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SUCCESSIVE TRADE LIBERALIZATION AND WAGE INEQUALITY

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Abstract: This paper examines the implications of initial conditions in terms of the levels of tariff protection from which countries liberalize their trade regimes on the wage inequality in trading nations. The discussion is confined to the standard two-country Heckscher-Ohlin-Samuelson model to see whether there can be channels, other than those discussed in the recent literature, through which the observed phenomena can be theoretically predicted. The initial conditions are observed to matter in the sense that for countries lowering their tariff levels successively rather than once and for all, intra-country wage inequality may change asymmetrically at different stages of liberalization.

Key words: Successive tariff reductions; Wage Inequality; Heckscher-Ohlin Model; Bilateral trade liberalization; Metzler paradox.

JEL Classification Number: F11, F13, F16.

1. INTRODUCTION

Empirical evidence regarding growing intra-country wage inequality in almost every part of the globe during the last two decades and a half has posed a serious theoretical challenge to the trade theorists to provide a plausible explanation for such observations[1]. At the same time, a sizeable number of economists and researchers have expressed their skepticism regarding the role of global free trade and instead have argued in favour of technological changes in the 1980s that have brought about large shifts in the world

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[1] For a documentation of evidences on almost universal rise in intra-country wage inequality readers are referred to Marjit and Acharyya (2003).

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demand for skill-intensive goods[2]. However, much of the skepticism regarding the role of trade arise primarily because of the failure of the standard neoclassical trade theories to predict the observed wage movements. The Heckscher-Ohlin (HO) theorem and the Stolper-Samuelson (SS) theorem, the two work-horses of the neoclassical trade theory, predict that freer trade between developed and developing countries should lower wage inequality in the developing countries but raise the same in the developed countries. But contrary to this prediction, wage inequality has been observed to rise in both parts of the world.

Indeed, the issue of trade vs. technology has to be settled through proper empirical estimates. But even then the theoretical challenge that remains is to provide analytical framework that explains two aspects of the observed phenomena: First, how does trade liberalization increase intra-country wage inequality in the developing countries given that they in general import skilled-labour intensive goods, and second, how does it increase intra-country wage inequality in almost all the trading nations, developing and developed countries alike. There have been some notable recent attempts to generate these kinds of predictions. One set of theories attempts to explain universal rise in intra-country wage inequality by generalizing the Heckscher-Ohlin-Samuelson (henceforth, HOS) and Ricardian models of trade. Production specialization in a different set of goods in the skill-intensity ranking by developing and developed countries in a multi-commodity setting except for a commonly produced "middle" good (for which the local and global skill-intensity ranking differ) is the building bloc of such explanations [Davis (1996), Feenstra and Hansen (1996), Marjit and Acharyya (2003, 2006), Zhu and Trefler (2005)]. In Feenstra and Hanson (1996) and Zhu and Trefler (2005), the two countries specialize along the vertical production chain of a final good[3]. Thus, the middle good is an intermediate stage of production. Marjit and Acharyya (2006) also consider a commonly produced intermediate good, but the two countries specialize in two final goods that have different skill-intensity. The intermediate good is used in the most skill-intensive final good in the global ranking. In such a set up, the universal rise in intra-country wage inequality is an outcome of asymmetric responses of local prices of the intermediate good following a tariff cut in the South. In contrast, Davis (1996) and Marjit and Acharyya (2003) couch their analyses in multi-country and multi-commodity settings respectively with trade and specialization in only final goods.

The other set of theoretical explanations is based on specificities in production such as existence of non-traded goods or increasing returns to scale [Chakraborty and Sarkar (2007, 2009), Jones and Marjit (2003), Marjit and Acharyya (2003), Xu (2003)]; factor market specificities such as segmented domestic labour markets in the developing countries [Marjit and Acharyya (2003)]; skill formation and adaptation [Yabuuchi and Chaudhuri (2009)]; and market imperfections [Ruffin (2003, 2009)]. Dogan (2008), on

[2] For different dogmatic positions in the debate over trade vs. technology, see arguments of Alan Deardorff, Paul Krugman, Edward Leamer and Arvind Panagariya in Journal of International Economics (2000, vol.50) and of Jones and Engerman (1996).

[3] Feenstra and Hanson (1996) use a Ricardian continuum stage-of-production model developed by Sanyal (1983).

the other hand, talks about the aggregation problem because prices of each the skill-intensive goods does not rise by the same percentage when trade is opened.

However, all these analyses consider only once for all trade liberalization or tariff reductions, and that too for a single country. But since the 1990s, most of the Asian and Latin American countries started lowering their tariffs either unilaterally under their respective structural adjustment programmes or through bilateral and regional trade agreements. At the same time, neither the unilateral tariff reductions by countries had been simultaneous, nor these were once and for all. More often, countries have lowered tariff barriers in different stages. Thus, except for reciprocated tariff reductions under regional trade agreements, at any point of time and at any phase of the trade liberalization process, levels of protection have been different across trading nations. The existing theoretical literature has so far not analyzed what implications these different tariff reduction scenarios and initial conditions may have on intra-country wage inequality. This paper takes into account these variations in initial conditions when countries liberalize their trade, and examines whether changes in the wage inequality depends on the initial conditions. To examine to what extent the initial conditions might offer explanations for the observed global rise in wage inequality, this paper confines itself to the standard two-factor, two-commodity HOS model without resorting to any of the above-mentioned assumptions or production specifications.

Two broad cases are considered. First is a successive tariff reduction by a single country in a two-country framework. Second is bilateral, but not necessarily coordinated or reciprocated, tariff reductions by both the countries. The latter case is analyzed under three alternative initial conditions–tariff reductions achieved from an initial arbitrarily chosen tariff levels; from an optimum-tariff global equilibrium; and from a revenue-maximizing tariff equilibrium. In this context, I establish the following results. First, in all these cases, it is possible to predict global rise in wage inequality. Of course, this is not unconditional, but more relevant is that the underlying conditions depend on the initial level of protection. Second, in case of only one country reducing its tariff but in successive stages, the domestic relative price of its import good changes asymmetrically across initial and later phases of tariff cuts, ceteris paribus. Thus, it *may* be possible that the intra-country wage inequality rises initially only in the exporting country, but then rises in both countries at a later stage of trade liberalization. Third, bilateral tariff reductions may still cause intra-country wage inequality to rise in both countries, but the condition gets even more stringent. Fourth, tariff reductions generate income effects that depend on the initial trade equilibrium or objective of the government. Marginal tariff reductions from an initial global optimum-tariff equilibrium will have no income effects, and thus will require a different condition than similar tariff reductions from other initial global equilibrium to cause global rise in wage inequality.

The rest of the paper is organized as follows. In section 2 we describe the standard two-commodity-two-factor-two-country HOS model and introduce the notations used. Section 3 and 4 discuss the conditions for rise in intra-country wage inequality in both countries under unilateral and bilateral tariff cuts respectively. Finally, section 5 provides some concluding remarks.

2. THE $2 \times 2 \times 2$ HOS MODEL

I consider the standard $2 \times 2 \times 2$ HOS model: Two countries, home (H) and foreign (F), produce two goods, 1 and 2, with two internationally immobile (but mobile across sectors in each country) factors of production, skilled labour (S) and unskilled labour (L). All the standard assumptions are assumed to hold: Production functions exhibit constant returns to scale technology with diminishing returns to the variable factor; technology for each good is identical in both the countries; all domestic and world markets are perfectly competitive; skilled and unskilled workers in each country are fully employed. Suppose, home country is relatively unskilled-labour rich and the foreign country is relatively skilled-labour rich by the physical factor abundance definition and good 1 is relatively skilled-labour intensive whereas good 2 is unskilled-labour intensive[4]. Thus, under the standard restrictions on demand, by the Heckshe-Ohlin (HO) theory the home country (or the developing country by specification) has a comparative advantage in producing relatively unskilled-labour intensive good 2 and thus exports this good to the foreign country. The foreign country, on the other hand, has a comparative advantage in relatively skilled-labour intensive good 1 and thus exports this good to the home country.

Let, p^w, p_d and P_d^* denote respectively the world relative price of imports of the home country (i.e., world relative price of the skill-intensive good 1), the domestic relative price of imports in the home country and the domestic relative price of imports in the foreign country. Note, by specification, P_d^* is the domestic relative price of the unskilled-labour intensive good 2 in the foreign country. For our purpose, it is sufficient to define world market equilibrium and the relationship between the two domestic prices and the world price. For convenience, we specify the world market equilibrium as the following trade-balance condition for the home country:

$$p^w M(p_d, y) = M^*(P_d^*, y^*) \tag{1}$$

where, $M(.)$ and $M^*(.)$ are respectively the home and foreign import demand functions; y and y^* are respectively home and foreign country's real income levels measured in terms of their respective export goods.

Let $t > 0$ and $t^* > 0$ denote the initial rates of ad-valorem tariffs imposed by the home and the foreign countries respectively. The relative domestic prices of imports in the two countries are now related to the world price as follows:

$$p_d = (1 + t)p^w \tag{2}$$

$$P_d^* \equiv \frac{1}{p_d^*} = \frac{(1 + t^*)}{p^w} \tag{3}$$

where p_d^* is the price of foreign export good (good 1) in the foreign country.

[4] We rule out factor-intensity reversals, which per se can explain rising wage-inequality in both these countries.

Apart from the trade balance condition (1), another set of key algebraic expressions that will be used throughout this paper is the decomposition of real income changes for each country evaluated in terms of their respective export goods[5]:

$$dy = -M dp^w + (p_d - p^w) dM \tag{4}$$

$$dy^* = \frac{M}{p^w} dp^w + \left(P_d^* - \frac{1}{p^w} \right) dM^* \tag{5}$$

The first term in both expressions capture the terms of trade (TOT) effect whereas the second term captures the volume of trade effect.

3. TARIFF REDUCTIONS BY ONE COUNTRY

Consider a unilateral tariff reduction by the home country: $dt < 0$. At initial TOT, this would lower the domestic relative price of imports at home proportionately, and consequently raise the home import demand by the value of import demand elasticity at the margin. Recalling (4), at initial TOT, the increased volume of imports brings in real income gains (which is larger in magnitude higher is the initial tariff rate) and consequently a multiplier expansion of home country's real income and import demand. For no change in the foreign tariff (and hence the import demand there at the initial TOT), the increased home import demand, both by the (domestic) price and income effects, worsens the TOT for the home country unambiguously. There would thus now be real income losses for the home country and real income gains for the foreign country. This TOT deterioration and consequent real income loss will result in further changes in the home import demand, but now in the downward direction, which in turn dampens the TOT deterioration to some extent. On the other hand, real income gain for the foreign country worsens the TOT for the home country further as the foreign country raises the consumption of the home-import good and thus lowers its supply in the world market. As shown in the appendix, putting together all these changes amount to the extent of TOT deterioration for the home country as specified below,

$$\hat{p}^w = \frac{-\varepsilon\mu}{(\varepsilon + \varepsilon^* - 1) + \tilde{m} + \tilde{m}^*} \hat{t} > 0 \tag{6}$$

where, $\tilde{m} = \frac{m}{1-tm}$, $\tilde{m}^* = \frac{m^*}{1-t^*m^*}$ and $\mu = \frac{t}{1+t}$. Note that the $\varepsilon + \varepsilon^* - 1 > 0$ by the Marshall-Lerner stability condition.

From the proportional-change form of equation (2)

$$\hat{p}_d = \hat{p}^w + \mu\hat{t} \tag{2a}$$

it then follows that the domestic relative price of home imports can rise after tariff reductions if the TOT deterioration is very large. The condition for such a possibility is given below:

$$\hat{p}_d = \frac{\mu[\varepsilon^* - (1 - \tilde{m} - \tilde{m}^*)]}{(\varepsilon + \varepsilon^* - 1) + \tilde{m} + \tilde{m}^*} \hat{t} > 0 \quad \text{if} \quad \varepsilon^* < (1 - \tilde{m} - \tilde{m}^*) \tag{7}$$

[5] See Caves, Frankel and Jones (1999) for algebraic details.

Thus, as long as $(1 - \tilde{m} - \tilde{m}^*) > 0$, a unilateral tariff reduction by the home country raises the domestic relative price of its imports if the foreign import demand elasticity is sufficiently small as defined in (7). Since the above condition implies that ε^* *must* be less than one in value, given a foreign import demand function along which elasticity of demand varies (such as a linear import demand function), the size of initial (restricted) trade must be large enough for realization of this condition.

On the other hand, the domestic relative price of foreign import good unambiguously falls since its tariff remains unchanged. Thus,

PROPOSITION 1. *As long as* $(1 - \tilde{m} - \tilde{m}^*) > 0$, *under condition* (7), *a unilateral tariff reductions only by the country importing skill-intensive good raises intra-country wage inequality in both the countries. But, under similar condition, if the country importing unskilled-labour intensive good unilaterally lowers its tariff rate, intra-country wage inequality declines in both the countries.*

The proof follows directly from the above discussion and the factor-intensity ranking of home import good relative to the foreign import good. Condition (7) can be explained as follows. Suppose, p^w increases proportionately to the tariff reduction thereby leaving the domestic relative price in the home country and hence its import demand unchanged. Thus, home's real income declines proportionately. Let us check the state of excess demand in the world market for home export good (i.e., good 2) under this presupposition. Decline in home country's real income lowers its domestic demand for the export good and hence supply of exports to the world market rises by $(1 - \tilde{m})$.[6] On the other hand, foreign country's import demand (i.e., demand for home country's export good in the world market) increases in two ways: first by the value of foreign import demand elasticity (ε^*)) at the margin as the TOT improves for the foreign country; second by the marginal propensity to consume (augmented by the multiplier effect) at the margin, $\tilde{m}^*$, as the foreign real income rises due to the TOT improvement. Hence, at the pre-supposed level of TOT, an excess supply of home country's export good arises, thereby inducing a further worsening of TOT for the home country (or a further rise in p^w) if $\varepsilon^* + \tilde{m}^* < (1 - \tilde{m})$. This is the condition stated in (7) above.

The possibility of tariff reduction raising the domestic (relative) price of imports for the home country instead of lowering it is similar to the Metzler Paradox. Metzler (1949) noted that a tariff may fail to protect the domestic import-competing industries as the tariff-inclusive price of foreign goods may actually decline. By similar logic as the above, this happens when[7],

$$\varepsilon^* < (1 - m) \tag{8}$$

[6] Note that since we had an initial positive rate of tariff at home, the domestic demand for exports rises at home by a greater margin $(1 - \tilde{m})$ than by $(1 - m)$ because of the multiplier expansion in change in demand induced by the real income change.

[7] As well argued in Caves, Frankel and Jones (1997), this possibility arises for all home tariffs that displace the home offer curve along the foreign curve within the point at which the income-consumption curve passing through the free trade point cuts the foreign offer curve.

The difference between this Metzler-condition and the one specified in (7) arises from the specification of the initial equilibrium. Metzler considered an initial free trade global equilibrium whereas in the above discussion the initial equilibrium is a restricted global trade. The volume of trade effects on real income of countries, and consequently on import demand become irrelevant when initially both tariffs are zero (the case of global free trade). But, when we begin with a restricted global trade equilibrium, volume of trade effects of tariff reductions on real income changes can no longer be ignored. These effects make the condition for a paradoxical change in domestic prices more stringent in the sense that the critical value of foreign import demand elasticity is now even lower than what Metzler noted. The initial conditions matter in another interesting way. Let ε^*_{UL} denote the critical value of the foreign import demand elasticity specified in (7):

$$\varepsilon^*_{UL}(m, m^*, t, t^*) = (1 - \tilde{m} - \tilde{m}^*) \tag{9}$$

It is straightforward to check that this critical value varies inversely with the initial level of tariff protection offered by the home country, ceteris paribus. On the other hand, less restricted is the initial trade, smaller is the value we can expect for the foreign import demand elasticity. Thus, a sequential tariff reduction may affect the domestic prices differently in the early and later phases of tariff reductions. In particular, it is quite possible that when small tariff reductions are achieved from a high level of protection, domestic prices change in the usual way; but at a later stage, when already a large degree of liberalization has been achieved, a further reduction of tariff raises the domestic price at home, leading to rise in intra-country wage inequality in both countries. Hence,

LEMMA 1. *When a country sequentially reduces its tariff rate, given the set of values of the marginal propensities to consume, (m, m^*), it may be possible that intra-country wage inequality worsens in both countries at a later stage of (unilateral) tariff reduction when already a significantly large degree of trade liberalization has been achieved.*

Note that since ε^*_{UL} is inversely related to t^*, so a global rise in the wage inequality is more likely following a reduction in the tariff rate by the home country smaller is the initial tariff rate of the foreign country.

Bilateral tariff reduction as discussed below reveals further implications of the initial conditions.

4. BILATERAL TARIFF REDUCTIONS

4.1. *Arbitrarily chosen initial tariff levels*

Consider now tariff reductions by both countries, which I term as bilateral tariff reductions. To keep things simple, consider equi-proportionate tariff reductions: $\hat{t} = \hat{t}^* = \delta < 0$.

First of all, note that bilateral tariff reductions will make the condition for above kind of price movements in the two countries more stringent. To see this, suppose the home country made the tariff cut initially followed by the foreign country. Suppose p_d rises after the reduction in home tariff rate under condition (7). When the foreign tariff rate is also lowered, the TOT improves in favour of the home country (i.e., p^w now falls) and thus p_d declines. If this TOT improvement is quite large, p_d may fall below the pre-liberalization level even under (7). In other words, whereas home country's tariff reduction moves the TOT against it, the foreign country's tariff reduction moves the TOT in favour of the home country. Thus, we now have two issues to resolve. First, at the new global equilibrium, does the TOT move in favour of or against the home country? Second, if the TOT moves against the home country, does it move so much as to cause the domestic price p_d to rise above the pre-liberalization level? As shown in the appendix, both these price changes are ambiguous:

$$\hat{p}^w = \frac{\varepsilon^* \mu^* - \varepsilon \mu}{(\varepsilon + \varepsilon^* - 1) + \tilde{m} + \tilde{m}^*}\delta > 0 \quad \text{if} \quad \varepsilon^* < \frac{\mu}{\mu^*}\varepsilon \tag{10}$$

$$\hat{p}_d = \frac{(\mu + \mu^*)\,\varepsilon^* - \mu(1 - \tilde{m} - \tilde{m}^*)}{(\varepsilon + \varepsilon^* - 1) + \tilde{m} + \tilde{m}^*}\delta > 0$$

$$\text{if} \quad \varepsilon^* < \frac{\mu}{\mu + \mu^*}(1 - \tilde{m} - \tilde{m}^*) \equiv \varepsilon^*_{BL} \tag{11}$$

Thus, the initial conditions now are important for both the TOT and domestic price changes. Further implication of initial conditions can be brought out when Metzler's own argument is extended to tariff war. Starting from an initial global free trade, the Metzler-condition (8) gets altered for a *tariff war* between these countries as follows:

$$\varepsilon^* < \frac{1}{2}(1 - m - m^*) \equiv \varepsilon^*_{BT} \tag{12}$$

A few observations are in order. First, if the sum of marginal propensities to consume (MPC) exceeds one then Metzler-paradox like price movement never occurs either under tariff war or under bilateral (and unilateral) tariff reductions. So sum of MPCs less than one is a necessary condition for the domestic price to rise in the home country and consequently intra-country wage inequality to worsen in both countries.[8] Second, depending on the initial tariff protections in the two countries, it is possible that (11) is satisfied even though (12) is not, i.e., $\varepsilon^*_{BT} < \varepsilon^*_{BL}$.

To examine under what initial conditions $\varepsilon^*_{BT} < \varepsilon^*_{BL}$, let me define,

$$A \equiv 1 - \tilde{m} - \tilde{m}^*$$

$$B \equiv \frac{1}{2}(1 - m - m^*) - \frac{\mu}{\mu + \mu^*}(1 - \tilde{m} - \tilde{m}^*)$$

If parameter values are such that $A < 0$, then the domestic relative price of imports at home declines both under tariff war and bilateral liberalization. For our purpose, we require as necessary condition that $A > 0$ so that both the critical elasticity values ε^*_{BT} and ε^*_{BL} are positive. On the other hand, for $\varepsilon^*_{BT} < \varepsilon^*_{BL}$ the parameter values must be such that $B < 0$. Let $(\bar{t}, \bar{t}^*)$ and $(\tilde{t}, \tilde{t}^*)$ be the rates of initial tariffs such that $A(\bar{t}, \bar{t}^*) = 0$

[8] The same condition held the centre-stage in the famous debate between John Maynard Keynes and Bertil Ohlin over the effect of German reparations payments to the Allies, known as the Transfer Problem [Keynes (1929), Ohlin (1929)]. This condition would mean that the TOT moves against Germany, thereby inflicting upon it a *secondary burden* of the transfer.

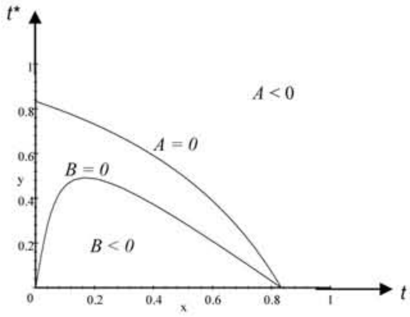

Figure 1a. $\varepsilon^*_{BT} < \varepsilon^*_{BL}$ for $m = m^* = 0.4$.

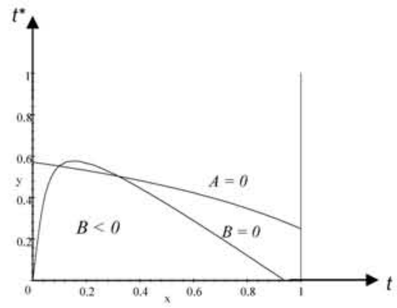

Figure 1b. $\varepsilon^*_{BT} < \varepsilon^*_{BL}$ for $m = 0.3$, $m^* = 0.5$.

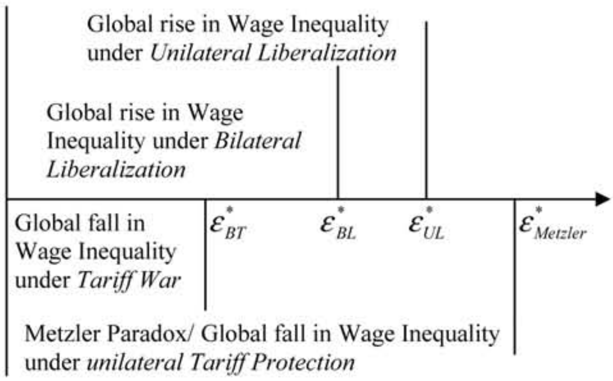

Figure 2. Metzler Paradox and Global change in Wage Inequality when $\varepsilon^*_{BT} < \varepsilon^*_{BL}$.

and $B(\bar{t}, \bar{t}^*) = 0$. For any given set of values of the MPCs for which their sum is less than one, the $A = 0$ locus is downward sloping in the (t, t^*) space as shown in Figure 1. A higher initial home tariff than $\bar{t}$ raises the value of $\tilde{m}$ and hence lowers A. Hence, a higher initial home tariff requires lower foreign tariff than $\bar{t}^*$ to leave A unchanged at zero. Given such an inverse relationship between the home and foreign tariff rates, the critical elasticity values ε^*_{BT} and ε^*_{BL} are positive for all pairs of tariff rates that lie below the $A = 0$ locus. The $B = 0$ locus is not monotonic like $A = 0$ locus, and its shape depends on the values of the MPCs. In Figure 1, I consider two specific examples: $(m = m^* = 0.4)$ and $(m = 0.3, m^* = 0.5)$. In both these cases, it is more likely that $\varepsilon^*_{BT} < \varepsilon^*_{BL}$.

Thus, it is quite possible that tariff war and bilateral tariff reductions have altogether different implications for the changes in domestic prices and hence intra-country wage inequality in the two countries. Given this possibility, Figure 2 summarizes the results derived above for parameter values for which $\varepsilon^*_{BT} < \varepsilon^*_{BL}$.

4.2. Further discussions on initial conditions: Optimum and Maximum-Revenue Tariffs[9]

Johnson (1953) in his analysis of tariff war between countries noted that each country will retaliate to the other by imposing an optimum tariff or best-response tariff rate. Consider such a global optimum-tariff-war equilibrium as the initial global equilibrium, where each country imposes its best-response tariff. Thus, small scale tariff reductions from such an initial condition would mean that real incomes do not change in both countries. Hence, the income effects of bilateral tariff reductions discussed above drop out, leaving the following changes in the prices:

$$\hat{p}^w = \frac{\varepsilon^*\mu^* - \varepsilon\mu}{(\varepsilon + \varepsilon^* - 1)}\delta > 0 \quad \text{if} \quad \varepsilon^* < \frac{\mu}{\mu^*}\varepsilon \tag{13}$$

$$\hat{p}_d = \frac{(\mu + \mu^*)\,\varepsilon^* - \mu}{(\varepsilon + \varepsilon^* - 1)}\delta > 0 \quad \text{if} \quad \varepsilon^* < \frac{\mu}{\mu + \mu^*} \equiv \varepsilon^*_{opt} \tag{14}$$

Thus, now the condition for global rise in intra-country wage inequality is more directly related to the initial levels of tariff protection. First of all, $\varepsilon^*_{BL} < \varepsilon^*_{opt}$. Second, since,

$$\frac{\partial \varepsilon^*_{opt}}{\partial t} = \frac{\partial \varepsilon^*_{opt}}{\partial \mu}\frac{\partial \mu}{\partial t} > 0$$

so, if initially the home tariff protection was very high and foreign tariff protection was low at the optimum-tariff-war equilibrium, the critical value of foreign import demand elasticity is higher. Hence, a larger set of values of foreign import demand elasticity supports global rise in intra-country wage inequality.

The other relevant initial global equilibrium is the one where the countries had imposed respective maximum-revenue tariff rates. The real income changes for the two countries specified in (3) and (4) can alternatively be expressed as:

$$dy = -M dp_d + d(tp^w M)$$
$$dy^* = -M^* dP^*_d + d\left(\frac{t^*}{p^w}M^*\right)$$

The second terms in both these expressions capture changes in tariff revenue for the two countries. For small scale bilateral tariff reductions in the neighbourhood of the maximum-revenue-tariff equilibrium, these terms vanish. Accordingly, using (2) and (3), the changes in the TOT and in the domestic price in the home country can be worked out as (see appendix):

$$\hat{p}^w = \frac{[\varepsilon^* + (1 + t^*)m^*]\mu^* - [\varepsilon + (1 + t)m]\,\mu}{(\varepsilon + \varepsilon^* - 1) + (1 + t)m + (1 + t^*)m^*}\delta \tag{15}$$

$$\hat{p}_d = \frac{[\varepsilon^* + (1 + t^*)m^*](\mu + \mu^*) - \mu}{(\varepsilon + \varepsilon^* - 1) + (1 + t)m + (1 + t^*)m^*}\delta \tag{16}$$

Thus, the income effects, as captured by the MPCs now determine the direction of change in the TOT. The reason is being that now the real income changes are proportional to the *tariff-inclusive* world price of imports. Thus, even at the initial TOT,

[9] I thank Roy Ruffin for drawing my attention to these cases.

reduction in the home tariff rate lowers the real income (unlike in the earlier cases), and thereby lowers the home import demand m at the margin. Similar is the case for reduction of tariff by the foreign country.

The change in domestic price of imports in the home country now rises, causing a global rise in intra-country wage inequality, only if

$$\varepsilon^* < \frac{\mu[1-(1+t^*)m^*] - \mu^*(1+t^*)m^*}{(\mu+\mu^*)} \equiv \varepsilon^*_{\mathrm{Re}\,v} \tag{17}$$

Two observations are in order. First, this condition is never satisfied if the foreign tariff rate at the global maximum-tariff-protected equilibrium is such that,

$$t^* \geq \frac{1-m^*}{m^*}$$

This brings out another dimension of the initial tariff protection. Second, the condition for global rise in wage inequality is now even stricter than in the case of initial optimum-tariff-protected global equilibrium. This is evident from the following alternative expression for condition (17):

$$\varepsilon^* < \frac{\mu}{(\mu+\mu^*)} - (1+t^*)m^* \equiv \varepsilon^*_{\mathrm{Re}\,v} < \varepsilon^*_{opt} \tag{18}$$

5. CONCLUSION

This paper has examined how far unilateral and bilateral reductions of tariff rates can explain the observed intra-country wage inequality in trading nations in the standard two-country framework of HOS model. The discussion brings out the importance of initial conditions not only in terms of initial level of protections, but also of the instrument of trade protection. The initial conditions are observed to matter in many ways. If one country liberalizes its trade through successive reduction of its tariff rates ceteris paribus, domestic prices of skill-intensive good *may* rise in both countries, which causes an increase in intra-country wage inequality to grow in both the countries. This is more probable when initial tariff protections were low than when they were high. This means that in case of countries adopting sequential trade liberalization, intra-country wage inequality in both the countries may change asymmetrically at different stages of liberalization.

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APPENDIX

A. *Change in the TOT under tariff reduction*

Using $P_d^* \equiv \frac{1}{p_d^*} = \frac{(1+t^*)}{p^w}$, total differentiation of the trade balance condition (1) yields:

$$Mdp^w + p^w\left(\frac{\partial M}{\partial p_d}dp_d + \frac{\partial M}{\partial y}dy\right) = \frac{\partial M^*}{\partial P_d^*}dP_d^* + \frac{\partial M^*}{\partial y^*}dy^*$$
$$\Rightarrow (p^w M)\hat{p}^w - \varepsilon(p^w M)\hat{p}_d + mdy = -\varepsilon^* M^* \hat{P}_d^* + p^w m^* dy^* \tag{A.1}$$

From (3), on the other hand, the change in home country's real income can be worked out as follows:

$$dy = -Mdp^w + tp^w dM = -Mdp^w + tp^w\left(\frac{\partial M}{\partial p_d}dp_d + \frac{\partial M}{\partial y}dy\right) \tag{A.2}$$

Using $p^w \frac{\partial M}{\partial y} = m$ and $\varepsilon \equiv -\frac{p_d}{M}\frac{\partial M}{\partial p_d}$, this boils down to,

$$dy = \frac{-p^w M\left[\hat{p}^w + \mu\dfrac{p_d}{p^w}\varepsilon\hat{p}_d\right]}{1-tm} = \frac{-p^w M[\hat{p}^w + t\varepsilon\hat{p}_d]}{1-tm} \tag{A.3}$$

Similarly,

$$dy^* = \frac{M^*\left[\hat{p}^w - \frac{p^w}{P_d^*}\mu^*\varepsilon^*\hat{P}_d^*\right]}{p^w(1-t^*m^*)} = \frac{M^*[\hat{p}^w - t^*\varepsilon^*\hat{P}_d^*]}{p^w(1-t^*m^*)} \tag{A.4}$$

Substitution of (A.3) and (A.4) in (A.1) yields:

$$\hat{p}^w - \varepsilon\hat{p}_d - \frac{m}{1-tm}\hat{p}^w + \frac{\frac{t}{(1+t)p^w}m\varepsilon dp_d}{1-tm}$$

$$= -\varepsilon^*\hat{P}_d^* + \frac{m^*}{1-t^*m^*}\hat{p}^w - \frac{\varepsilon^* m^*\frac{t^*}{1+t^*}p^w dP_d^*}{1-t^*m^*}$$

$$\Rightarrow \left[1 - \frac{m}{1-tm} - \frac{m^*}{1-t^*m^*}\right]\hat{p}^w - \left[1 + \frac{tm}{1-tm}\right]\varepsilon\hat{p}_d$$

$$= -\varepsilon^*\hat{P}_d^*\left[1 + \frac{t^*m^*}{1-t^*m^*}\right]$$

$$\Rightarrow \left[1 - \frac{m}{1-tm} - \frac{m^*}{1-t^*m^*}\right]\hat{p}^w - \varepsilon[\hat{p}^w + \mu\hat{t}] = -\varepsilon^*[\hat{p}^w - \mu^*\hat{t}^*] \tag{A.5}$$

Solving for $\hat{p}^w$ yields the change in TOT under bilateral tariff reduction as specified in the text, which is reproduced below as eq. (A.6):

$$\hat{p}^w = \frac{\varepsilon^*\mu^* - \varepsilon\mu}{(\varepsilon + \varepsilon^* - 1) + \tilde{m} + \tilde{m}^*}\delta \tag{A.6}$$

Hence, using $\hat{p}_d = \hat{p}^w + \mu\hat{t}$ and (A.5) we arrive at the change in the domestic price of imports in the home country as specified in eq. (7) in the text.

For unilateral tariff reduction by the home country, the second term on the right hand side in (A.5) is zero so that the TOT change now equals,

$$\hat{p}^w = \frac{-\varepsilon\mu}{(\varepsilon + \varepsilon^* - 1) + \tilde{m} + \tilde{m}^*}\delta > 0$$

Once again the change in domestic prices can be calculated as before.

B. PRICE CHANGES UNDER MAXIMUM-REVENUE TARIFF

Recall from the text that, at the maximum-revenue tariff, the real income changes equal,

$$dy = -M\,dp_d$$
$$dy^* = -M^*dP_d^*$$

Substitution of these values in (A.1) yields:

$$\hat{p}^w - \left[\varepsilon + \frac{p_d m}{p^w}\right]\hat{p}_d = -[\varepsilon^* + p^w P_d^* m^*]\hat{P}_d^*$$

$$\Rightarrow \hat{p}^w - [\varepsilon + (1+t)m]\hat{p}_d = -[\varepsilon^* + (1+t^*)m^*]\hat{P}_d^*$$

Using $\hat{p}_d = \hat{p}^w + \mu\hat{t}$ and $\hat{P}_d^* = -\hat{p}^w + \mu^*\hat{t}^*$ this boils down to when solved for the change in TOT as,

$$\hat{p}^w = \frac{[\varepsilon^* + (1+t^*)m^*]\mu^* - [\varepsilon + (1+t)m]\,\mu}{(\varepsilon + \varepsilon^* - 1) + (1+t)m + (1+t^*)m^*}\delta$$

which is the expression in the text.