A simple model of the juggernaut effect of trade liberalisation

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Abstract

This paper posits a political economy model where (i) reciprocity in multilateral trade talks results in a one-off tariff cut below their unilateral level because reciprocal trade talks turn each nation’s exporters into anti-protectionists at home and (ii) this one-off global tariff is self-reinforcing because it reshapes the political economy landscape via entry and exit.

Reference


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1. Introduction

The GATT is arguably the highest achiever among the international institutions set up in the postwar period – especially when it comes to its key goal of fostering mutually advantageous trade liberalisation. During multilateral negotiations held every few years, the GATT’s developed-nation members lowered their industrial tariffs from very high postwar levels to the very low levels we see today. The big developed traders – the US, EU, Canada and Japan – have zero tariffs on about half their imports (for Japan the figure is 80%); the non-zero tariffs are almost all under 10%. The process, however, took almost 50 years and many GATT members did almost no liberalisation at all.

We posit a model of how world trade talks based on reciprocal tariff cutting could gradually reduce tariffs for GATT members that participated in the reciprocity. The model has two key ingredients: reciprocity and gradual firm exit and entry. According to the principle of reciprocity, which is a fundamental GATT norm, negotiating countries exchange tariff reductions (or ‘concessions’ in the mercantilist jargon of trade negotiators). Announcement of this exchange of concessions rearranges special interests inside each participating nation. Exporters – who previously had only a very indirect interest in their nation’s import tariffs – become anti-protectionists at home since foreign tariffs will come down only if domestic tariff come down as well. This one-off shift in the line-up of pro- and anti-tariff lobbies results in negotiated tariffs that are below the tariffs set unilaterally and non-cooperatively before the GATT was established.

The one-off tariff cuts, however, produce firm-exit in the import-competing sectors of all participating nations and firm-entry in export sectors. The reason is simple. Tariffs create rents and firms enter up to the point where their fixed costs are just balanced by these rents. As domestic tariff cuts reduce rents, import-competing firms exit until the
balance is restored. As foreign tariff reductions increase rents for exporters, so more exporters enter to re-equilibrate rents and fixed costs.

The resulting firm entry and exit – which naturally takes years – reshapes the political economy landscape in which the next GATT Round is held. In particular, the size of the pro-tariff lobby (import competitors) shrinks in each participating nation while the size of the anti-tariff lobby (exporters) rises.

When the next GATT Round is held, another reciprocal tariff cut is politically optimal since the pro-tariff lobby is smaller and the anti-tariff lobby is larger in each GATT member that participated in the last Round’s reciprocal cuts. In short, firm entry and exit is the slow process that explains the gradual reduction of negotiated tariffs. This is the juggernaut effect.\(^2\)

Figure A1 illustrates this gradual reduction of negotiated tariffs for the US from the GATT’s launch in 1947 to 1988. Tariff rates are unreliable back to the 1940s due to changes in commodity classifications, so we use the effective rate, i.e. value of tariff revenue over value of all imports with positive tariffs. Direct data on rates is available from 1989 and are shown in Figure A2; note that both MFN tariffs (those negotiated under the auspices of the GATT) and preferential tariffs are declining over time.

In terms of the literature, the model starts from the notion that the uncoordinated pursuit of terms-of-trade gains results in high tariffs, but Pareto-improving cooperation is possible since this is a Prisoner Dilemma and thus a less-than-zero-sum game. This is why the GATT succeeded according to the received theory (Bagwell and Staiger 1999, 2012; Ossa 2011; and Mrazova 2011).\(^3\) We add detail to the political economy structure to account for three facts. First, tariff cutting occurred through multilateral trade negotiations (MTNs) rather than spontaneously, i.e. it took trade talks to get the juggernaut rolling (Grossman and Helpman 1995). Second, tariffs cuts were ratchet-like, rather than fluctuating with the degree of cooperation, and third the process took almost 50 years.

Our formal model considers only two countries, so bilateral trade talks are trivially multilateral. The model’s logic, however, would seem to apply to any kind of trade talks based on the principle of reciprocity. We discuss this point in the concluding remarks. In terms of evidence on this point, Estevadeordal, Freund and Ornelas (2008) and Fugazza and Robert-Nicoud (2014) provide empirical evidence consistent with the juggernaut mechanism. The former find that preferential tariff reductions in the period 1990-2001 led to subsequent reductions in the applied MFN tariffs in their sample of ten Latin American countries; the latter find that the US granted faster tariff reductions to their Regional Trade Agreements partners in sectors where the US cut its MFN tariffs the most during the Uruguay Round.

### 2. Basic model

Starting from high non-cooperative tariffs, announcement of MTNs with reciprocity alters the array of political forces inside each nation. Each nation’s exporters begin to

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2. See Baldwin (1994) for the original presentation of the ideas without any formal theory. For an early version of a formal treatment, see Baldwin and Robert-Nicoud (2007).
lobby against tariffs as a way of lowering foreign tariffs. Thus, MTNs change the political objective function facing all governments and a new political equilibrium emerges with lower tariffs everywhere. The novel aspect of the juggernaut idea links this view of the GATT with viewing liberalisation as a dynamic process where the one-time tariff-cut is not the end of the story (Baldwin 1994, 2000, Staiger 1995, Maggi and Rodriguez-Clare 2007). Phasing in tariff cuts expands export sectors’ output/employment and contracts import-competing sectors’ production/employment worldwide. When the next MTNs arrive, the pro-cutting group (exporters) is stronger and the anti-cutting group (import-competitors) is weaker in each nation so governments find it optimal to cut again. Once the juggernaut starts rolling, it crushes all tariffs in its path although this may take four or five decades since entry and exit is slow.

We model this in a two-country, three-sector economy. Two sectors are organised as in Grossman and Helpman (1994), the third is not.

Preferences of all factor owners are quasi-linear:

\[ v = E + \sum_{j=M,X} s_j[p_j] \]

where M and X are the two organised sectors and \( s_j(p_j) \) is sector-specific consumer surplus. For Ricardian reason, M imports and X exports. The competitive third sector, taken as numeraire, uses only labour but M and X use a sector-specific factor as well.

Costless trade and constant returns to labour in the untaxed numeraire sector equalise wages internationally with units chosen so \( w = 1 \). E equals labour income \( wL = L \) plus a share of tariff revenue, \( r \), plus the payment to sector-specific factors owned.

The nations are identical except that their trade patterns are mirror images, so \( s_j[p_j] = s[p_j] \), for all \( j \).

The government’s objective function \( \Omega \) is:

\[ \Omega = aW + (1-a)(C_M + C_X) ; \quad a \in (0,1) \]

where \( W \) is the sum of utility, \( C \) is the political contribution to the government and \( a \) is a parameter capturing the ‘benevolence’ of the government (fully benevolent governments, \( a = 1 \), maximise \( W \) only). Incumbent government cater to the interests of the public as a whole and to campaign contributors. See Grossman and Helpman (1994) for a discussion of this assumption. We assume that contribution schedules are linear in profits so that the incumbent government is a residual claimant on rents created by tariffs:

\[ C_j(p) = \pi_j(p_j) + \alpha_jN \left[ r(p) + s(p) + \frac{L}{N} \right] - B_j, \quad j = M, X \]

Where \( p \equiv [p_M, p_X] \) is the vector of producer prices, \( B \) is a constant (it is the outcome of a political economy game in Grossman and Helpman 1994), \( \pi \) is the Ricardian surplus earned in sector \( j \), \( N \) is the population, \( r \) is per capita tariff revenue and \( \alpha_j \) is the fraction of the population owning the sector-\( j \) factor (this is so small that it is
approximated by zero).\textsuperscript{4} Together (1) and (2) mean that governments maximise an objective function that places a weight of $a$ on consumer surplus and tariff revenue and a unit weight on Ricardian surpluses, as in Baldwin (1987) and Grossman and Helpman (1994).

We obtain demand in sector $j$ by applying Roy’s identity on the quasi-linear preferences:

$$D_j(p_j) = -\frac{\partial}{\partial p_j} s_j[p_j] = -\frac{\partial}{\partial p_j} s[p_j]$$

We assume that the supply curves are Ricardian-different across nations within a sector, but are mirror images across nations. For $M$:

$$Z^h_M = b n_M z(p_M), \quad Z^f_M = n_X z(p_X) ; \quad p_X = p_M - T , \quad 0 \leq b < 1$$

where the $Z$’s are Home and Foreign supplies, $p_M$ and $p_X$ are the Home internal price and the Foreign internal price (i.e. Home’s border price); $n_M$ is the number of active firms in the import-competing sector; each firm supplies $bz(\cdot)$ units of the good; and $z$ is an increasing and concave function. In the $X$ sector, the ‘1’ and ‘b’ are reversed by nation and there are $n_X$ active firms.

The equilibrium price $p_M$ is defined implicitly as:

$$p_M = \left\{ p : Z^h_M(p) + Z^f_M(p-T) = D^h_M(p) + D^f_M(p-T) \right\}$$

and similar in $X$, thus:

$$s_j = s[p_j], \quad \pi_j = \pi[p_j], \quad j = M, X; \quad r = (p_M - p_X)M$$

where $M = D^h_M - Z^h_M$ is Home’s volume of imports of good $M$. The solution to (3) is unique and increasing in $T$.

Firms enter quickly but exit slowly so that per-firm producer surplus equals a fixed cost, $F$, which is rising in $n$ due to congestion costs. Using a specific form for the congestion:

$$\pi_M[p_M] = n_M^2 F$$

Plugging the market clearing condition (3) into the zero pure-profit condition (4) establishes the long run relationship between $n_M$ and $T$:

$$FE: T(n_M) = \left\{ T : \pi_M[p_M(T), n_M] = n_M^2 F \right\}$$

This Free-Entry condition shows what the tariff would have to be to ensure that $n_M$ firms break even. Individual profit $\pi_M$ are increasing in domestic prices and thus in $T$ so

that the solution to \((5)\) is unique and increasing in \(n_M\): as \(T\) falls the number (mass) of firms that manage to break even falls. This is a ‘steady state’ equilibrium relationship. We assume that firms myopic for simplicity: they enter as long as the individual profit is larger than the fixed cost and exit if the former is smaller than the latter. Specifically, we assume that the rate of change of active firms evolves according to 
\[
\dot{n}_j = \gamma \left( \pi_j / n_j - n_j F \right), \text{ some } \gamma > 0.
\]

3. Unilateral tariff setting
Governments choose tariffs independently to maximise:

\[
\Omega = aN \left[ r(p_M, T) + s_M(p_M) \right] + \pi_M(p_M) + \text{CONSTANTS}
\]

where the X-sector surpluses are in the CONSTANTS since they are independent of \(T\). Normalising \(N = 1\), the FOC, omitting M-subscripts, is:

\[
0 = a \left[ T \frac{dM}{dp_X} \frac{dp_X}{dT} + M \left( \frac{dp_M}{dT} - \frac{dp_X}{dT} \right) \right] + D \frac{dp_M}{dT} + Z \frac{dp_M}{dT} + (1 - a)Z \frac{dp_M}{dT}
\]

\[
= a \left[ \frac{T}{p_X} \eta - 1 \right] M \frac{dp_X}{dT} + (1 - a)Z \frac{dp_M}{dT}
\]

where \(\eta \equiv \frac{\ln M / \ln p_X}{p_X} > 0\) is the elasticity of foreign exports with respect to home border prices (\(p_X\) is the border price of imports by symmetry). The first two terms in the first square bracket above are changes in tariff revenue due to a marginal import tariff increase (its size is positive if and only if imports are relatively inelastic, i.e. \(\eta < 1\)); the third term is the reduction in consumer surplus; and the fourth term is the increase in producer surplus. The term outside the square bracket arises because the government puts an extra weight on producer surplus by assumption. The second equality rearranges terms. Assuming that the shapes of \(Z(.)\) and \(D(.)\) are standard in the sense that the \(T\) that satisfies \((6)\) is the unique interior maximum, country symmetry implies that the equilibrium tariff is:

\[
(7) \quad \text{GFOC}_{\text{Unil}}: T_{\text{Unil}}(n_M) = \left\{ T: \frac{T}{p_X} = \frac{1}{\eta} \left[ 1 + \frac{1 - a - dp_M / dT}{dp_X / dT} \frac{Z}{M} \right] \right\}
\]

Unlike \((5)\), this second relationship between \(n\) and \(T\) holds at all moments. A tariff change moves the border and domestic prices in opposite directions so the coefficient on \((1-a)/a\) is positive, hence when government cater to importers’ special interests the unilateral tariff is at least as large as the (positive) optimal tariff, or

\[
\left( \frac{T}{p_X} \right)_{\text{Unil}} \geq \left( \frac{T}{p_X} \right)_{\text{Opt}} > 0 \text{.}
\]

Ceteris paribus, the equilibrium ad-valorem tariff rate is decreasing in the export elasticity (itself a measure of market power of the importing country), increasing in the relative economic strength of the domestic lobby as captured by the inverse import ratio (or, equivalently, \(Z / M\)), and decreasing in the benevolence of the government. Note that with fully benevolent governments, \(a = 1\), the politically optimal tariff reduces to the standard optimal inverse elasticity rule, \(\left( \frac{T}{p_X} \right)_{\text{Opt}} = 1 / \eta\), and that the economic strength of the domestic lobby, \(Z / M\), does not matter anymore.
Figure 1 plots equations (5) and (7).\(^5\) The long run equilibrium \(E^1\) is stable.\(^6\)

![Figure 1](image)

Analytic solutions are available, but too unwieldy to be informative. Thus:

**Result 1:** The long-run unilateral political-equilibrium tariff is positive and increasing in the weight on contributions (decreasing in \(a\)).

**Proof.** By inspection of (7).

4. **Multilateral Trade Negotiations**

With symmetric countries, the MTN reciprocity rule is that \(T^*=T\), so exporters’ profits are now directly affected by their government’s choice. Using symmetry:

\[
\Omega = a \left[ r(n,T) + s_M(n,T) \right] + \pi_M(n,T) + \pi_X(n,T) + \text{CONSTANTS}, \quad n = \begin{bmatrix} n_M \\ n_X \end{bmatrix}
\]

\(\pi_X\) is decreasing in \(T\), so each government faces an additional political cost to raising \(T\). Note that here the producer surplus of sector X is now excluded from the CONSTANTS (in contrast from the expression for \(\Omega\) in the previous section). The FOC becomes:

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\(^5\) The shapes drawn correspond to the case in which both demand and supply are linear.  
\(^6\) If the parameters of the model are such that \(\text{GFOC}^{\text{Unil}}\) is steeper than \(\text{FE}\), then \(E^1\) is unstable and the LR equilibrium will have either zero of prohibitive tariffs.
\[ 0 = a \left[ M \left( \frac{dp_M}{dT} - \frac{dp_X}{dT} \right) - D_M \frac{dp_M}{dT} + Z_M \frac{dp_M}{dT} - D_X \frac{dp_X}{dT} + Z_X \frac{dp_X}{dT} \right] \]
\[ + aT \frac{dM}{dp_X} \frac{dp_X}{dT} + (1 - a) \left[ Z_M \frac{dp_M}{dT} + Z_X \frac{dp_X}{dT} \right] \]

with complementary slackness. By symmetry, the first term in the right hand side above is equal to zero; therefore, assuming that the SOC holds: \(^7\)

\[ \left( \frac{T}{p_x} \right)^{MTN} = \frac{1 - a}{a} \max \left\{ 0, \frac{1}{\eta} \left[ -Z_X + \frac{-dp_M}{dT} Z \right] \right\} \]

Totally differentiating the market clearing condition (3) yields

\( (\partial M / \partial p_M) dp_X = (\partial X / \partial p_X) dp_X \). Using this, we may rewrite the second term of the curly bracket in (9) as

\[ \frac{1}{\eta} \left[ -Z_X + \frac{-dp_M}{dT} Z \right] = \frac{1}{M} \left[ -Z_X + Z \right] + \frac{Z}{\eta} \]

where \( \eta_m = -d \ln M / d \ln p_m > 0 \) is the absolute value of the import elasticity is the appropriately weighted sum of exporter and importer respective economic strengths. A sector’s strength is increasing in its size (and \( Z_X > Z \) by symmetry and this on its own makes the export sector more powerful than the import-competing one) and decreasing in its elasticity.

The sign of (10) is ambiguous because exporters have an interest in reducing domestic tariffs: as in Grossman and Helpman (1995), domestic tariffs are the currency to ‘buy’ reciprocal tariff reductions abroad in trade ‘talks’. Expressions (9) and (10) show three results.

First, in the symmetric case, governments chose \( T = 0 \) if \( a = 1 \) (i.e. cooperating benevolent governments chose the first best policy). Second, for any upward-sloping supply function and any downward-sloping demand function, the multilateral tariff is lower than the unilateral tariff, given \( n_M \):

**Result 2:** The multilateral tariff is lower than the unilateral one: \( (T/p_x)^{MTN} \leq (T/p_x)^{Unil} \).

**Proof.** See appendix.

Third, we can sign (10) in a special case. If demands and supplies are linear then (10) is negative for all values of \( T \) where trade occurs and the solution to (9) is \( T^{MTN} = 0 \). MTNs allow governments to trade protection for market access and, since the benefits of market access are larger than the benefits of domestic protection, they choose free trade. When governments care more about profits than welfare, MTNs give exporters a say that encourages trade liberalisation: \( \partial \left( \frac{T}{p_x} \right)^{MTN} / \partial a \leq 0 \) from (9). To summarise:

**Result 3:** The long-run political-equilibrium tariff under reciprocity is zero when

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\(^7\) See appendix.
demand and supply functions are linear. This effect is stronger the more mercantilist the negotiating governments are.

Proof. See appendix.

5. Lessons from this simple model

Figure 2 illustrates the contrast between Results 1, 2 and 3.

![Figure 2](image_url)

FE shows the long run n-T relationship; the GFOC curves show relationships that must hold at all times under the two alternative institutional situations. The transition is shown with the arrows. This model shows how reciprocity in MTNs changes the lobbying facing the government’s tariff choice. The inclusion of exporter profits makes the government want to set \( T = T^2 \) instead of \( T^1 \); the immediate effect of holding MTNs is to move the equilibrium from \( E^1 \) to \( E^2 \). This is because a slight tariff increase \((dT > 0)\) raises the profit of import-competing firms by \( dT \) times their output, while a slight increase in the foreign tariff reduces exporters’ profit by \( dT^* \) times their output. Given the assumed comparative advantage, exporters produce more than import competitors so any increase in tariffs actually lowers political contributions.

Over time, firms exit the import-competing sector (towards \( n^3 \)). Thus, in the next MTN held several years down the road, an even lower tariff is optimal. In the very long run, tariffs are zero and the steady state equilibrium number of firms, \( n^3 \) on point \( E^3 \) is the one that solves the zero pure-profit condition (4).

Another case, not shown on the Figure, is possible. If the two schedules intersect in the first quadrant, then the steady-state tariff is positive at the political equilibrium. The stalling of the Doha Round of multilateral WTO negotiations is consistent with this

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8 In the case shown GFOC intercepts FE in the fourth quadrant. Otherwise, the tariff prevailing at E3 would be small but positive.
case. Another plausible explanation for the lack of progress in the Doha Round, which is also consistent with our setting, is that sensitive sectors such as agriculture were initially left out and are proving difficult to liberalize now that tariffs in most other sectors (mostly manufactures) have been negotiated away.

6. Concluding remarks

This paper presented a simple model of a dynamic political economy process that accounts for the gradual, reciprocal liberalisation that marked the multilateral trading system from 1947 till the 2000s. In the model, trade talks are a reciprocal tariff-cutting bargain that is proposed to two nations. The reciprocity is essential since the I-will-cut-mine-if-you-cut-yours deal brings forth pro-liberalisation contributions from new special interest groups in each nation, namely the exporters. As the reciprocal tariff cuts are phased in, import-competing firms exit and exporting firms enter, so the initial cuts push the political economy line-up in each nation towards further liberalisation. In this way, the next time a GATT Round is held, accepting a package of further cuts is politically optimal for both governments even though the same cuts were not politically optimal in the previous Round.

The analysis is kept as simple as possible to highlight the core logic, but we conjecture that the basic mechanism would work in a wide range of settings. For example, consider a multilateral negotiation where some GATT members free-ride. Under GATT rules, any multilateral tariff cut is extended automatically to all GATT members – even those that do not play reciprocally. All throughout the GATT’s history, this made developing nations into free riders since only developed-nation members were required to play reciprocally under the GATT. In this situation, all exporters enjoy terms-of-trade gains from developed-nation tariff cuts. The size of the gains, however, are limited by non-liberalisation of the free-riders’ markets. By the usual Grossman-Helpman logic, this lower potential gain for exporters translates into lower pro-liberalisation lobbying by exporters. If the free-riders are sufficiently economically unimportant – as was the case for most of the postwar period – the juggernaut can still work. This conclusion may be reversed if the free-riders’ markets are sufficiently important. This reasoning also shows how the juggernaut logic accounts for the very asymmetric liberalisation pattern of developed and developing nation members of the GATT. For the former, reciprocity kept exporters engaged politically in the tariff cutting, while in the later the lack of reciprocity meant that GATT Rounds did nothing to change the political economy equilibrium and thus did not lead to tariff cutting.

When it comes to preferential reciprocity, such as bilateral free trade agreements (FTAs), the basic logic goes through but there are additional considerations (Baldwin and Jaimovich 2012). The main additional factor concerns trade diversion. This gives exporters in the FTA nations an extra incentive to lobby for the agreement since the preferential cuts grant them a competitive advantage over third-nation exporters. This gain is on top of better direct access to the FTA partner’s market. As far as the entry and exit aspects of the juggernaut are concerned, the basic mechanism works as before. The number of firms in the liberalising sectors tend to fall, while the number of firms in sectors enjoying better access to foreign markets tend to rise.

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9 This stemmed from special provisions in the GATT that were intended to help developing nations industrialise by allowing them to maintain infant-industry tariffs. Under the WTO, developing nations have more flexibility than developed nations when it comes to reciprocity, but they must make some tariff cuts.
We conjecture that the model’s logic also holds in the presence of intraindustry trade, but it is mitigated since firms are both exporters and import competitors. In the classic Krugman model with perfectly symmetric nations, reciprocal tariff cutting leads to no change in rents and thus no juggernaut effect. There are still two ways in which the logic carry through. The first is when there is intraindustry trade but this is imbalanced sector by sector. For example, if Home is a net exporter of industry A while Foreign is a net exporter of industry B, the basic logic can be applied. Firms in Home would lobby for Home tariff cutting in industry B since this is key to their getting better access for Foreign’s market in industry A.

The second way the juggernaut works with intraindustry trade is to allow for heterogeneous firms a la Melitz (2003). In such settings, only large, profitable firms with low marginal costs export; other firms only sell domestically. Thus even within the same sector, there are import competing firms and exporters. While the exporters are also import competitors themselves, they profit from reciprocal liberalisation since tariff cutting allows them to gain market share from the non-exporting firms. This mechanism, first introduced by Baldwin and Forslid (2006, 2010), has received empirical support from Bombardini (2008).

REFERENCES


APPENDIX A. FIGURE


![Graph of US tariff liberalisation & GATT Rounds.](image)


Note: Average is ratio of tariff duties collected to value of dutiable imports (i.e. imports with zero tariffs, such as raw materials, are not included in denominator).

Figure A2: US Tariffs (Simple Means), 1989 – 2007.

![Graph of US Tariffs.](image)

Note. At the tariff line level, the effectively applied tariff corresponds to the lowest available tariff. Whenever it exists, the lowest preferential tariff is the effectively applied tariff. Otherwise it is the MFN applied tariff.
APPENDIX B. PROOFS OF RESULTS 2 AND 3

This appendix demonstrates Results 2 and 3.

Economic coherence restricts analysis to the case $n_x > b_M n_x$: countries do not import the good in which they have a comparative advantage. Assuming that the parameters are such that second-order-conditions (SOC) hold, the equilibrium is characterised by the solution to the FOCs.

Proof of Result 2. \( T^{\text{MTN}} \) solves (8), which we can rewrite as

\[
\text{FOC}_{MTN}(T^{\text{MTN}}) \leq 0, \quad T^{\text{MTN}} \geq 0, \quad T^{\text{MTN}} \text{ FOC}_{MTN}(T^{\text{MTN}}) = 0
\]

where

\[
\text{FOC}_{MTN}(T) = \frac{d\eta(T)M(T)}{dT} \left[ \frac{T}{p_X(T)} + \frac{(1-a)Z(T)}{\eta(T)M(T)} \left( \frac{Z_X(T)}{Z(T)} + \frac{dp_M}{dT} \right) \right]
\]

is a non-increasing function (the SOC is satisfied). Evaluating FOC\(_{MTN}\) at \( T_{\text{Unil}} \) yields

\[
\text{FOC}_{MTN}(T^{\text{Unil}}) = \frac{d\eta(T^{\text{Unil}})}{dT}M(T^{\text{Unil}}) \times \left[ \frac{T^{\text{Unil}}}{p_X(T^{\text{Unil}})} + \frac{(1-a)Z(T^{\text{Unil}})}{\eta(T^{\text{Unil}})M(T^{\text{Unil}})} \frac{dp_M}{dT} - \frac{1}{\eta(T^{\text{Unil}})} \right]
\]

The term in the upper part of the square bracket after the first equality is zero by (6), whereas the inequality follows from \( dp_XdT < 0 \); since FOC\(_{MTN}\) is a decreasing function of \( T \), this implies \( T^{\text{MTN}} < T^{\text{Unil}} \), as was to be shown. QED.

Proof of Result 3: Let

\[
D_j(p_j) = \Lambda - Ap_j, \quad z(p_j) = zp_j, \quad j = M, X; \quad \Lambda, A, z > 0
\]

Solving for border prices such that imports equal exports (for Home’s imports of M, the border price is denoted by \( p_X \)):

\[
p_X(T) = \frac{2\Lambda - (A + zbn_M)T}{2A + z(n_x + bn_M)}
\]

which is positive as long as \( T \leq T^{\text{max}} = 2\Lambda/(A + zbn_M) \). Substituting (11) and (12) into the definition of imports, \( M = D_M(p_M) - Z_M(p_M) \) and using \( p_M = p_X + T \) leads to a non-negative volume of imports if (and only if):
\begin{equation}
T \leq \bar{T} \equiv \Lambda \frac{z(n_x - bn_M)}{(A + zb n_M)(A + zn_x)} < T_{\text{max}}
\end{equation}

It can be shown that $\text{FOC}_{MTN}(T)$ is non-increasing if (and only if) governments care enough about social welfare; i.e. the SOC is satisfied only if $a \in [\bar{a}, 1]$, with $0 < \bar{a} < 1$ (the analytical solution for $\bar{a}$ is cumbersome and available upon request). Also:

$$\text{FOC}_{MTN}(0) = -2zA\Lambda \frac{(1-a)(n_x - bn_M)}{[(A + zb n_M) + (A + zn_x)]^2} < 0$$

For all $T \in [0, \bar{T}]$, $\text{FOC}_{MTN}(T) < 0$. These facts imply that in the linear case:

$$\forall a \in [\bar{a}, 1]: \quad T_{MTN} = 0$$

If $0 \leq a < \bar{a}$, the SOC is violated ($\text{FOC}_{MTN}$ is increasing in $T$) and hence $T_{MTN}$ is equal to the prohibitive tariff defined in (13). However, under these conditions, $T_{Unil}$ equals $\bar{T}$, therefore Result 2 stands in a weak sense (albeit in a trivial way) even in this case.