Asymmetric cartel formation under trade liberalization

heterogeneous firms with capacity constraints

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Abstract

In a context of trade liberalization , this paper is interested in studying the impact of a decline in trade costs on cartel formation between foreign and domestic firms. In a model that endogenize the cartel formation between heterogeneous firms in their capacities and their marginal costs, the paper investigates how the decrease in trade tariffs affects the formation of such a cartel. Contrary to previous works in this area, the paper does not study how trade liberalization affects cartel stability, however it is interested in testing whether the cartel becomes more or less inclusive after this openness.

JEL Classification : L13, L22, L40, F12, D41

1 Introduction

Over the last decades, the volume of trade all over the world has largely increased. This can be explained by the fact that economic liberalization has been largely spread among developed countries in 1980s and developing countries in 1990s. This increase was contemporaneous with the fact that several countries have adopted policies of deregulation, trade liberalization and privatization. These trends were of great impact on the countries economic outcomes. This growth in trade volumes among countries motivated the researchers to investigate the impact of such open borders on the competition in a given market and hence, on welfare gains. The interaction between the trade and competition policies is very important to study as on one hand trade liberalization can be considered as a substitute to the competition policy when it can triggers competitive environment. However, on the other hand, anti-competitive behaviors may reduce the benefits from trade openness, that's why there were demand of integration of world competition law in the WTO [1].

The competition law aims to ensure an efficient resource allocation which enhances welfare through the prevention of anti-competitive actions and promotion of competition between firms. Doing so, the competition policy ensure welfare increase in the society. As well, economic literature on trade liberalization argues that it leads to an increase in welfare through an improved domestic resources allocation. This can be explained by the fact that trade barriers create a bias against imported goods by increasing their prices and, hence, the elimination of such barriers leads to more efficient resource allocation through the shift from the production of imports substitutes to the production of export-goods.

According to traditional trade theory, trade liberalization[2] enhances the competition in the market as it increases the quality and the quantity of the products available to domestic buyers. This is in the consumer's benefit as the trade tariffs hinder national industry from the foreign competition.
This assumption could be true if the markets are perfectly competitive. Nevertheless, in the new trade system, as the markets are imperfectly competitive, it has been seen, in many countries, that the decline in trade tariffs does not lead to a decrease in the level of price but it encourages the firms to collude between them as the punishment is more severe with the lower trade costs which leads to more stable cartels.
Likewise, it has been seen that there were many cartels formed between foreign and domestic agents despite the existence of antitrust law. It was seen that U.S and British firms were accused to jointly monopolize the Canadian market (Caves, 1979). Also, a same feature was seen in the European market in 1984 where fines were imposed on producers from many countries : Canada, U.S.,

[1] The Singapore ministerial conference 1996 set up a working group on the interaction between trade and competition policies in order to study which anti-competitive practices should be included in the WTO framework.

[2] Trade liberalization is defined as a decline in trade costs.

Sweden and Portugal. These cases give an international aspect of the cartels, that's why it is important to reconsider international trade theories taking into account the possibility of collusion between domestic and foreign partners.

The rest of the paper is organized as follows : Section 2 describes the literature. Section 3 studies the trade openness framework and how it will affect cartel composition. Section 4 studies how the decline in trade tariffs affects cartel membership and finally section 5 concludes.

2 Literature review

In this paper, we are interested in studying the impact of a unilateral decline in trade tariffs on the incentive of foreign and domestic firms to collude. The literature in this area gives very different results depending on the model structure. This paper builds an intra-industry trade model in which heterogeneous firms in terms of capacity constraints and marginal costs coexist in the domestic market. The model allows for the formation of a non all-inclusive cartel between domestic and foreign firms where the larger firms have more incentive to be a part of this cartel and the smaller ones prefer to be outside.

This model is related to two trends of the literature. *The first one* is international trade in oligopolistic market structures[3]. In these models, the market structure is at the origin of intra-industry trade despite the homogeneity of the traded goods. This literature takes into account, also, the possibility of collusion between the firms in a context of free trade.

As shown by Brander and Krugman (1983), in a duopoly model of homogeneous goods, intra-industry trade increases if trade costs are not too large. However, following Pinto(1986), collusive outcomes may reveal if the firms maximize their joint profits by preventing exporting to each other markets. However, it is important to say that the stability[4] of such a cartel depends on the discount factor,which in his turn depends on the trade costs. The lower the trade costs, and hence the discount factor, the larger the incentive to deviate[5] . However, in the same time, this increases the opportunity of the rival to deviate and export to your own market and, so this lowers your profits (Ashournia *et al.*, 2011). Yet, Lommerud and Sϕrgard (2001) found that the stability of the collusion depends on the level of trade costs; and with lower trade costs due to liberalization, the scope for a collusive outcome between firms increases in the case of Bertrand competition. This result is reversed in the case of Cournot competition. Their results are robust for different demand functions and possible asymmetry between the two countries.

Markusen (1981) shows, in the case of integrated market, that multilateral free trade between two symmetric countries will have pro-competitive effect. Also,

[3]This literature dates back from the 80s with the models of Markusen (1980), Brander(1981), etc...

[4]The punishment path that he uses is less severe than the static Nash equilibrium

[5]His results are specific to the Cournot competition between the firms.

Fung (1991) was the first to analyze intra-industry trade taking in consideration the possibility of collusion between domestic and foreign firms, allowing for the product to be differentiated. In his static game, he found that intra-industry trade is positively correlated with the degree of product differentiation and negatively with the per-unit transport costs. As well, Clarke and Collie (2003) use a Bertrand duopoly model in the two cases of unilateral and multilateral free trade and show that a decline in trade costs has always a pro-competitive effect that increases domestic welfare even if these costs were initially too high. Bond and Syropoulos (2008), in their duopoly model *à* la Cournot, show that trade openness can lead to collusion between firms in both markets in the case of homogeneous goods. This depends on the magnitude of trade costs (transport costs and tariffs).

The second trend in the literature is related to the industrial organization with endogenous cartel formation between firms. It is worth noting that most of the models studying market cartelization do not take into account the possibility that it is more profitable for some firms not to be part of the cartel. In this literature the cartels are all-inclusive , and no firm has incentive to serve the market outside the cartel. Although, there are some examples of international cartel[6] where some firms are not part of it.

Although the theory on collusion is based on the assumption that all the firms in the market are cartel members, this paper will use endogenous cartel formation between heterogeneous firms where the cartel is not all-inclusive. There are some previous works that endogenize the cartel composition, but they are different form this article as they proceed in a static framework.

The first works in this area date back from Selten (1973), d'Aspermont *et al.* (1983) and Donsimoni (1985), their models found that with endogenous cartel composition, that is more profitable for the firms to be outside the cartel if the number of firms in the market and/or the number of cartelized firms is sufficiently large. However, the firm prefers to be a cartel member when the opposite is true. Nevertheless, these models maximize the collusive outcome without taking into account the incentive compatibility constraints that ensure cartel stability.

In a repeated game framework, there are some works similar to this one, Compte, Jenny and Rey (2002) show, in their price game setting with capacity constraints, that asymmetric capacities can facilitate collusion when the total market capacity is higher than the market size, however when the aggregate capacity is limited, this may make collusion more difficult.

Likewise, Vasconcelos (2005) used a capacity-constrained quantity game with homogeneous goods and shows that less asymmetry in the capacity distribution between the smallest and the biggest firm will make collusion more sustainable. However, these two models are based on the assumption of an all-inclusive cartel.

[6]The global citric acid cartel in the 90s excluded the Chinese producers from the cartel.

To the best of our knowledge, the first paper that assumes a non all-inclusive cartel is Bos and Harrington (2010), they show that when firms have different capacity constraints the largest firms have more incentive to join the cartel and the price set by cartel members is seen as an "*umbrella*" for the non-cartel members to undercut slightly. However, this paper differs from theirs in two points: the first one is the study of the impact of trade liberalization on the cartel membership and the second one is the study of whether asymmetry in marginal costs of production besides the heterogeneity in capacity constraints affects the incentive of the largest firms to join the cartel or not.

The originality of this paper is two-fold : *the first* one is that the models on the impact of trade openness on cartel stability are usually composed of two firms only that are either symmetric or differ in the level of their marginal costs. However, in this paper we have n domestic firms and n^* foreign firms that are heterogeneous in terms of their capacity constraints within each group. Also, there is another source of asymmetry between the two groups which is the difference in the marginal cost between the foreign and domestic firms due to the trade tariffs.
The second is that although there are some models that endogenize the cartel composition, this paper is the first to endogenize cartel membership in an infinitely repeated game in an international environment.
As the cartel maximization problem is respecting firms' incentive compatibility constraints , so the cartel is stable and the paper is not interested in studying the impact of tariff decline on the cartel stability. However, the model examines how this decline can affect the cartel membership, whether it becomes more or less inclusive , and hence, its impact on price level.

3 The model: basic set-up

Developing the model of Bos & Harrington (2010) to allow for the possibility of trade , we suppose that we have two countries: the domestic one denoted by "D" and the foreign country by "F". There are "n" domestic firms in country "D" and "n^*" foreign firms. From now on, all foreign variables will be denoted by an asterisk. The firms produce homogeneous goods and compete in prices. These firms are heterogeneous in term of their endowment of capacities.
We suppose that the firms in both countries have the same marginal costs "c". However the foreign firms support an additional trade cost denoted by "t". The trade costs generate another source of asymmetry between firms beside their heterogeneous capacity constraints. The capacity constraints are fixed and the discount factor $\delta \in [0, 1]$.

We assume that the foreign firms export a capacity"K^*" to the home market. This exported capacity K^* is a subset of the foreign country's total capacity K^F. Doing that, we suppose that the foreign firms have two divisions that are completely independent as if the production for their domestic market and for

the export one are totally non substitutable.
The market demand function is linear $D(p) = a - bp$, it is twice continuously differentiable and strictly decreasing in prices. The demand at the competitive price "c" is positive $D(c) > 0$.
There are two main assumptions made on this demand function:

1. If a firm "i" charges a price higher than its competitors, it will collect, if there is, the residual demand in the market.

2. There is some symmetry between firms concerning the demand function: which means that if the "n" firms set the same price, the market demand will be allocated symmetrically between them, i.e. if at this price, there is an excess of capacity on the whole market, demand faced by each firm is also lower than its capacity. If $0 < \sum_i D_i(p_i, p_{-i}) < \sum_i k_i$, then $0 < D_i(p_i, p_{-i}) < k_i \; \forall$ "i".

Each firm "i" has a capacity level denoted by k_i and faces a downward sloping demand curve $D_i(p_i, p_{-i})$ where p_i is its own price and p_{-i} is the vector of prices of its competitors.
For simplicity reasons, it is assumed that:

- The largest firm cannot meet the monopoly demand so, $k_i < D(p^m) \forall \, k_i \in K, K^*$.

- $(n + n^* - 1)$ firms can provide the competitive demand and so it is a Nash equilibrium $\sum\limits_{i \neq j} k_i + \sum\limits_{i \neq j} k_i^* \geq D(c) \; \forall \, i, i^*$.

Hence, we can say that the largest firm is not too big which is true for several markets. This assumption imply that the number of firms in the market $n + n^*$ should exceed 3 (See Bos and Harrington 2010 for more details).
We assume that the firms decide to collude between them and form a cartel, doing so they maximize their joint profits. Contrary to the previous models that study the cartel stability, in this model we are not interested in studying this stability as the firms maximize their objective function under the incentive compatibility constraint of the colluding firms to not leave the cartel as they realize higher profits being cartel members.

4 Price equilibrium and cartel formation

After describing the model basic characteristics and assumptions, it is important to analyze how the cartel membership is determined and to study the equilibrium price prevailing on the market.
Aiming that, we will study, mainly, in this section how the market price is fixed taking into account the cartel stability.

4.1 Nash Equilibrium under unilateral trade openness

As $\sum_{i \neq j} k_i + \sum_{i \neq j} k_i^* \geq D(c) \, \forall \, i, i^*$, the one-shot game price equilibrium is characterized by a Nash equilibrium where the price is equal to c. In such a market, the competitive price is the lower marginal cost, given in that case by "c", the domestic firms realize zero profits and the foreign ones have negative profits.
It is important to say that non-cartel members' price has no impact on their continuation payoff, so a non-cartel firm maximizes its current profit in equilibrium taking into account the price set by the cartel members. Also, past pricing behavior by non-cartel members do not affect cartel members' current behavior. Denote by ω the subset of firms that join the cartel and define "ε" to be very small that $\varepsilon \to 0$.
Lemma 1: If the cartel , ω, sets a price $p^c > c+t+\varepsilon$ and $D(p^c) > \sum_{j \notin \omega} k_j + \sum_{j \notin \omega} k_j^*$, the unique Nash equilibrium price set by the non-colluding firms is $p^c - \varepsilon$ and they sell their whole capacity.

In order to realize higher profits than that realized in the case of the competitive environment, the firms that decide to collude should set a price p^c higher than that of the Nash equilibrium $p^c > c + \varepsilon$. If the colluding firms realize positive profits at this price, *i.e.* there exists a residual demand for the colluding firms, so the firms in the competitive fringe will undercut slightly that collusive price. As well, it is worth noting that, for the foreign firms to be encouraged to join the cartel, the colluding price should exceed their marginal cost which is equivalent to $c + t$. Otherwise, they could not realize positive profits and they prefer not to export.
To summarize, necessary and sufficient conditions for the cartel to exist :

- There is a residual demand for the colluding firms at this price level $D(p^c) > \sum_{j \notin \omega} k_j + \sum_{j \notin \omega} k_j^*$
- The cartel price p^c is higher than the foreign firms' marginal cost$c + t$, to be able to join the cartel.

4.2 Collusive price equilibrium

In order to describe the market equilibrium, it is worth noting that after any firm deviation from the collusive outcome, this will lead to reversion to static Nash equilibrium forever. As $\sum_{i \neq j} k_i + \sum_{i \neq j} k_i^* \geq D(c) \, \forall \, i, i^*$, this market is described by a Nash equilibrium where $p = c + \varepsilon$.

Following the literature in this area , we assume that each cartel member's sales are proportional to its capacity within the cartel[7]. It is worth noting that this sharing rule is conform to reality as many cartels have followed this rule

[7]See Vasconcelos (1995) for more details on this sharing rule.

of allocation of cartel demand between their members. Scherer (1980) observes that during the 20s , the German cartels allocated the production between the firms according to their production capacities.
The collusive price is set such that $D(p^c) > K + K^* - K_\omega$ which means that, under this price, there is residual demand for the cartel members. Hence a domestic colluding firm i has a current profit defined by:

$$[D(p^c) - (K + K^* - K_\omega)](p^c - c)\left[\frac{k_i}{K_\omega}\right]$$

And a foreign colluding firm i^*, the current profit is denoted by :

$$[D(p^c) - (K + K^* - K_\omega)](p^c - c - t)\left[\frac{k_i^*}{K_\omega}\right]$$

where $K_\omega = \sum_i k_i$ and $K + K^*$ is the total market capacity.
Given that non colluding firms slightly undercut the price set by the cartel members, the residual demand faced by the cartel is given by $D(p^c) - \sum\limits_{j\notin\omega} k_j - \sum\limits_{j\notin\omega} k_j^*$. So, the total cartel profits are given by

$$\Pi^c = \left[D(p^c) - \sum_{j\notin\omega} k_j - \sum_{j\notin\omega} k_j^*\right]\left[(p^c - c)(\sum_{i\in\omega} k_i) + (p^c - c - t)(\sum_{i\in\omega} k_i^*)\right] \quad (1)$$

Based on the fact that each firm earns a profit proportional to its capacity, the Incentive Compatibility Constraint(ICC) of each domestic firm is given by :

$$(p^c - c)\left[\frac{D(p^c) - \sum\limits_{j\notin\omega} k_j - \sum\limits_{j\notin\omega} k_j^*}{1-\delta}\right]\left(\frac{k_i}{K_\omega}\right) \geq (p^c - c)k_i$$

and for the foreign firms , this constraint is given by :

$$(p^c - c - t)\left[\frac{D(p^c) - \sum\limits_{j\notin\omega} k_j - \sum\limits_{j\notin\omega} k_j^*}{1-\delta}\right]\left(\frac{k_i^*}{K_\omega}\right) \geq (p^c - c - t)k_i^*$$

As the only difference between foreign and domestic firms is in their marginal costs, thus if two firms have the same capacity, the foreign firm will earn less profit due to its lower markup. Thanks to this, the ICC is the same for both home and foreign firms. So the cartel maximization problem is described as follows :

$$\max_{p^c, K_\omega} \Pi^c = \left(\frac{1}{1-\delta}\right)[(p^c - c) + (p^c - c - t)]\left[\frac{D(p^c) - (K + K^* - K_\omega)}{K_\omega}\right]$$

subject to

$$D(p^c) \geq K + K^* - \delta K_\omega$$

This maximization has two possible answers depending on whether the ICC is binding or not. And as the objective function is strictly concave, the colluding price is the minimum of the two values.

Proposition 1: If t:$D(c+t) > K + K^* - \delta K_\omega$, the collusive price equilibrium is given by:

- If δ is high enough that the ICC is binding, the price is given by $p^c = \frac{a-K-K^*+\delta K_\omega}{b}$.
- If δ is such that the ICC is not binding the equilibrium price in this case is described as $p^c = \frac{bt(\sum_{i\in\omega} k^*)+K_\omega(a+bc-(K+K^*-K_\omega))}{2bK_\omega}$.

We suppose that $D(c) > K + K^* - \delta K_\omega$ in order to allow the cartel to price above the competitive equilibrium c. Otherwise, there will be no price that satisfies the ICC and exceeds the competitive outcome. Moreover, we should have $D(c+t) > K + K^* - \delta K_\omega$ so the foreign firms could join the cartel and realize positive profits[8] .
Note that if $D(c+t) < K + K^* - \delta K_\omega$ then there is no $p > c + t$ that satisfies the ICC $D(p^c) \geq K + K^* - \delta K_\omega$, and hence no foreign firm has an incentive to export.
Hence, to summarize, an additional necessary condition for such a cartel to exist is that the trade cost value t is low enough to ensure a colluding price higher than the foreign firms' marginal cost $c + t$.
After analyzing the collusive price fixed by the cartel members, it is important to study how the cartel is formed and which firms have more incentive to join such a cartel.

4.3 Cartel membership

Given that, in our model, the cartel in a non all-inclusive cartel, there are some firms that prefer to be outside and remain in the competitive fringe, however, other firms prefer to be cartel members. In this section, we will study which firms join the cartel and which prefer to be outside.
When δ is sufficiently close to 1 that the ICC is not binding, a necessary and sufficient condition for the cartel to exist is that $K_\omega > K + K^* - D(c+t)$. Comparing this condition with the one in the closed economy where $K_\omega > K - D(c)$, we can see that the lower threshold for the cartel capacity under open trade depends on the level of trade cost; as long as these costs increase, the cartel becomes more encompassing.
Yet, in the extreme case where there is no trade cost and products are freely

[8]This condition requires that the discount factor is high enough in order to ensure the cartel formation $\delta > \frac{K+K^*-D(c+t)}{K_\omega}$.

traded between the 2 countries $t \to 0$ the cartel capacity is greater under free trade than in the closed economy. So, we can conclude that, under free trade, the cartel controls more capacity.
Moreover, the cartel collusive value is given by

$$\left(\frac{1}{1-\delta}\right)[(p^c - c) + (p^c - c - t)](D(p^c) - (K + K^* - K_\omega))$$

it is clear that it is positively correlated to the capacity encompassed by cartel members. So, the colluding firms find that it is profitable that non cartel members join the cartel. However, for the firms in the competitive fringe they are encouraged to join the cartel if and only if their profit as cartel members exceeds their profit outside.
Due to the asymmetry between foreign and domestic firms in term of their marginal cost ; we can see that a home firm would like to join the cartel ω iff:

$$k_i(p^c(K_\omega + k_i) - c)\left(\frac{D(p^c(K_\omega + k_i)) - (K + K^* - K_\omega - k_i)}{K_\omega + k_i}\right) > (p^c K_\omega) - c)k_i \tag{2}$$

This condition, for the foreign firms, is given by :

$$k_i^*(p^c(K_\omega + k_i^*) - c - t)\left(\frac{D(p^c(K_\omega + k_i^*)) - (K + K^* - K_\omega - k_i^*)}{K_\omega + k_i^*}\right) > (p^c(K_\omega) - c - t)k_i^* \tag{3}$$

Proposition 2 In a context of open trade where $t > 0$, foreign firms have more incentive to join the cartel than the domestic ones.
Proof: See the Appendix
Given that any firm that decides to join the cartel and leaves the competitive fringe faces a trade off between being outside the cartel, and hence producing at capacity and joining the cartel and dropping out a part of its capacity. We can remark that foreign firms have more incentive than the domestic ones to collude as the decrease in their production will have lower effect on their profit due to their higher marginal cost.
Assume $k_i = k_i^*$ then (i) if firm i finds it optimal to join the cartel ω, then so does firm i^*; and (ii) if firm i^* does not find it optimal to join the cartel ω then neither does firm i.
Hence, as the marginal cost is higher the decrease in the profit of a firm with capacity k_i is less when the firm is a cartel member than being in the competitive fringe $|\frac{\partial \Pi_{i \in \omega}}{\partial c}| < |\frac{\partial \Pi_{i \notin \omega}}{\partial c}|$.
As the cartel price is positively correlated to the cartel members' capacity, so the firms members of the cartel find it optimal that any firm outside the cartel joins it. This can be seen as the cartel's "*external stability*". As long as the number of colluding firms increases, the equilibrium price increases, and hence

does the cartel collusive value.
For a firm that is in the competitive fringe, it will join the cartel if its profit increases after being a cartel member. This is referred to as "*internal stability*".

Lemma 2 The largest firms have more incentive than small firms to join the cartel.
In Bos & Harrington (2010), firms with more capacity endowments have more incentive to join the cartel as the decline in their output and hence in their profits is lower. Given that the equilibrium price is positively related to the capacity encompassed by the cartel member, we can see that the largest firms are still more encouraged to join the cartel, as the decrease in a firm's sales after becoming a cartel member is negatively correlated to its capacity thanks to the *"fair"* sharing rule.

As the largest firms have more incentive to join the cartel, it is worth noting that a cartel is stable if and only if the largest firm outside the cartel finds it not profitable to join the cartel and that the smallest firm in the cartel finds it more profitable to stay in the cartel.

5 Tariffs cut-off and cartel stability

After studying the cartel formation in the case of open borders, it is important to know how an additional decline in trade tariffs may affect the cartel composition and, hence the equilibrium price that prevails in the market.
As the cartel capacity depends on the level of trade tariffs, it is, hence, important to study how the cartel membership changes with the variation in trade costs which will affect the equilibrium price prevailing in the market.
Given that the foreign firms are more inclined to join the cartel than the home ones, the marginal foreign firm's capacity is lower than the marginal domestic firm's capacity thanks to the higher marginal cost of the foreign firms $c+t$ (*See the Appendix fore more details on marginal firms*).
However, as long as trade costs decrease, the asymmetry in terms of marginal cost between the foreign and the domestic firms decreases .
Hence, in the limit case where $t \to 0$ the two groups of firms will have the same incentive to join the cartel with no firm encouraged than the other if they have the same capacity.

Proposition 3Assume $t_1 < t_2$ then (i) $K_{\omega_{t1}} < K_{\omega_{t2}}$, and (ii) $p(K_{\omega_{t1}}) < p(K_{\omega_{t2}})$.

For a given level for trade costs $t > 0$, if the government decides to decrease more the level of tariff, the foreign firms are encouraged to leave the cartel, however, the domestic firms are now encouraged to be cartel members *(proof: See the Appendix).*
As long as the trade costs decline, the marginal foreign firm's capacity increases, however for the domestic marginal firm, its capacity decreases after a decline in

trade costs.
It is clear that, after a decrease in trade costs , there are two contradictory forces that affect the capacity under the cartel control, the final effect on the total cartel capacity depends on which of the two forces dominates.

After that the government decides to more liberalize its trade through decreasing the level of tariffs, the exit of the foreign firms from the cartel outweighs the entry of the domestic ones and hence, the cartel capacity decreases which leads to a lower price in the market.(For more details : see the Appendix).

It is important to study how the open borders affect the price level in the market, in order to do that, we should compare the two cases in the autarky and after that the foreign firms start to export.
It is well known that, the price should exceed the foreign firm's marginal cost $c + t$, so the foreign firms can have access to the home market and start to export, otherwise, there is no trade exchange. So, following proposition 1, when t does not satisfy this condition $D(c+t) > K+K^*-\delta K_\omega$, the equilibrium price can not be higher than $c + t$, and hence there is autarky and only the domestic firms are able to serve the home market.
As long as the government decides to decrease the tariffs and liberalize its trade, the foreign firms are more encouraged to export if the price exceeds their marginal cost.
Proposition 4 There exists a tariff level t^* where
$$\text{P}=\begin{cases} P^c_{autarky} & \text{if } t > t^* \\ P^c_{trade} & \text{if } t < t^* \end{cases}$$ [9]
It is well known that the trade tariff level affects directly the market structure through its impact on the incentive of the foreign firms to sell on the home market or not. If the tariff level falls in the *"so called"* prohibitive level where $t > t^*$, there is no trade that occurs and the price prevailing on the market is the "autarky" price where only the domestic firms are in the market.
Yet, when the trade costs decrease and become less than t^*, the foreign firms start to export to the domestic market, and hence, join the cartel.
In order to study the price level prevailing on the market and the impact of tariff level on it, we should distinguish between the two following cases :

- If $t < t^*$, then there is trade that occurs and foreign firms export to the home market, so the price prevailing in the market depends on the level of the discount factor δ :
  - If δ is high enough that the ICC is binding, the price is given by $p^c_{trade} = \frac{bt(\sum_{i\in\omega} k^*)+K_\omega(a+bc-(K+K^*-K_\omega))}{2bK_\omega}$
  - If δ is such that the ICC is not binding the equilibrium price in this case is described as $p^c_{trade} = \frac{a-K-K^*+\delta K_\omega}{b}$.

[9] $P^c_{autarky}$ is the market price in the autarky

- If t is in the prohibitive level i.e. $t > t^*$ the price prevailing on the market is the autarky price where only the home firms sell on the market.
  - If δ is high enough that the ICC is binding the price prevailing in the market is given by $p^c_{autarky} = \frac{a-K+\delta K_\omega}{b}$
  - If the value of δ is low, the ICC is not binding , hence the price equals $p^c_{autarky} = \frac{a+bc-K+k_\omega}{2b}$

When $t > t^*$, there is no trade, and hence the price is not affected by the trade costs as the home firms, only, sell on the market. Nevertheless, when the tariff level is in the interval where the foreign firms export to the home market $t < t^*$, the price is positively related to the tariff level, and in this region, more liberalized trade is reflected in lower prices. When the ICC is not binding, this relation is more robust as the price level is affected by the decline in the level of trade costs through two channels. The first one is direct as the trade cost appears explicitly in the price formula. As well, a decrease in the level of the tariffs induce a decrease in the cartel capacity which is reflected also in a decline in the level of the price prevailing on the market.
Moreover, it is important to mention that according to proposition 3 when t decreases to pass from the prohibitive level $t > t^*$ to the level where the foreign firms export to the home market, the foreign firms have more incentive than the domestic firms to be cartel members.
However, an extra decline of the trade costs in this interval encourages the foreign firms to leave the cartel and the home firms to join.

Yet, when t decreases from the prohibitive value to be in the interval where $t < t^*$, the impact on the price level depends on the foreign firms' capacity distribution, if their capacities are large enough, the openness may lead to higher prices. However, if the capacities are small on average, the trade openness will lead to lower prices in the home market.

Proposition 5 The price level after trade openness depends on the distribution of capacities of the foreign firms. Suppose that we have two foreign countries 1 & 2 with different capacity distribution where country 1 has more large firms. Hence,

a. $p^c_{trade}(k^{*1}) > p^c_{autarky}$

b. $p^c_{trade}(k^{*2}) < p^c_{autarky}$

It is clear that trade openness will not always lead to a decrease in the equilibrium price on the market. However, it may lead to higher prices. This could be explained by the distribution of capacities inside the foreign country. Openness with countries where firms are large enough will lead to higher prices. However, it will lead to lower prices when foreign country has enough small firms.
For a developing country where the firms are relatively small, trade liberalization

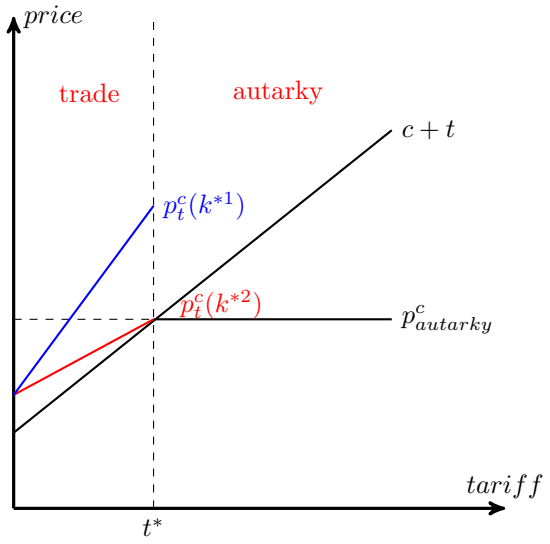

Figure 1: Relation between price level and trade costs

with a developed country where the firms are more likely to be large, this may lead to higher prices than in the case where only the home firms sell on the market. Yet, trade with similar developing country could lead to lower prices.

We could say that the impact of a decline in trade costs on the price level is ambiguous; as it could be seen a potential reason for an increase in the price prevailing on the market if the capacity distribution of the firms in the foreign country is concentrated around very large firms. However on the other hand, after that the trade tariff reaches the level below which the foreign firms start to export, the market price is positively correlated with the the tariff level and any decrease in trade costs leads to lower market prices.

6 Conclusion

It is well known that asymmetry in capacities between firms affects the tacit collusion as this asymmetry will decrease both the incentive to deviate by the firms and the severity of punishment phase after deviation. So, the final impact depends on the specification of each model. In this model of heterogeneous firms in term of capacity buildings , there is cartel formation where the larger firms have more incentive to be cartel members than the small ones.
Moreover, this cartel is a non all-inclusive cartel where very small firms prefer to be in the competitive fringe. The collusive price fixed by the cartel members serves as an umbrella for the firms in the competitive fringe; they slightly undercut that price.
The market price Nash equilibrium of such a non all-inclusive cartel is asymmetric as the equilibrium price that serves as an umbrella for the firms outside

the cartel may lead to higher profits for the competitive fringe than for the cartelized firms (Paha, 2010).
The equilibrium price is positively correlated to the capacity controlled by the cartel, when the cartel encompasses higher capacities this will lead to higher price. That's why the cartel membership is said *"open"*, as it is more profitable for cartel members that more firms join the cartel, this is referred to as *"internal stability"*.
Yet, for a firm in the competitive fringe, it faces a trade off between being in the competitive fringe and produces its total capacity or joining the cartel and drop a part of its capacity, as the cartel demand is allocated between the cartel members proportionally to each firm's capacity. That's why larger firms are more inclined to join the cartel.
In this paper, we are interested in studying the impact of trade liberalization on the competition in the market. We focus, more precisely, on the impact of the trade openness on the price level in the domestic market.
Obviously, there is no trade that occurs unless trade costs "t" is lower than a certain threshold "t^*" which encourages the foreign firms to export to the home market as they may realize positive profits. As long as the tariffs exceed this threshold, there is no trade and only the home firms sell on the domestic market. The price prevailing on the market, in that case is the autarky price "$p^{autarky}$".
If trade costs decrease to be lower than this threshold "t^*", foreign firms start to sell to the home market. As their marginal costs are higher than the domestic firms' marginal costs due to trade costs afforded, they are more encouraged to join the cartel as the magnitude of decrease in their profits after joining the cartel is less important due to their higher marginal cost.
However, when "t" declines, the comparative advantage of the domestic firms becomes less important and foreign firms prefer to be in the competitive fringe. Yet, domestic firms prefer to join the cartel. The final impact on the cartel capacity is a decrease in the capacity encompassed by the collusive firms which is reflected in lower equilibrium prices.

If we compare the price level before and after trade openness, it is clear that it depends on the capacity distribution in the foreign country. If the foreign country has sufficient large firms on average, this will lead, in contradiction with traditional trade theory, to higher prices after trade openness. However, this result would be reversed if the trade occurs with a country where the firms have sufficiently small capacity, and , hence price after trade is lower than in autarky.

Finally, we can conclude that, trade openness will not , always , lead to more competition in the market. However, it may lead to higher prices which in detriment of national consumers. This could be interpreted by the fact that, for a developing country, openness with developed countries where firms are sufficiently large may lead to higher prices. However, openness with similar developing country is less likely to lead to higher prices.

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Appendix

Table 1: Comparative statistics

Autarky	Trade	ICC
$P = \frac{a-K+\delta K_\omega}{b}$	$P = \frac{a-K-k^*+\delta K_\omega}{b}$	binding
$k_i \leq \frac{(a-bc)-K+\delta K_\omega}{1-\delta}$	$k_i \leq \frac{(a-bc)-K-K^*+\delta K_\omega}{1-\delta}$ $k_i^* \leq \frac{(a-bc-bt)-K-K^*+\delta K_\omega}{1-\delta}$	
$P = \frac{a+bc-K+k_\omega}{2b}$	$P = \frac{bt(\sum_{i\in\omega} k^*)+K_\omega(a+bc-(K+K^*-K_\omega))}{2bK_\omega}$	not binding
$k_i \leq \sqrt{K_\omega^2-(K-(a-bc))^2}$		

- Proposition 2 : In a context of open trade, foreign firms have more incentive to join the cartel than the domestic ones. *proof*
  In order to prove that, we proceed as follows : we suppose that two firms k_i and k_i^* have the same capacity, and that both of them find it more profitable to be in the cartel than being outside. So we have :

$$\phi(k_i) = k_i(p^c(K_\omega+k_i)-c)\left(\frac{D(p^c(K_\omega+k_i))-(K+K^*-K_\omega-k_i)}{K_\omega+k_i}\right) - (p^c(K_\omega)-c)k_i > 0$$

  We can easily verify that this value is increasing with the marginal cost which means that this value is greater for the foreign firms than for the domestic ones : $\frac{\partial\phi}{\partial c} = \frac{K+K^*-D(p(K_\omega+k_i)}{K_\omega+k_i} > 0$.
  Holding the cartel price fixed at a certain level $p^{'}$ and comparing the decline in profits in and out the cartel with the increase of marginal cost for two firms with the same capacity k_i:

$$\Pi_{i\in\omega} = [p^{'}-c][D(p^{'})-(K+K^*-K_\omega)]\left[\frac{k_i}{K_\omega}\right]$$

  The derivative of this equation with respect to the marginal cost c is

$$-k_i\left[\frac{D(p^{'})-(K+K^*-K_\omega)}{K_\omega}\right]$$

  Yet, for a firm with the same capacity which is in the competitive fringe, the profit is given by $[p^{'}-c]k_i$, and the derivative with respect to the marginal cost is "$-k_i$".
  Comparing the two derivatives together, it is easy to see that :

$$0 < \left[\frac{D(p^{'})-(K+K^*-K_\omega)}{K_\omega}\right] < 1$$

- Cartel capacity and price
  The cartel price is positively correlated to the capacity encompassed by the cartel members :

- If the ICC is binding, we can see that $\frac{\partial p^c}{k_\omega} = \frac{\delta}{b} > 0$.
- If the ICC is not binding : $\frac{\partial p^c}{k_\omega} = \frac{k_\omega^2 - bt \sum_{i \in \omega} k_i^*}{2bk_\omega^2} > 0$.

- <u>Cartel composition after a decline in trade tariffs "t"</u>
  - The marginal home firm's capacity does not depend on the level of trade costs "t", and a decline in these costs leaves its capacity unaffected.
  - The marginal foreign firm's capacity is directly affected by the level of "t"; $\frac{\partial k_i^*}{\partial t} = \frac{-b}{1-\delta}$
    $\rightarrow This$ will lead to a total decrease in the cartel capacity.