

# Anti-Dumping with Heterogeneous Firms: New Protectionism for the New-New Trade Theory<sup>1</sup>

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## **Abstract:**

This paper analyzes anti-dumping policies in a two-country model with heterogeneous firms in monopolistic competition. Enforcement of anti-dumping legislation in one country imposes a no-dumping condition on firms exporting from the other country, altering their pricing behavior both domestically and abroad. Some firms with intermediate productivity cease export activity, the remaining raise their export price, but lower their price on the domestic market. New entrants will tend towards the anti-dumping protected country, which has now become relatively more attractive. Protecting firms with anti-dumping therefore increases the number of firms entering and eventually increases competition, leading to welfare gains for the consumers. In the country without anti-dumping legislation, fewer entrants and less competition causes welfare losses. This analysis therefore offers an additional potential explanation for the recent proliferation of anti-dumping use, but also shows how the gains from anti-dumping protection are on expense of trading partners.

Keywords: Trade policy, anti-dumping, monopolistic competition, heterogeneous firms

JEL-codes: F12, F13

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# 1 Introduction

With Melitz (2003) as the seminal paper, models of monopolistic competition with heterogeneous firms have become one of the most prominent frameworks in international trade, for both theoretical and empirical research. So far, however, only limited attention has been devoted to thinking trade policies into the framework.

A trade policy of particular topicality is anti-dumping (AD). The trade liberalizations of the last decades have been accompanied by a surge in the adoption and use of AD legislation.<sup>3</sup> This paper shows how AD can be introduced in models with heterogeneous firms, and points to a number of new insights that can be gained by analyzing AD in this new context.

The theoretical results of this paper are derived in the two-country model of Melitz and Ottaviano (2008). To disentangle how both countries in the two-country model are affected by one country's AD policy, an asymmetric AD regime scenario is analyzed, where one country (Foreign) has AD legislation, whereas the other country (Home) has not. The focus is on indirect effects of AD, arising from firms wishing to avoid the risk of an AD petition.

The modelling strategy is to set exporters in Home subject to a no-dumping constraint: When exporting, they must price such that they cannot be found guilty of dumping by Foreign's AD authorities. The outcome of this pricing may be interpreted as an evaluation of the AD legislation in Foreign: it is what the AD legislation is trying to achieve.

A model with heterogeneous firms has the advantage of allowing each firm to react differently to the AD policy. Indeed, firms in Home with intermediate productivity levels will stop exporting, although they were productive enough to export in the model's free trade equilibrium.<sup>4</sup>

This reduction in Foreign's imports through the extensive margin (the number of firms exporting to Foreign) leaves unsatisfied demand there, and new firms will set up in Foreign's AD protected market to fill the gap. Counter-intuitively, shielding firms from import competition leads to increased competition in the long run: The excess profits that AD protected firms earn is more than absorbed by new entrants. Consumers in Foreign face lower prices and have access to more varieties. In Home, however, fewer firms

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<sup>3</sup>See for instance Vandenbussche and Zanardi (2008a, 2008b) and Prusa (2005).

<sup>4</sup>Free trade equilibrium will in the text refer to the equilibrium of the two-country model derived in Melitz and Ottaviano (2008)

will enter due to the reduced export opportunities, and competition falls in the long run.

The results of this paper are in contrast to most theoretical treatments of AD in partial equilibrium models, where the focus is on firm's strategic use of, and response to, AD legislation. This part of the literature stresses how AD protection leads to welfare losses from higher prices and higher risk that firms collude.<sup>5</sup>

More akin to the predictions of this paper is "AD jumping FDI", introduced theoretically in Haaland and Wooton (1998): The threat or application of AD measures may induce a firm to serve a foreign market through FDI rather than exports. Empirically, the behavior has been documented by Blonigen and Feenstra (1997) and Barrell and Pain (1999) for Japanese multinationals, but Blonigen (2002) shows that the examined sample matters: AD jumping FDI is infrequent and only an option for large multinationals. The fact that AD jumping FDI does occur, shows, however, that firms' long term decisions can be affected by a country's use of AD measures.

Vandenbussche and Zanardi (2008a) find that countries that use their AD legislation extensively depress their imports substantially, beyond what one would expect from the 2-5% of world trade flows directly affected by AD investigations or tariffs. This finding lends realism to this paper's predictions in two ways: First, it suggests that threat effects of AD are important in magnitude. Second, as AD enforcements depress imports substantially, the policy is likely to have the same "production relocation externality" as tariffs.<sup>6</sup>

The next section briefly reviews the two-country model of Melitz and Ottaviano (2008), introducing its free trade equilibrium for comparison with the AD regime.

## 2 The Free Trade Equilibrium

Consider two countries, Home ( $H$ ) and Foreign ( $F$ ). There are  $L^l$  representative consumers in country  $l = H, F$ , each supplying one unit of labor. Utility for the representative consumer is:

$$U = q_0^c + \alpha \int_{i \in \Omega} q_i^c di - \frac{1}{2} \gamma \int_{i \in \Omega} (q_i^c)^2 di - \frac{1}{2} \eta \left( \int_{i \in \Omega} q_i^c di \right)^2. \quad (1)$$

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<sup>5</sup>Examples are Prusa (1992), Prusa (1994), Reitzes (1993), Pauwels, Vandenbussche and Weverbergh (2001)

<sup>6</sup>That protecting a market with tariffs can attract new entrants to the protected market was first pointed out by Venables (1985), see also Venables (1987), Helpman and Krugman (1989, ch.7) and Baldwin et al. (2003, ch. 12). I provide a further discussion in this paper's conclusion.

The numeraire good  $q_0^c$  is supplied at constant returns to scale with perfect competition and traded costlessly, wages in both countries are therefore fixed at unity.  $\Omega$  is the set of possible varieties of the differentiated good, where  $q_i^c$  indicates quantity consumed of variety  $i$ .  $\alpha$  and  $\eta$  determine the size of the differentiated goods industry compared to the numeraire industry,  $\gamma$  governs the degree of differentiation between varieties.

The demand for variety  $i$  in country  $l$ , resulting from the  $L^l$  representative consumers' utility maximization subject to the budget constraint  $q_0^c + \int_{i \in \Omega} q_i^c di \leq 1$ , is

$$q_i^l \equiv L^l q_i^c = \frac{\alpha L^l}{\gamma + \eta N^l} - \frac{L^l}{\gamma} p_i^l + \frac{\eta N^l}{\gamma + \eta N^l} \frac{L^l}{\gamma} \bar{p}^l, \quad (2)$$

where  $p_i^l$  is the variety's price,  $N^l$  is the number of firms operating in market  $l$ , and  $\bar{p}^l = (\int_{i \in \Omega} p_i^l di) / N^l$  is the average price of varieties on the market. With the linear demand, there is a 'choke price' on a market, for which demand for a given variety is zero:

$$p^l = \frac{1}{\gamma + \eta N^l} (\gamma \alpha + \eta N^l \bar{p}^l).$$

To set up a firm, a fixed entry cost  $f_E$  must be paid, which is thereafter sunk. The entering firm then learns its marginal cost  $c$ , drawn from the distribution  $G(c) = (c/c_M)^k$  ( $c_M$  is the maximal cost draw,  $k$  is the Pareto shape parameter). The firm may thereafter produce with cost function  $C(q) = cq$ . The "domestic cost cutoff" in country  $l$ ,

$$c_D^l = \frac{1}{\gamma + \eta N^l} (\gamma \alpha + \eta N^l \bar{p}^l), \quad (3)$$

is the cost draw that is so high that a firm with this marginal cost will sell zero units if it sets price equal to marginal cost. A firm with cost draw higher than  $c_D^l$  will not be able to cover its marginal costs and exits immediately upon entry. Since  $f_E$  is sunk, any firm with  $c < c_D^l$  will serve its domestic market.

Export of the varieties is costly, in order for one unit of a variety to arrive abroad,  $\tau^l > 1$  units must be shipped. The iceberg cost  $\tau^l$  is country-specific, it may be more costly to export from Home to Foreign than the other way round. In addition to capturing geographical barriers,  $\tau^l$  is also seen as a variable that country  $l$  to some degree can change through trade policies.

The marginal cost for a firm in  $l$  of exporting a good to  $h = H, F$ ,  $h \neq l$  is therefore  $\tau^h c$ . The "export cost cutoff", the cost draw for which a firm will sell zero units abroad, is therefore defined as

$$c_X^l = \frac{c_D^h}{\tau^h}. \quad (4)$$

Firms with cost draws equal to or lower than  $c_X^l$  will export.

The profit-maximizing prices and quantities <sup>7</sup> of a firm's domestic and export market can be expressed using the cutoffs, as:

$$p_D^l(c) = \frac{1}{2} (c_D^l + c), \quad p_X^l(c) = \frac{\tau^h}{2} (c_X^l + c) \quad (5)$$

$$q_D^l(c) = \frac{L^l}{2\gamma} (c_D^l - c), \quad q_X^l(c) = \frac{L^h}{2\gamma} \tau^h (c_X^l + c). \quad (6)$$

From (5), it holds that  $p_D^l(c) > p_X^l(c)/\tau^h$ , as the export cutoff must be lower than the domestic cutoff in the equilibrium where both countries produce varieties of the differentiated good<sup>8</sup>. By the legal definition in AD legislation, in which trade costs may be deducted from the export price in order to achieve "factory gate prices", any exporting firm is dumping.

Prices and quantities give rise to profits

$$\pi_D^l(c) = \frac{L^l}{4\gamma} (c_D^l - c)^2, \quad \pi_X^l(c) = \frac{L^h}{4\gamma} (\tau^h)^2 (c_X^l - c)^2. \quad (7)$$

Naturally, a firm only operates on a market if it has non-negative profits there. All firms operating on market  $l$  have lower profits if the domestic cutoff  $c_D^l$  is reduced, the domestic cutoff thus summarizes the degree of competition on a market.

Firms will continue to enter in  $l$  until the expected profit of domestic and export sales is driven down to the entry cost  $f_E$ :

$$\int_0^{c_D^l} \pi_D^l(c) dG(c) + \int_0^{c_X^l} \pi_X^l(c) dG(c) = f_E. \quad (8)$$

The cutoffs, containing information about the average price and number of active firms, will adjust to make this relation hold. With the Pareto distribution, the two free entry conditions can be solved for the two unknowns, the domestic cutoffs, as:

$$c_D^l = \left[ \frac{\gamma\phi}{L^l} \frac{1 - \rho^h}{1 - \rho^l \rho^h} \right]^{\frac{1}{k+2}} \quad (9)$$

where  $\rho^l = (\tau^l)^{-k}$ ,  $\rho^l \in (0, 1)$ , indicates the 'freeness' of trade, a lower  $\rho^l$  means a more open market.  $\phi = 2(k+1)(k+2)(c_M)^k f_E$  captures technology-related variables. In the closed economy, corresponding to  $\rho^l = 0$ ,  $c_D^l = (\gamma\phi/L^l)^{1/(k+2)}$ , the cutoff falls with more trade freeness, reflecting the increased import competition.

<sup>7</sup>As a firm and its variety are completely characterized by a firm's marginal cost  $c$ , the variety subscript  $i$  can be dropped.

<sup>8</sup>See appendix A.4 in Melitz and Ottaviano (2008).

With the cutoffs determined, the average price in  $l$  can be computed. Prices of domestic and imported goods on the market follow the same distribution,

$$p_D^l = \frac{1}{2} (c_D^l + c), \quad c \in [0, c_D^l]; \quad p_X^h = \frac{1}{2} (c_D^l + \tau^l c), \quad c \in [0, c_D^l/\tau^l],$$

giving the average price

$$\bar{p}^l = \frac{2k+1}{2k+2} c_D^l. \quad (10)$$

Combining (10) with the expression for the cutoff in (3) gives the number of firms operating in  $l$ ,

$$N^l = \frac{2(k+1)\gamma\alpha - c_D^l}{\eta c_D^l}. \quad (11)$$

The number of firms trying to enter in  $l$ ,  $N_E^l$ , can be found by solving the two equations

$$N_E^h G(c_D^l/\tau^l) + N_E^l G(c_D^l) = N^l, \quad (12)$$

giving

$$N_E^l = \frac{2(k+1)\gamma(c_M)^k}{\eta(1-\rho^h\rho^l)} \left[ \frac{\alpha - c_D^l}{(c_D^l)^{k+1}} - \rho^l \frac{\alpha - c_D^h}{(c_D^h)^{k+1}} \right]. \quad (13)$$

Welfare can be assessed using the indirect utility function

$$U^l = 1 + \frac{1}{2} \left( \eta + \frac{\gamma}{N^l} \right)^{-1} (\alpha - \bar{p}^l)^2 + \frac{1}{2} \frac{N^l}{\gamma} \sigma_{p,l}^2, \quad (14)$$

where  $\sigma_{p,l}^2$  is the price variance: For a given average price, if the price variance is higher, some varieties are cheaper, and consumers can get more total consumption by buying more of these.

In this equilibrium, welfare can be expressed in terms of the domestic cutoff only:

$$U^l = 1 + \frac{1}{2\eta} (\alpha - c_D^l) \left( \alpha - \frac{k+1}{k+2} c_D^l \right). \quad (15)$$

Welfare increases with lower domestic cutoff, reflecting lower average prices and more variety access.

### 3 The Anti-Dumping Regime

The AD regime I analyze is one, where only one of the two countries, Foreign, has acquired AD legislation. In Foreign, the AD legislation is so effective that firms in Home face a no-dumping constraint on their export market. All the effects of AD found in the following are therefore due to these "threat effects"

of AD and not from AD filings and tariffs. The perspective is the long run, the changed conditions for Home exporters have been in place long enough to affect entry and exit of firms. The asymmetric regime is chosen in order to disentangle the different consequences AD has in the country implementing the legislation and in its trading partner.

In principle, this scenario may be more common than one would expect at first sight. If the threat and associated expected cost of an AD petition are perceived as high, it may well be optimal to price in a manner that avoids dumping investigations. The strong reputation effects found by Vandebussche and Zanardi (2008) accruing to frequent ("tough") users of AD legislation point in this direction, and as that paper also documents, AD has effects on trade flows beyond the flows directly affected by AD tariffs or investigations. The regime I here analyze provides a framework for examining these indirect threat effects, from firms complying with the AD legislation to avoid petitions.

Whenever I write ‘AD’ in the following, I refer only to this specific regime, unless otherwise stated.

The firms directly affected by the AD are Home exporters, and due to the non-strategic nature of the monopolistic competition models, these are the only firms to react directly. In order to be sure to avoid anti-dumping investigations, a firm in Home that wishes to export, must set its export price as  $p_{XA}^H \geq \tau^F p_{DA}^H$ <sup>9</sup>. This leads to a new, constrained profit maximization problem:

$$\begin{aligned} \max_{p_{XA}^H, p_{DA}^H} \pi^H(p_{XA}^H, p_{DA}^H) &= \pi_{XA}^H(p_{XA}^H) + \pi_{DA}^H(p_{DA}^H) \\ \text{subject to } p_{XA}^H &\geq \tau^F p_{DA}^H \end{aligned}$$

Maximizing the constrained profits leads to:

**Result 1:** Optimal Domestic Distortion

To avoid dumping, the optimal pricing strategy is to set domestic and export prices as:

$$p_{DA}^H(c) = \frac{1}{2} \left[ \beta^H c_X^H + (1 - \beta^H) c_D^H + c \right], \quad p_{XA}^H(c) = \frac{\tau^F}{2} \left[ \beta^H c_X^H + (1 - \beta^H) c_D^H + c \right], \quad (16)$$

where

$$\beta^H = \frac{L^F (\tau^F)^2}{L^F (\tau^F)^2 + L^H} = \frac{1}{1 + \frac{L^H}{L^F (\tau^F)^2}}, \quad \beta^H \in (0, 1) \quad (17)$$

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<sup>9</sup>I use subscript *A* to indicate the anti-dumping scenario

For an exporting firm facing a no-dumping constraint, it is optimal to distort prices downwards on the domestic market to be able to set a lower export price.

The degree of domestic distortion is governed by the parameter  $\beta^H$ , weighting the importance of the export market relative to the domestic market. If the export market has more consumers,  $L^F > L^H$ ,  $\beta^H$  will tend to one, the AD export price tends to the unconstrained export price. A bit counterintuitively,  $\beta^H$  increases with Foreign's iceberg cost  $\tau^F$ , higher trade barriers means more domestic distortion. The reason is that part of the trade cost is absorbed into the domestic price; when the trade cost increases, the absolute amount absorbed into the domestic price increases.

The results of this paper are all consequences of result 1. There are two levels of effects, before and after the domestic cutoffs have been determined by free entry. Effects prior to the determination of cutoffs are described just below.

The AD prices lead to quantities for a Home exporter

$$q_{DA}^H(c) = \frac{L^H}{2\gamma} \left[ c_D^H - c + \beta^H (c_D^H - c_X^H) \right], \quad q_{XA}^H(c) = \frac{L^F}{2\gamma} \tau^F \left[ c_X^H - c - (1 - \beta^H) (c_D^H - c_X^H) \right], \quad (18)$$

Compared to the free trade equilibrium, (6) quantities increase on the domestic market as function of the lower price, and decline on the export market. Profits are

$$\begin{aligned} \pi_{DA}^H(c) &= \frac{L^H}{4\gamma} \left[ (c_D^H - c)^2 - (\beta^H)^2 (c_D^H - c_X^H)^2 \right], \\ \pi_{XA}^H(c) &= \frac{L^F}{4\gamma} (\tau^F)^2 \left[ (c_X^H - c)^2 - (1 - \beta^H)^2 (c_D^H - c_X^H)^2 \right]. \end{aligned} \quad (19)$$

Due to the constrained optimization problem, profits are naturally smaller than in the free trade equilibrium. On the domestic market, the profit loss is associated with a decrease in the deadweight loss, due to the lower price and higher quantity, so isolated from the dynamic consequences, there is a pro-competitive effect of the AD policy on the export market. On the export market, the deadweight loss increases.

A firm in Home can always choose to serve only its domestic market. It can then get 'regular' profits  $\pi_D^H(c)$  as given in (7). Due to the reduction of domestic profits that is associated with exporting, an exporting firm, who earns relatively little on the export market, may get more profits with this strategy. Firms will serve only their domestic market if

$$\pi_D^H(c) > \pi_{DA}^H(c) + \pi_{XA}^H(c) \Leftrightarrow c > c_X^H - \sqrt{1 - \beta^H} (c_D^H - c_X^H). \quad ^{10}$$

<sup>10</sup>From (16), to be able to set an export price lower than the export cutoff, an exporting firm's marginal cost must satisfy

**Result 2:** The export cutoff cost for firms who must avoid dumping is given by:

$$c_{XA}^H = c_X^H - \sqrt{1 - \beta^H} (c_D^H - c_X^H) < c_X^H \quad (20)$$

Firms must be more productive to export to the anti-dumping regime than exporters in free trade economy equilibrium.

This novel implication of AD legislation, that some firms simply stop exporting to avoid AD petitions, can only be found using the recent models with heterogeneous firms. Models with homogeneous firms can only predict changes to the intensive margin of export, not the extensive margin of exports as found here.

The anti-dumping regime in Foreign has reduced the export potential for firms in Home. This leads to reduced expected profits prior to entry, and fewer firms will enter in Home, it takes fewer active firms to drive the expected operating profit down to the entry cost  $f_E$ . Both the decreased profits and the reduced probability of being productive enough to become an exporter are reflected in the new free entry condition:

$$\int_0^{c_D^H} \pi_D^H(c) dG(c) + \int_0^{c_{XA}^H} [\pi_{DA}^H(c) + \pi_{XA}^H(c) - \pi_D^H(c)] dG(c) = f_E. \quad (21)$$

In Foreign, where there are no direct effects of the AD enforcement, the free entry condition is still given by

$$\int_0^{c_D^F} \pi_D^F(c) dG(c) + \int_0^{c_X^F} \pi_X^F(c) dG(c) = f_E. \quad (22)$$

The two free entry conditions again give two equation in two unknowns, the domestic cutoffs, but these can now only be determined numerically.

Given solutions for the cutoffs, expressions for average prices, varieties and the number of entrants as functions can be computed. The average prices are computed in appendix 2 as

$$\begin{aligned} \bar{p}_A^H &= \frac{2k+1}{2k+2} c_D^H - \frac{N_E^H G(c_{XA}^H)}{N^H} \frac{1}{2} \beta^H (c_D^H - c_X^H) \\ \bar{p}_A^F &= \frac{N_E^F G(c_D^F)}{N^F} \frac{2k+1}{2k+2} c_D^F + \frac{N_E^H G(c_{XA}^H)}{N^F} \frac{\tau^F}{2} \left[ \left( \beta^H c_X^H + (1 - \beta^H) c_D^H \right) + \frac{k}{k+1} c_{XA}^H \right]. \end{aligned}$$

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$c \leq c_X^H - (1 - \beta^H) (c_D^H - c_X^H)$ . The present condition is stronger, as  $(1 - \beta^H) < \sqrt{1 - \beta}$ .

The second terms in the two expressions summarize how the changed pricing by Home exporters affect . In Home, exporters distort their domestic prices downwards. In Foreign, imports get more expensive . The values for the two cutoffs, along with the number of entrants and varieties have changed, however. The numerical solutions for (21) and (22) unambiguously show that  $c_D^H$  increases and  $c_D^F$  decreases in the anti-dumping scenario. The reason is the change in market attractiveness and hence entry patterns. The implications for Home and Foreign are outlined in results 3 and 4, respectively. The rather complicated derivations and expressions for entrants, varieties and welfare as functions of the cutoffs are given in appendix 2. Graphs from the simulations can be found in appendix 1.

**Result 3:** Post entry effects of trading partner’s anti-dumping enforcement

The domestic cutoff in Home increases. With less market opportunities awaiting an entering firm, a higher domestic cost cutoff is sufficient to keep the expected operating profit equal to the entry cost  $f_E$ . The domestic competitiveness is reduced by the protectionist policy on the export market. Note, however, that as average price and price variance no longer is a function of the domestic cutoff only, the cutoff is a supply side measure of competitiveness; for the demand side the relevant measures are average price and price variance.

The export cutoff falls dramatically, the export propensity is much lower compared to the free trade equilibrium. The large drop in the probability of becoming an exporter is the main driver behind the model’s results. As a consequence of the reduced export propensity, the number of firms attempting entry into Home falls substantially. This, in turn, leads to the reduced competition captured by the increased domestic cutoff: as fewer firms attempt entry, less productive firms are able to survive on the domestic market.

As a consequence of the fewer entrants, consumers suffer from a fall in variety access. There is a large shift towards consumption of imported rather than domestically produced varieties. Home’s net export of varieties decreases, both as a result of the increased imports and as a consequence of the two-fold decrease in exports: The export selection is much tougher, and there are fewer firms attempting entry, meaning fewer firms that end up being productive enough to export.

Prices are affected both by the reduced prices of Home exporters and by the reduced

competition on the market. The latter effect dominates the average price, which increases. The price variance increases as well, a result of the downward shift in Home exporters' domestic prices and of the increased domestic cutoff.

Due to the decreased variety access and increased average prices, welfare falls in Home. The effect is softened somewhat, though, as domestic distortion by Home exporters enable consumers to concentrate consumption on the cheaper varieties which are also exported.

**Result 4:** Post entry effects to a country enforcing anti-dumping

There are much fewer imports in Foreign, so more domestic entrants are needed before the market potential is satisfied. This, in turn, results in tougher selection and a lower domestic cutoff, as more entering firms means more firms with low marginal cost draws. Quite counter-intuitively, the long run effect of protecting Foreign producers with AD legislation is increased competition. On the export market, conditions are easier. The export cutoff follows Home's domestic cutoff up, the decreased competition in Home enables less efficient Foreign exporters to survive there.

Following the increased number of entrants, variety access for Foreign consumers increase. Due to the sub-optimal pricing of Home exporters, domestic varieties must replace imported varieties more than one for one to absorb the entire profit potential in Foreign. Variety consumption is shifted towards domestic varieties, and net exports of varieties increase.

Total entry,  $N_E^H + N_E^F$ , is always lower under anti-dumping than in the free trade equilibrium. Some firms in Home are now benefiting less from their cost draw, and this profit destruction reduces total entry.

The increased prices of imports coming from Home are not sufficient to outweigh the price reductions from increased competition in Foreign, the latter acting through the reduced cutoff. On net, the average price increases in Foreign. For the price variance, however, the upward shift in import prices reduces the variance of prices in Foreign.

The overall welfare effects in Foreign are positive: Consumers enjoy lower average prices and more varieties. Some of the welfare gain, however, is cancelled by the increased price variance: In the free trade equilibrium, some imported varieties were relatively cheap, and

consumers were able to direct their consumption towards them. As imports now are fewer and more expensive, this is possible to a much lower degree in the AD regime.

## 4 Discussion

As described in Results 3 and 4, the effects of Foreign's tough AD enforcement are softened by the domestic distortion of Home exporters. The extent to which Home loses and Foreign gains in the AD regime depend on the other factors affecting the relative market attractiveness, market sizes,  $L^H$  and  $L^F$ , and trade barriers,  $\tau^H$  and  $\tau^F$ . When trade costs are low, the benefits from the AD regime are higher, as the attractiveness of using Foreign as an export base is higher.

If Home is large relative to Foreign, the benefits from AD enforcement are lower: There will be more firms in Home that are still productive enough to export, so it hurts consumers in Foreign more that imports are more expensive. It is possible for this negative effect to dominate so that welfare falls in Foreign, if in addition to Home being larger, it also has much higher trade barriers ( $\tau^H \gg \tau^F$ ). Foreign then remains relatively unattractive as an export platform, so the gains from increased entry are smaller. Actually, under these asymmetries, Home may enjoy a welfare gain: since it still has many active exporters, the price decrease from domestic distortion may dominate the negative entry effects.

The results are insensitive to changes in technology parameters  $k$ ,  $f_E$  and  $c_M$  and the preference parameters  $\alpha$  and  $\eta$  that scale the variety industry . Changing these parameters shift both the free trade equilibrium and the AD regime in the same direction, even the quantitative impact of AD policies remains roughly the same. The love-of-variety parameter  $\gamma$  has some influence, however. When  $\gamma$  is higher, consumers are less price sensitive, and the softening effects of domestic distortion are smaller. The welfare loss in Home and gain in Foreign are therefore larger.

The gains for the AD enforcing country arise only through increased *relative* attractiveness of its market. If Home were to retaliate, adopting AD legislation and enforcing it harshly, all the gains that Foreign enjoyed would disappear, and only adverse effects would remain, now hitting Foreign as well. Entry would decrease in both countries, leading to lower competition, fewer varieties and welfare losses in both countries. Retaliatory AD legislation would be the natural reaction in Home, by removing the relative attractiveness of entering Foreign, it can eliminate some of the welfare loss caused by Foreign's

AD enforcement. As for many other trade policies, we have a prisoners' dilemma outcome.

Although the potential positive welfare effects of enforcing AD contradict much of the existing AD literature, the effects are not unfamiliar to the heterogeneous firms framework. Similar, but not identical, effects arise if one country unilaterally increases its iceberg cost  $\tau^l$ . As mentioned in section 2, when both countries simultaneously increase their openness to trade, competition increases in both countries, leading to welfare gains. If only one country changes its openness to trade the mechanisms are rather different: The long-run solution for  $c_D^l$  (after entry has taken place) is seen in (9) to be increasing in a country's own openness parameter  $\rho^l$ .

If a country restricts import competition, it becomes relatively more attractive for potential entrants, and in the long run, as more firms enter, competition will increase, leading to welfare gains. These welfare gains are on the expense of the other country, as fewer firms enter there, leading to less competition and variety access for consumers. The basic mechanism is the same as for AD enforcement: When a market is protected behind trade barriers, be they from increased iceberg cost or through AD enforcement, its relative profit potential increases, more firms enter and competition increases, leading to welfare gains.

With the simulations it can be shown that the analyzed AD regime corresponds to a quite severe trade restriction. The size differs somewhat across specifications, but  $\tau^F$  must be increased with around 25 per cent to get the same effect on  $c_D^F$  as the AD regime has. And even this increase is insufficient to distort entry patterns with the same amount as the AD regime. The welfare loss in Home, however, is lower in the AD regime, because consumers there can shift towards varieties being sold by Home exporters.

The concept of domestic distortion from result 1, that an exporting firm may wish to change its domestic pricing behavior has some precedents in the existing literature. Essentially the same effect is found in Reitzes (1993), in a partial equilibrium setting with a monopolist exporting to a country with AD legislation. Gallaway, Blonigen and Flynn (1999) and Pauwels, Vandebussche and Weverbergh (2001), on the other hand, both argue that firms are unlikely to distort their domestic market to avoid AD accusations. It is possible to analyze this "no domestic distortion" in my setting, simply setting  $\beta^H = 0$  gives that result. Indications in favor of domestic distortion exist, however:

The consultant Cliff Stevenson, who is behind the website [antidumpingpublishing.com](http://antidumpingpublishing.com) recommends exactly this strategy: "for high risk products/markets, there are simple strategies that can reduce the risk of anti-dumping problems [...] [such as] [P]rice cutting: if you are dumping, can you cut domestic prices

to reduce the dumping margin?"<sup>11</sup> Moreover, both Gallaway, Blonigen and Flynn (1999) and Pauwels, Vandebussche and Weverbergh. (2001) have their own motivations for assuming no domestic distortion. The welfare loss found in Gallaway, Blonigen and Flynn.(1999) is lower with a magnitude of ten if all price distortion takes place outside the US ( $\beta^H = 1$  in my model, so this is also a special case, "full domestic distortion"). For Pauwels et al. (2001), letting the normal value be exogenous is a simplifying assumption. The argument that the export market is relatively less important is already accounted for by the weight  $\beta^H$ , which indicates the relative importance of the export market and therefore the degree of domestic distortion.

Results 3 and 4 hinge on AD protection having long run effects on firm entry and exit behavior. As argued in the introduction, a country's use of AD legislation can affect firms' long term decisions, so it is not implausible that entry patterns may be affected. Empirically assessing this question is an interesting, but likely difficult, exercise.

## 5 Conclusion

This paper has examined the effects of AD in the recently introduced class of monopolistic competition models with heterogeneous firms. As has been shown, AD has wide consequences at the industry level, such as firms ceasing export activity and sectorial reallocations, which are difficult to capture in the customary oligopolistic partial equilibrium modeling. The present paper has analyzed a specific AD regime, where AD in one of the two countries is so heavily enforced that firms exporting to the country are subject to a no-dumping condition, and a series of novel AD effects are found:

For the firms in Home, the country exporting to an AD regime, the export prospects are severely reduced, and this leads to reduced entry there in the long run. The incumbent firms in Home, who are too inefficient to export in the free trade equilibrium, actually gain from the AD policies on the export market: competition in Home is reduced, so their profits go up. Firms in Home that lose the export status that they had in the free trade equilibrium are quite naturally worse off, export profits are lost. Firms who are productive enough to export in the AD regime also lose, both on their domestic and export market.

AD in the trading partner thus favors the least productive firms.

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<sup>11</sup>Cited from: Strategies to Avoid Dumping by Cliff Stevenson, available at [www.antidumpingpublishing.com](http://www.antidumpingpublishing.com)

In Foreign, the AD regime, the AD enforcement renders the market more attractive, so more firms wish to enter there. In the long run, this has the counterintuitive implication that competition rises. For firms who are not productive enough to export, the long run effects of AD enforcement is therefore reduced profits. Due to decreased competition on the export market, however, more firms are able to export, and those that do, earn more export profits. In the long run, the most productive firms benefit from AD protection.

The main new policy perspective that this paper offers is that AD enforcement comes with the same inefficiencies as tariffs. The result that protecting a market with tariffs can attract new entrants dates back to Venables (1985). Ossa (2009) dubs this result a "production relocation externality" of tariffs, and shows how the tariff setting game between countries has an inefficient prisoner's dilemma equilibrium: All countries try to attract firms by raising tariffs, rendering all countries less attractive to new entrants. He then shows how the GATT/WTO negotiation principles of reciprocity and nondiscrimination help countries escape the prisoner's dilemma outcome. This paper has shown that AD enforcement may have the same production relocation externality as tariffs; countries have the incentive to unilaterally adopt and enforce AD legislation, making their market relatively more attractive to entering firms. Since AD is sanctioned by the WTO, there is no institutional support to guide countries out of an outcome where countries enforce AD legislation against each other, to the detriment of all.

Appendix 1: Deriving the number of entrants, varieties, the average prices and welfare:

(In its current form, this appendix is intended for referees)

**Foreign:**

Domestic varieties are still priced as

$$p_D^F(c) = \frac{1}{2} (c_D^F + c), \quad c \in [0, c_D^F],$$

and they make up a fraction  $N_E^H G(c_{XA}^H) / N^F$  of the varieties available in Foreign.

Imported varieties are in the AD regime priced as

$$p_{XA}^H(c) = \frac{1}{2} \left[ \beta^H c_D^F + (1 - \beta^H) \tau^F c_D^H + \tau^F c \right], \quad c \in [0, c_{XA}^H],$$

and they make up the fraction  $\frac{N_E^H G(c_{XA}^H)}{N^F}$  of the varieties in Foreign.

The average price can therefore be computed from

$$\begin{aligned} \bar{p}^F &= \frac{N_E^F G(c_D^F)}{N^F} \int_0^{c_D^F} \frac{p_D^F(c)}{G(c_D^F)} dG(c) + \frac{N_E^H G(c_{XA}^H)}{N^F} \int_0^{c_{XA}^H} \frac{p_{XA}^H(c)}{G(c_{XA}^H)} dG(c). \\ \Leftrightarrow N^F \bar{p}^F &= N_E^F \frac{2k+1}{2k+2} c_D^F G(c_D^F) + N_E^H G(c_{XA}^H) \left\{ \frac{\tau^F}{2} \left[ \beta^H c_X^H + (1 - \beta^H) c_D^H \right] + \frac{\tau^F}{2} \frac{k}{k+1} c_{XA}^H \right\} \end{aligned}$$

There are two more conditions in the model relating the average price to the number of entrants and varieties, the threshold price condition  $N^F c_D^F - N^F \bar{p}^F = \frac{\gamma}{\eta} (\alpha - c_D^F)$  (from (3)) and the number of active firms corresponding to (12),  $N^F = N_E^F G(c_D^F) + N_E^H G(c_{XA}^H)$ : Combining these three gives an expression in  $N_E^H$  and  $N_E^F$  only.

$$\begin{aligned} N_E^F c_D^F G(c_D^F) + N_E^H c_D^F G(c_{XA}^H) - N_E^F \frac{2k+1}{2k+2} c_D^F G(c_D^F) - \\ N_E^H \left\{ \frac{\tau^F}{2} \left[ \beta^H c_X^H + (1 - \beta^H) c_D^H \right] G(c_{XA}^H) + \frac{\tau^F}{2} \frac{k}{k+1} c_{XA}^H G(c_{XA}^H) \right\} = \frac{\gamma}{\eta} (\alpha - c_D^F) \Leftrightarrow \end{aligned}$$

$$N_E^F c_D^F G(c_D^F) \frac{1}{2k+2} + N_E^H G(c_{XA}^H) \left[ c_D^F - \frac{1}{2} \beta^H c_D^F - \frac{\tau^F}{2} (1 - \beta^H) c_D^H - \frac{\tau^F}{2} \frac{k}{k+1} c_{XA}^H \right] = \frac{\gamma}{\eta} (\alpha - c_D^F) \Leftrightarrow$$

$$N_E^F c_D^F G(c_D^F) + N_E^H G(c_{XA}^H) \left[ (k+1) \left( c_D^F + (1 - \beta^H) (c_D^F - \tau^F c_D^H) - \tau^F k c_{XA}^H \right) \right] = 2(k+1) \frac{\gamma}{\eta} (\alpha - c_D^F) \Leftrightarrow$$

$$N_E^F (c_D^F)^{k+1} + N_E^H (c_{XA}^H)^k \left[ (k+1) \left( c_D^F + (1 - \beta^H) (c_D^F - \tau^F c_D^H) - \tau^F k c_{XA}^H \right) \right] = 2(k+1) \frac{\gamma}{\eta} (\alpha - c_D^F) (c_M)^k \Leftrightarrow$$

$$N_E^F + N_E^H \left( \frac{c_{XA}^H}{c_D^F} \right)^k \left\{ (k+1) \left[ 1 + (1 - \beta^H) \left( 1 - \frac{\tau^F}{c_D^F} c_D^H \right) \right] - \frac{\tau^F}{c_D^F} k c_{XA}^H \right\} = 2(k+1) (c_M)^k \frac{\gamma}{\eta} \frac{(\alpha - c_D^F)}{(c_D^F)^{k+1}}$$

A similar relation can be computed for Home:

### Home:

Home non-exporters set prices as  $p_D^H(c) = \frac{1}{2} (c_D^H + c)$ ,  $c \in [0, c_D^H]$ . Their varieties make up a fraction

$N_E^H [G(c_D^H) - G(c_{XA}^H)] / N^H$  of varieties for sale in Home.

Home exporters set prices as  $p_{DA}^H(c) = \frac{1}{2} [\beta^H c_X^H + (1 - \beta^H) c_D^H + c]$ ,  $c \in [0, c_{XA}^H]$ , and these varieties make up a fraction  $N_E^H G(c_{XA}^H) / N^H$  of the varieties available in Home.

Foreign exporters set prices as  $p_X^F(c) = \frac{1}{2} (c_D^H + \tau^H c)$ ,  $c \in [0, c_D^H / \tau^H]$ , corresponding to the fraction  $N_E^F G(c_D^H / \tau^H) / N^H$ .

The average price can therefore be computed from:

$$\bar{p}^H = \frac{N_E^H [G(c_D^H) - G(c_{XA}^H)]}{N^H} \int_{c_{XA}^H}^{c_D^H} \frac{p_D^H(c)}{[G(c_D^H) - G(c_{XA}^H)]} dG(c) + \frac{N_E^H G(c_{XA}^H)}{N^H} \int_0^{c_{XA}^H} \frac{p_{XA}^H(c)}{G(c_{XA}^H)} dG(c) + \frac{N_E^F G(c_D^H / \tau^H)}{N^H} \int_0^{c_D^H / \tau^H} \frac{p_X^F(c)}{G(c_D^H / \tau^H)} dG(c) \Leftrightarrow$$

$$N^H \bar{p}^H = N_E^H \int_{c_{XA}^H}^{c_D^H} p_D^H(c) dG(c) + N_E^H \int_0^{c_{XA}^H} p_{XA}^H(c) dG(c) + N_E^F \int_0^{c_D^H / \tau^H} p_X^F(c) dG(c) \Leftrightarrow$$

$$N^H \bar{p}^H = N_E^H \int_0^{c_D^H} p_D^H(c) dG(c) - N_E^H \int_0^{c_{XA}^H} [p_D^H(c) - p_{XA}^H(c)] dG(c) + N_E^F \int_0^{c_D^H / \tau^H} p_X^F(c) dG(c) \Leftrightarrow$$

$$N^H \bar{p}^H = N_E^H \frac{2k+1}{2k+2} c_D^H G(c_D^H) - N_E^H \int_0^{c_{XA}^H} \frac{1}{2} \beta^H (c_D^H - c_X^H) dG(c) + N_E^F \frac{2k+1}{2k+2} c_D^H G(c_D^H / \tau^H) \Leftrightarrow$$

$$N^H \bar{p}^H = N_E^H \frac{2k+1}{2k+2} c_D^H G(c_D^H) - N_E^H \int_0^{c_{XA}^H} \frac{1}{2} \beta^H (c_D^H - c_X^H) dG(c) + N_E^F \frac{2k+1}{2k+2} c_D^H G(c_D^H / \tau^H) \Leftrightarrow$$

$$N^H \bar{p}^H = N_E^H \frac{2k+1}{2k+2} c_D^H G(c_D^H) - N_E^H \frac{1}{2} \beta^H (c_D^H - c_X^H) G(c_{XA}^H) + N_E^F \frac{2k+1}{2k+2} c_D^H G(c_D^H / \tau^H)$$

Inserting into the threshold price condition  $N^H c_D^H - N^H \bar{p}^H = \frac{\gamma}{\eta} (\alpha - c_D^H)$  and the number of active firms  $N^H = N_E^H G(c_D^H) + N_E^F G(c_D^H / \tau^H)$  gives:

$$N_E^H G(c_D^H) c_D^H + N_E^F G(c_D^H / \tau^H) c_D^H - N_E^H \frac{2k+1}{2k+2} c_D^H G(c_D^H) + N_E^H \frac{1}{2} \beta^H (c_D^H - c_X^H) G(c_{XA}^H) - N_E^F \frac{2k+1}{2k+2} c_D^H G(c_D^H / \tau^H) = \frac{\gamma}{\eta} (\alpha - c_D^H) \Leftrightarrow$$

$$N_E^H \left[ \frac{1}{2(k+1)} c_D^H G(c_D^H) + \frac{1}{2} \beta^H (c_D^H - c_X^H) G(c_{XA}^H) \right] + \rho^H N_E^F \frac{1}{2(k+1)} c_D^H G(c_D^H) = \frac{\gamma}{\eta} (\alpha - c_D^H) \Leftrightarrow$$

$$N_E^H \left[ \frac{1}{2(k+1)} c_D^H G(c_D^H) + \frac{1}{2} \beta^H (c_D^H - c_X^H) G(c_{XA}^H) \right] + \rho^H N_E^F \frac{1}{2(k+1)} c_D^H G(c_D^H) = \frac{\gamma}{\eta} (\alpha - c_D^H) \Leftrightarrow$$

$$N_E^H \left[ 1 + (k+1) \beta^H \left( 1 - \frac{c_D^F}{\tau^F} \frac{1}{c_D^H} \right) \frac{(c_{XA}^H)^k}{(c_D^H)^k} \right] + \rho^H N_E^F = 2(k+1) (c_M)^k \frac{\gamma}{\eta} \frac{(\alpha - c_D^H)}{(c_D^H)^{k+1}}$$

### Solving for the number of entrants in Home:

The number of entrants in Home and Foreign can now be found by solving these two equations for

$N_E^H$  and  $N_E^F$ .

$$\text{Let } A = \left[ 1 + (k+1)\beta^H \left( 1 - \frac{c_D^F}{\tau^F} \frac{1}{c_D^H} \right) \left( \frac{c_{XA}^H}{c_D^F} \right)^k \right] \text{ and } B = \left( \frac{c_{XA}^H}{c_D^F} \right)^k \left\{ (k+1) \left[ 1 + \left( 1 - \beta^H \right) \left( 1 - \frac{\tau^F}{c_D^F} c_D^H \right) \right] - \frac{\tau^F}{c_D^F} k c_{XA}^H \right\}.$$

Rewrite the two equations as

$$\begin{aligned} N_E^F + N_E^H B &= 2(k+1)(c_M)^k \frac{\gamma}{\eta} \frac{(\alpha - c_D^F)}{(c_D^F)^{k+1}} \\ N_E^H A + \rho^H N_E^F &= 2(k+1)(c_M)^k \frac{\gamma}{\eta} \frac{(\alpha - c_D^H)}{(c_D^H)^{k+1}} \end{aligned}$$

Isolating for  $N_E^F$  in the upper equation, and inserting into the lower gives:

$$2(k+1)(c_M)^k \frac{\gamma}{\eta} \frac{(\alpha - c_D^F)}{(c_D^F)^{k+1}} \rho^H - N_E^H B \rho^H + N_E^H A = 2(k+1)(c_M)^k \frac{\gamma}{\eta} \frac{(\alpha - c_D^H)}{(c_D^H)^{k+1}} \Leftrightarrow$$

$$N_E^H = \frac{1}{A - B\rho^H} \frac{2(k+1)(c_M)^k \gamma}{\eta} \left[ \frac{(\alpha - c_D^H)}{(c_D^H)^{k+1}} - \rho^H \frac{(\alpha - c_D^F)}{(c_D^F)^{k+1}} \right] \quad (\text{A1})$$

The expression is somewhat similar to the expression for the free trade equilibrium (13), rewriting gives:

$$N_E^H = \left[ \frac{1 - \rho^H \rho^F}{A - B\rho^H} \right] \frac{2(k+1)(c_M)^k \gamma}{\eta(1 - \rho^H \rho^F)} \left[ \frac{(\alpha - c_D^H)}{(c_D^H)^{k+1}} - \rho^H \frac{(\alpha - c_D^F)}{(c_D^F)^{k+1}} \right] \quad (\text{A2})$$

which is similar to the open economy number of entrants, corrected with  $\left[ \frac{1 - \rho^H \rho^F}{A - B\rho^H} \right]$ . Entry distortions not only take place through changes in cutoffs, but also through this term. In all simulations,  $\left[ \frac{1 - \rho^H \rho^F}{A - B\rho^H} \right] < 1$ , entry is reduced in Home.

### The number of entrants in Foreign:

$$N_E^F + N_E^H B = 2(k+1)(c_M)^k \frac{\gamma}{\eta} \frac{(\alpha - c_D^F)}{(c_D^F)^{k+1}}, \text{ inserting } N_E^H:$$

$$N_E^F + \frac{B}{A - B\rho^H} \frac{2(k+1)(c_M)^k \gamma}{\eta} \left[ \frac{(\alpha - c_D^H)}{(c_D^H)^{k+1}} - \rho^H \frac{(\alpha - c_D^F)}{(c_D^F)^{k+1}} \right] = 2(k+1)(c_M)^k \frac{\gamma}{\eta} \frac{(\alpha - c_D^F)}{(c_D^F)^{k+1}} \Leftrightarrow$$

$$N_E^F = \frac{2(k+1)(c_M)^k \gamma}{\eta} \frac{1}{A - B\rho^H} \left[ A \frac{(\alpha - c_D^F)}{(c_D^F)^{k+1}} - B \frac{(\alpha - c_D^H)}{(c_D^H)^{k+1}} \right]$$

Again, some similarities to the open economy number of entrants (13), rewriting to clarify this:

$$N_E^F = \frac{2(k+1)(c_M)^k \gamma}{\eta(1-\rho^H \rho^F)} \left[ \frac{1-\rho^H \rho^F}{A-B\rho^H} \right] \left[ A \frac{(\alpha - c_D^F)}{(c_D^F)^{k+1}} - \frac{B}{\rho^F} \rho^F \frac{(\alpha - c_D^H)}{(c_D^H)^{k+1}} \right]$$

Comparing to (13), entry into both Home and Foreign are adjusted downwards by the term  $\left[ \frac{1-\rho^H \rho^F}{A-B\rho^H} \right] <$

1. Entry into Foreign is then corrected by  $A$  and  $B$ , which for all parameters implies an increase, representing how Foreign has become relatively more attractive as a market.

### Varieties and average prices

With the expressions for the entrants at hand, and numerical solutions for the cutoffs,  $N^H$  and  $N^F$  can be found numerically as:

$$N^F = N_E^F G(c_D^F) + N_E^H G(c_{XA}^H)$$

and

$$N^H = N_E^H G(c_D^H) + N_E^F G(c_D^H/\tau^H)$$

Average prices can then also be found numerically, as:

$$\begin{aligned} \bar{p}^H &= \frac{N_E^H G(c_D^H)}{N^H} \frac{2k+1}{2k+2} c_D^H - \frac{N_E^H}{N^H} \frac{1}{2} \beta^H (c_D^H - c_X^H) G(c_{XA}^H) + \frac{N_E^F G(c_D^H/\tau^H)}{N^H} \frac{2k+1}{2k+2} c_D^H \\ &= \frac{2k+1}{2k+2} c_D^H - \frac{N_E^H}{N^H} \frac{1}{2} \beta^H (c_D^H - c_X^H) G(c_{XA}^H) \end{aligned}$$

and

$$\bar{p}^F = \frac{N_E^F G(c_D^F)}{N^F} \frac{2k+1}{2k+2} c_D^F + \frac{N_E^H G(c_{XA}^H)}{N^F} \frac{\tau^F}{2} \left\{ \left[ \beta^H c_X^H + (1-\beta^H) c_D^H \right] + \frac{k}{k+1} c_{XA}^H \right\}$$

### Computing Welfare under Anti-Dumping

Welfare is given by:

$$U^l = 1 + \frac{1}{2} \left( \eta + \frac{\gamma}{N^l} \right)^{-1} (\alpha - \bar{p}^l)^2 + \frac{1}{2} \frac{N^l}{\gamma} \sigma_{p^l}^2, \quad l = H, F$$

The price variance is given by  $\sigma_p^2 = E(p^2) - \bar{p}^2$ , where  $\bar{p}$  has been derived for each country above.

The missing term is the second uncentered moment  $E(p^2)$ :

**Foreign:**

$E[p^F(c)^2]$  is given by:

$$\begin{aligned}
E[p^F(c)^2] &= \frac{N_E^F G(c_D^F)}{N^F} \int_0^{c_D^F} [p_D^F(c)]^2 dG(c | c \leq c_D^F) + \frac{N_E^H G(c_{XA}^H)}{N^F} \int_0^{c_{XA}^H} [p_{XA}^H(c)]^2 dG(c | c \leq c_{XA}^H) \\
&= \frac{N_E^F G(c_D^F)}{N^F} \int_0^{c_D^F} \frac{1}{4} (c_D^F + c)^2 \frac{kc^{k-1}}{(c_D^F)^k} dc + \\
&\quad \frac{N_E^H G(c_{XA}^H)}{N^F} \int_0^{c_{XA}^H} \frac{(\tau^F)^2}{4} \left[ \beta^H c_D^F / \tau^F + (1 - \beta^H) c_D^H + c \right]^2 \frac{kc^{k-1}}{(c_{XA}^H)^k} dc
\end{aligned}$$

The integrals give:

$$\begin{aligned}
\int_0^{c_D^F} \frac{1}{4} (c_D^F + c)^2 \frac{kc^{k-1}}{(c_D^F)^k} dc &= \frac{1}{2} (c_D^F)^2 \frac{(1 + 4k + 2k^2)}{(1 + k)(2 + k)} \\
\int_0^{c_{XA}^H} \frac{(\tau^F)^2}{4} \left[ \beta^H c_D^F / \tau^F + (1 - \beta^H) c_D^H + c \right]^2 \frac{kc^{k-1}}{(c_{XA}^H)^k} dc &= \\
\frac{(\tau^F)^2}{4} \left( M^2 + \frac{k}{k+2} (c_{XA}^H)^2 + 2M \frac{k}{k+1} c_{XA}^H \right) &: \quad \text{where } M = \beta^H c_D^F / \tau^F + (1 - \beta^H) c_D^H
\end{aligned}$$

With all the components determined, Welfare in Foreign can be computed with numerical values for cutoff..

**Home:**

$E[p^H(c)^2]$  is given by:

$$\begin{aligned}
E[p^H(c)^2] &= \\
\frac{N_E^H [G(c_D^H) - G(c_{XA}^H)]}{N^H} \int_{c_{XA}^H}^{c_D^H} [p_D^H(c)]^2 dG(c | c_{XA}^H < c \leq c_D^H) &+ \\
\frac{N_E^H G(c_D^H)}{N^H} \int_0^{c_{XA}^H} [p_{DA}^H(c)]^2 dG(c | c \leq c_{XA}^H) + \frac{N_E^F G(c_{XA}^H)}{N^H} \int_0^{c_X^F} [p_X^F(c)]^2 dG(c | c \leq c_X^F) & \\
= \frac{N_E^H}{N^H} \int_{c_{XA}^H}^{c_D^H} [p_D^H(c)]^2 \frac{kc^{k-1}}{(c_M)^k} dc + \frac{N_E^H}{N^H} \int_0^{c_{XA}^H} [p_{DA}^H(c)]^2 \frac{kc^{k-1}}{(c_M)^k} dc + \frac{N_E^F G(c_{XA}^H)}{N^H} \int_0^{c_X^F} [p_X^F(c)]^2 \frac{kc^{k-1}}{(c_X^F)^k} dc & \\
= \frac{N_E^H}{N^H} \left[ \int_0^{c_D^H} [p_D^H(c)]^2 \frac{kc^{k-1}}{(c_M)^k} dc - \int_0^{c_{XA}^H} \left( [p_D^H(c)]^2 - [p_{DA}^H(c)]^2 \right) \frac{kc^{k-1}}{(c_M)^k} dc \right] + \frac{N_E^F G(c_{XA}^H)}{N^H} \int_0^{c_X^F} [p_X^F(c)]^2 \frac{kc^{k-1}}{(c_X^F)^k} dc &
\end{aligned}$$

Reducing the term in the second integral:

$$\begin{aligned}
[p_D^H(c)]^2 - [p_{DA}^H(c)]^2 &= (c_D^H + c)^2 - \left( (c_D^H + c) - \beta^H (c_D^H - c_D^F / \tau^F) \right)^2 \\
&= (c_D^H + c)^2 - (c_D^H + c)^2 - (\beta^H)^2 (c_D^H - c_D^F / \tau^F)^2 + 2\beta^H (c_D^H - c_D^F / \tau^F) (c_D^H + c) \\
&= -(\beta^H)^2 (c_D^H - c_D^F / \tau^F)^2 + 2\beta^H (c_D^H - c_D^F / \tau^F) (c_D^H + c) \\
\int_0^{c_{XA}^H} \frac{1}{4} \left( -(\beta^H)^2 (c_D^H - c_D^F / \tau^F)^2 + 2\beta^H (c_D^H - c_D^F / \tau^F) (c_D^H + c) \right) \frac{kc^{k-1}}{(c_M)^k} dc &
\end{aligned}$$

So  $E[p^H(c)^2]$  can be written as:

$$= \frac{N_E^H}{N^H} \left[ \int_0^{c_D^H} \frac{1}{4} (c_D^H + c)^2 \frac{kc^{k-1}}{(c_M)^k} dc - \int_0^{c_{XA}^H} \left( -(\beta^H)^2 (c_D^H - c_D^F/\tau^F)^2 + 2\beta^H (c_D^H - c_D^F/\tau^F) (c_D^H + c) \right) \frac{kc^{k-1}}{(c_M)^k} dc \right] \\ + \frac{N_E^F G(c_{XA}^H)}{N^H} \int_0^{c_X^F} \frac{\tau^H}{4} (c_X^F + c)^2 \frac{kc^{k-1}}{(c_X^F)^k} dc$$

The first integral:

$$\int_0^{c_D^H} \frac{1}{4} (c_D^H + c)^2 \frac{kc^{k-1}}{(c_M)^k} dc = \frac{1}{2} (c_D^H)^2 \frac{(1+4k+2k^2)}{(1+k)(2+k)} \frac{(c_D^H)^k}{(c_M)^k} = \frac{1}{2} (c_D^H)^2 \frac{(1+4k+2k^2)}{(1+k)(2+k)} G(c_D^H)$$

The second integral:

$$- \int_0^{c_{XA}^H} \left( (\beta^H)^2 (c_D^H - c_D^F/\tau^F)^2 - 2\beta^H (c_D^H - c_D^F/\tau^F) (c_D^H + c) \right) \frac{kc^{k-1}}{(c_M)^k} dc \\ = \frac{1}{4} G(c_{XA}^H) (\beta^H) (c_D^H - c_D^F/\tau^F) \left( (\beta^H) (c_D^H - c_D^F/\tau^F) - 2c_D^H - 2c_{XA}^H \frac{k}{1+k} \right)$$

where  $V = (\beta^H) (c_D^H - c_D^F/\tau^F)$  (The expression could be reduced a bit further, but since I insert the results in a simulation program, the exact expression matters little).

The third integral:

$$\int_0^{c_X^F} \frac{\tau^H}{4} (c_X^F + c)^2 \frac{kc^{k-1}}{(c_X^F)^k} dc = \frac{1}{2} (c_D^H)^2 \frac{1+4k+k^2}{(1+k)(2+k)}$$

(using  $(c_X^F)^2 (\tau^H)^2 = (c_D^H)^2$ ).

Weighting and summing the three integrals, the first and the third simplify each other:

$$E[p^H(c)^2] = \frac{1}{2} (c_D^H)^2 \frac{1+4k+k^2}{(1+k)(2+k)} + \frac{1}{4} \frac{N_E^H}{N^H} G(c_{XA}^H) V \left( V - 2c_D^H - 2c_{XA}^H \frac{k}{1+k} \right)$$

Welfare for Home can now be computed numerically as well, by inserting all the components in the expression for welfare, above.

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