REVENUE TARIFF REFORM*

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Abstract

What kind of tariff reform is likely to raise welfare in situations where tariff revenue is important? Uncertainty about specification and risk from imprecise parameter estimates of any particular specification both reduce the credibility of simulation estimates. A promising alternative is to develop rules which are robust with respect to uncertainty. We present sufficient conditions for a class of linear rules which guarantee welfare improving tariff reform. The rules span cones of welfare improving tariff reforms consisting of convex combinations of (i) trade-weighted average preserving dispersion cuts and (ii) uniform tariff cuts that preserve domestic relative prices among tariff-ridden goods.

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What kind of tariff reform is likely to raise welfare in situations where tariff revenue is important? Uncertainty about the proper specification of the economy and risk from imprecise estimates of parameters of any particular specification combine to make it very difficult to provide believable confidence intervals for simulation estimates of the effects of reform proposals. A promising alternative is to set out reform rules which are robust with respect to uncertainty. But past efforts to formulate rules in the face of highly differentiated tariff structures and unknown substitution effects have met little progress. This paper presents sufficient conditions for a wide class of operational linear rules which guarantee welfare improving tariff reform under limited information about the economy. The rules span cones of welfare improving tariff reforms. Remarkably, we provide a scientific justification (in plausible special circumstances) for the World Bank's long standing recommendation for dispersion cuts which lower high tariffs and raise low tariffs. Most remarkably, the sufficient condition for welfare-improving dispersion cuts encompasses the many household case: such cuts are Pareto-superior.

Replacing border taxes with domestic consumption taxation is often advocated.[1] Anderson (1999) shows that gradual reform of this type need not improve welfare when uniform radial reductions are used to lower tariffs. The present paper admits a much broader class of trade reforms when domestic consumption taxation is the alternative revenue source and provides more optimistic prospects for tariff reform which reduces dispersion.

An extensive literature has considered welfare improving tariff reform when tariff revenue is not important. Recent extensions (Anderson and Neary, 2005) develop new techniques to derive 'cones of liberalization'. These techniques derive from a decomposition of the effect of tariff changes into their effect on the generalized mean and generalized variance of tariffs, both of which are negatively related to welfare. Since linear paths can be specified which lower either mean or variance, convex combinations of these paths will also be welfare improving. In particular, dispersion reduction looks promising. The setup of the literature and of the Anderson-Neary analysis presumes, however, that any lost tariff revenue can be replaced with nondistortionary taxation. Where tariff revenue considerations are impor-

[1] The intuitive argument that the base is broader can be supplemented with optimality considerations. Diamond and Mirrlees (1971) demonstrated that it is inefficient to distort productive efficiency when raising revenue with distortionary taxation. Trade taxes, by subsidizing production, drive a wedge between domestic and international marginal rates of transformation.

tant, the applicability of the new insights remains questionable. This paper combines elements of the Anderson-Neary and Anderson techniques to characterize welfare-improving tariff reform where revenue must be made up with distortionary taxation.

Section 1 sets up the model. Section 2 analyzes trade reform and derives the main results of the paper. Section 3 extends the results to the case of many households. Section 4 analyzes consumption and production taxation. Section 5 concludes.

1 The Setup

A small open economy raises its revenue with a set of tariffs and with a wage tax. The wage tax is distortionary because labor supply is variable (due to household choice in an economy where immigration is shut down) and leisure cannot be taxed. Tariffs and the wage tax are initially set suboptimally. The objective of the reform to move the taxes gradually toward their optimal (Ramsey) values. This section first describes the economy and then turns to main job of the paper, the analysis of gradual reform of taxes.

The representative consumer's net expenditure function is given $e(\pi, w, u)$. u is the real income of the representative consumer, π is the vector of traded goods prices and w is the wage rate. By Shephard's Lemma, $-e_w$ gives labor supply while e_π gives the vector of final demand for traded goods. The aggregate profit function is given by $g(\pi, w+t, v)$, where t is the tax on labor income. By Hotelling's Lemma, the vector of supply of traded goods (or where appropriate, minus the demand for traded inputs) is given by g_π and $-g_w$ gives labor demand.

The trade expenditure function for this economy is defined by

$$E(\pi, t, u) = \max_w [e(\pi, w, u) - g(\pi, w+t)]. \tag{1}$$

E gives the net transfer to the private sector needed to support utility u when domestic prices of traded goods are set at π and the wage tax is set at t. The definition embeds labor market clearance in the background. Hotelling's and Shehard's Lemmas imply that E_π is the vector of excess demand for traded goods. By construction, $E_t = -g_w$, the labor demand. Since $e(\pi, w, u)$ and $g(\pi, w)$ are homogeneous of degree one in π, w, E is homogeneous of degree one in (π, t).[2] Since $e - g$ is concave in (π, w, t), $E(\pi, t, u)$ is concave in (π, t).

[2] $E_\pi \pi = e_\pi \pi + e_w w - g_\pi \pi - g_w w = E + g_w t$.

The private budget constraint is:

$$E(\pi, t, u) - s = 0. \tag{2}$$

Here, s is the transfer from the government to the private sector.

The government budget constraint expresses the requirement that a given amount of revenue must be raised net of subsidies. Taxes are collected on tradable goods at rates $\pi - \pi^*$ and on labor at the rate t. Here π^* denotes the fixed vector of world prices of the taxed tradable goods. The government budget constraint is given by:

$$R(t, \pi, u, s) \equiv tE_t + (\pi - \pi^*)'E_\pi - s \geq R^0. \tag{3}$$

The gradual reform problem is to determine welfare-improving directions of change in the set of reformable tariffs, equivalent to varying π while at the same time not decreasing revenue. One class of reforms takes the wage tax as given and examines tariff reform that raises both welfare and revenue.

A more ambitious class of tariff reforms permits the wage tax to vary endogenously in order to maintain government revenue. To exactly maintain revenue, t must change to offset the movement in π. Along the government budget constraint, this implies the endogenous wage tax function $t(\pi, u, s, R^0) = t : R(t, \pi, u, s) = R^0$.

In contrast, the standard analysis of tariff reform in the trade literature (see Anderson and Neary, 2005, for a recent statement) assumes that any revenue change is lump sum transferred between private and government budgets. Thus the government budget constraint can be solved for s with the result substituted into the private constraint to form the social budget constraint.

1.1 Tariff Changes Only

Differentiating the private budget constraint (2) with respect to π yields:

$$E_u du = -E_\pi d\pi. \tag{4}$$

Differentiating the government budget constraint (3) and using $-E_\pi d\pi$ to substitute for $E_u du$ yields:

$$dR = [1 - (\pi - \pi^*)'E_{\pi u}/E_u - tE_{tu}/E_u]E'_\pi d\pi + (\pi - \pi^*)'E_{\pi\pi}d\pi + tE_{t\pi}d\pi. \tag{5}$$

The square bracket term is equal to $1-R_I$ where R_I denotes the derivative of revenue with respect to nominal income given the tax structure. This is ordinarily positive. A host of arguments has been raised in the literature to defend this presumption. Normality suffices, as does a standard stability condition. Violation of the defense would be perverse indeed since it implies that a gift of foreign exchange to the private sector, enabling a rise in real income, would at constant prices π make government revenue fall. In the presence of lump sum redistribution, moreover, this would imply that gifts make the economy worse off.

The first term of (5) reveals the tension between private and public spending: more for the government means less for the private sector. The second term can, however, be positive by enough to offset the first term, permitting a rise in both real income and revenue. This possibility arises from reforms that remove inefficiency in the tariff structure. Below, we characterize such possibilities in terms of tariff moments.

1.2 Tariff and Wage Tax Changes

It is convenient in the endogenous wage tax case to consider the cost to the government of supporting real income u when the exogenous instruments are π, s. This government cost function G is obtained by substituting the endogenous wage tax function into the private budget constraint, yielding $E[\pi, t(\pi, u, s, R^0), u] - s \equiv G(\pi, u; s, R^0)$.

The reduced form social budget constraint is given by $G(\pi, u; s, R^0) = 0$.Welfare improves if directions of change $d\pi$ are found for which the reduced form social budget constraint permits higher real income. Differentiating the government cost function, the relationship between $d\pi$ and du is given by

$$G'_\pi d\pi = E'_\pi d\pi + E_t t'_\pi d\pi = -[1 - E_t t_u / E_u] E_u du.$$

The concept of the Marginal Cost of Funds (MCF) greatly aids the analysis of gradual reform. The MCF of using t to raise revenue is defined as E_t/R_t : raising a dollar of revenue R by a small change in t imposes a cost on the consumer per dollar raised equal to E_t/R_t.

The differential of the reduced form social budget constraint can now usefully be rewritten replacing t_π with $-R_\pi/R_t$ and t_u with $-R_u/R_t$:

$$G'_\pi d\pi = E'_\pi d\pi - MCF^t R'_\pi d\pi = -[1 - MCF^t R_I] E_u du$$

where $R_I \equiv R_u/E_u$, the derivative of revenue with respect to nominal income. Multiplying and dividing R_π by corresponding elements of E_π, and using the definition of MCF for elements of π ($MCF_i^\pi \equiv E_{\pi_i}/R_{\pi_i}$), the differential of the reduced form social budget constraint becomes:

$$-\sum_i (1 - MCF^t/MCF_i^\pi) E_{\pi_i} d\pi_i = [1 - MCF^t R_I] E_u du. \tag{6}$$

The implication of (6) is that reducing all elements π_i associated with $MCF_i^\pi > MCF^t$ and increasing all elements for which the inequality is reversed will produce a surplus. The surplus applied to the right hand side causes an increase in real income, provided that the square bracket term on the right is positive. Provided that t is appropriately chosen to fall on an activity with low MCF, the positive sign of $1 - MCF^t R_I$ is plausible.[3] It is often claimed that labor supply has low elasticity, hence low MCF^t is plausible.

2 Tariff Reform

The tariff reform problem is to advise on directions of change of tariffs from initial values. Full optimization is not feasible, for reasons which are not relevant to the analysis, by assumption.

To make progress with the revenue tariff advice problem it is necessary for the analyst to have at least some information. We seek to characterize cones of welfare-improving tariff reform that are sufficient with minimal information conditions. The information set includes the knowledge that the economy has a price-taking representative agent with convex technology and preferences and performs with no distortions other than those of taxes. The information set also includes some knowledge about specification and its implications that is spelled out below. This knowledge may include whether tariffs are on average over or under-utilized, in the sense that a uniform absolute tariff change (that preserves domestic relative prices) has a marginal cost MCF^T which is greater or less than the alternative source of funds MCF^t.

Initial tariffs are set such that domestic prices are given by π^A. Optimal revenue tariffs imply prices π^X. These are associated with points A and X

[3] While the discussion describes t as a wage tax, the mathematics describes a tax on any nontraded good or factor.

respectively in Figure 1. The iso-value locus G through point A is drawn such that $G(\pi, u^A)$ is convex in π. It has upward slope as drawn but this is neither necessary to the analysis nor particularly to be expected. The full locus G is an iso-value contour surrounding π^X which for simplicity we may consider to enclose a convex set. The tariff reform problem is to set out rules which will improve welfare under minimal information. We seek directions of change for π that lower G.

The key intermediate step in the analysis of trade reform is a decomposition of the effect of tariff changes into their effect on two moments of the distribution of tariffs, the generalized mean and the generalized variance. Anderson and Neary (2005) examine welfare improving directions of tariff reform in the case where revenue considerations are unimportant, effectively $MCF^t = 1$. The moments decomposition technique is applied here to the revenue tariff problem.

The setup begins with defining tariffs on the domestic price base: $T_i = (\pi_i - \pi_i^*)/\pi_i$. The analog for the wage tax is $T^w = t/(w+t)$ The generalized mean tariff $\overline{T}$ is defined by $\overline{T} \equiv \iota' ST$, the generalized variance is defined by $V \equiv (T - \overline{T})' S (T - \overline{T})$ and the positive definite weighting matrix S is defined by $S \equiv -\overline{s}^{-1} \pi' E_{\pi\pi} \pi$ where $\overline{s} \equiv -\pi' E_{\pi\pi} \pi > 0$ is the normalization coefficient for the substitution effects matrix and ι is the vector of ones. The normalization implies that $\iota' S \iota = 1$.

The trade weighted average tariff is defined as $T^a \equiv \sum \omega_i^a T_i$ where $\omega_i^a \equiv \pi_i E_{\pi_i} / \pi' E_\pi \geq 0$. Its change is defined by $dT^a = \sum \omega_i^a dT_i$. Notice that whereas $T^a > 0$ so long as imports are not heavily subsidized, the generalized mean tariff need not necessarily be positive even with all positive tariffs. A negative generalized mean is surely a perverse case, however, since it can be shown that $\overline{T} < 0 \Leftarrow (\Rightarrow) MCF^T < 1$ provided the composite commodity of the π goods is a substitute (complement) for the labor.[4] $\overline{T} < 0$ is necessary and sufficient in the borderline case of zero cross effects. If $\overline{T} < 0$, replacing lump sum taxes with a uniform absolute rise in tariffs would be welfare increasing. Being able to assume a positive generalized mean turns out to be crucially important for the assessment of the welfare implications of tariff

[4] $MCF^{T^a} = E_\pi' \pi / R_\pi' \pi = \frac{1}{1 - \frac{\overline{s}}{E_\pi' \pi} \overline{T} + t E_{t\pi} \pi / E_\pi' \pi}$. Substitutability/complementarity in the text above is defined in terms of $E_{t\pi}$, where

$$E_{t\pi} = -g_{w\pi} + g_{ww} \frac{e_{w\pi} - g_{w\pi}}{e_{ww} - g_{ww}}.$$

changes when information is limited. In the remainder of this paper we assume that the generalized mean tariff is positive.

As for changes in trade policy, we define the changes in tariff moments as based on constant weights, $d\overline{T} \equiv \iota' S dT$ and $dV \equiv 2T' S dT - 2\overline{T} d\overline{T}$. These expressions, while intuitive, are not directly useful because they depend on unobservables. Nevertheless, analytic expressions in changes in generalized means and variances help formulate linear tariff change rules that are sufficient for welfare improvement even in the absence of detailed information about substitution effects.

An important special case of preferences or technology provides a very illuminating and convenient illustration of the generalized moments. Suppose that the group of goods with price vector π enters either preferences or technology separably, so that $E(\pi, w, u) = F[\phi(\pi), w, u]$. The function $\phi(\pi)$ is concave and homogeneous of degree one. Separability is a very common assumption in applied work with both econometric and simulation modeling. Within the full general equilibrium model above, separability is very stringent, but the appendix shows that all our present argument can be applied to any separable group while more general substitution possibilities continue to govern relationships between groups.

Lemma *Under separable preferences or technology as defined above,* $T^a = \overline{T}$

Proof The definition of $\overline{T}$ is

$$\overline{T} = -\overline{s}^{-1} \pi' E_{\pi\pi} (\pi - \pi^*).$$

For the separable case, using the homogeneity of ϕ, $\pi' E_{\pi\pi} = F_{\phi} \pi' \phi_{\pi\pi} + F_{\phi\phi} \pi' \phi_{\pi} \phi'_{\pi} = F_{\phi\phi} \phi \phi'_{\pi}$, $\overline{s} = -\pi' E_{\pi\pi} \pi = -F_{\phi\phi} \phi^2$and therefore:

$$\overline{T} = \phi'_{\pi} (\pi - \pi^*)/\phi = T^a. ||$$

This development generalizes Anderson and Neary (2005), who showed that $\overline{T} = T^a$ in a special case where tariffed imports were final goods imperfectly substitutable with domestic production and preferences were CES. Separability is a considerably weaker sufficient condition.

2.1 Tariff Changes Only

With tariff reform restricted to tariff changes only, the task is to find directions of improvement that raise welfare and/or revenue without lowering either one. Using the differentials of the private and government budget constraints:

$$E_u du/E_\pi \pi = -dT^a$$

and

$$dR/E_\pi \pi = (1 - R_I)dT^a - \eta(dV/2 + \overline{T}d\overline{T}) + T^w \theta dT^\theta,$$

where $\theta = E_{t\pi}\pi/E'_\pi \pi$, $\eta = -\pi' E_{\pi\pi}\pi/E'_\pi \pi$, and $dT^\theta = \sum w_i^\theta dT_i$ with $w_i^\theta = E_{t\pi_i}/\sum E_{t\pi_i}$.

The familiar case of lump sum redistribution results when $dR = 0$and the two equations above imply

$$E_u du/E'_\pi \pi = (1 - R_I)^{-1}[-\eta(dV/2 + \overline{T}d\overline{T}) + T^w \theta dT^\theta].$$

See Anderson and Neary (2005) for more development of this case.

Without redistribution, the first equation implies that the change in money metric utility as a percent of trade expenditure is equal to minus the change in the trade weighted average tariff. The second equation reveals that revenue must fall with a fall in T^a, unless compensated by changes in the other tariff moments. What type of tariff structure changes can induce both welfare and revenue to rise?[5]

Reductions in the generalized variance must always increase revenue, all else equal. Mean-preserving reductions in dispersion are thus attractive if it is feasible to preserve all three means $(T^a, \overline{T}, T^\theta)$. When the group of tariff-ridden goods being reformed enters preferences or technology separably, the three first moments are all equal, using the Lemma and a similar proof that $T^\theta = E_{t\pi}(\pi - \pi^*)/E'_{t\pi}\pi = T^a$.[6] Then under separability, trade-weighted average tariff preserving cuts in dispersion will raise revenue.

Apart from separability, a useful benchmark cut in tariff means that preserves dispersion is the uniform absolute reduction reform $dT = -\iota d\alpha$, yielding $dT^a = d\overline{T} = dT^\theta = -d\alpha$. Revenue changes by

$$dR/E'_\pi \pi = -[1 - R_I - \eta\overline{T} + T^w \theta]d\alpha$$

[5] In contrast, Anderson and Neary (2005) show that welfare and 'market access' (trade volume) are moved in the same direction by changes in $\overline{T}$ but in opposite directions by changes in variance V.

[6] The proof is a little more elaborate. Under separability, the group of goods aggregated in the price index ϕ enter either preferences or technology. In general, $E_{t\pi} = -g_{w\pi} - g_{ww}w_\pi$ and $w_\pi = -(e_{w\pi} - g_{w\pi})(e_{ww} - g_{ww})$. With separability, either $e_{w\phi} = 0$ or $g_{w\phi} = 0$, but in either case $E_{t\pi}$ is proportional to ϕ_π. Then like terms cancel in forming T^θ and the unlike terms give the trade weights.

When $\eta\overline{T}$and $R_I$are large and $T^w\theta$is small, uniform absolute reductions in tariffs will raise revenue and welfare at the same time.

Pulling together results:

Proposition 1 *(a) Under separability, trade weighted average preserving cuts in tariff dispersion raise revenue while not harming welfare. (b) Uniform absolute reductions in* T *raise both welfare and revenue when* $1 - R_I - \eta(\bar{T}) - T^w\theta < 0$.

Considering that very large dispersion is common in tariff structures, even in countries that raise a substantial portion of government revenue from tariffs, the proposition does imply considerable scope for efficiency improvement from dispersion cuts. Combining uniform absolute tariff cuts with dispersion cuts gives further scope for tariff reform that both raises welfare and revenue.

2.2 Tariff Reform with Wage Tax Changes

Tariff reform advice has more scope for efficiency gains when the wage tax t can be changed so as to hold revenue constant. Advice remains problematic because information about the derivative vector G_π is limited. The information constraint boils down to the analyst not knowing the expected values and standard errors of MCF's of the various tariffs. What rules can be derived which are robust to the analyst's restricted information about the MCF's of individual tariffs?

As a preliminary step, an important benchmark MCF for reformable tariffs overall is associated with a uniform proportional exogenous change in the domestic price of tariff-ridden goods, $d\pi = \pi d\alpha$, where $d\alpha$ is a scalar. This case preserves the dispersion of the tariff schedule but reduces the average (with any set of weights) tariff by $d\alpha$. In this case the change in the government cost, the left hand side of (6), $-G'_\pi d\pi$, reduces to

$$-E'_\pi \pi[1 - MCF^t/MCF^T]d\alpha$$

where $MCF^T \equiv R'_\pi \pi / E'_\pi \pi$. By the composite commodity theorem, the group of tariff ridden goods is treated as if it were one good when prices move equiproportionately, with composite marginal cost of funds equal to MCF^T. Another important benchmark is optimality, the solution to the Ramsey problem. This requires that the MCF be equal for all π, and equal to the MCF for the alternative source of tax revenue, in this case the wage tax.

Now we take up the analysis of tariff reform using the tariff moment definitions. Any change in domestic prices due to tariff changes, $d\pi$, changes the policy objective by dG via terms which can be decomposed into generalized tariff moments and their changes.

For general tariff changes $d\pi$ that are made revenue neutral by endogenous changes in the wage tax t, the change in the government cost as a proportion of the domestic value of π good trade is given by:

$$\frac{1}{E'_\pi \pi} dG = (1 - MCF^t)dT^a + MCF^t \eta \left(dV/2 + \overline{T} d\overline{T}\right) - MCF^t T^w \theta dT^\theta. \quad (7)$$

The first term of (7) is decreasing in the trade weighted mean tariffs assuming that $MCF^t > 1$. This term gives the revenue effect of the tariff change at constant quantities demanded, without substitution effects. The second term gives the effect of tariff changes acting through within-group substitution effects, all multiplied by η, the own elasticity of the π group with respect to an equiproportionate change in π. It is increasing in the generalized variance and mean of tariffs, provided $\overline{T} > 0$. The third term gives the cross effect on revenue as due to a 'cross-effect weighted average tariff change' multiplied by the cross elasticity of demand θ between the p good and the group of π goods.

What combinations of assumed information and rules for tariff changes are likely to improve welfare by reducing G? The general expression (7) provides useful clues. First, variance reduction is useful, all else equal. Second, uniform absolute reductions in T ($dT = -\iota d\alpha$ where ι is the vector of ones) preserve relative prices among the π goods. This results in

$$\begin{aligned} -\frac{1}{E'_\pi \pi}\frac{dG}{d\alpha} &= [1 - MCF^t/MCF^T] \\ &= \left[1 - MCF^t(1 - \eta\overline{T} + \theta T^w)\right]. \end{aligned}$$

A necessary condition for $MCF^T > 1$ is $\eta\overline{T} > \theta T^w$. This is assumed for tariff reform to make any sense at all, otherwise a tariff increase is more efficient than a lump sum tax. The analyst may also have confidence that $MCF^t/MCF^T < 1$, a tariff is less efficient than the alternative distortionary tax, based on simulation exercises with a number of countries and simulation models. For example, this is the finding of Erbil (2004) when comparing the MCF of trade taxes with consumption taxes. The preceding expression may be useful in interpreting simulation results to strengthen what confidence in such trade reform the analyst may have.

For more general results that can cover more of the complexity of actual tariff changes, it is very helpful to restrict tariff changes to linear paths, $dT = (T - \beta\iota)d\alpha$. A rise in α will raise variance and will raise T^a if $\beta \geq T^a$. Linear paths have simple relationships to the generalized mean and variance of tariffs. The general linear path is a combination of uniform absolute and uniform proportional changes in tariffs. It is also a convex combination of uniform absolute tariff changes and trade weighted mean preserving variance changes.[7] On the linear path

$$\begin{aligned} \frac{1}{E_\pi' \pi}\frac{dG}{d\alpha} &= (1 - MCF^t)(T^a - \beta) + MCF^t \eta V \\ &\quad + MCF^t[\eta\overline{T}(\overline{T} - \beta) - \theta T^w (T^\theta - \beta)]. \end{aligned} \tag{8}$$

Then using $MCF^T > 1$ and additionally supposing that $\overline{T} \geq T^\theta \geq \beta$, the second line must be positive. Welfare rises with cuts in α if $dG/d\alpha > 0$. Then setting the tariff change rule such that $T^a = \beta$, $dG/d\alpha > 0$ whenever $\overline{T} \geq T^\theta \geq T^a = \beta$.

Proposition 2 *(i) Trade-weighted mean preserving reductions in tariff variance are welfare improving when* $\overline{T} \geq T^\theta \geq T^a$ *and* $MCF^T > 1$.

(ii) Uniform absolute tariff reductions are welfare improving when $1 < MCF^t < MCF^T$,

(iii) Convex combinations of uniform absolute tariff cuts and trade-weighted mean preserving dispersion cuts, $\beta \leq T^a$, *are welfare improving under the conditions of (i) and (ii).*

Proof: (i) and (ii) have already been proved. Rearrange the right hand side of (8), dividing by $T^a - \beta > 0$ as

$$1 - MCF^t\left[1 - \eta\overline{T}\frac{\overline{T} - \beta}{T^a - \beta} + \theta T^w \frac{T^\theta - \beta}{T^a - \beta}\right] + MCF^t \eta \frac{V}{(T^a - \beta)}.$$

The square bracket term is smaller than the inverse of MCF^T under the conditions of (i) and hence the entire expression is positive under the condition of (ii).||

The condition $\overline{T} \geq T^\theta \geq T^a$ is problematic, depending on two unobservable average tariffs. But the condition is met in an important benchmark

[7] $(T - \beta\iota)d\alpha = [\omega(T - T^a\iota) - (1 - \omega)\delta\iota]\, d\gamma$ where $d\gamma = d\alpha/\omega$ and $\beta = T^a + \delta(1 - \omega)/\omega$ for $1 \geq \omega \geq 0$. The scalar δ can be positive or negative.

simplification that yields strikingly simple conclusions. In the separable case, by the Lemma, $T^{\theta} = \overline{T} = T^{a}$. Then the proposition holds with separability and the condition of (ii), $1 < MCF^{t} < MCF^{T}$. In the future, more insight into the behavior of the unobservables will be generated by examining simulations with a variety of models and data for different countries.

The separable case shows that mere substitutability is not important in ranking $\overline{T}$ and T^{θ} relative to T^{a}. Substitution effects within classes of tariff-ridden goods are irrelevant, complementarities are admissible along with highly asymmetric substitution effects. For example, it is natural to think of an aggregate like clothing as a goods class, entering preferences separably but having complex substitution effects within class: shirts and trousers may be complements while silk and chambray shirts may be substitutes. What does matter for the ranking is that nonseparability admits varying substitution effects between tariff-ridden goods and the numeraire. Using the standard algebra of covariance, $\overline{T} - T^{a} = Cov(\omega, T) - Cov(\omega^{a}, T)$, where the covariance uses arithmetic (equal) weights. The generalized weights ω differ from the trade share weights ω^{a} only if the goods are non-separable and $\overline{T} < T^{a}$ with non-separability if numeraire substitution effect shares ω are more sensitive to high tariffs than are trade shares ω^{a}.

Proposition 2 can readily be extended to many classes of separable tariff -ridden goods. Let T^{ka} denote the trade weighted average tariff in separable goods class k, while T^{a} continues to denote the overall trade weighted average tariff and $\overline{T}$ continues to denote the overall generalized mean tariff.

Proposition 3 *Welfare improves with*
(i)trade weighted mean preserving dispersion cuts within separable goods classes,
(ii) any convex combination of such dispersion cuts and a uniform absolute tariff change across as well as within classes that decreases (increases) tariffs when they are over (under) utilized.

Proposition 3 is proved in the Appendix. The key element is that the condition of Proposition 2 is met under separability by the lemma. The proposition is quite useful because separability is a ubiquitous assumption in applied work. Faced with some ten thousand tariff lines, aggregation is inevitable for any econometric or simulation work. The proposition assures the analyst that trade-weighted average preserving dispersion cuts within classes are welfare improving without detailed knowledge of substitution effects (either parameter values or specification) within goods classes. National tariff schedules are full of dispersion in detailed product classes, so there is a lot of room in practice for beneficial cuts. It is worth noting that under separability, a trade weighted mean-preserving tariff dispersion cut improves welfare strictly by raising government revenue; trade expenditure remains constant under this reform.

The separable case restriction yields a directly useful expression for MCF^T that can be used to calculate the relative under or over-utilization of tariffs. Let the trade expenditure function be written as $E(\pi, t, u) = F[\phi(\pi), t, u]$ where the price aggregator ϕ is concave and homogeneous of degree one in π. Then[8]

$$MCF^T = \frac{1}{1 - \eta T^a + \theta T^w}$$

where $\eta = -F_{\phi\phi}\phi/F_\phi$, the elasticity of demand for the group of tariff-ridden goods. T^a and T^w are observable and it is easy to test the sensitivity of MCF^t/MCF^T with respect to various values of the elasticities η, θ which are not known with certainty.

2.3 How Over-sufficient Are the Conditions?

Tariff reform within a separable goods class can improve welfare by movements that are not within the cone formed by the sufficient conditions of Propositions 2 and 3. Thus it is useful to examine what can be said about MCF's within a class in order to gauge how much of the potential space of welfare improving movements is covered by the cone of Propositions 2 and 3. Imposing zero cross effects ($\theta = 0$) for simplicity,

$$\begin{aligned} MCF_\pi &= [\iota + \underline{E}_\pi^{-1} E_{\pi\pi}(\pi - \pi^*)]^{-1} \\ &= [\iota - \frac{\overline{s}}{\pi' E_\pi}(\underline{w}^a)^{-1} ST]^{-1} \end{aligned}$$

Not much can be done in general with this expression because S has too many variables known imprecisely. Imposing the restriction of separability, $E(\pi, t, u) = F[\phi(\pi, u), t, u]$ and $\overline{s}/\pi' E_\pi = F_{\phi\phi}\phi/F_\phi = \eta$, the aggregate elasticity of demand. Moreover, $S_{ij} = (1/\phi\eta)\pi_i \phi_{ij} \pi_j + w_i^a w_j^a$, and hence $MCF_\pi = [1 - \eta T^a - (\pi_i/\phi w_i) \sum_j \phi_{ij} \pi_j T_j]^{-1}$. The third term might be thought

[8] $MCF^T = [1 + (\pi - \pi^*)' E_{\pi\pi} \pi / E_\pi' \pi]^{-1}$ in the general case. Using the definitions of generalized moments, this reduces to $MCF^T = \left[1 - \overline{T}\overline{s}/\pi' E_\pi\right]$. With separability, $\overline{T} = T^a$ and $\overline{s} = -F_{\phi\phi}\phi^2$ while $\pi' E_\pi = F_\phi \phi$. Substituting into the general case expression yields the simple form in the text.

to be small because $\sum_j \phi_{ij}\pi_j = 0$ but in some cases it may be large, so this expression remains too general to be useful. Specialization to the CES case produces especially simple results.[9]

$$MCF_{\pi_i} = 1/[1 - \eta T^a - \sigma(T_i - T^a)]. \tag{9}$$

The CES expression (9) for MCF reveals that the focus of Propositions 2 and 3 on convex combinations of mean-preserving tariff cuts and dispersion-preserving mean cuts does indeed capture all the relevant characteristics of welfare improving revenue tariff reform which can be guaranteed without full knowledge of substitution effects. If exact values of η and σ are assumed to be known, it is of course possible to improve welfare with tariff reforms outside the cones based on (9).[10] As substitution possibilities range more widely outside the CES, more welfare improving revenue tariff reforms can be found which are not within the cones of Propositions 1 and 2. But again, showing that these reforms raise welfare depends on information that this paper assumes, realistically, that the analyst is unlikely ever to have with any certainty.

Note that the CES expression for MCF sheds light on the esoteric possibility that some tariffs may actually have $MCF < 1$. The right hand side of (9) can be greater than one (and hence the MCF of tariffs in good i can be less than one). The necessary and sufficient condition for $MCF_{\pi_i} < 1$ is $(1 - \eta/\sigma)T^a > T_i$. The sufficient condition requires either that $\eta/\sigma < 1$, substitution elasticities within the separable group exceed substitution elasticities between that group and all other goods, or that $T_i < 0$. Normally neither condition would be met.

[9] In the CES case,

$$\phi_{ij} = \sigma(-\delta_{ij} + w_j)w_i \frac{\phi}{\pi_i \pi_j}$$

[10] The half space defined by tariff changes such that $G'_\pi d\pi < 0$ gives the full set of government cost reducing reforms. In the CES case this space is defined by tariffs such that $\{\iota - [MCF^t(1-\eta T^a)\iota - MCF^t\sigma(T - T^a\iota)]\}' d\pi < 0$. The condition that $MCF^t/MCF^T > 1$ is equivalent to $MCF^t(1 - \eta T^a) < 1$. Mean preserving dispersion cuts reduce government costs, dispersion-preserving mean cuts (uniform absolute cuts) reduce government costs, convex combinations of these also reduce costs. But many other cuts lie in the half space below the constraint.

2.4 The Desirability of Dispersion Cuts

Further analysis of the desirability of trade-weighted mean-preserving dispersion cuts is useful, since it seems to argue for uniformity in contrast to the intuition of the Ramsey principle. The sufficiency condition $\overline{T} \geq T^a$ appears to be puzzlingly powerful.

Figure 1 shows that the ray through the Ramsey optimal tariff point X divides the domestic price space into half spaces. Starting at point X, draw a mean-preserving line to uniform tariff ray OF. For points on this line between uniform tariff ray OF and optimal tariff ray OX, trade weighted mean preserving dispersion increases are welfare improving. For points in the space below ray OX, dispersion increases are welfare decreasing. If the cone FOX is small, the World Bank intuition about the desirability of dispersion reduction holds in some sense for most of the tariff space.

Next, consider a particular tariff A, with iso-value locus G^A. The line labeled $dT^a = 0$ gives the mean-preserving tariff change path. As drawn, decreases in dispersion raise welfare, implying $\overline{T} > T^a$. A line tangent to G^A at point A represents the situation where $V + \overline{T}(\overline{T} - T^a) = 0$. If the locus $dT^a = 0$ is steeper than the tangent line to G^A at A, dispersion reductions lower welfare.

With separability, $\overline{T} = T^a$, hence $dG/d\alpha > 0$ for mean preserving changes in dispersion. This implies that the Ramsey optimal tariff is uniform in the separable case (Guesnerie, 1995). Thus point X lies on OF. Extending separability to multiple classes as in Proposition 3, uniformity of tariffs within classes is optimal. This benchmark case suggests that optimal departures from uniformity may be small for a fairly wide class of reasonable general equilibrium structures.

The desirability of dispersion cuts becomes less mysterious when we recall that the linear reform rule restricts outcomes relative to the starting point. The full optimum is not attainable. The optimal tariff structure implied by the linear reform rule $dT = (T - \beta\iota)d\alpha$ is, for mean-preserving dispersion changes $\beta = T^a$, consistent with $V = -\overline{T}(\overline{T} - T^a)$. Figure 2 illustrates a case where the mean-preserving dispersion cut line AU is associated with increases in welfare relative to u^A for each point on the path to the uniform tariff ray OF. Nevertheless, the full optimal tariff point X is non-uniform and yields still higher welfare.[11] Moreover, there is a best tariff subject to the linear rule and the initial condition T^A which lies somewhere on the path from A to U, and this tariff is non-uniform unless it lies at U. $\overline{T} < T^a$ is necessary for movement from A to U not to raise welfare relative to u^A for each point on the path.

3 Many Households

The preceding expressions extend with appropriate modification to the case of many households. For simplicity, assume that zero cross effects obtain, $\theta = 0$. The government budget constraint continues to hold using E for the aggregate trade expenditure function and its derivatives while E^i denotes the individual household i trade expenditure function. The aggregate cost function G is is obtained as before. The gradient vector with respect to π is given by

$$G_\pi = (1 - MCF^p) \sum E^i_\pi(\pi, u^i) - MCF^p(\pi - \pi^*)' \sum E^i_{\pi\pi}(\pi, u^i)$$

Compare to the one household case, aggregate compensated excess demand and expenditure replace the representative agent's excess demand and expenditure. The aggregate expression can be decomposed into N separate expressions G^i, one for each of the N households in the economy.

Trade reform effects on welfare can be analyzed at the level of each household i. For each household the linear reform rule $dT^i = (T - \beta^i)d\alpha$ yields a version of (8):

$$\frac{dG^i}{d\alpha} = (1 - MCF^p)(T^{ai} - \beta^i)\pi' E^i_\pi + MCF^p \overline{s}^i [V^i + (\overline{T}^i - \beta^i)\overline{T}^i],$$

where $T^{ai} \equiv \sum_j \omega^{ai}_j T_j$ where $\omega^{ai}_j \equiv \pi_j E^i_{\pi_j} / \pi' E_\pi$ and the generalized moments are defined with substitution effects matrices which are household specific.

What minimal information is needed to specify welfare improving rules for each household (Pareto superior rules)? Tariffs are widely levied on intermediate goods. In this case there is no household-specific weighting, $T^{ai} = T^a$,

[11] The optimal tariff vector is given by

$$T^0 = \frac{MCF^t - 1}{MCF^t \overline{s}} S^{-1} \underline{\pi} E_\pi,$$

where all variables are evaluated at the optimal tariff point.

so dispersion cuts are Pareto-superior. As for final goods, assume that imported goods in a separable goods class have no domestic perfect substitute, and that household expenditure patterns E^i_π are observable. The former is a widely used empirical assumption because the perfect substitutes assumption yields implications wildly at variance with the trade data. The observability of household expenditure patterns is a more problematic assumption but it is satisfied for a number of countries.

Under these assumptions, the β^i parameters can be set equal to the household level trade-weighted average tariff T^{ai} to implement the mean preserving dispersion cut: $dT^i = (T - T^{ai})d\alpha$. The mechanism is a uniform deviation from the common tariff cut rule for each household: $dT^i - dT = (T^{ai} - T^a)\iota d\alpha$. All tariffs are changed according to $dT = (T - T^a\iota)d\alpha$. Implementation of the household specific deviations could presumably take place at the retail level (as with food stamps or senior citizen discounts), supplemented by some governmental identification system. Doing so, for example, all clothing tariffs change according to the common rule, then each household receives or pays its household specific deviation $(T^{ai} - T^a)d\alpha$. Alternatively, the implementation could be done through income tax credits. To avoid shirking, the common rule could be set around the highest T^{ai}, so that all households with lower average tariffs receive a rebate.

In this scheme of tariffs, the real income of each household is maintained, the individual variation of β^i is revenue neutral since $\sum_i (T^{ai} - T^a)\pi' E^i_\pi = 0$, and the government revenue will rise due to the revenue-increasing cut in dispersion. Thus dispersion cuts are a Pareto-superior reform. As for uniform absolute cuts in tariffs, the requirement of Propositions 2 and 3 that 'tariffs are over (under) utilized' becomes extremely stringent because it requires that the MCF of the alternative revenue source be less (more) than *each* individual agent's MCF of tariffs. This is seldom likely to appear plausible to analysts evaluating potential reforms.

The implication is that the Pareto-superiority of dispersion cuts holds in the many household case under the separability assumption and zero cross effects, understanding that trade weighted average tariffs must be calculated and applied at the household level. The separability assumption is plausible for some goods classes and not for others. Still, this discussion suggests the surprisingly wide desirability of dispersion cuts.

4 Consumption and Production Tax Reform

Standard fiscal advice to developing economies urges the replacement of trade taxes with consumption taxes. So in this section we focus on the reform of internal tax/subsidy systems, subject to the revenue constraint. We omit consideration of administrative costs from our analysis (except implicitly insofar as some goods are assumed to be untaxed).[12] Consumption and production taxes and subsidies are a far more prominent source of revenue and expenditure than are trade taxes for most economies, so much of the fixed cost of administration may often be plausibly taken as sunk. Nevertheless, administrative costs may sometimes be a significant consideration in fiscal reform. For this section of the paper, we eliminate wage taxation (continuing to push equilibrium wage determination into the background).

It is useful to ground the analysis in the well-known equivalence between a tariff and a combination of a tax on consumption and a subsidy on production at the same rate. Similarly, an export tax is equivalent to a tax on production combined with a subsidy on production. Differential tax/subsidy rates for traded goods break the equivalence of a tariff with a consumption tax *cum* production subsidy. In contrast, for nontraded goods a consumption tax and a production tax are equivalent.

Reform can be viewed, when consumption and production policies are uncoupled, as starting from a base with border taxes and possibly additional consumption or production policies, and then adding changes in consumption and production policies separately. We simplify this picture to a typical distortion reform situation which involves consumption taxes and production subsidies at different rates. The direction of welfare improving change is typically a reform in the consumption tax vector that reduces taxes overall combined with a reform of the subsidy vector that reduces subsidies overall. In keeping with the setup of this paper, the net revenue change must be made up from an alternative revenue source with MCF greater than 1.

The first subsection deals with the reform of taxes and subsidies on traded goods. For simplicity, cross effects between the reformed group of taxes/subsidies and the alternative revenue source are ruled out. Cross effects are reintroduced in the concluding subsection where the alternative revenue source is domestic taxation of nontraded goods.

[12] See Emran and Stiglitz (2005) for an argument that restrictions on available tax instruments due to administrative costs make the desirability of replacing border taxes with domestic taxes very dubious.

4.1 Reform of Consumption Taxes and Production Subsidies

Let q denote the consumer price vector while π denotes the producer price vector, all for the goods subject to tax reform. Typically the consumer of good i is taxed at rate $q_i - \pi_i^* > 0$ and a the producers of good i are subsidized at rate $\pi_i - \pi_i^* > 0$. The pure import tax case arises when $q_i = \pi_i$. For export taxes the inequalities are reversed and consumption is subsidized while production is taxed. The government budget constraint is given by

$$(q - \pi^*)' e_q(q, p, u) - (\pi - \pi^*)' g_\pi(\pi, p) - (p - p^*)(e_p - g_p) - s = 0.$$

The private budget constraint is given by $e(q, p, u) - g(\pi, p) - s = 0$. Solve the government budget constraint for the endogenous value of p that satisfies the constraint given the values of q, π, u, then substitute the results into the private budget constraint to form the government cost function and the reduced form social budget constraint.

Changes in distortions imply changes in the government cost function

$$\begin{aligned} G_q' &= (1 - MCF^p) e_q' - MCF^p (q - \pi^*)' e_{qq} \\ G_\pi' &= -(1 - MCF^p) g_\pi' + MCF^p (\pi - \pi^*)' g_{\pi\pi}. \end{aligned}$$

Note that subsidy increases are cost increasing except in the highly perverse case where the cross effects (in $(\pi - \pi^*)' g_{\pi\pi}$ for production subsidies and $(q - p^*)' e_{qq}$ for consumption subsidies) are so large as to offset the other terms (arising when a subsidy increase shifts production so powerfully away from more highly subsidized industries that the subsidy budget actually falls). The increasing government cost associated almost everywhere with production or consumption subsidies argues for the desirability at the margin of leaning away from border taxes toward consumption taxes. Nevertheless, the administrative cost of instituting or levying producer taxes which effectively lower the producer subsidy due to the tariff argue for caution in applying this advice. (See Emran and Stiglitz, 2005, for a strong statement of this view.)

The decomposition methods of this paper can be applied to consumption taxes and production subsidies straightforwardly. On the production subsidy side the decomposition is not really needed for reform rules, however, since virtually the entire subsidy space southeast of the initial subsidies is welfare-improving. Reductions of tariffs paired with increases in consumption taxes such that consumer prices stay constant will achieve the desired decrease in production subsidies for constant q. Hatzipanayotou, Michael and Miller (1994) provide the basic result. Keen and Ligthart (2002) extend the result and show that it must be qualified upon the introduction of intermediate inputs and imperfect competition. The present treatment is slightly more general in that it allows for an endogenous change in a distortionary tax to meet the government revenue constraint.

Reform of consumption taxes is in contrast very much like trade taxes. Define the consumption tax on the domestic price base as $T^e = \underline{q}^{-1}(q - \pi^*)$. The generalized mean and generalized variance of consumption taxes are formed using the demand system substitution effects. The consumption tax change rule $dT^q = (T^q - \beta^q \iota)da$ causes government cost to change by

$$\frac{dG}{d\alpha} = e_q' q \left\{ (1 - MCF^p)(T^{e,a} - \beta^q) + MCF^p \eta^e \left[V^e + \overline{T}^e (\overline{T}^e - \beta^e) \right] \right\}.$$

Note the close resemblance of this expression to (8). The results of Propositions 2 and 3 (with the obvious extension to include cross effects) thus apply to the reform of consumption taxation on traded goods. Except in perverse cases, production subsidy reduction is beneficial in all directions.

4.2 Nontraded Goods Taxation

Finally, consider taxation of nontraded goods for the purpose of neutralizing the revenue effects of tariff reform. It is convenient to assume once again that all other taxes are trade taxes (or subsidies). Thus primary factors are not taxed, but the formal analysis is much like that of the wage tax in the earlier sections of the paper.

Let t denote the specific tax (which can be thought of as either a producer or a consumer tax) on the nontraded good with producer price p and consumer price $p + t = q$. The private budget constraint is given by $e(\pi, p + t, u) - g(\pi, p) - s = 0$ while the government budget constraint is given by $(\pi - \pi^*)'(e_\pi - g_\pi) + te_q - s = 0$. Market clearance for nontraded goods determined p as a function of $\pi, \pi^*, t, u, s : P(\pi, \pi^*, t, u, s) = p :$ $e_q(\pi, p + t, u) - g_p(\pi, p) = 0$. Solving the government budget constraint for t as a function of π, π^*, u, s and substituting into the private budget constraint yields the government cost function $G(\pi, u; \pi^*, s)$.

The marginal cost of a change in trade taxes is given by

$$G'_\pi = (1 - MCF^p)(e'_\pi - g'_\pi) \\ -MCF^p \left[(\pi - \pi^*)'(e_{\pi\pi} - g_{\pi\pi}) + te_{q\pi}\right]$$

where

$$MCF^p = e_q / \left[e_q + te_{qq}(1 + P_t) + (\pi - \pi^*)'(e_{\pi q} - g_{\pi p})P_t + (\pi - \pi^*)'e_{\pi q}\right],$$
$$P_t = -\frac{e_{qq}}{e_{qq} - g_{pp}}.$$

The formal expressions for G'_π and MCF^p feature a partial separation of substitution effects between the demand side and the supply side of the economy as in the preceding subsection along with a reintroduction of cross effects between the π goods and the p good.

The reform results of preceding sections evidently apply when the alternative tax is on a nontraded good. Note once again that the condition $MCF^p < MCF^{T^\alpha}$ may sometimes not be met. Anderson (1999) provides a contrary example, but Erbil (2004) provides far more examples with more appropriate models and data for which the condition is met. Of course, for separable groups of traded goods it remains true that trade-weighted average preserving reductions in dispersion are welfare improving without qualification: they raise revenue regardless of the ranking of MCF^p and MCF^{T^α}.

Tax reform within sets of nontraded goods and factors is beyond the scope of this paper. The expression for MCF^p indicates the difficulties which must be handled — P_t becomes a matrix with complex structure.

5 Conclusion

This paper has set out cones of welfare improving trade reform that permit confident policy advice despite the (assumed partial) ignorance of analysts about the 'true' structure of the economy. Dispersion reducing trade reform is surprisingly widely beneficial: whenever households have implicitly separable preferences with respect to the same partitions of goods, dispersion of tariffs within separable groups is inefficient. Cuts in average tariffs are efficient when the MCF of such tariffs is greater than the MCF of alternative revenue sources. Convex combinations of uniform absolute cuts and mean-preserving dispersion cuts are beneficial under these conditions.

6 Appendix

The separable case gives rise to useful simplifications of the model. Here the logic is extended to many separable classes.

Suppose that the tariff-ridden group of goods forms an implicitly separable class in the trade expenditure function: $E(\pi, p, \pi_0, u) = F[\phi(\pi, u), p, \pi_0, u]$, where ϕ is concave and homogeneous of degree one in π. When imported goods form separable classes indexed by k, such as $\eta^k(\pi^k)$, the logic of the text yields $\overline{T}^k = T^{ak}$ with the natural extension of notation. Mean-preserving dispersion reduction is desirable within classes. When combined with overall uniform tariff change, the tariff change policy rule is given by

$$dT^k = (T^k - \beta^k \iota^k)d\alpha, \ \forall k \tag{10}$$

where ι is understood to be the vector of ones with dimension appropriate to goods class k and β^k is a scalar for goods class k. The combination of trade-weighted mean preserving change with uniform absolute change overall requires $\beta^k = T^{ak} + \beta$. As for overall mean tariffs, we define $T^a = \sum \omega_k^a T^{ak}$ where $\omega_k^a = E_{\eta^k}\eta^k / \sum E_{\eta^k}\eta^k$, the trade weights for the classes of imports. The generalized mean overall tariff is defined by $\overline{T} = \sum \omega_k T^{ak}$ where the generalized weights are defined as in the text, but using the price aggregators η^k as the individual prices.

Define the row vector $b' \equiv \{\beta^1\iota^1, ..., \beta^K\iota^K\}$. The trade weighted average of b is $b^a = T^a + \beta$, while the generalized average of b is $\overline{b} = \overline{T} + \beta$. Applying the rule (10) to evaluate its effect on the cost of supporting real income yields:

$$\frac{dG}{d\alpha} = (1 - MCF^t)(T^a - b^a)E'_\pi \pi + MCF^t \overline{s}\{V + \overline{T}(\overline{T} - \overline{b}) - Cov(T, b)\}.$$

Here, Cov denotes the generalized covariance $(T - \overline{T})'S(b - \overline{b})$. In the separable case with b constructed as given, the covariance is equal to zero. Covariation within class is obviously equal to zero because the elements of b within class do not vary. Between classes, the class-mean-preserving element of β^k implies no change in price aggregates while the mean shift element of β^k implies a uniform shift which gives no variation. Applying the other implications of the structure of b yields

$$\begin{aligned}\frac{dG}{d\alpha} &= -\beta(1 - MCF^t)E'_\pi \pi + MCF^t \overline{s}\overline{T}\{V/\overline{T} - \beta\} \\ &= -E'_\pi \pi \left[\left(MCF^t/MCF^T - MCF^t\right)V/\overline{T} + \beta\left(1 - MCF^t/MCF^T\right)\right].\end{aligned}$$

The substitutions from the first to the second line also uses $\overline{s}\overline{T}/\pi' E_{\pi} = 1 - 1/MCF^T$ and then simplifies. When $\lambda/MCF^T < 1$, $dG/d\alpha > 0$ when $\beta < 0$. This is the case of uniform tariff increases combined with trade-weighted mean preserving dispersion increases, so such reductions improve welfare. Thus we have proved Proposition 3.

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