Evaluating trade reform with many consumers

JIANDONG JU University of Oklahoma
KALA KRISHNA Pennsylvania State University and NBER

Abstract. In this paper we look at the welfare effects of trade reform in the many-consumers case. We show that Pareto-improving reforms with lump-sum taxation or with non-lump-sum taxation are possible in the small country case if sufficient conditions for welfare to rise in the single-consumer case are met. JEL Classification: F0, F1

Evaluation d'une réforme de la politique commerciale quand il y a plusieurs consommateurs. Les auteurs examinent les effets de bien-être d'une réforme de la politique commerciale quand il y a plusieurs consommateurs. On montre que des réformes améliorant la situation au sens de Pareto sont possibles grâce à des taxes forfaitaires ou non forfaitaires dans le cas de petits pays si on satisfait les conditions nécessaires pour une amélioration du niveau de bien-être dans le cas d'un seul consommateur.

1. Introduction

There have been two broad approaches to evaluating the effects of reform in the literature. The first looks for policy prescriptions that under general conditions will raise welfare. The policy of uniform proportionate cuts in tariffs (the UPC rule) or of reducing the highest tariffs first (the Concertina rule) are examples of such results. The second approach is based on the revealed-preference approach. It looks for indicators that can be examined to see if welfare has risen or not as a consequence of exogenous changes in price. Our work lies in this second area.

In trade, Ohyama (1972) used this revealed-preference approach to derive sufficient conditions for welfare to rise. These sufficient conditions are couched in terms of a single representative consumer and assume perfect competition. Grinols

This work has been supported by the National Science Foundation under grant SBR-9725019. We are grateful to Eric Bond, Elhanan Helpman, and two anonymous referees for their very useful comments. Email: kmk4@psu.edu.

Canadian Journal of Economics / Revue canadienne d'Economique, Vol. 33, No. 3
August / août 2000. Printed in Canada / Imprimé au Canada

0008-4085 / 00 / 787–798 /

and Wong extend Ohyama's results to the many consumers case. They derive a necessary and sufficient condition for Pareto-improving gains to occur when lump-sum redistribution is possible. Their extensions, however, require that the welfare weights of individuals, which are the reciprocals of marginal utilities of income (see Varian 1984, 208), are constant.

Dixit and Norman (1980, 1986) look for conditions under which Pareto improvements are ensured by trade. They assume constant returns to scale, no joint production, continuous demand, and that the Weymark condition holds. They show that if the government undertakes suitable lump-sum or non-lump-sum redistribution in the background, it can ensure that trade results in a Pareto improvement.

Our work builds on that of Dixit and Norman and makes the same assumptions. We consider only the small-country case. We show that if we allow lump-sum taxation to redistribute income as specified, Ohyama's conditions are sufficient for a Pareto improvement to occur. We then show that if lump-sum taxes are not available and a version of Ohyama's condition is met, the same result obtains.[1] In section 2 we outline the model and Ohyama's results. Sections 3 and 4 are the heart of the paper and in them we deal with the many consumer case. Section 5 is the conclusion.

2. The model

There are H households in the country being studied, which are indexed by h. Denote by u^h the utility level of household h. Let U denote the vector of utility levels for each household. There are assumed to be n goods[2] and m factors, with $n + m = N$, and with product[3] and factor prices denoted by the vectors P and W, respectively. Specific tariffs are denoted by the vector T. The factor availability vector is denoted by V. We will index the time period by the use of a superscript, $i \in \{0,1\}$. Subscripts denote partial derivatives. Thus:

$$P^i = P^{wi} + T^i, \tag{1}$$

or the domestic price at time i equals the world price plus the specific tariff. We assume throughout that there are constant returns to scale, no joint production, and perfect competition everywhere. We also assume that preferences satisfy the usual assumptions in that they can be represented by an increasing and strictly quasi-concave utility function so that demand is single valued. We also assume that demand functions are continuous.

1 This is not to say that all agents will gain from such reform in practice, since these transfers need not be carried out.

2 These could be final or intermediate goods. Intermediate goods enter the output vector as negative elements, and pure intermediate goods enter the demand vector as zeros.

3 We will always denote partial derivatives by the use of subscripts. We will treat all vectors as column vectors and denote transposes by primes.

$E(P,u)$ and $R(P,V)$ denote the standard expenditure and revenue functions. They have all the standard properties: $E_p^h(P,u^h) = C^h(P,u^h)$ is the vector of compensated demand functions of individual h, and $R_p(P,V) = X(P,V)$ is the aggregate supply vector. We define $E(P,U)$ to be the sum of the expenditure functions of all households so that

$$E(P,U) = \sum_{h=1}^{H} E^h(P,u^h) \tag{2}$$

is the aggregate expenditure level, while

$$C(P,U) = E_p(P,U) = \sum_{h=1}^{H} E_p^h(P,u^h) = \sum_{h=1}^{H} C^h(P,u^h) \tag{3}$$

is the aggregate consumption vector and

$$M(P,U,V) = C(P,U) - X(P,V) \tag{4}$$

denotes imports. We now turn to sufficient conditions for welfare to rise with tariff reform. We first look at the single-consumer case. These results are based on the work of Ohyama (1972).

2.1. *The single-consumer case*

Here, we use the simplest set-up of exogenous factor supplies. Note that by definition

$$\begin{aligned} E(P^1,u^1) &= P^{1'}C(P^1,u^1) + P^{1'}C(P^0,u^0) - P^{1'}C(P^0,u^0) \\ &\geq P^{1'}[C(P^1,u^1) - C(P^0,u^0)] + E(P^1,u^0), \end{aligned} \tag{5}$$

where the inequality follows from the definition of the expenditure function, so that

$$E(P^1,u^1) - E(P^1,u^0) \geq P^{1'}[C(P^1,u^1) - C(P^0,u^0)]. \tag{6}$$

Hence, if

$$P^{1'}[C(P^1,u^1) - C(P^0,u^0)] > 0, \tag{7}$$

then $u^1 > u^0$. This gives a sufficient condition for welfare to rise as a result of the reform which moved prices from those prevailing in the period 0 to those prevailing in period 1. It says that if the consumption bundle chosen before the reform is affordable at post reform prices, than the reform must be welfare enhancing.

Second, note that if (7) holds, then adding a negative number,

$$-P^{1'}[X(P^1,V) - X(P^0,V)], \tag{8}$$

and requiring that this remain positive will also be a sufficient condition. Thus, a second sufficient condition is that

$$P^{1'}[M(P^1,u^1,V) - M(P^0,u^0,V)] > 0. \tag{9}$$

For a small country, $P^{w1} = P^{w0} = P^w$. Hence:

$$\begin{aligned} P^{1'}[M(P^1,u^1,V) - M(P^0,u^0,V)] &= (P^w + T^1)'[M(P^1,u^1,V) - M(P^0,u^0,V)] \\ &= T^{1'}[M(P^1,u^1,V) - M(P^0,u^0,V)], \end{aligned} \tag{10}$$

since by budget balance the value of net trade at world price is zero. Therefore:

$$T^{1'}[M(P^1,u^1,V) - M(P^0,u^0,V)] > 0 \tag{11}$$

is sufficient for $u^1 > u^0$ for the small-country case. Thus, Ohyama showed that (7) or (9) were sufficient for a change in tariffs to be welfare improving, and for a small country, (11) was sufficient as well.

3. The many consumer case with lump-sum taxes

Grinols and Wong (1991) show that if all individuals are given equal weight in welfare, then condition (7) is sufficient for a Pareto improvement to be possible by the use of suitable lump-sum taxes. We extend these results to the case of a small country with no restriction on the social welfare function. We build on the work of Dixit and Norman (1980, 76–8). We allow for endogenous factor supplies but otherwise maintain our earlier assumptions.

PROPOSITION 1. *In a small country with many consumers, where lump-sum taxes are available as instruments and assuming perfect competition, constant returns to scale and no joint production, equation (9) is sufficient for the change in tariffs to result in a potential Pareto improvement in welfare.*

Proof. Let $C^h(P,W,u^h)$ and $V^h(P,W,u^h)$ denote the consumption and factor supply of household h, while P and W denote the product and factor prices they face.[4] Define $E^{*h}(P,W,u^h)$ to be the minimum lump-sum transfer/tax needed to keep household h at utility level u^h. Thus:

$$E^{*h}(P,W,u^h) = P'C^h(P,W,u^h) - W'V^h(P,W,u^h). \tag{12}$$

Similarly, let $X(P,W)$ and $V(P,W)$ denote the output of goods and demand for factors by firms. Firms maximize profits and

$$R^*(P,W) = P'X(P,W) - W'V(P,W) \tag{13}$$

4 Thus, we allow for endogenous factor supplies.

defines the maximized value of profits.[5] All the usual envelope results apply, so that

$$E_P^{*h}(P,W,u^h) = C^h(P,W,u^h)$$

$$E_W^{*h}(P,W,u^h) = -\ V^h(P,W,u^h)$$

$$R_P^*(P,W) = X(P,W)$$

$$R_W^*(P,W) = -\ V(P,W). \tag{14}$$

The rest of the world's excess supply,[6] when the domestic price is P and specific tariffs are T, is given by $M(P,T)$. Equilibrium prior to the reform is given by

$$\sum_{h=1}^{H} E_P^{*h}(P^0,W^0,u^{h0}) = R_P^*(P^0,W^0) + M(P^0,T^0)$$

$$\sum_{h=1}^{H} E_W^{*h}(P^0,W^0,u^{h0}) = -\ V(P^0,W^0)$$

$$E^{*h}(P^0,W^0,u^{h0}) = \frac{T^{0\prime}M(P^0,T^0)}{H} \qquad \text{for } h = 1..H. \tag{15}$$

These equations state that goods markets clear internationally, factor markets clear nationally and that tariff revenues are returned to households in a lump-sum manner. They determine the equilibrium domestic utility, price, and wage vectors (U^0,P^0,W^0) when tariffs are T^0. Similarly, let U^1, P^1, and W^1 be the equilibrium domestic utility, price, and wage vectors when tariffs are reformed to be T^1. We wish to know whether there exists a set of lump-sum taxes and transfers that will make all households at least as well off as they were under T^0. To do so, we will construct a policy that keeps each household at u^{h0} and check if it is feasible.

Consider a policy by government which imposes lump-sum taxes/transfers as needed to keep each individual h at the utility level u^{h0}. Thus, household h gets a lump-sum transfer of $E^{*h}(P,W,u^{h0})$ if prices are P and factor prices are W. Note that these lump-sum transfers change as prices change. Assume that the government then spends an equal amount of its net revenue of $T^{1\prime}M(P,T^1) - \sum_h E^{*h}(P,W,u^{h0})$ on each good. This defines the vector of government demands g, where the ith

5 The maximized value of profits is zero, since we assume that there are constant returns to scale and perfect competition.

6 In fact, the rest of the world's excess supply depends only on the world prices they face, which are $P - T$.

element of g, g^i, is given by the rule that expenditure on all goods is the same. Thus:

$$g^i = \frac{T^{1'} M(P, T^1) - \sum_h E^{*h}(P, W, u^{h0})}{np^i}, \tag{16}$$

where n is the number of goods. In this case, equilibrium P and W, denoted by P^ϵ and W^ϵ (ϵ for equilibrium under this imaginary policy), are determined by

$$\sum_{h=1}^{H} E_P^{*h}(P^\epsilon, W^\epsilon, u^{h0}) + g = R_P^*(P^\epsilon, W^\epsilon) + M(P^\epsilon, T^1) \tag{17}$$

$$\sum_{h=1}^{H} E_W^{*h}(P^\epsilon, W^\epsilon, u^{h0}) = R_W^*(P^\epsilon, W^\epsilon) = -V(P^\epsilon, W^\epsilon). \tag{18}$$

By construction, utility is u^{h0} for household h.

This policy is feasible if government net revenue (GNR) is positive, where

$$\text{GNR} = T^{1'} M(P^\epsilon, T^1) - \sum_{h=1}^{H} E^{*h}(P^\epsilon, W^\epsilon, u^{h0}). \tag{19}$$

Recall that

$$\begin{aligned} \sum_{h=1}^{H} E^{*h}(P^\epsilon, W^\epsilon, u^{h0}) &\le \sum_h [P^{\epsilon'} C^{*h}(P^0, W^0, u^{h0}) - W^{\epsilon'} V^h(P^0, W^0, u^{h0})] \\ &= P^{\epsilon'} [X(P^0, W^0) + M(P^0, T^0)] - W^{\epsilon'} V(P^0, W^0) \\ &\le P^{\epsilon'} X(P^\epsilon, W^\epsilon) - W^{\epsilon'} V(P^\epsilon, W^\epsilon) + P^{\epsilon'} M(P^0, T^0) \\ &= R^*(P^\epsilon, W^\epsilon) + P^{\epsilon'} M(P^0, T^0) \\ &= P^{\epsilon'} M(P^0, T^0) \end{aligned} \tag{20}$$

as firms make zero profits, owing to constant returns to scale. From (20) and the fact that the value of net trade at world prices is zero, it follows that

$$\begin{aligned} \text{GNR} &= T^{1'} M(P^\epsilon, T^1) - \sum_h E^{*h}(P^\epsilon, W^\epsilon, u^{h0}) \\ &\ge T^{1'} M(P^\epsilon, T^1) - P^{\epsilon'} M(P^0, T^0) \\ &= P^{\epsilon'} [M(P^\epsilon, T^1) - M(P^0, T^0)]. \end{aligned} \tag{21}$$

Thus, $P^\epsilon [M(P^\epsilon, T^1) - M(P^0, T^0)] > 0$ is sufficient for all consumers to be no worse off than before the reform through the use of lump-sum taxes and transfers. In general, P^ϵ is not readily observable, since it is the equilibrium under a hypothetical policy of redistribution. For the small country case, however, world prices are given and denoted by P^w, so that $P^\epsilon \equiv P^{w\epsilon} + T^1 = P^{w1} + T^1 = P^1$! Thus, in the small-country case, if

$$P^1[M(P^1, T^1) - M(P^0, T^0)] > 0, \tag{22}$$

we can ensure that no one is worse off from the reform.[7]

Making consumers better off than before the reform is easy. As GNR is strictly positive and $E^*(\cdot)$ is continuous and increasing in u, raising the utility level for each household by an infinitesimal amount α to $u^{h0} + \alpha$ and providing lump-sum transfers of $E^{*h}(P^\epsilon, W^\epsilon, u^{h0} + \alpha)$ is also feasible for the government. As this is a small country, prices and production do not change; the only things that change are demand, imports, and the surplus of government. This surplus remains positive as long as α is small enough, which completes the proof.

4. The many-consumer case without lump-sum taxes

What about the possibility of Pareto improvements without lump-sum transfers? We proceed using the approach of Dixit and Norman (1986). We change our notation slightly so that it is as close to theirs as possible. Let P^1 now denote the vector of *goods and factor* prices and is $N \times 1$. Let $C^h(P)$ denote the vector of *uncompensated* net demands by agent h. A positive entry denotes a demand, while a negative one denotes the supply of a factor. In the absence of transfers and taxes $PC^h(P) = 0$, owing to the budget constraint. Utility of agent h is given by the utility of his choices or $u^h[C^h(P)]$. Let $C(P)$ denote aggregate net demand summed over all households. Let $X(P)$ denote aggregate supply. Positive elements denote output, while negative ones denote inputs used. As before, we assume that there are constant returns to scale everywhere and no joint production.

We also assume that demand is continuous and that the following condition holds. We do so to ensure that there is some direction in which prices can change so that everyone is made no worse off and some are made better off. Clearly, this can be done if all consumers are on the same side of the market for some goods or composite goods. If they all are net (sellers) buyers, we can (raise) reduce the price and make them better off. If prices are on the boundary of the simplex, however, then we could have problems doing so. After all, if everyone is a net seller, but the price of all other goods is zero, it is impossible to raise the relative price of this good further! Similarly, if everyone is a net buyer, but the price of this good is zero, it is impossible to reduce its price further! For these reasons we assume the following.

CONDITION W′. *There exists at least one commodity, either pure or Hicksian composite, such that in pre-reform economy one of the following holds: (i) some consumers are net buyers and none is a net seller of it, and it is not a free good;*

7 In the small-country case, product prices are given. Equation (18) then solves for W^ϵ. This gives demand and supply, which depend on P and W. Substituting (16) into equation (17), gives the import vector.

(ii) some consumers are net sellers and none is a net buyer of it, and it is not the only valuable good.

This condition is that of Weymark (1979), as augmented by Dixit and Norman (1986). It is needed to ensure that there exists a Pareto-improving direction of change in consumer prices away from the pre-reform economy, that is, a vector π such that for sufficiently small positive scalar α, the consumption vector $C^{h2} = C^h(P^0 + \alpha\pi)$ is at least as good as $C^h(P^0)$ for all h and better for some h.

PROPOSITION 2. *Assume that we have perfect competition everywhere, constant returns to scale, and no joint production, and that world prices are given to this small country. Also, that condition W' holds in pre-reform economy. Then, as long as equation (7) holds, there exists a set of non-lump-sum taxes and transfers that ensure that all agents in the country are no worse off than before the reform, while some are better off.*[8]

Proof. The proof is a constructive one. The procedure consists of two stages. In the first stage, we find taxes to support the pre-reform levels of utility. In the second stage, we find a post-reform equilibrium with commodity taxation that is Pareto superior to the pre-reform equilibrium.

In the first stage, we construct an artificial economy with the same production and trade possibilities as the existing domestic one, but with preferences given by fixed coefficient preferences radiating out along the 45° line from the pre-reform point chosen by consumers. Tariffs are set at post-reform levels. If the equilibrium of this economy puts the hypothetical consumer of the artificial economy at a point that lies strictly above the pre-reform point, it is easy to ensure that everyone can be kept at their pre-reform utility levels.

The idea is illustrated in figure 1. Before the reform, aggregate consumption is at point D, while aggregate production is at point A. Domestic prices are represented by the slope of the line labelled P^0 and world prices are fixed at P^w. Note that the value of production and consumption are equal at world prices as trade balances. Reform changes domestic prices to P^1, moves production to B, and moves consumption to C. The straight line through C is given by $P^1X = P^1C^1$, while the straight line through D is given by $P^1X = P^1C^0$. The condition $P^{1'}[C^1 - C^0] > 0$ implies that C lies above D. Then, if consumers face P^0 and are at D, while producers face P^1 and are at B, the government can buy CD and the rest of the world, which is willing to sell all that is needed at these prices, trades CB so that the market clears. Thus, markets clear and, as shown, the procedure is feasible. We will show that sufficient conditions for C to lie above D are that equation (7) holds; alternatively, and easier to see in figure 1, that the value of output at world prices rises after the reform.

8 Note that *all* goods and factors need to be taxable. Thus, if entrepreneurship enters as a factor of production to account for profits, profits must also be taxable.

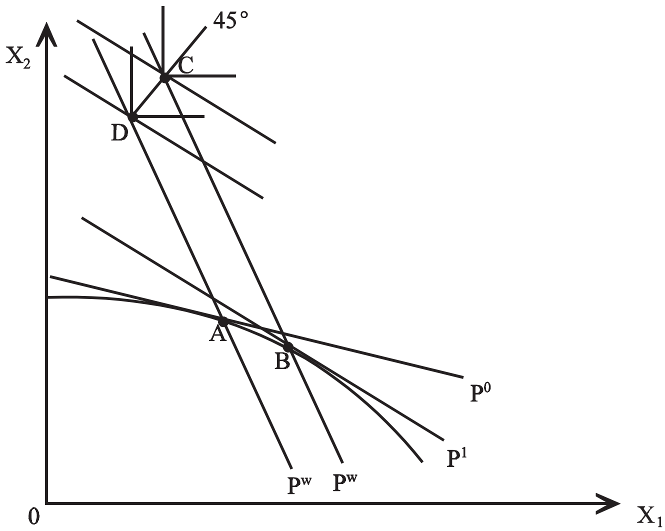

FIGURE 1

More formally, let $C^0 \equiv C(P^0) = \sum_{h=1}^{H} C^h(P^0)$ denote the aggregate demand vector in the pre-reform equilibrium and $I = \{1, \cdots, N\}$ be an index set. Let

$$U(C) = \min_{i \in I} [C^i - C^{i0}] \tag{23}$$

define the preferences of the hypothetical consumer in the artificial economy. Let P be normalized so that $\sum_{i=1}^{N} P^i = 1$.

Equilibrium for the artificial economy[9] after reform in the artificial economy is a price vector, P^e such that supply does not exceed demand, and, if it does, price is zero, which is the associated complementary slackness condition; also, consumers and producers are doing the best they can, that is, maximizing their objective functions subject to their constraints.

As preferences are of the fixed-coefficients form, as given, an equal increase or decrease in the amount of each good is chosen by the hypothetical consumer in the artificial economy. Hence:

$$C^e(P^e) = C(P^0) + \Delta i, \tag{24}$$

9 Note that whereas, in the previous proof with lump-sum taxes, P^ϵ denoted the equilibrium price under a policy of redistribution, in this section, we use P^e to denote the equilibrium price in an artificially constructed economy. Note, also, that whereas production of the artificial economy is that of the actual economy, its consumption is not. For this reason, we superscript imports and consumption by '*e*' to denote that they refer to the artificial economy, not to the actual one.

where i is an $N \times 1$ vector of ones and Δ is a scalar, which we show is positive if equation (7) is met for the artificial economy.

In the small-country case, $P^e = P^1$ and, owing to the normalization rule on prices,

$$\Delta = P^{1'}(C^e(P^e) - C(P^0))$$
$$= P^{1'}(C(P^1) - C(P^0)), \qquad (25)$$

since $P^{1'}C^e(P^e) = 0 = P^{1'}C(P^1)$, because there are no lump-sum taxes and transfers. If $\Delta > 0$, the equilibrium for the artificial economy lies strictly outside the pre-reform one. However, this is ensured by equation (7)'s holding. This condition is also easily verifiable. Alternatively, multiplying (24) by world prices gives

$$\Delta = P^{w'}(C^e(P^1) - C(P^0))/(P^{w'}i)$$
$$= P^{w'}(X(P^1) - X(P^0))/(P^{w'}i), \qquad (26)$$

since $P^{w'}C^e(P^1) = P^{w'}X(P^1)$, because the value of consumption and production of an economy are equal at world prices, $(P^{w'}i) > 0$, and the production side of the artificial economy is that of the actual one.

Hence, if (7) holds, or if the value of output at world prices rises,[10] then $\Delta > 0$ and the government can ensure that no one is made worse off by doing the following. First, have consumers face prices of P^0, so that they will demand goods and offer factor services, as in $C(P^0)$. Hence, they are as well off as they were prior to the reform. Second, have producers face prices of P^1 and produce $X(P^1)$. Finally, have government spend its tax and tariff revenue to buy the excess, which is

$$M^e(P^1,T^1) + X(P^1) - C(P^0) = C^e(P^1) - X(P^1) + X(P^1) - C(P^0)$$
$$= C^e(P^1) - C(P^0)$$
$$= \Delta i. \qquad (27)$$

Since $\Delta > 0$, the government buys a positive level of each good. Moreover, it can meet its budget constraint while doing so, because its expenditure equals its income as

$$P^1[M^e(P^1,T^1) + X(P^1) - C(P^0)] = T^1M^e(P^1,T^1) + (P^0 - P^1)C(P^0), \qquad (28)$$

which equals net government revenue. This follows from $P^wM^e(P^1,T^1) = P^1X(P^1) = 0$, since the value of net trade is zero at world prices and there are zero profits, $P^0C(P^0) = 0$, since there are no lump-sum transfers, and from $(P^0 - P^1)$

10 As noted by Dixit and Norman (1980, 72): 'if the indifference curves or the production frontiers have kinks at the relevant points, it may be impossible to change the consumption or production patterns to take advantage of the changed prices.' Dixit and Norman (1986) explicitly require that there are production gains in their approach, but we use the condition (7) instead. Condition (7) is equivalent to requiring that the value of output at world prices rises in the artificial economy.

being the taxes levied on consumers so that they face P^0. Hence, this policy makes everyone as well off as before the reform and is feasible.

In the second stage, we show that we can improve on the initial equilibrium. We do so by perturbing the tax policies so that all agents gain and by having the government buy the remaining positive surplus. Let $P^2 = P^0 + \alpha\pi$, where π is the direction of price change such that no agent loses and some agents gain. The existence of this direction is ensured by condition W'. Define additional taxes, $\tau = P^2 - P^1$, so that consumers face prices P^2 rather than P^0. Producers face prices P^1, and government buys the slack,

$$\begin{aligned} g &= C^e(P^1) - C(P^2) \\ &= C^e(P^1) - C(P^0) + [C(P^0) - C(P^2)] \\ &= \Delta i + [C(P^0) - C(P^2)]. \end{aligned} \tag{29}$$

Since (7) ensures that $\Delta > 0$ and since demand is continuous, we can choose α sufficiently small so that P^2 is sufficiently close to P^0, which ensures that $g > 0$.

Markets clear by construction, since government buys the slack. What about government expenditure relative to revenue? Note that the consumer's budget constraint at P^2 is $P^2C(P^2) = P^1C(P^1) = P^1C^e(P^1) = 0$, since there are no lump-sum transfers. Government expenditure equals

$$\begin{aligned} P^1g &= P^{1'}[C^e(P^1) - C(P^2)] \\ &= P^{1'}[X(P^1) + M^e(P^1) - C(P^2)] \\ &= T^{1'}M(P^1,T^1) - P^{1'}C(P^2) + P^{2'}C(P^2) \\ &= T^{1'}M(P^1,T^1) + [P^2 - P^1]'C(P^2) \\ &= T^{1'}M(P^1,T^1) + \tau'C(P^2), \end{aligned} \tag{30}$$

since $P^1X(P^1) = 0$, $P^{1'}M^e(\cdot) = P^1(C^e(P^1) - X(P^1)) = P^1(C(P^1) - X(P^1)) = P^{1'}M(P^1,T^1)$ and $P^{w'}M(P^1,T^1) = 0$. In other words, government expenditure on purchases equals revenue from tariffs and taxes. Hence the government budget balances that complete the proof.[11]

5. Conclusion

An aspect of our results is worth emphasizing. Our results provide only a partial ordering among outcomes. For example, if the value of the net trade vector at the post-trade-reform domestic prices falls, our conditions cannot determine the direc-

11 Note that the Dixit-Norman technique, while producing Pareto gains, may be wasteful of government purchases, and the technique does not identify the size of the gains relative to the waste.

tion of the change in potential welfare. Nevertheless, since applying them seems to require readily available data, it may well be worth doing.

References

Dixit, Avinash, and Victor Norman (1980) *Theory of International Trade* (Cambridge: Cambridge University Press)
— (1986) 'Gains from trade without lump sum compensation,' *Journal of International Economics* 21, 111–22
Grinols, E.L., and K. Wong (1991) 'An exact measure of welfare change,' *Canadian Journal of Economics* 24, 428–49
Ohyama, M. (1972) 'Trade and welfare in general equilibrium,' *Keio Economic Studies* 9, 37–73
Varian, Hal R. (1984) *Microeconomic Analysis* (New York: W.W. Norton)
Weymark, J.A. (1979) 'A reconciliation of recent results in optimal taxation theory,' *Journal of Public Economics* 12, 171–89