-H_{22})-1.$$

B. *Proof of the lemma*: If $S_{22}>0$, then $\theta>0$ since $H_{22}<0$ and $\beta>0$. So, ε^* must be positive and greater than unity in (17) since $1+\tau_0>0$. This implies that $\alpha^* = 1/(\varepsilon^*-1) > 0$. And the normality of commodities implies that $M>0$ and, so, $P^*\ (S_{22}-H_{22})/\ M>0$, which, with $\alpha^*>0$, implies that $[(1-\beta)\ P\ S_{22}+\tau_0(\partial Z_2/\partial\tau)] < 0$.