Trade Policy under Monopolistic Competition with Firm Selection

Kyle Bagwell & Seung Hoon Lee

October 2018

Two motivations and some specific questions

- The perplexing treatment of export subsidies
  - Large literature on purpose and design of trade agreements
  - WTO prohibits export subsidies (ag exception)
  - Standard models: export subsidies imply *positive* ToT externality
  - Wrong treatment? Wrong model?
- Trade policy with heterogeneous firms
  - Vast literature on trade when firms are heterogeneous
  - What about trade policy with heterogeneous firms?
  - Much smaller literature
- Some specific questions:
  - Can heterogeneous-firms models provide further insight into the use and treatment of export subsidies?
  - Do they provide new perspective on the design and purpose of trade agreements?

Our approach here

- Adopt the heterogeneous-firms model of Melitz-Ottaviano (2008), generalized slightly to include import and export tariffs and thus tariff revenue.
- Focus on two-country, symmetric version of the model.
- The model features segmented markets, positive transport costs, monopolistic competition with endogenous entry, and an outside good (two sectors).
- Characterize optimal, efficient, Nash and politically optimal import and export trade policies.
- Three driving forces: selection effect, delocation effect and entry-externality effect. Model generates a Metzler paradox.

Main Findings: Policies

- Starting at global free trade, a country gains from (1) a small import tariff; (2) a small export subsidy, if trade costs are small and the dispersion of productivities is high; and (3) an appropriately combined small increase in its import and export tariffs. The welfare of its trading partner falls in each of these 3 cases.

- Global free trade is generally not efficient: may be excessive or insufficient entry.

- The symmetric Nash eq is inefficient, with trade policies that are too restrictive. Starting at Nash, countries can gain by exchanging small reductions in import tariffs, export tariffs or combinations thereof.

- Starting at global free trade, an efficiency-based rationale for a prohibition on the use of export subsidies is present and can be effective when entry is excessive.

Main Findings: Purpose

- Bagwell-Staiger (2016b): Politically optimal policies are efficient in a variety of models, including Cournot and mono-comp (CES) delocation models with an outside good.
- We offer a first analysis of political optimality in a heterogeneous firms model.
- Result still holds: politically optimal policies are efficient.
- In this sense, firm heterogeneity does not provide a new purpose for trade agreements. But the design of trade agreement can be sensitive to nature of heterogeneity.

Sequel Paper

- Bagwell-Lee (2018) consider same questions in a version of the Melitz model with an outside good (two sectors).
- Preferences are again quasi-linear but now with CES preferences for differentiated sector. Distribution is again Pareto.
- Many similar results, but entry-externality effect is now always positive.
- Starting at global free trade, a country always has an incentive to introduce a small export subsidy, and this intervention now always *raises* joint welfare. No longer have an efficiency-based rationale for a prohibition on the use of export subsidies.

Related Literature

- *Delocation*: Venables (1985, 1987), Helpman-Krugman (1989), Ossa (2011), Bagwell-Staiger (2012b, 2015), Campolmi et al (2014).
- *Entry-externality effect analysis*: Dhingra-Morrow (2014), Nocco-Ottaviano-Salto (2014).
- *Trade policy with heterogeneous firms and CES prefs*: Demidova-Rodriguez-Clare (2009), Felbermayr-Jung-Larch (2013), Haaland-Venables (2014), Caliendo-Feenstra-Romalis-Taylor (2017), Costinot-Rodriguez-Clare-Werning (2015).
- *Trade policy with heterogeneous firms and quadratic prefs*: Spearot (2014, 2015), Demidova (2017).
- *Metzler paradox*: Emprical issue. Large literature on imperfect pass through; negative pass-through rate less common. SR v LR effects? Ludema-Yu (2016) find "quasi-Metzler paradox."
- *Trade Agt purpose*: Bagwell-Staiger (1999, 2012b, 2015), DeRemer (2013b), Maggi (2014), Campolmi et al (2014), Grossman (2016).

Model Description: Overview

- Melitz-Ottaviano's setup: two countries, symmetric version, modified to include tariff revenue.
- Each country $I \in \{H, F\}$ has unit mass of agents.
- A government chooses import and export tariffs to maximize its country's welfare.
- Tariffs affect tariff revenue, entry, selection, varieties, prices

Model Description: Consumers

All consumers in country $l \in \{H, F\}$ share the same preferences given by $U^l \equiv$

$$\max_{q_0^l, \{q_i^l\}_{i \in \Omega^l}} \left[q_0^l + \alpha \int_{i \in \Omega^l} q_i^l di - \frac{1}{2}\gamma \int_{i \in \Omega^l} \left(q_i^l\right)^2 di - \frac{1}{2}\eta \left(\int_{i \in \Omega^l} q_i^l di \right)^2 \right]$$

s.t.

$$q_0^l + \int_{i \in \Omega^l} p_i^l q_i^l di \leq w^l + TR^l + \Pi^l \equiv I^l$$

where consumer income consists of a numeraire-good holding $w^l = 1$, aggregate profit Π^l, and government transfers TR^l. Assume $(\alpha, \gamma, \eta) > 0$ and $q_0^l > 0$.

Model Description: Consumers, cont.

- Integrate over demand functions $q_i^l = (\alpha - \eta Q^l - p_i^l)/\gamma$ to express $Q^l \equiv \left(\int_{i \in \Omega^l} q_i^l d_i\right)$ in terms of the average price and the measure N^l of consumed varieties in Ω^{*l}. Substituting:

$$q_i^l = (p_{\max}^l - p_i^l)\frac{1}{\gamma} \text{ for } i \in \Omega^{*l}$$

where

$$p_{\max}^l \equiv \frac{\alpha\gamma + \eta N^l \overline{p}^l}{\gamma + \eta N^l}$$

and

$$\overline{p}^l \equiv \left(\int_{i \in \Omega^{*l}} p_i^l di\right)\left(\frac{1}{N^l}\right)$$

is the average price of a consumed variety in country l.

- Ω^{*l} is the largest subset of Ω^l for which $p_i^l \leq p_{\max}^l$.

Model Description: Firms

- To enter the market, a firm pays a fixed cost $f_e > 0$ and draws its marginal production cost c_i from a Pareto distribution with c.d.f.

$$G(c_i) = (c_i / c_M)^k \text{ for } c_i \in [0, c_M] \text{ and } k > 1$$

- Firms engage in monopolistic competition in the segmented markets (i.e., each firm makes separate decisions about its domestic and export prices, and takes as given the number of firms/varieties and the average price in each market). Recall $p^l_{\max}$ depends on N^l and $\overline{p}^l$.

- For exports, delivered cost per unit is τc_i where $\tau > 1$. Exports also incur ad valorem export and import tariffs, with negative values indicating subsidies. We assume $t^h > -1$ and $\widetilde{t}^l < 1$, where $h \neq l$ and tilde denotes export policy.

Model Description: Firms, cont.

- Profit maximization in the domestic market

$$\pi_D^I(c) = \max_{p_D^I}(p_D^I - c)(p_{\max}^I - p_D^I)\frac{1}{\gamma}$$

- The critical cut-off level for sales in the domestic market is $c_D^I \equiv p_{\max}^I$.
- For $c \leq c_D^I$,

$$p_D^I(c) = \frac{c_D^I + c}{2} \text{ and } \pi_D^I(c) = \frac{1}{4\gamma}(c_D^I - c)^2$$

Model Description: Firms, cont.

- Profit maximization in the export market

$$\begin{aligned}\pi_X^l(c) &= \max_{p_X^l}[(\frac{p_X^l}{1+t^h})(1-\widetilde{t}^l)-\tau c](p_{\max}^h - p_X^l)\frac{1}{\gamma} \\ &\equiv \max_{p_X^l}[\frac{p_X^l}{\chi^h}-\tau c](p_{\max}^h - p_X^l)\frac{1}{\gamma}\end{aligned}$$

p_X^l is the delivered price in country $h \neq l$ and $\chi^h \equiv \frac{(1+t^h)}{(1-\widetilde{t}^l)} > 0$.

- The critical cut-off for sales in the export market, c_X^l, is

$$c_X^l = \frac{p_{\max}^h}{\tau\chi^h} = \frac{c_D^h}{\tau\chi^h},$$

where we assume $\tau\chi^h > 1$.

- For $c \leq c_X^l$, $p_X^l(c) = \tau\chi^h(\frac{c_X^l+c}{2})$ and $\pi_X^l(c) = \tau^2\chi^h\frac{1}{4\gamma}(c_X^l - c)^2$.

Model Description: Free Entry Conditions

- The expected profit for a firm located in country l is given as

$$\overline{\pi}^l \equiv \int_0^{c_D^l} \pi_D^l(c)dG(c) + \int_0^{c_X^l} \pi_X^l(c)dG(c).$$

- The free-entry conditions are $\overline{\pi}^l = f_e$ for $l = H, F$.
- Following M-O, these two equations determine c_D^l, $l = H, F$:

$$c_D^l = [\frac{\phi\gamma(1-\rho^h)}{1-\rho^l\rho^h}]^{\frac{1}{k+2}}$$

with c_X^l, $l = H, F$ then following as above. Note c_D^l is indep of α.

- The parameter values here are $\phi \equiv 2(k+1)(k+2)(c_M)^k f_e > 0$ and $\rho^l \equiv (\tau)^{-k}(\chi^l)^{-(k+1)}$. We assume $\rho^l \in (0,1)$.

Model Description: Numbers of varieties sold, entrants

- Know from demand expression above that

$$c_D^l \equiv p_{\max}^l \equiv \frac{\alpha\gamma + \eta N^l \overline{p}^l}{\gamma + \eta N^l}$$

- Given Pareto dbn, M-O show that

$$\overline{p}^l = c_D^l \cdot \frac{2k+1}{2k+2}.$$

- Substitution yields a solution for N^l in terms of c_D^l :

$$N^l = \frac{2\gamma(\alpha - c_D^l)(k+1)}{\eta c_D^l}.$$

- Can now plug in free-entry value for c_D^l to determine free-entry solution for N^l in terms of model parameters.

Model Description: Number of Entrants

- The numbers of entrants, N_E^l, in the two countries can now be determined as the solutions to the following two equations::

$$N^l = G(c_D^l)N_E^l + G(c_X^h)N_E^h.$$

- The solution to this system is given by

$$N_E^l = \frac{2(k+1)(c_M)^k\gamma}{\eta[1-\xi^l\xi^h]}\left[\frac{\alpha - c_D^l}{(c_D^l)^{k+1}} - \frac{\xi^l(\alpha - c_D^h)}{(c_D^h)^{k+1}}\right]$$

  where $\xi^l \equiv \rho^l \cdot \chi^l < 1$ follows from our assumptions.

- Maintained assumption: trade policies under consideration are such that $N_E^l > 0$ for $l = H, F$. At global free trade, this means $\alpha > c_D^{FT}$, where c_D^{FT} is the value taken by $c_D^H = c_D^F$ under global free trade.

Model Description: Welfare

- As M-O show, consumer welfare takes a simple form:

$$U^I = I^I + \frac{(\alpha - c_D^I)}{2\eta}[\alpha - c_D^I \frac{k+1}{k+2}].$$

- It follows that consumer surplus is

$$CS^I = \frac{(\alpha - c_D^I)}{2\eta}[\alpha - c_D^I \frac{k+1}{k+2}].$$

- Since expected profits are zero in a free-entry equilibrium,

$$I^I = w^I + TR^I + \Pi^I = 1 + TR^I$$

- We have left to determine tariff revenue.

Model Description: Tariff Revenue

- Prior to the imposition of the import tariff, the value of country l's imports is

$$IMP^l = \frac{N_E^h}{1+t^l}\int_0^{c_X^h} p_X^h(c)q_X^h(c)dG(c) = \frac{N_E^h}{1+t^l}\frac{(\tau\chi^l)^{-k}(c_D^l)^{k+2}}{2\gamma(k+2)(c_M)^k}.$$

where $q_X^h(c) \equiv (p_{\max}^l - p_X^h(c))\frac{1}{\gamma}$.

- Prior to the imposition of the import tariff, the value of country l's exports is

$$EXP^l = \frac{N_E^l}{1+t^h}\int_0^{c_X^l} p_X^l(c)\, q_X^l(c)\, dG(c) = \frac{N_E^l}{1+t^h}\frac{(\tau\chi^h)^{-k}(c_D^h)^{k+2}}{2\gamma(k+2)(c_M)^k}.$$

- Tariff revenue for country l is thus $TR^l \equiv t^l \cdot IMP^l + \widetilde{t}^l \cdot EXP^l$.

Model Description: Welfare

- We now define the welfare function for a national-income maximizing government:

$$U^l = I^l + CS^l = 1 + t^l \cdot IMP^l + \widetilde{t}^l \cdot EXP^l + \frac{(\alpha - c_D^l)}{2\eta}[\alpha - c_D^l \frac{k+1}{k+2}].$$

- Tariffs affect tariff revenue both directly and also indirectly through the induced long-run impact on trade values, IMP^l and EXP^l.

Three Driving Forces

- We begin our trade-policy analysis by highlighting three driving forces:
  - selection effect
  - firm-delocation effect
  - entry-externality effect
- The first two effects are related to findings by Melitz-Ottaviano, in their analysis of the consequences of unilateral reductions in trade costs.
- The Metzler paradox also follows easily from these effects.
- The third effect concerns differences b/t market and socially optimal levels of entry. We decompose the difference.

Three Driving Forces: Selection Effect

Proposition 1 *(Selection effect) For countries l and h with $l, h \in \{H, F\}$ and $l \neq h$, an increase in country l's import tariff or in country h's export tariff results in a decrease in the critical cut-off cost level for sales in country l's domestic market and in an increase in the critical cut-off cost level for sales in country h's domestic market:*

$$\frac{\partial c_D^l}{\partial t^l}, \frac{\partial c_D^l}{\partial \tilde{t}^h} < 0 < \frac{\partial c_D^h}{\partial t^l}, \frac{\partial c_D^h}{\partial \tilde{t}^h}.$$

Intuition: A higher import tariff (or foreign export tariff) increases the number of entrants and generates a higher level of competition, so that firms must be more efficient to survive.

Three Driving Forces: Firm-delocation Effect

Proposition 2 *(Firm-delocation effect) For countries l and h with $l, h \in \{H, F\}$ and $l \neq h$, an increase in country l's import tariff or in country h's export tariff results in an increase in the number of entrants in country l, a decrease in the number of entrants in country h, an increase in the number of varieties sold in country l, and a decrease in the number of varieties sold in country h:*

$$\frac{dN_E^l}{dt^l}, \frac{dN_E^l}{d\tilde{t}^h} > 0 > \frac{dN_E^h}{dt^l}, \frac{dN_E^h}{d\tilde{t}^h}$$
$$\frac{dN^l}{dt^l}, \frac{dN^l}{d\tilde{t}^h} > 0 > \frac{dN^h}{dt^l}, \frac{dN^h}{d\tilde{t}^h}$$

Three Driving Forces: The Metzler Paradox is implied

Proposition 3 *(Metzler paradox) For countries l and h with $l, h \in \{H, F\}$ and $l \neq h$, an increase in country l's import tariff or in country h's export tariff results in a decrease in the average price in country l and an increase in the average price in country h:*

$$\frac{d\bar{p}^l}{dt^l}, \frac{d\bar{p}^l}{d\tilde{t}^h} < 0 < \frac{d\bar{p}^h}{dt^l}, \frac{d\bar{p}^h}{d\tilde{t}^h}$$

Three Driving Forces: The Entry-Externality Effect

- Focus on closed economy, where

$$
\begin{aligned}
CS &= \frac{(\alpha - c_D)}{2\eta}[\alpha - c_D \frac{k+1}{k+2}]. \\
\overline{\pi} &= \int_0^{c_D} \pi_D(c) dG(c) \\
N &= G(c_D) N_E \\
N &= 2\gamma(\alpha - c_D)(k+1)/(\eta c_D).
\end{aligned}
$$

- Social planner selects N_E in a closed economy with the objective:

$$\max_{N_E} CS + N_E(\bar{\pi} - f_e).$$

- Find that CS can be decomposed as $CS = N_E \cdot \overline{CS} + VE$ where $\overline{CS}$ represents expected consumer surplus at single varieties given profit-maximizing pricing.

Three Driving Forces: The Entry-Externality Effect, cont.

- The socially optimal N_E^* satisfies the FOC:

$$\overline{CS} + N_E \frac{d\overline{CS}}{dN_E} + \frac{dVE}{dN_E} + N_E \frac{d\bar{\pi}}{dN_E} + \bar{\pi} - f_e = 0$$

- By contrast, the market determines the entry level to satisfy $\bar{\pi} = f_e$.

- The externalities that a market economy does not consider are thus:

$$EXT = \overline{CS} + \frac{dVE}{dN_E} + N_E \frac{d\overline{CS}}{dN_E} + N_E \frac{d\bar{\pi}}{dN_E}$$

where in expectation $\overline{CS} > 0$ is the direct consumer surplus gain from a new variety, $\frac{dVE}{dN_E} > 0$ is the beneficial variety effect, $N_E \frac{d\overline{CS}}{dN_E} < 0$ is the consumer surplus losses on pre-existing varieties, and $N_E \frac{d\bar{\pi}}{dN_E} < 0$ is a business-stealing effect.

Three Driving Forces: The Entry-Externality Effect, cont.

Proposition 4 *(Entry-externality effect) Starting at the market equilibrium for a closed economy benchmark setting, additional entry generates a negative externality iff* $\alpha > 2 \cdot c_D^m$*; that is,*

$$EXT < 0 \text{ if and only if } \alpha > 2 \cdot c_D^m,$$

where c_D^m *is the critical cutoff cost level in the market equilibrium under free entry.*

- This is a second-best analysis, where the planner only has a lump-sum entry tax/subsidy instrument.
- It will help to interpret trade-policy findings below.
- Nocco, Ottaviano and Salto (2014) consider first-best and an alternative second-best analyses.

Unilateral Trade Policies: Small Import Tariff

Proposition 5: *(Small import tariff) For countries l and h with $l, h \in \{H, F\}$ and $l \neq h$, if both countries initially adopt a policy of free trade, then the introduction of a small import tariff by country l generates a welfare gain for country l and a welfare loss for country h:*

$$\frac{dU^l}{dt^l} \Big|_{t^l=\tilde{t}^l=t^h=\tilde{t}^h=0} = \frac{dCS^l}{dt^l} + IMP^l \Big|_{t^l=\tilde{t}^l=t^h=\tilde{t}^h=0} > 0$$
$$\frac{dU^h}{dt^l} \Big|_{t^l=\tilde{t}^l=t^h=\tilde{t}^h=0} = \frac{dCS^h}{dt^l} \Big|_{t^l=\tilde{t}^l=t^h=\tilde{t}^h=0} < 0.$$

- Reflects average price, variety and (import) tariff revenue effects.
- Related to Venables (1987) but includes selection effects and quadratic prefs.

Unilateral Trade Policies: Small Export Subsidy

Proposition 6: *(Small export subsidy) For countries l and h with $l, h \in \{H, F\}$ and $l \neq h$, if both countries initially adopt a policy of free trade, then the introduction of a small export subsidy by country l has the following effects: 1). It generates a welfare gain for country l,*

$$\frac{dU^l}{d\tilde{t}^l} \mid_{t^h=\tilde{t}^h=t^l=\tilde{t}^l=0} = \frac{dCS^l}{d\tilde{t}^l} + EXP^l \mid_{t^h=\tilde{t}^h=t^l=\tilde{t}^l=0} < 0,$$

when (a) the selection effect is strong in that $\tau < (4+2k)^{1/k}$ or (b) the selection effect is weak in that $\tau \geq (4+2k)^{1/k}$ and

$$\alpha < \left(1 + \frac{\tau^k}{\tau^k - 2(k+2)}\right) c_D^{FT}$$

2). It generates a welfare loss for country h,

$$\frac{dU^h}{d\tilde{t}^l} \mid_{t^h=\tilde{t}^h=t^l=\tilde{t}^l=0} = \frac{dCS^h}{d\tilde{t}^l} > 0.$$

Unilateral Trade Policies: Small Export Subsidy, cont.

Corollary 1: *(Small export subsidy) If both countries initially adopt a policy of free trade, and if* $\alpha \leq 2 \cdot c_D^{FT}$, then the introduction of a small export subsidy by country I generates a welfare gain for country I.

- Immediate if selection effect is strong; and if selection effect is weak, the α inequality condition follows from $\alpha \leq 2 \cdot c_D^{FT}$.
- Intuition: Small subsidy enables intervening country to obtain larger slice of a "global pie," where the pie itself is (weakly) larger due to the subsidy given $\alpha \leq 2 \cdot c_D^{FT}$.
- Partial perspective on WTO export subsidy rules.
- Related to Venables (1985) but includes selection and variety effects and identifies role for dispersion and trade cost parameters.

Unilateral Trade Policies: Small Import and Export Tariff

- Idea: All price and variety effects on CS^l are channeled through c_D^l. Starting at global free trade, consider raising import and export tariffs for country l together in a way that maintains CS^l. Welfare in country l would then rise due to tariff-revenue gain.

Proposition 7 *(Small import and export tariffs) For countries l and h with $l, h \in \{H, F\}$ and $l \neq h$, if both countries initially adopt a policy of free trade, then the introduction of a small import tariff and a small export tariff by country l that maintains c_D^l is sure to increase country l's welfare and lower country h's welfare.*

- Related to Bagwell and Staiger (2012b), but includes variety and selection effects and establishes negative impact on trading partner (starting at global free trade).

Joint Welfare and Lump-Sum Transfers

- **Lemma 1**: *Joint welfare, $U \equiv U^H + U^F$, depends on individual tariffs, $\{t^H, \tilde{t}^H, t^F, \tilde{t}^F\}$, only through $\chi^H \equiv \frac{1+t^H}{1-\tilde{t}^F}$ and $\chi^F \equiv \frac{1+t^F}{1-\tilde{t}^H}$.*
- Countries can thus effect lump-sum transfers through tariff changes that maintain χ^H and χ^F; e.g., $t^H \uparrow$ and $\tilde{t}^F \downarrow$ that preserves χ^H.
- Lump-sum transfers via tariffs fix volumes (local prices) and change world prices. True here, too.
- Define (avg.) world price associated with home import goods:

$$\overline{p}^{wH} \equiv \frac{\overline{p}^H}{1+t^H}$$

- $t^H \uparrow$ and $\tilde{t}^F \downarrow$ that preserves χ^H also preserves c_D^H and thus $\overline{p}^H$, giving H a ToT gain: a lower avg. world price on its import goods.

Efficient χ-Symmetric Trade Policies

- *Efficient tariffs* maximize $U(\chi^H, \chi^F)$ over χ^H and χ^F. Let χ^* maximize $U(\chi, \chi)$ over $\chi = \chi^H = \chi^F$.
- *χ-symmetric tariffs* induce $\chi^H = \chi^F = \chi$. *Efficient χ-symmetric tariffs* are χ^*-symmetric tariffs.
- *Efficient χ-symmetric tariffs can be achieved with a continuum of tariff vectors*, each satisfying $\chi^* = \frac{1+t^H}{1-\tilde{t}^F} = \frac{1+t^F}{1-\tilde{t}^H}$.
- We assume χ^* exists and satisfies the FOC: $\frac{dU(\chi,\chi)}{d\chi}|_{\chi=\chi^*} = 0$.

Efficient Symmetric Trade Policies

Proposition 8 *(Free trade and efficiency) If both countries initially adopt a policy of free trade so that* $t^H = \tilde{t}^H = t^F = \tilde{t}^F = 0$*, then the introduction of a small increase in any tariff raises joint welfare if and only if* $\alpha > 2 \cdot c_D^{FT}$*, lowers joint welfare if and only if* $\alpha < 2 \cdot c_D^{FT}$*, and has no first-order effect on joint welfare if and only if* $\alpha = 2 \cdot c_D^{FT}$*.*

- Also holds for small and symmetric increases in $\chi = \chi^H = \chi^F$. Global free trade is efficient ($\chi^* = 1$) only if $\alpha = 2 \cdot c_D^{FT}$. (Prop. 9 in paper.)
- Resonates with Prop. 4, which suggests that additional entry generates a negative externality for the economy when $\alpha > 2 \cdot c_D^{FT}$.
- Starting at global free trade and in the strong-selection environment, the model is consistent with effective and efficiency-enhancing restrictions on the use of export subsidies in a trade agreement if $\alpha \geq 2 \cdot c_D^{FT}$. But when $\alpha > 2 \cdot c_D^{FT}$ the model does not rationalize restrictions on the introduction of small import tariffs.

Nash Trade Policies

- A *symmetric Nash equilibrium* is a set of tariffs, $\left\{t^H, \tilde{t}^H, t^F, \tilde{t}^F\right\}$, that forms a Nash equilibrium in the full strategy set and is also symmetric in the sense that $t^H = t^F$ and $\widetilde{t}^H = \widetilde{t}^F$.
- For a symmetric Nash equilibrium, the *symmetric Nash tariffs* are $(t^N, \widetilde{t}^N)$, where $t^N \equiv t^H = t^F$ and $\widetilde{t}^N \equiv \widetilde{t}^H = \widetilde{t}^F$.
- Symmetric Nash tariffs are χ-symmetric tariffs. Let $\chi^N \equiv \frac{1+t^N}{1-\widetilde{t}^N}$.
- Complicating factor: With non-zero tariffs, we must understand how tariff changes affect trade values and thereby tariff revenue.
- Assume that efficient and Nash tariffs are interior (satisfy FOCs).

Liberalization Paths: Nash v Efficient

Proposition 10 *(Liberalization paths) If $U(\chi, \chi)$ is quasi-concave in χ, then the symmetric Nash equilibrium is inefficient with a value for χ that is too high: $\chi^N > \chi^*$. Starting at a symmetric Nash equilibrium, countries thus mutually gain by symmetrically exchanging small reductions in import tariffs, export tariffs, or combinations thereof.*

- Prop 10 is not intended to imply that $t^N > 0$ and/or $\widetilde{t}^N > 0$.
- *Proof approach*: Add Nash FOCs for t^I and $\widetilde{t}^I$, impose symmetry, express in terms of χ^N, compare to efficiency FOC for χ^*, and use quasi-concavity of $U(\chi, \chi)$.
- *Striking feature* (see also Bagwell-Staiger, 2012a): A country's export tariff reduction (export subsidy increase) generates a ToT loss for its partner (Lerner paradox) and yet exerts a positive international externality *at Nash*.

Liberalization Paths: Nash v Efficient, cont.

Proposition 11 *(Nash and efficient tariffs). Assume* $\alpha > 2c_D^{FT}$ *and that* $U(\chi, \chi)$ *is quasi-concave in* χ*. Then* $\chi^N > \chi^* > 1$.

- Captures setting where χ-symmetric efficient trade barriers are positive, and symmetric Nash trade barriers are higher yet.
- Common feature of poli-econ models, but here zero expected profits.
- Builds from Propositions 9 and 10.
- Can show further that $t^N > \widetilde{t}^N$ is also implied. (Prop 12 in paper.)

Nash in the Limit

Proposition 13 *(Nash in the limit).*

$$\begin{aligned} \lim_{\tau \longrightarrow \infty} t^N &= \frac{1}{k} > 0 \\ \lim_{\tau \longrightarrow \infty} \frac{\widetilde{t}^N}{1 - \widetilde{t}^N} &= \frac{1}{2(2+k)k} \frac{(\alpha - 2 \cdot c_D^m)}{(\alpha - c_D^m)} \end{aligned}$$

where $c_D^m = \lim_{\tau \longrightarrow \infty} c_D^l$.

- No symmetry requirement for Nash tariffs here.
- Resonates with Corollary 1: export subsidy is unilaterally attractive when $\alpha < 2 \cdot c_D^m$.
- Sign of entry externality dictates sign of export policy as $\tau \longrightarrow \infty$.
- Sign of limiting import tariff is positive. (See also Demidova, 2017.)

Diagnosing the Problem: Politically Optimal Policies

- Let $c_D(\chi^l, \chi^h) = c_D^l$ and define local and world prices:

$$\begin{aligned}
\chi^l &= \chi^l(t^l, \tilde{t}^h) = \frac{1+t^l}{1-\tilde{t}^h} \\
\overline{p}^l &= \overline{p}^l(\chi^l, \chi^h) = c_D(\chi^l, \chi^h) \cdot \frac{2k+1}{2k+2} \\
\widetilde{p}^h &= \widetilde{p}^h(\chi^l, \chi^h) = \frac{\overline{p}^l(\chi^l, \chi^h)}{\chi^l} \\
\overline{p}^{wl} &= \overline{p}^{wl}(\chi^l, \chi^h, t^l) = \frac{\overline{p}^l(\chi^l, \chi^h)}{1+t^l}.
\end{aligned}$$

- Let $f(\chi^l, \chi^h)/(1+t^l) \equiv IMP^l = EXP^h$ and $CS(\chi^l, \chi^h) = CS^l$:

$$U^l = 1 + \frac{t^l}{1+t^l} \cdot f(\chi^l, \chi^h) + \frac{\tilde{t}^l}{1+t^h} \cdot f(\chi^h, \chi^l) + CS(\chi^l, \chi^h),$$

where $\frac{t^l}{1+t^l} = \frac{\overline{p}^l - \overline{p}^{wl}}{\overline{p}^l}$, $\frac{\tilde{t}^l}{1+t^h} = \frac{\overline{p}^{wh} - \widetilde{p}^l}{\overline{p}^h}$, $\chi^l = \frac{\overline{p}^l}{\widetilde{p}^h}$.

Diagnosis, continued

- Can now write welfare, $V^l = U^l$, in terms of prices

$$V^l(\overline{p}^H, \overline{p}^F, \widetilde{p}^H, \widetilde{p}^F, \overline{p}^{wH}, \overline{p}^{wF})$$
$$= 1 + \frac{\overline{p}^l - \overline{p}^{wl}}{\overline{p}^l} \cdot f(\frac{\overline{p}^l}{\widetilde{p}^h}, \frac{\overline{p}^h}{\widetilde{p}^l}) + \frac{\overline{p}^{wh} - \widetilde{p}^l}{\overline{p}^h} \cdot f(\frac{\overline{p}^h}{\widetilde{p}^l}, \frac{\overline{p}^l}{\widetilde{p}^h}) + CS(\frac{\overline{p}^l}{\widetilde{p}^h}, \frac{\overline{p}^h}{\widetilde{p}^l})$$

- Can now write joint welfare, $V = V^H + V^F = U$, in terms of prices

$$V(\overline{p}^H, \overline{p}^F, \widetilde{p}^H, \widetilde{p}^F) = \sum_{l=H,F} V^l(\overline{p}^H, \overline{p}^F, \widetilde{p}^H, \widetilde{p}^F, \overline{p}^{wH}, \overline{p}^{wF})$$

- World prices cancel: lump sum transfers. (Prop 14 in paper.)

Diagnosis, continued

- Can now compare Nash, efficient and PO policies.
- Nash: World and local price motivations.
- Efficient: Choose χ^H and χ^F (i.e., local prices).
- Political Optimality: Hypothetical setting where govs act as if

$$\frac{\partial V^H}{\partial \overline{p}^{wH}} = \frac{\partial V^H}{\partial \overline{p}^{wF}} = 0 = \frac{\partial V^F}{\partial \overline{p}^{wH}} = \frac{\partial V^F}{\partial \overline{p}^{wF}}$$

- 4 PO FOCs. Look at t^H for H and $\widetilde{t}^F$ for F

$$\begin{aligned}
[\frac{\partial V^H}{\partial \overline{p}^H}\frac{\partial \overline{p}^H}{\partial \chi^H} + \frac{\partial V^H}{\partial \overline{p}^F}\frac{\partial \overline{p}^F}{\partial \chi^H} + \frac{\partial V^H}{\partial \widetilde{p}^H}\frac{\partial \widetilde{p}^H}{\partial \chi^H} + \frac{\partial V^H}{\partial \widetilde{p}^F}\frac{\partial \widetilde{p}^F}{\partial \chi^H}]\frac{\partial \chi^H}{\partial t^H} &= 0 \\
[\frac{\partial V^F}{\partial \overline{p}^H}\frac{\partial \overline{p}^H}{\partial \chi^H} + \frac{\partial V^F}{\partial \overline{p}^F}\frac{\partial \overline{p}^F}{\partial \chi^H} + \frac{\partial V^F}{\partial \widetilde{p}^H}\frac{\partial \widetilde{p}^H}{\partial \chi^H} + \frac{\partial V^F}{\partial \widetilde{p}^F}\frac{\partial \widetilde{p}^F}{\partial \chi^H}]\frac{\partial \chi^H}{\partial \tilde{t}^F} &= 0
\end{aligned}$$

- Bracketed terms $= 0$. Add them. Get efficiency FOC for χ^H.

Diagnosis, Continued

- **Proposition 15** *(Nash, efficiency and political optimality) After expressing welfare functions in terms of local and world prices, we find that Nash tariffs are inefficient but the politically optimal tariffs are efficient.*
- New part: PO is efficient. Also Nash inefficient w/o symmetry restriction.
- Unilateral policies would be efficient w/o a trade agreement if all govs were not motivated by ToT externality.
- Identifies sense in which ToT externality is fundamental rationale for trade agreement in MO model, too.

CES/Melitz Model with outside good: Comparisons

- Consumer preferences: For $0 < \theta < 1$ and $\sigma > \epsilon \equiv 1/(1-\theta)$,

$$U^l = \max_{q_0^l, \{q_\omega^l\}_{\omega \in \Omega^l}} \left[q_0^l + \frac{(C^l)^\theta}{\theta} \right], \text{ where } C^l = \left[\int_{\omega \in \Omega^l} \left(q_\omega^l \right)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}}$$

$$\text{s.t. } q_0^l + \int_{\omega \in \Omega^l} p_\omega^l q_\omega^l d\omega \leq w^l + TR^l + \Pi^l \equiv I^l$$

with $w^l = 1$ and $\Pi^l = 0$ under free entry.

- Two differences: CES preferences for differentiated sector, and selection achieved via fixed production costs, $f_X > f_D > 0$.
- As in Chaney (2008), assume productivities drawn from Pareto with dispersion parameter k, where $1 + k - \sigma > 0$.

Comparisons, continued

- Selection effect, Metzler paradox (for price index) continue to hold.
- Entry externality effect is changed: Starting at the market equilibrium, additional entry always generates a positive externality: $EXT > 0$.
- Unilateral trade policy results continue to hold, except that now a small export subsidy is always beneficial to the intervening country. (See also Campolmi, et al (2014) in homogeneous firm model.)
- Starting at global free trade, the introduction of a small export subsidy now always raises joint welfare.
- Does not deliver an efficiency-based rationale for prohibition of export subsidies.
- For quasi-concave $U = U^H + U^F$ and χ-symmetric policies, Nash policies are again too restrictive: $\chi^N > \chi^*$, where $1 > \chi^*$ is now always true.

Conclusion

- We analyze trade policy in a symmetric, two-country version of the Melitz-Ottaviano (2008) model.
- Three driving forces: the selection effect, the firm-delocation effect, and the entry-externality effect.
- We characterize optimal, efficient, Nash and politically optimal trade policies. Nash is inefficient (too restrictive), political optimum is efficient.
- We also consider the use and treatment of export subsidies. Starting at global free trade, optimal export subsidies may be more likely in sectors with strong selection effects, and are beggar-thy-neighbor but not necessarily efficiency reducing.
- We also show how results vary under CES with linear outside good.