International Trade, Upstream Market Power, and Endogenous Mode of Downstream Competition

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Abstract

In a trade model with both horizontal and vertical product differentiation, we analyze the implications of upstream market power for the endogenous mode of downstream competition. We show that when high-quality exports are manufactured under large frictions due to upstream monopoly power, the exporter can become a Bertrand competitor against a Cournot local rival in equilibrium, especially when the relative product quality of the foreign variety is sufficiently high and trade costs are sufficiently low (implying higher input price distortions due to double marginalization). We also show that the availability of FDI as an alternative to trade can make strategic asymmetry even more likely, especially when both input trade costs and fixed investment costs are sufficiently low and trade costs in final goods are sufficiently large. Our results show that strategic asymmetry is welfare improving and has important implications for both trade and FDI policy.

JEL: D43; F12; L13
Keywords: International trade; upstream market power; vertical product differentiation; horizontal product differentiation; Cournot-Bertrand-Nash equilibrium

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Abstract

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1 Introduction

Anecdotal evidence suggests that firms competing in the same product market may adopt different strategies in terms of their mode of competition. Such strategic asymmetry has been observed in various industries.[1] The literature shows that various factors, ranging from institutional asymmetry to contract-switching costs and delays, may lead firms to adopt asymmetric strategies.[2] While this literature predominantly focuses on homogeneous goods or horizontal product differentiation, there is a small emerging literature on endogenous mode of competition

[1]See, for example, Tremblay et al. (2013) for the US small car market and the US aerospace connector industry, and Sato (1996) for the Japanese home electronics industry.

[2]See, for example, Sato (1996), Tremblay and Tremblay (2011), Schroeder and Tremblay (2015), Schroeder and Tremblay (2016), and Chao et al. (2018) and the recent survey by Tremblay and Tremblay (2019).

under vertical product differentiation. Correa-López (2007) focuses on the vertical relationship and bargaining over input(s) between upstream input suppliers and downstream firms, and shows that both a sufficiently large degree of vertical product differentiation and substantial bargaining power on the part of the input suppliers are required to support asymmetric choices of strategic variables as equilibrium. International trade is, however, not considered by Correa-López (2007). Gilbert et al. (2020a) show that analyzing asymmetric choices in strategic variables in the context of international trade is important. By the same token, Gilbert et al. (2020b) show that both trade costs and product quality are crucial explanations for strategic asymmetry between exporting firms and their local rivals. In their model, however, firms are vertically integrated from the outset, and thus there is no upstream industry modeled, nor are there any frictions over high-quality manufactures. Therefore, they find that while sales expansion is a potential exporter's strictly dominant strategy, the exporter's favorable competitive position in terms of sales in the product market (e.g., a sufficiently high product quality and sufficiently low trade costs) leads the local rival to commit to a price-cutting strategy, and thus strategic asymmetry will be observed.

Vertical product differentiation is one of the few crucial strategies that oligopolistic firms employ to enhance their competitive positions in product markets. The empirical trade literature, in particular, documents significant evidence that exporting firms tend to procure higher-quality inputs and produce higher quality products.[3] In particular, the trade literature distinguishes between inputs that are sold on an exchange (or reference priced in trade publications) with several buyers and sellers and those that are highly specialized, enabling the input supplier to exercise market power, and thus generating large frictions over final manufactures (see, for example, Rauch, 1999 and Nunn, 2007). Antràs and Staiger (2012) observe that the share of differentiated and customized input trade in world trade has increased substantially. These observations constitute the empirical motivation for this paper, in which we examine the important implications of large frictions over high-quality manufactures for the endogenous mode of downstream competition in a trade model. In doing so, we provide an intuitive explanation for why, in some markets, we observe exporters (relying on input suppliers for highly customized inputs to produce high-quality final goods) and local firms competing by choosing asymmetric strategies.

[3] See, for example, Hallak and Sivadasan (2013), Kugler and Verhoogen (2012), and Manova and Zhang (2012).

We employ a differentiated duopoly trade model with both horizontal and vertical product differentiation, and focus on quality inputs that are highly customized according to the needs of the downstream exporter. High-quality exports require high-quality inputs supplied by an upstream monopoly, and thus are costly due to double marginalization. Relative product quality, product substitutability, and trade costs determine not only the exporter's competitive position in terms of sales in the downstream product market (as in the related literature), but also how much high-quality input prices will be distorted by the upstream monopoly. In contrast to the related literature, we show that when high-quality exports are manufactured under large frictions due to upstream monopoly power, the exporter (rather than the local firm) can have an incentive to become a Bertrand competitor against a Cournot rival. Such strategic asymmetry will be an equilibrium outcome especially when the exporter has a favorable competitive position in terms of sales in the product market (i.e., when the relative product quality of the foreign variety is sufficiently high and trade costs are sufficiently low). The reason is that a favorable sales position for the exporter in our model also implies higher input price distortions due to double marginalization. Thus, as manufacturing high-quality exports becomes more costly, the exporter behaves more aggressively by choosing prices over quantities.

In addition, we show that such strategic asymmetry increases consumer surplus by more than the decrease in local profits, and thus welfare improves. Our results also confirm that such strategic asymmetry has potentially important implications for trade policy, in that decreasing trade costs not only increases welfare for a given optimal mode of competition, but also can change the optimal mode of competition from Cournot to the case of asymmetric strategies (where the foreign firm adopts a price-cutting strategy), under which welfare will be still higher. Finally, we extend the analysis to foreign direct investment (FDI) and study the endogenous choice of the market entry mode. We show that the availability of FDI as an alternative foreign market entry mode can make strategic asymmetry even more likely, when both input trade costs and fixed investment costs are sufficiently low and trade costs in final goods are sufficiently large.

The remainder of the paper is organized as follows. In Section 2 we introduce the model. In Sections 3 and 4 we solve the model for the the equilibrium mode of competition. Section 5 discusses the welfare and trade policy implications of the model. In Section 6, we extend the model to FDI and endogenize the foreign market entry mode choice, and solve the model both for the equilibrium market entry mode and the equilibrium mode of competition. Finally, Section 7 offers some concluding remarks. For convenience, most of the proofs and technical details are relegated to the Appendix.

2 The model

We develop a differentiated duopoly trade model with both horizontal and vertical product differentiation similar to Gilbert et al. (2020b), and introduce an upstream industry structure similar to Koska (2020). Thus, while allowing for the endogenous choice of quantity or price as the strategic variable, we are able to capture large frictions over manufacturing high quality goods via upstream market power, which is the main contribution of this paper to the existing trade literature. In particular, we consider a country (home) with a single local downstream firm, denoted h, which produces a low-quality local product. There is no friction associated with the production of the low-quality local variety. To produce the local variety, firm h procures a (standard) low-quality input from home's perfectly competitive upstream industry. Low-quality inputs are produced at zero marginal cost, and assembly is costless and linear such that the local downstream firm can produce one unit of the low-quality product by using one unit of standard inputs at zero marginal cost. Firm h may face international rivalry due to the existence of a potential exporter producing a related high-quality good, firm f, which is located outside the country.

In contrast to firm h, to produce high-quality exports firm f has to rely on a monopoly upstream firm producing a high-quality input with zero marginal cost.[4] Similar to firm h, having procured high-quality inputs (denoted z), firm f can produce the final (high-quality) good according to the production function $f(z)$ without any further cost (the input price is the only production cost for firm f).[5] Therefore, denoting final goods by x and inputs by z, we can express $x_i = f(z) = z$, $i = \{h, f\}$. Upstream monopoly power over high-quality inputs renders manufacturing high quality goods costly: the high-quality input price p_z is

[4]For discussion of the empirical relevance of this modeling structure, see Koska (2020).

[5]High-quality inputs produced by the upstream monopoly are highly customized according to the needs of the downstream exporter, whose exports to H shall be regarded as country specific: its production for another country (other than H) does not affect the price of this specific input.

solely determined by the upstream monopoly, leading to the double marginalization problem. In addition, servicing the home market via export sales is costly: firm f incurs a per-unit trade cost, denoted t, should it enter the home market.

On the demand side, we consider a representative consumer in home maximizing:

$$U(x_h, x_f, M) = u_h x_h + u_f x_f - x_h^2/2 - x_f^2/2 - \sigma x_h x_f + M \tag{1}$$

with respect to the budget constraint $\sum_i p_i x_i + M \leq Y$, where Y is income, p_i denotes the price of the differentiated good $i = \{h, f\}$, and the price of a composite good M plays the role of numéraire. The degree of horizontal product differentiation is measured by $\sigma \in (0, 0.78)$ - where the upper bound adds stability to the model - implying that the goods are substitutes.[6] The degree of vertical product differentiation is measured by u_i, $i = \{h, f\}$, such that $u_f > u_h$ and that u_i is interpreted as an index of product quality.[7] The first-order conditions of the utility maximization problem:

$$\frac{\partial U(\cdot)}{\partial x_i} : u_i - x_i - \sigma x_j - p_i = 0, \quad i \neq j \in \{h, f\}$$

yield the optimal consumption of each variety $i = \{h, f\}$ of the good, such that:

$$x_i(p_i, p_j) = \frac{(u_i - p_i - \sigma(u_j - p_j))}{(1 - \sigma^2)}, \quad i \neq j \in \{h, f\},$$

in the region $\{p \in R_+^2 : u_h - p_h - \sigma(u_f - p_f) > 0, u_f - p_f - \sigma(u_h - p_h) > 0\}$. The inverse demand functions are linear for each variety i and can be expressed as:

$$p_i(x_i, x_j) = u_i - x_i - \sigma x_j, \quad i \neq j \in \{h, f\}.$$

It is clear that the quantity demanded of variety i of the good is always decreasing in its own price and increasing in the price of the rival's variety.

The game structure is as follows. In the first stage, the potential exporter makes the foreign market entry decision. In the second stage (assuming the exporter has decided to be active in Home's market), both firms procure their inputs to produce their varieties: (i) the exporting downstream firm procures high-

[6]Each firm's market power increases as σ decreases such that if $\sigma = 0$, then each firm would have the ability to behave as a monopolist, whereas the products would be perfect substitutes when there is no vertical differentiation between the varieties and when $\sigma = 1$.

[7]An increase in u_i increases the marginal utility of good $i = \{h, f\}$, ceteris paribus.

quality inputs from the upstream monopoly firm located in the country where the exporting downstream firm's headquarters are located and produces high-quality exports; and (ii) the local firm procures low-quality inputs from home's perfectly competitive upstream industry and produces a low-quality local variety. In the third stage, the local firm and the exporter (if it has entered the market) simultaneously choose their strategic variables (quantities or prices), and in the final stage, they compete in home's differentiated product market. The model is solved by backward induction.

3 Upstream behavior and downstream competition

In the last stage of the game the local firm and the exporter (if it has entered the market) compete in the differentiated downstream product market. The two firms' choices of their strategic variables and upstream monopoly behavior (determining the high-quality input price) determine the final outcome. In the last stage, there are four possibilities for downstream product market competition: two symmetric outcomes such that either both downstream firms compete in quantities (Cournot) or in prices (Bertrand); and two asymmetric outcomes such that one downstream firm competes by setting its price, while the other downstream firm competes by setting its quantity (Cournot-Bertrand).

3.1 Downstream Cournot duopoly

In the case of Cournot duopoly in the downstream product market, each firm simultaneously chooses quantities x_i, $i \in \{h, f\}$ maximizing own profits, $\pi_i = (p_i(x_i, x_j) - c_i)x_i$, $i \neq j \in \{h, f\}$. Using the first-order conditions of the profit maximization problems and solving for x_h^* and x_f^* give us the expressions for the equilibrium quantities set by each firm in equilibrium:

$$x_i^* = \frac{2(u_i - c_i) - \sigma(u_j - c_j)}{4 - \sigma^2}, \quad i \neq j \in \{h, f\}, \tag{2}$$

in the region of quality spaces where equilibrium quantities are positive. We can substitute the equilibrium prices given in eq. (2) into the inverse demand functions and obtain the equilibrium prices of each variety:

$$p_i^* = \frac{2u_i + (2-\sigma^2)c_i - \sigma(u_j - c_j)}{(4-\sigma^2)}, \quad i \neq j \in \{h, f\}. \tag{3}$$

Using eqs. (2) and (3), we can show that under Cournot duopoly $p_i^* - c_i = x_i^*$, $i \in \{h, f\}$, and thus that the equilibrium profits can be expressed as $\pi_i^* = (x_i^*)^2$, $i \in \{h, f\}$. Note that $c_h = 0$ and $c_f = t + p_z$, where per-unit input price p_z is determined by the upstream monopoly. Given $x_f = f(z) = z$, substituting z for x_f and re-arranging the expression, the inverse input demand can be written as $p_z(z) = (2(u_f - t) - \sigma u_h - (4-\sigma^2)z)/2$. The upstream monopoly firm maximizes $p_z(z)z$ by setting the input price and sales as

$$z^* = \frac{2(u_f - t) - \sigma u_h}{2(4-\sigma^2)}; \quad p_z^* = \frac{2(u_f - t) - \sigma u_h}{4}. \tag{4}$$

In eq. (4), both the high-quality input price and sales increase with a decrease in trade costs in final goods, t, or with an increase (decrease) in firm f's (the local rival's) product quality. As might be expected, firm f's costs, $c_f = p_z^* + t = (2u_f - \sigma u_h + 2t)/4$, increase with an increase in t, with an increase in the degree of horizontal product differentiation (i.e., a decrease in σ), or with an increase (decrease) in firm f's (the local rival's) product quality. It is now straightforward to show that, in equilibrium:

$$p_f^{CC} = \frac{(6-\sigma^2)(2u_f - \sigma u_h) + 2(2-\sigma^2)t}{4(4-\sigma^2)}; \quad x_f^{CC} = \frac{2u_f - \sigma u_h - 2t}{2(4-\sigma^2)};$$
$$p_h^{CC} = x_h^{CC} = \frac{(8-\sigma^2)u_h - 2\sigma(u_f - t)}{4(4-\sigma^2)}, \tag{5}$$

where superscript **CC** represents the case of Cournot duopoly. Note that foreign output is positive (and thus choosing output is a viable strategy, given that the rival firm chooses output) only if $t < u_f - \sigma u_h/2$. Similarly, there is no crowding out of the local firm, even for zero trade costs, if $u_f < (8-\sigma^2)u_h/2\sigma$.

3.2 Downstream Bertrand duopoly

In the case of Bertrand duopoly in the downstream product market, each firm simultaneously chooses prices p_i, $i \in \{h, f\}$ maximizing own profits, $\pi_i = (p_i - c_i)x_i(p_i, p_j)$, $i \neq j \in \{h, f\}$. Using the first-order conditions of the profit maximization problems and solving for p_h^* and p_f^* gives us the expressions for the optimal prices set by each firm in equilibrium:

$$p_i^* = \frac{(2-\sigma^2)u_i - \sigma u_j + 2c_i + \sigma c_j}{(4-\sigma^2)}, \quad i \neq j \in \{h, f\}, \tag{6}$$

in the region of quality spaces where equilibrium quantities are positive. We can substitute the equilibrium prices given in eq. (6) into the demand system to obtain equilibrium sales:

$$x_i^* = \frac{(2-\sigma^2)(u_i - c_i) - \sigma(u_j - c_j)}{(4-\sigma^2)(1-\sigma^2)}, \quad i \neq j \in \{h, f\}. \tag{7}$$

Using eqs. (6) and (7), we can show that $p_i^* - c_i = (1-\sigma^2)x_i^*$, $i \in \{h, f\}$, and thus that the equilibrium profits can be expressed as $\pi_i^* = (1-\sigma^2)(x_i^*)^2$. Recall that $c_h = 0$ and $c_f = t + p_z$, where the per-unit input price p_z is determined by the upstream monopoly. Given $x_f = f(z) = z$, substituting z for x_f and re-arranging the expression, the inverse input demand can be written as $p_z(z) = ((2-\sigma^2)(u_f - t) - \sigma u_h - (4-\sigma^2)(1-\sigma^2)z)/(2-\sigma^2)$. The upstream monopoly firm maximizes $p_z(z)z$ by setting the input price and sales as

$$z^* = \frac{(2-\sigma^2)(u_f - t) - \sigma u_h}{2(4-\sigma^2)(1-\sigma^2)}; \quad p_z^* = \frac{(2-\sigma^2)(u_f - t) - \sigma u_h}{2(2-\sigma^2)}. \tag{8}$$

In eq. (8), both the high-quality input price and sales increase with a decrease in trade costs in final goods, t, or with an increase (decrease) in firm f's (the local rival's) product quality. Firm f's costs, $c_f = p_z^* + t = ((2-\sigma^2)(u_f + t) - \sigma u_h)/2(2-\sigma^2)$, increase with an increase in t, with an increase in the degree of horizontal product differentiation (a decrease in σ), or with an increase (decrease) in firm f's (the local rival's) product quality. Comparing eq. (4) to eq. (8), we can show that

Proposition 1. *Input prices (and thus per-unit production costs inclusive of trade costs) are greater under Cournot competition than under Bertrand competition.*

Moreover, an increase in the exporter's product quality index (or a decrease in trade costs) increases input demand and output under Cournot by more than it does under Bertrand, although the marginal impact on the input price will be the same in the two cases. By contrast, a decrease in the local rival's product quality index increases both the input price and input demand under Bertrand by more that it does under Cournot. It is now straightforward to show that, in equilibrium:

$$p_f^{BB} = \frac{(3-\sigma^2)((2-\sigma^2)u_f - \sigma u_h) + (2-\sigma^2)t}{(4-\sigma^2)(2-\sigma^2)}; \quad x_f^{BB} = \frac{(2-\sigma^2)(u_f - t) - \sigma u_h}{2(4-\sigma^2)(1-\sigma^2)};$$
$$p_h^{BB} = \frac{(8-9\sigma^2+2\sigma^4)u_h - \sigma(2-\sigma^2)(u_f - t)}{2(4-\sigma^2)(2-\sigma^2)};$$
$$x_h^{BB} = \frac{(8-9\sigma^2+2\sigma^4)u_h - \sigma(2-\sigma^2)(u_f - t)}{2(4-\sigma^2)(2-\sigma^2)(1-\sigma^2)}, \tag{9}$$

where superscript **BB** represents the case of Bertrand duopoly. Note that foreign output is positive (and thus choosing price is a viable strategy, given the rival firm chooses price) only if $t < u_f - \sigma u_h/(2-\sigma^2)$. Similarly, there is no crowding out of the local firm, even for zero trade costs, if $u_f < (8-9\sigma^2+2\sigma^4)u_h/\sigma(2-\sigma^2)$.

In a model without trade and without upstream market power, Singh and Vives (1984) argue that Cournot duopoly would be less competitive than Bertrand duopoly. In their model, they focus only on Cournot versus Bertrand competition between two local firms, and find that quantities are lower and prices and profits are higher in Counot than in Bertrand duopoly, and thus firms would strictly prefer Cournot over Bertrand had they been given the choice. Häckner (2000) extends the model by Singh and Vives (1984) to n-firm oligopoly, where $n > 2$, and shows that while Cournot prices (quantities) are higher (lower) compared to Bertrand oligopoly, Cournot profits are higher than Bertrand profits only when quality differences are sufficiently small. We extend these discussions to a trade model with upstream market power in Proposition 2 and Corollary 1.

Proposition 2. *While, for any permissible parameter value, $p_i^{BB} < p_i^{CC}$, $i \in \{h, f\}$, only for sufficiently low trade costs (i.e., $t < t'$), $x_f^{BB} > x_f^{CC}$, and only if the quality difference is sufficiently small (i.e., $u_f < u_f'$), or if both the quality difference and trade costs are sufficiently large (i.e., $u_f > u_f'$ and $t > t''$), then $x_h^{BB} > x_h^{CC}$.*

Proof. See Appendix A.1. □

The Proof of Proposition 2 in Appendix A.1 shows that the greater (smaller) is the quality index of the high-quality (low-quality) variety and the higher is the degree of horizontal product differentiation such that the lower is σ, the higher is the likelihood, for a given t, that the Bertrand output is greater than Cournot output for the high-quality variety. In contrast, the smaller (greater) is the quality index of the high-quality (low-quality) variety and the higher is the degree of horizontal product differentiation such that the lower is σ, the higher is the likelihood, for a given t, that Bertrand output is greater than Cournot output for the low-quality variety. It is also clear from the proof of Proposition 2 that $t'' < t'$, which leads to the following Corollary.

Corollary 1. *Output is greater under Bertrand than under Cournot for both varieties when $t'' < t < t'$ is satisfied, where $(t' - t'')$ - the likelihood of such an occurrence for a given t - is greater the greater is the quality index of the low-quality variety and the greater is the horizontal degree of product differentiation (the lower is σ).*

In Corollary 1, it should be noticed that, for a given quality index of the high-quality foreign variety, a greater quality index of the low-quality local variety implies a lower quality difference between the varieties, which can be related to the finding of Häckner (2000).

3.3 Asymmetric downstream strategies

In the case of asymmetric strategies in the downstream product market, firm i maximizes $\pi_i = (p_i(x_i, p_j) - c_i)x_i$, $i \neq j \in \{h, f\}$ by choosing its quantity, and firm j maximizes $\pi_j = (p_j - c_j)x_j(p_j, x_i)$, $i \neq j \in \{h, f\}$ by choosing its price. We can express $p_i(x_i, p_j) = u_i - \sigma u_j - (1 - \sigma^2)x_i + \sigma p_j$ and $x_j(p_j, x_i) = u_j - \sigma x_i - p_j$.

Solving the first-order conditions of the profit maximization problems for x_i^* and p_j^*, $i \neq j \in \{h, f\}$, yields the optimal prices and quantities set by each firm in equilibrium:

$$x_i^* = \frac{2(u_i - c_i) - \sigma(u_j - c_j)}{4 - 3\sigma^2}, \quad i \neq j \in \{h, f\}, \tag{10a}$$

$$p_j^* = \frac{(2 - \sigma^2)u_j + 2(1 - \sigma^2)c_j - \sigma(u_i - c_i)}{4 - 3\sigma^2}, \quad i \neq j \in \{h, f\}, \tag{10b}$$

in the region of quality spaces where optimal quantities are positive. We can substitute the optimal quantities and prices given by eq. (10) into $x_j(p_j, x_i)$ and $p_i(x_i, p_j)$ given above, and express the output of the firm committing to a price contract, x_j^*, and the price of the firm committing to a quantity contract, p_i^*, $i \neq j \in \{h, f\}$, as

$$x_j^* = \frac{(2-\sigma^2)(u_j - c_j) - \sigma(u_i - c_i)}{4 - 3\sigma^2}, \quad i \neq j \in \{h, f\}, \tag{11a}$$

$$p_i^* = \frac{(1-\sigma^2)(2u_i - \sigma u_j + \sigma c_j) + (2-\sigma^2)c_i}{4 - 3\sigma^2}, \quad i \neq j \in \{h, f\}. \tag{11b}$$

Using eqs. (10) and (11), it follows that $(p_i^* - c_i) = (1-\sigma^2)x_i^*$ and $(p_j^* - c_j) = x_j^*$, $i \neq j \in \{h, f\}$, thus the equilibrium profits can be expressed as $\pi_i^* = (1-\sigma^2)(x_i^*)^2$ for firm i opting to compete in quantities, and as $\pi_j^* = (x_j^*)^2$ for firm j opting to compete in prices, $i \neq j \in \{h, f\}$, where equilibrium quantities are given in eqs. (10a) and (11a). Recall that $c_h = 0$ and $c_f = t + p_z$, where the per-unit input price p_z is determined by the upstream monopoly. Given $x_f = f(z) = z$, substituting z for x_f and re-arranging the expression will give us the inverse input demand. When the potential exporter chooses output (given that the rival local firm chooses price) to maximize profits, x_f will be equivalent to x_i^* given in eq. (10a), in which case the inverse input demand function can be written as $p_z(z) = (2(u_f - t) - \sigma u_h - (4 - 3\sigma^2)z)/2$. The upstream monopoly firm thus maximizes $p_z(z)z$ by setting the input price and sales as

$$z^* = \frac{2(u_f - t) - \sigma u_h}{2(4 - 3\sigma^2)}; \quad p_z^* = \frac{2(u_f - t) - \sigma u_h}{4}, \tag{12}$$

in the case where the downstream exporter chooses output and its rival chooses price. When the potential exporter chooses price instead (given the rival local firm chooses output) to maximize profits, x_f will be equivalent to x_j^* given in eq. (11a), in which case the inverse input demand function can be written as $p_z(z) = ((2-\sigma^2)(u_f - t) - \sigma u_h - (4 - 3\sigma^2)z)/(2 - \sigma^2)$. The upstream monopoly thus maximizes $p_z(z)z$ by setting the input price and sales as

$$z^* = \frac{(2-\sigma^2)(u_f - t) - \sigma u_h}{2(4 - 3\sigma^2)}; \quad p_z^* = \frac{(2-\sigma^2)(u_f - t) - \sigma u_h}{2(2 - \sigma^2)}. \tag{13}$$

In eqs. (12) and (13), both the high-quality input price and sales increase with a decrease in trade costs in final goods, t, or with an increase (decrease) in exporter firm f's (local firm h's) product quality. It is worth noting that an increase in the exporter's product quality index (or a decrease in trade costs) increases input demand and output when the exporter chooses output by more than it does when the exporter chooses price, although the marginal impact on the input price will be the same in the two cases. By contrast, a decrease in the local rival's product quality index increases the input price in the case the exporter chooses price by more that it does in the case the exporter chooses output, although the marginal impact on input demand will be the same in the two cases.

As might be expected, firm f's costs in the case of choosing output (given that the rival chooses price), $c_f = p_z^* + t = (2(u_f + t) - \sigma u_h)/4$, or in the case of choosing price (given that the rival chooses output), $c_f = p_z^* + t = ((2-\sigma^2)(u_f + t) - \sigma u_h)/2(2-\sigma^2)$, increase with an increase in t, with an increase in the degree of horizontal product differentiation (a decrease in σ), or with an increase (decrease) in firm f's (the local rival's) product quality index. Comparing eqs. (12) and (13) to eqs. (4) and (8), we can show that the input prices (and thus per-unit production costs inclusive of trade costs) do not change with a local rival's choice of the strategic variable for a given choice of the exporter.

Lemma 1. *Input prices (and thus per-unit production costs inclusive of trade costs) change only with the exporter's choice of the strategic variable.*

The local rival's choice of the strategic variable does, however, matter for input demand. Comparing the marginal impacts, we can show that an increase in the exporter's product quality index (or a decrease in trade costs or in the local rival's product quality index) increases input demand and output the most (least) under Bertrand (Cournot). Marginal impacts under asymmetric strategies are as discussed above, and are in between Bertrand and Cournot in magnitudes. It is now straightforward to show that, should the exporter (the local rival) choose output (price), in equilibrium:

$$p_f^{BC} = \frac{(6-5\sigma^2)(2u_f - \sigma u_h) + 2(2-\sigma^2)t}{4(4-3\sigma^2)}; \quad x_f^{BC} = \frac{2(u_f - t) - \sigma u_h}{2(4-3\sigma^2)};$$
$$p_h^{BC} = x_h^{BC} = \frac{(8-5\sigma^2)u_h - 2\sigma(u_f - t)}{4(4-3\sigma^2)}, \tag{14}$$

where superscript **BC** represents the case of a Bertrand local rival choosing local price and a Cournot exporter setting foreign output.

If, however, the exporter (the local rival) chooses price (output), then, in equilibrium:

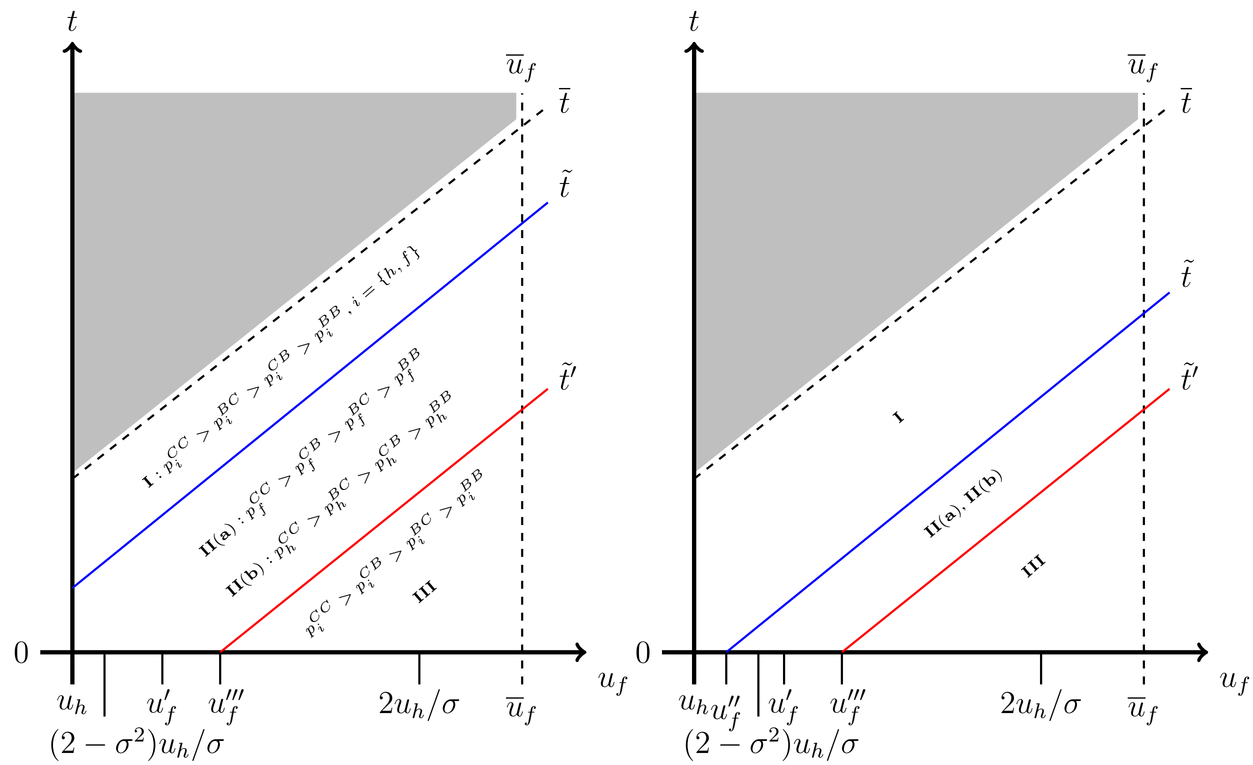
$$p_f^{CB} = \frac{(3-2\sigma^2)((2-\sigma^2)u_f - \sigma u_h) + (2-\sigma^2)(1-\sigma^2)t}{(4-3\sigma^2)(2-\sigma^2)}; \quad x_f^{CB} = \frac{(2-\sigma^2)(u_f - t) - \sigma u_h}{2(4-3\sigma^2)};$$

$$p_h^{CB} = (1-\sigma^2)\frac{(8-5\sigma^2)u_h - \sigma(2-\sigma^2)(u_f - t)}{2(4-3\sigma^2)(2-\sigma^2)}; \quad x_h^{CB} = \frac{(8-5\sigma^2)u_h - \sigma(2-\sigma^2)(u_f - t)}{2(4-3\sigma^2)(2-\sigma^2)}, \tag{15}$$

where superscript **CB** represents the case a Cournot local rival (setting local output) competes against a Bertrand exporter (choosing foreign price). Note that as in Cournot and Bertrand competition, in the case of asymmetric strategies, (i) setting output is a viable strategy for an exporter, given the rival firm chooses price, only if $t < u_f - \sigma u_h/2$; and (ii) setting price is a viable strategy for the exporter, given the rival firm chooses quantity, only if $t < u_f - \sigma u_h/(2-\sigma^2)$. The latter threshold binds more tightly than the former. Similarly, in the case of asymmetric strategies, there is no crowding out of the local firm, even for zero trade costs, if $u_f < (8-5\sigma^2)u_h/2\sigma$ in the case a Cournot exporter competes against a Bertrand local rival; or if $u_f < (8-5\sigma^2)u_h/\sigma(2-\sigma^2)$ in the case a Bertrand exporter competes against a Cournot local rival. Comparing these two thresholds to those in the cases of Cournot and Bertrand competition, we can show that $(8-9\sigma^2+2\sigma^4)u_h/\sigma(2-\sigma^2)$ (which is the relevant threshold in the case of Bertrand competition) is the most binding threshold. Throughout the remainder of the paper, we focus on non-prohibitive trade costs such that $t < \bar{t} = u_f - \sigma u_h/(2-\sigma^2)$ (and thus both setting output and price will be viable) and on a quality difference that is bounded from above such that $u_h < u_f < \overline{u}_f = (8-9\sigma^2+2\sigma^4)u_h/\sigma(2-\sigma^2)$. Comparing prices given in eq. (5), in the case of Cournot competition, in eq. (9), in the case of Bertrand competition, and in eqs. (14) and (15), in the case of asymmetric strategies, we establish the following result and illustrate in Figures 1a and 1b.

Proposition 3. *While, for any permissible parameter value,* $p_i^{BB} < p_i^k < p_i^{CC}$, $i \in \{h, f\}$, $k \in \{BC, CB\}$, $p_f^{BC} > p_f^{CB}$ *if* $t > \tilde{t}$, *given* $\sigma < 0.52$. *If, however,* $\sigma > 0.52$, *then* $p_f^{BC} > p_f^{CB}$ *only if* $u_f < u_f''$, *or if* $u_f > u_f''$ *and* $t > \tilde{t}$. *Similarly,* $p_h^{BC} > p_h^{CB}$ *only if* $u_f < u_f'''$, *or if* $u_f > u_f'''$ *and* $t > \tilde{t}'$.

Proof. See Appendix A.2 □



(a) $\sigma < 0.52$

(b) $\sigma > 0.52$

Figure 1: Price of each variety

In both figures, trade costs ($t < \bar{t}$) are on the vertical axis and the quality index of the high-quality foreign variety ($u_f < \overline{u}_f$) is on the horizontal axis. Also it is worth noting that while the slope of the trade cost thresholds (colored lines) is the same for all and does not change, the quality index thresholds labeled on the horizontal axis can move along the axis as the degree of horizontal product differentiation takes a different value. The order of the thresholds, however, stays intact. The only difference between Figures 1a and 1b is that the blue line shifts in (and intersects the horizontal axis instead of the vertical axis) when the degree of horizontal product differentiation is sufficiently small (when $\sigma > 0.52$). In either case, it is clear from the figures that both varieties charge the highest (lowest) price under Cournot (Bertrand) competition. As for the prices in the case of asymmetric strategies, while the intensity of competition is less (more) than Bertrand (Cournot), sufficiently high trade costs lead to more aggressive pricing (and thus to cheaper prices) by both firms in the case a Bertrand exporter competes against a Cournot local rival. The opposite is true for sufficiently low trade costs such that cheaper prices will be observed when a Cournot exporter competes against a Bertrand rival.

As for firm output in the cases of Bertrand, Cournot, and an exporter choosing output against a local rival choosing price, comparing eqs. (5), (9) and (14) leads to the following result:

Proposition 4. *While, for any permissible parameter value,* $x_f^{CC} < x_f^{BC}$ *and* $x_h^{CC} > x_h^{BC}$*,* $x_f^{BB} < x_f^{BC}$ *if* $u_f < (2-\sigma^2)u_h/\sigma$*, or if both* $u_f > (2-\sigma^2)u_h/\sigma$ *and* $t > t'''$*. Similarly* $x_h^{BB} > x_h^{BC}$ *if* $u_f < \hat{u}_f$*, or if both* $u_f > \hat{u}_f$ *and* $t > \hat{t}$*.*

Proof. See Appendix A.3. □

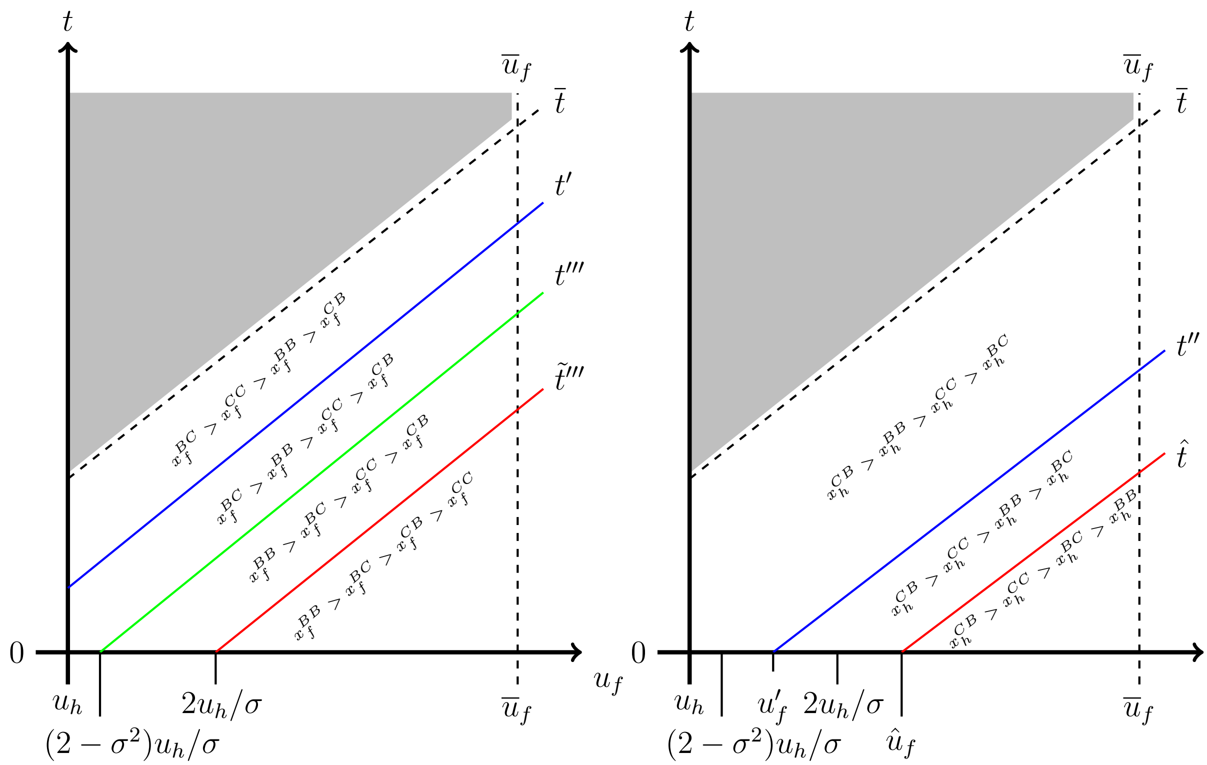
Similarly, comparing firm output in the cases of Cournot (given in eq. (5)) and Bertrand (given in eq. (9)) to the case of an exporter choosing price against a local rival choosing output (given in eq. (15)) we can show the following result holds:

Proposition 5. *While, for any permissible parameter value,* $x_f^{BB} > x_f^{CB}$ *and* $x_h^k < x_h^{CB}$*,* $k \in \{CC, BB\}$*,* $x_f^{CC} > x_f^{CB}$ *only if* $u_f < 2u_h/\sigma$*, or if both* $u_f > 2u_h/\sigma$ *and* $t > \tilde{t}'''$*.*

Proof. See Appendix A.4. □

Similar to Figures 1a and 1b, we illustrate the ranking of firm output that summarizes Proposition 2, where we compare Cournot and Bertrand output, and Propositions 4 and 5, where we compare firm output also in the case of asymmetric strategies. Figure 2a illustrates output of the high-quality foreign variety, while Figure 2b illustrates output of the low-quality local variety for the permissible parameter values of the model.

It is clear from Figure 2a that, for sufficiently high trade costs, the high-quality foreign variety sells more in the case of a Cournot exporter competing against a Bertrand local rival as compared to the other modes of competition. For sufficiently low trade costs, it is Bertrand competition under which foreign sales will be greater. As might be expected, irrespective of trade costs, a Cournot exporter competing against a Bertrand local rival sells more than a Bertrand exporter competing against a Cournot local rival. In contrast, Figure 2b shows that, irrespective of trade costs, local sales of the low-quality product are the greatest (as compared to the other modes of competition) when the local firm competes by setting output against an exporter setting price. Moreover, for sufficiently high



(a) High-quality foreign output (b) Low-quality local output

Figure 2: Output of each variety

trade costs, the low-quality local variety sells more under Bertrand than under Cournot competition, whereas for sufficiently low trade costs, this is reversed.[8]

Double marginalization due to upstream monopoly power over high-quality inputs increases a potential exporter's production costs. We can compare outputs and prices in these four different cases (CC,BB,CB,BC) under upstream market power to those under vertical integration explored by Gilbert et al. (2020b), and show that the following results will hold: Compared to the case of a vertically integrated upstream firm, (i) the potential exporter's sales of the high-quality foreign variety will be lower, while the price of the high-quality foreign variety will be higher; whereas (ii) both sales and the price of the low-quality local variety will be higher. Moreover, we can compare the prices of the high-quality foreign variety and the low-quality local variety in each of these four cases, and show that upstream market power will not be *shipping the good apples out*, such that

[8] It is important to understand the changes in the rankings of firm output and prices as they are the key in determining the optimal mode of competition (which we analyze in Section 4) and drive the main results on welfare and trade policy implications of the model (which we analyze in Section 5).

the price of the high-quality foreign variety will be always higher than the price of the low-quality local variety, irrespective of the mode of competition.

4 Mode of competition

In this section we consider the two firm's optimal choice of the strategic variables in the first stage. Recall that firm f (the exporter) has a cost disadvantage not only due to trade costs, but also due to frictions over manufacturing high-quality (due to upstream market power over high-quality inputs required for manufacturing the high-quality final good) such that $c_h = 0$ and $c_f = p_z^* + t$, where input price p_z^* (determined by the upstream monopoly) is given in eqs. (4), (8), (12) or (13), depending on the mode of competition. From Proposition 1 and Lemma 1 we know that a Cournot exporter's production costs are greater than a Bertrand exporter's costs due to higher input prices, which are not responsive to the local rival's choice of the strategic variable. Also we have already shown that each firm's equilibrium profits can be expressed as a function of the firm's optimal output such that $\pi_i^{CC} = (x_i^{CC})^2$, $i \in \{h, f\}$, where x_i^{CC} is given in eq. (5); $\pi_i^{BB} = (1-\sigma^2)(x_i^{BB})^2$, $i \in \{h, f\}$, where x_i^{BB} is given in eq. (9); $\pi_h^{BC} = (x_h^{BC})^2$ and $\pi_f^{BC} = (1-\sigma^2)(x_f^{BC})^2$, where x_i^{BC}, $i = \{h, f\}$, are given in eq. (14); $\pi_h^{CB} = (1-\sigma^2)(x_h^{CB})^2$ and $\pi_f^{CB} = (x_f^{CB})^2$, where x_i^{CB}, $i = \{h, f\}$, are given in eq. (15).

We can now show that, when a potential exporter is a Bertrand rival (committing to a price contract), the local firm earns $\pi_h^{\mathbf{B}B} \equiv (1-\sigma^2)(x_h^{\mathbf{B}B})^2$ by committing to a price contract, or $\pi_h^{\mathbf{C}B} \equiv (1-\sigma^2)(x_h^{\mathbf{C}B})^2$ by committing to a quantity contract. We have already established in Propositions 3 and 5, and shown in Figures 1a, 1b and 2b that $p_h^{CB} > p_h^{BB}$ and $x_h^{CB} > x_h^{BB}$, $\forall t < \bar{t}$. That is, given that a potential exporter competes by choosing price, committing to a quantity contract earns the local firm more profits than choosing price. Similarly, when a potential exporter is a Cournot rival (committing to a quantity contract), the local firm earns $\pi_h^{\mathbf{B}C} \equiv (x_h^{\mathbf{B}C})^2$ by committing to a price contract, or $\pi_h^{\mathbf{C}C} \equiv (x_h^{\mathbf{C}C})^2$ by committing to a quantity contract. We have already established in Propositions 3 and 4, and in Figures 1a, 1b and 2b that $p_h^{CC} > p_h^{BC}$ and $x_h^{CC} > x_h^{BC}$, $\forall t < \bar{t}$. That is, given a potential exporter competes by choosing output, also committing to a quantity contract earns the local firm more profits. Thus, irrespective of a potential exporter's choice of the strategic variable, the local firm is better off by merely committing to a quantity contract. This leads to the following result.

Proposition 6. *Irrespective of a potential exporter's strategic choice, the local rival always prefers to compete by quantities.*

Proposition 6 shows that the standard result reported in the IO literature extends for the local firm facing potential competition by an exporter in the context of international trade with vertically differentiated products and upstream market power. An important point to note that this result contrasts with the result in Gilbert et al. (2020b), who show that when there is no upstream market power, committing to a quantity contract is only the potential exporter's dominant strategy. The main intuition is that when there is no upstream market power, the local firm can alleviate a weak competitive position (when the quality index of the high-quality foreign variety is sufficiently high and trade costs are sufficiently low) by adopting a more aggressive pricing strategy, as the exporter's marginal cost does not increase with a more favorable competitive position. In the case of upstream market power that renders manufacturing high quality costly, however, a more favorable sales position of the exporter implies higher costs due to the double marginalization problem which benefits the local firm. Moreover, even if the local firm adopts an aggressive price-cutting strategy, this will be inconsequential in terms of input prices as is shown by Lemma 1. That is, relaxing the competitive pressure by adopting the strategy of sales expansion will be the most effective way to put an upward pressure on the exporter's costs.

As for a potential exporter, we can show that, when the local firm is a Bertrand rival (committing to a price contract), a potential exporter earns $\pi_f^{B\mathbf{B}} \equiv (1-\sigma^2)(x_f^{B\mathbf{B}})^2$ by committing to a price contract, or $\pi_f^{B\mathbf{C}} \equiv (1-\sigma^2)(x_f^{B\mathbf{C}})^2$ by committing to a quantity contract. We have already established in Propositions 3 and 4, and shown in Figures 1a, 1b and 2a that, while $p_f^{BC} > p_f^{BB}, \forall t < \bar{t}$, committing to a quantity contract earns a potential exporter more profits (because $x_f^{B\mathbf{C}} > x_f^{B\mathbf{B}}$) only if $t > t'''$. Similarly, when the local firm is a Cournot rival (committing to a quantity contract), a potential exporter earns $\pi_f^{C\mathbf{B}} \equiv (x_f^{C\mathbf{B}})^2$ by committing to a price contract, or $\pi_f^{C\mathbf{C}} \equiv (x_f^{C\mathbf{C}})^2$ by committing to a quantity contract. We have already established in Propositions 3 and 5, and shown in Figures 1a, 1b and 2a that, while $p_f^{CB} > p_f^{CC}, \forall t < \bar{t}$, committing to a quantity contract earns a potential exporter more profits (because $x_f^{C\mathbf{C}} > x_f^{C\mathbf{B}}$) only if $t > \tilde{t}'''$. As we have already established in Proposition 6 that the local firm will be a Cournot rival, irrespective of a potential exporter's choice of the strategic variable, the following result shows the equilibrium mode of competition.

Proposition 7. *In equilibrium, strategic asymmetry is observed (such that a Bertrand exporter competes against a Cournot local rival) when the exporter's relative product quality is sufficiently high ($(2u_h/\sigma) < u_f < \overline{u}_f$) and trade costs are sufficiently low ($0 \leq t < \tilde{t}'''$). If, however, $(u_h < u_f < 2u_h/\sigma)$, or if $(2u_h/\sigma) < u_f < \overline{u}_f$ and $\tilde{t}''' < t < \bar{t}$, then both firms will be Cournot rivals setting output.*

Proposition 7 establishes that whenever the exporter's competitive position is sufficiently strong (i.e, when the foreign variety is of sufficiently high quality relative to the local variety and the foreign firm's cost disadvantage due to trade costs is sufficiently low), it will be best for the exporter to opt for a more aggressive strategy by setting prices. This helps alleviate the double marginalization problem due to upstream market power, which decreases production costs by decreasing input prices. It should be noted that, without a sufficiently large quality difference between the foreign and the local varieties (i.e., when $u_h < u_f < 2u_h/\sigma$), $\tilde{t}''' < 0$, and thus for any non-negative (and non-prohibitive) $t < \bar{t}$, the outcome will be Cournot duopoly. That is, a sufficiently large quality difference is needed for strategic asymmetry to arise in this framework. Using the change of this threshold with σ, we can also show that horizontal product differentiation can play a crucial role in determining the scope for strategic asymmetry.

Proposition 8. *Given a sufficiently high quality difference between the two varieties, a lower degree of horizontal product differentiation (a higher σ) can make strategic asymmetry more likely, for a given t.*

With a lower degree of horizontal product differentiation (a higher σ), the threshold $2u_h/\sigma$ gets smaller and $\tilde{t}'''$ increases, and thus a lower quality difference and a higher trade cost would be sufficient to support strategic asymmetry in equilibrium. The intuition is that market entry by a foreign rival with a higher quality product and a small trade cost disadvantage will have a stronger negative impact on the local firm's market share when the products are more closely related (i.e, when σ is higher) leading the upstream monopoly to charge an even higher price for the high-quality inputs. While this would give a greater incentive to the local firm to adopt a pricing strategy to alleviate a weak competitive position in the case of no frictions over high-quality manufactures (as in Gilbert et al., 2020b), this paper shows that it would be no longer the case when there is upstream market power. That is, a greater negative impact on the local firm's sales due to the exporter's better competitive position in the market results in a more severe double marginalization problem giving the exporter's greater incentives to adopt a pricing strategy, while the local firm focuses on a sales expansion strategy.

5 Welfare and trade policy implications

We now turn to an analysis of local welfare and the trade policy implications of our model. As is already shown in Proposition 7, in equilibrium, the mode of competition is either Cournot (which we denote by superscript **CC**) or a Cournot local firm competing against a Bertrand exporter (which we denote by superscript **CB**). Therefore, in this section, we will focus only on these two equilibrium modes of competition. We define local welfare (W) as the sum of consumer surplus (CS) and local profits (π_h):

$$CS^k = U(x_h^k, x_f^k, M) - p_h^k x_h^k - p_f^k x_f^k - M; \quad k \in \{CC, CB\},$$

where $U(x_h^k, x_f^k, M)$ is given in eq. (1), and x_i^k and p_i^k, $k \in \{CC, CB\}$, $i \in \{h, f\}$, are given in eqs. (5), and (15). As might be expected, we can show that upstream market power hurts consumers and benefits the local firm, irrespective of the mode of competition. Comparing profits and consumer surplus in the two cases (**CC** and **CB**) leads to the following Lemma.

Lemma 2. *While* $\pi_h^{CC} > \pi_h^{CB}$ *and* $CS^{CB} > CS^{CC}$, $\forall t < \bar{t}$, $W^{CB} > W^{CC}$, $\forall t < \bar{t}$, *where* $\partial CS^k/\partial c_f < 0$, $k \in \{CC, CB\}$, *and* $\partial[CS^{CB} - CS^{CC}]/\partial t > 0$, $\partial[\pi_h^{CC} - \pi_h^{CB}]/\partial t > 0$, *and* $\partial[W^{CB} - W^{CC}]/\partial t < 0$.

Proof. See Appendix A.5. □

Lemma 2 holds not only for the case of upstream market power, but also for the case of a vertically integrated exporter. We show that consumers (the local firm) prefer a Cournot local firm competing against a Bertrand exporter (Cournot competition), and decreases in trade costs decrease both the difference in consumer surplus and in profits between the two cases and increase the welfare difference between the two cases (making the case of a Bertrand exporter entering the market more attractive from the home country's perspective). This has an important trade policy implication summarized in the following proposition:

Proposition 9. *When both trade costs and the quality index of the high-quality foreign variety is sufficiently high such that* $(2u_h/\sigma) < u_f < \overline{u}_f$ *and* $\tilde{t}''' < t < \bar{t}$*, not only does decreasing trade costs increase welfare, the welfare impact is magnified by leading the exporter to become a Bertrand rival when competing against a Cournot local firm.*

From Proposition 7, we know that the equilibrium mode of competition will be Cournot if $(2u_h/\sigma) < u_f < \overline{u}_f$ and $\tilde{t}''' < t < \bar{t}$. In such a case, while decreasing trade costs will decrease local profits (as local output decreases with a decrease in the exporter's cost disadvantage), Lemma 2 (including the proof in Appendix A.5) has shown that decreasing trade costs will increase consumer surplus by more than the decrease in local profits, and thus welfare will increase under Cournot competition. Once trade costs decrease below $\tilde{t}'''$, Proposition 7 has also shown that in equilibrium, the exporter will adopt a price-cutting strategy to compete against a Cournot rival. We already know from Lemma 2 that $W^{CB} > W^{CC}$, and that $\partial[W^{CB} - W^{CC}]/\partial t < 0$. Note that when the quality index of the high-quality foreign variety is sufficiently low such that $u_h < u_f < (2u_h/\sigma)$, the equilibrium mode of competition will be Cournot for any $t < \bar{t}$ (see Proposition 7), and thus, while decreasing trade costs will still increase welfare (see the proof Lemma 2 in Appendix A.5), there will be no jump to a higher welfare level by a change in the mode of competition. Therefore, to induce pro-competitive effects by a trade policy that helps change the equilibrium mode of competition, a sufficiently high quality index of the exporter's product is required.

6 Endogenous foreign market entry mode

In this section we extend our model to horizontal foreign direct investment (FDI) and allow the foreign firm to choose between exports and FDI to enter the market. We simply add an initial stage to the game where the foreign firm chooses between exports and FDI, and this choice is observed by the local firm. That is, given the foreign firm's market entry mode choice, both firms first procure their inputs, then choose their strategic variable (output or price) to compete in the downstream differentiated product market. We model FDI as duplicating all production stages in a new plant established in a foreign country. Therefore, as in the traditional trade and FDI models, an exporter has to incur trade costs in final goods, whereas a multinational (undertaking FDI) can avoid such costs by paying fixed investment costs and locating a plant in a foreign country.[9] In addition to fixed investment costs (denoted G), given that high-quality inputs (specific to the foreign firm's needs) are available only in foreign (produced by the upstream monopoly), we distinguish between input trade costs and trade costs in final goods. If the foreign firm becomes multinational and undertakes FDI in home, then, in addition to G, it has to incur per-unit input trade costs (denoted τ) to transfer high-quality inputs to its subsidiary in home.

Given this background, it should be clear that, in the case of FDI, we should replace t by τ in all equations given in the previous sections, and we should subtract G from the foreign firm's profits. That is, all our results up to this point hold also for a multinational, so long as we replace t by τ. The main difference will be, however, the endogenous choice of the foreign market entry mode, depending on different constellations of parameter values of the quality difference between the two varieties, input trade costs, trade costs in final goods, and fixed investment costs. In particular, following our result in Proposition 7 (which applies also to a multinational so long as t is replaced by τ), we distinguish between four different cases:

1. If, for any $t < \bar{t} = \bar{\tau}$ and for any $\tau < \bar{\tau}$, $u_h < u_f < (2u_h/\sigma)$, or if $(2u_h/\sigma) < u_f < \overline{u}_f$, and $t > \tilde{t}''' = \tilde{\tau}'''$ and $\tau > \tilde{\tau}'''$, Cournot competition will emerge as the equilibrium mode of competition, irrespective of the foreign firm's entry mode choice. Thus we need to compare $\pi_f^{T,CC}$ with $\pi_f^{FDI,CC}$.

2. If $(2u_h/\sigma) < u_f < \overline{u}_f$, and $t < \tilde{t}''' = \tilde{\tau}'''$ and $\tau < \tilde{\tau}'''$, the foreign firm will choose price to compete against a Cournot local firm, irrespective of the foreign firm's entry mode choice. Thus we need to compare $\pi_f^{T,CB}$ with $\pi_f^{FDI,CB}$.

3. If $(2u_h/\sigma) < u_f < \overline{u}_f$ and $t < \tilde{t}''' = \tilde{\tau}''' < \tau$, an exporter will choose price to compete against a Cournot local firm, whereas a multinational will be a

[9]See Markusen (2002) and Navaretti and Venables (2004), and references therein.

Cournot rival to a Cournot local firm. Thus we need to compare $\pi_f^{T,CB}$ with $\pi_f^{FDI,CC}$.

4. If $(2u_h/\sigma) < u_f < \overline{u}_f$ and $\tau < \tilde{t}''' = \tilde{\tau}''' < t$, an exporter will be a Cournot rival to a Cournot local firm, whereas a multinational will choose price to compete against a Cournot local firm. Thus we need to compare $\pi_f^{T,CC}$ with $\pi_f^{FDI,CB}$.

The following proposition, in which a superscript T and FDI stand for the foreign firm's entry mode, trade and FDI, respectively, summarizes our results on each of the four cases above.

Proposition 10. *In equilibrium, the foreign firm's profits are such that:*

(i) If, for any $t < \bar{t} = \overline{\tau}$ and any $\tau < \overline{\tau}$, $u_h < u_f < (2u_h/\sigma)$, or if $(2u_h/\sigma) < u_f < \overline{u}_f$, and $t > \tilde{t}''' = \tilde{\tau}'''$ and $\tau > \tilde{\tau}'''$, then $\pi_f^{T,CC} > \pi_f^{FDI,CC}$ for any $G \geq 0$, so long as $\tau > t$, or whenever $\tau \leq t$ and $G > G_1$;

(ii) If $(2u_h/\sigma) < u_f < \overline{u}_f$, and $t < \tilde{t}''' = \tilde{\tau}'''$ and $\tau < \tilde{\tau}'''$, then $\pi_f^{T,CB} > \pi_f^{FDI,CB}$ for any $G \geq 0$, so long as $\tau > t$, or whenever $\tau \leq t$ and $G > G_2$;

(iii) If $(2u_h/\sigma) < u_f < \overline{u}_f$ and $\tau < \tilde{t}''' = \tilde{\tau}''' < t$, then $\pi_f^{T,CC} > \pi_f^{FDI,CB}$ only if $G > G_3$;

(iv) If $(2u_h/\sigma) < u_f < \overline{u}_f$ and $t < \tilde{t}''' = \tilde{\tau}''' < \tau$, then $\pi_f^{T,CB} > \pi_f^{FDI,CC}$ for any $G \geq 0$.

Proof. See Appendix A.6. □

We illustrate Proposition 10 in Figure 3, where non-prohibitive input trade costs are drawn on the vertical axis and non-prohibitive trade costs in final goods are drawn on the horizontal axis.

In Figure 3, the equilibrium market entry and competition modes are illustrated for a sufficiently high quality index of the high-quality foreign variety such that $(2u_h/\sigma) < u_f < \overline{u}_f$. If we were to treat trade costs t and τ as physical costs, then empirically the most relevant case would be $t > \tau$ (the area below the 45-degree line) as shipping inputs is less costly than shipping final goods (each larger in size and heavier in weight as compared to inputs). In such a case, the most interesting case is where $\tau < \tilde{t}''' = \tilde{\tau}''' < t$ (the blue-colored area) such that not only does the size of fixed investment costs imply a different market entry mode (as in the standard proximity-concentration trade-off) but also a different mode of

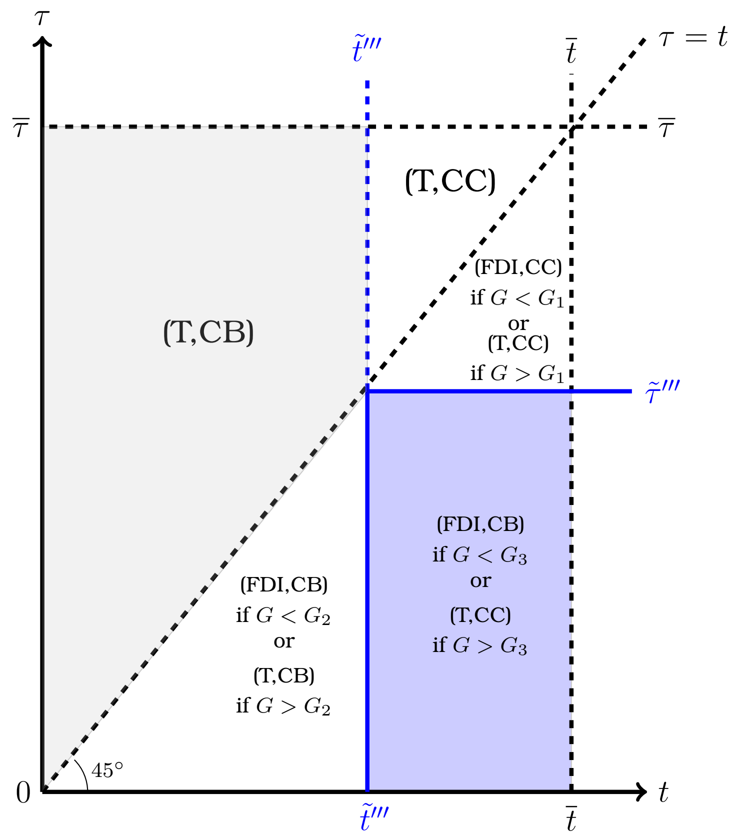


Figure 3: Equilibrium market entry and competition modes

competition. This leads us to the following interesting implication of Proposition 10.

Corollary 2. *Decreasing fixed investment costs can lead the foreign firm to become a Bertrand multinational (instead of a Cournot exporter) to compete against a Cournot local rival, especially when* $(2u_h/\sigma) < u_f < \overline{u}_f$ *and* $\tau < \tilde{t}''' = \tilde{\tau}''' < t$.

Notice that without the possibility of FDI, the equilibrium mode of competition will be Cournot, that is, the availability of FDI to the foreign firm makes asymmetric strategies more likely.

7 Concluding remarks

This paper contributes to the emerging trade literature on endogenous mode of competition under vertical product differentiation. Following the anecdotal evidence from several industries on the use of asymmetric strategies by firms in product markets, Gilbert et al. (2020a) show that analyzing asymmetric choices in strategic variables in the context of international trade is important, and Gilbert et al. (2020b) show that such strategic asymmetry can be observed when the quality of local and foreign varieties are sufficiently different. Moreover, following the empirical trade literature documenting significant evidence that exporting firms tend to procure higher-quality inputs and produce higher quality products, we have developed a differentiated duopoly trade model with both horizontal and vertical product differentiation that also features frictions over manufacturing high quality. Given the observation that the share of differentiated and customized input trade in world trade has increased substantially, we have modeled such frictions by upstream market power and analyzed the implications for the endogenous mode of downstream competition and for different policy tools.

Our results suggest that when high-quality exports are manufactured under large frictions due to upstream monopoly power, the exporter can have an incentive to become a Bertrand competitor against a Cournot rival. Such strategic asymmetry will be an equilibrium outcome especially when the exporter has a favorable competitive position in terms of sales in the product market (i.e., when the relative product quality of the foreign variety is sufficiently high and trade costs are sufficiently low). The reason is that a favorable sales position of the exporter in our model also implies higher input price distortions due to double marginalization. Thus, as manufacturing high-quality exports becomes more costly, the exporter behaves more aggressively by choosing prices over quantities. We also show that such strategic asymmetry would be welfare improving and can be achieved by employing trade policy, so long as the quality difference between the local and foreign varieties is sufficiently large. Moreover, we have extended the model to FDI and shown that the availability of FDI would make such strategic asymmetry more likely, especially when investment policy tools are employed to decrease fixed investment costs.

Our model can also be interpreted differently so as to discuss the implications for industrial policy. In particular, trade costs generate a wedge in productivity between a foreign and a local firm. In the case of domestic firms only, this would be qualitatively equivalent to heterogeneity in competitive advantages among local firms producing different quality goods. By the same token, the choice between FDI and exports can be recast as a potential technology upgrading problem that requires fixed costs. Thus, the arguments in Sections 5 and 6 in regards to trade and investment policies can also be applied to industrial policy.

Appendix

A.1 Proof of Proposition 2

For the high-quality foreign variety, comparing p_f^{CC} given in eq. (5) to p_f^{BB} given in eq. (9), we can show that $(p_f^{BB} - p_f^{CC}) = -\sigma^2(2(2-\sigma^2)(u_f - t) + \sigma(4-\sigma^2)u_h)/4(4-\sigma^2)(2-\sigma^2) < 0$ and that $\partial(p_f^{BB} - p_f^{CC})/\partial u_i < 0$, $i \in \{h, f\}$, and $\partial(p_f^{BB} - p_f^{CC})/\partial t > 0$. As for the price of the low-quality local variety, comparing p_h^{CC} given in eq. (5) to p_h^{BB} given in eq. (9), we can show that $(p_h^{BB} - p_h^{CC}) = -\sigma^2(8 - 3\sigma^2)u_h/4(8 - 6\sigma^2 + \sigma^4) < 0$, and that $\partial(p_h^{BB} - p_h^{CC})/\partial u_h < 0$. We can also compare x_f^{CC} given in eq. (5) to x_f^{BB} given in eq. (9), and show that $(x_f^{BB} - x_f^{CC}) = \sigma^2(u_f - \sigma u_h - t)/2(4 - 5\sigma^2 + \sigma^4)$, which is positive for $t < t' = u_f - \sigma u_h$, or negative for $t > t'$. As for the low-quality local variety, comparing x_h^{CC} given in eq. (5) to x_h^{BB} given in eq. (9), we can show that $\partial(x_h^{BB} - x_h^{CC})/\partial t > 0$ and $(x_h^{BB} - x_h^{CC}) = 0$ at $t = t'' = u_f - u'_f$, where $u'_f = (8 - 7\sigma^2 + \sigma^4)u_h/2\sigma(2 - \sigma^2)$. That is, for the low-quality local variety, $(x_h^{BB} - x_h^{CC}) > 0$ if $u_f < u'_f$ (so for any $t < \bar{t}$, $t > t''$), or if $u_f > u'_f$ and $t > t''$. Otherwise, $(x_h^{BB} - x_h^{CC}) < 0$.

A.2 Proof of Proposition 3

For the high-quality foreign variety, comparing p_f^{CC} given in eq. (5) to p_f^{BC} given in eq. (14), we can show that $(p_f^{CC} - p_f^{BC}) = \sigma^2(2-\sigma^2)(2u_f - \sigma u_h - 2t)/(32 - 32\sigma^2 + 6\sigma^4) > 0$. As for the low-quality local variety, comparing p_h^{CC} given in eq. (5) to p_h^{BC} given in eq. (14), we can show that $(p_h^{CC} - p_h^{BC}) = \sigma^3(2u_f - \sigma u_h - 2t)/(32 - 32\sigma^2 + 6\sigma^4) > 0$. Similarly, for each variety, comparing p_i^{CC} given in eq. (5) to p_i^{CB} given in eq. (15), $i \in \{h, f\}$, we can show that $\partial(p_i^{CC} - p_i^{CB})/\partial t > 0$ and that $(p_i^{CC} - p_i^{CB}) = 0$ at a negative trade cost threshold (given $u_f < \overline{u}_f$). Thus, for any $t \geq 0$, $(p_i^{CC} - p_i^{CB}) > 0$, $i \in \{h, f\}$.

Also for each variety, comparing p_i^{BB} given in eq. (9) to p_i^{BC} given in eq. (14), $i \in \{h, f\}$, we can show that $\partial(p_i^{BB} - p_i^{BC})/\partial t < 0$ and that $(p_i^{BB} - p_i^{BC}) = 0$ at a negative trade cost threshold (given $u_f < \overline{u}_f$). Thus, for any $t \geq 0$, $(p_i^{BB} - p_i^{BC}) < 0$,

$i \in \{h, f\}$. Similarly, for each variety, comparing p_i^{BB} given in eq. (9) to p_i^{CB} given in eq. (15), $i \in \{h, f\}$, we can show that $\partial(p_i^{BB} - p_i^{CB})/\partial t > 0$ and that $(p_i^{BB} - p_i^{CB}) = 0$ at $t = \bar{t}$. Thus, for any $t < \bar{t}$, $(p_i^{BB} - p_i^{CB}) < 0$, $i \in \{h, f\}$. This completes the proof of the first part of Proposition 3.

As for the proof of the second (itemized) part, comparing p_f^{BC} given in eq. (14) to p_f^{CB} given in eq. (15), we can show that $\partial(p_f^{BC} - p_f^{CB})/\partial t > 0$ and that $(p_f^{BC} - p_f^{CB}) = 0$ at $t = \tilde{t} \equiv u_f - \sigma(8 - 5\sigma^2)u_h/2(2 - \sigma^2) < \bar{t}$. For values $\sigma > 0.52$, $\tilde{t} > 0$ for any $u_h < u_f < \overline{u}_f$. Thus, for $\sigma > 0.52$, $(p_f^{BC} - p_f^{CB}) > 0$ if $t > \tilde{t}$, or $(p_f^{BC} - p_f^{CB}) < 0$ if $t < \tilde{t}$. As for values $\sigma > 0.52$, $\tilde{t} < 0$ if $u_f < u_f'' \equiv \sigma(8 - 5\sigma^2)u_h/2(2 - \sigma^2)$, or $\tilde{t} > 0$ if $u_f > u_f''$. Thus, for any given $\sigma > 0.52$, $(p_f^{BC} - p_f^{CB}) > 0$ if $u_f < u_f''$, or if $u_f > u_f''$ and $t > \tilde{t}$. If, however, $u_f > u_f''$ and $t < \tilde{t}$, then $(p_f^{BC} - p_f^{CB}) < 0$. For the low-quality local variety, comparing p_h^{BC} given in eq. (14) to p_h^{CB} given in eq. (15), we can show that $\partial(p_h^{BC} - p_h^{CB})/\partial t > 0$ and that $(p_h^{BC} - p_h^{CB}) = 0$ at $t = \tilde{t}' \equiv u_f - (8 - 5\sigma^2)u_h/2\sigma(2 - \sigma^2) < \bar{t}$. It is clear that $\tilde{t}' < 0$ if $u_f < u_f''' \equiv (8 - 5\sigma^2)u_h/2\sigma(2 - \sigma^2)$, or $\tilde{t}' > 0$ if $u_f > u_f'''$. Hence, $(p_h^{BC} - p_h^{CB}) > 0$ if $u_f < u_f'''$, or if $u_f > u_f'''$ and $t > \tilde{t}'$. If, however, $u_f > u_f'''$ and $t < \tilde{t}'$, then $(p_h^{BC} - p_h^{CB}) < 0$.

A.3 Proof of Proposition 4

For the high-quality foreign variety, comparing x_f^{CC} given in eq. (5) to x_f^{BC} given in eq. (14), we can show that $(x_f^{BC} - x_f^{CC}) = \sigma^2(2u_f - \sigma u_h - 2t)/(4 - \sigma^2)(4 - 3\sigma^2) > 0$. As for the low-quality local variety, comparing x_h^{CC} given in eq. (5) to x_h^{BC} given in eq. (14), we can show that $(x_h^{CC} - x_h^{BC}) = -\sigma^3(2u_f - \sigma u_h - 2t)/(32 - 32\sigma^2 + 6\sigma^4) < 0$. Similarly, comparing x_f^{BB} given in eq. (9) to x_f^{BC} given in eq. (14), we can show that $\partial(x_f^{BC} - x_f^{BB})/\partial t > 0$ and that $(x_f^{BC} - x_f^{BB}) = 0$ at $t = t''' \equiv u_f - ((2 - \sigma^2)u_h/\sigma)$. It is clear that $t''' < 0$ if $u_f < ((2 - \sigma^2)u_h/\sigma)$, or $t''' > 0$ if $u_f > ((2 - \sigma^2)u_h/\sigma)$. Hence, $(x_f^{BC} - x_f^{BB}) > 0$ if $u_f < ((2 - \sigma^2)u_h/\sigma)$, or if $u_f > ((2 - \sigma^2)u_h/\sigma)$ and $t > t'''$. If, however, $u_f > ((2 - \sigma^2)u_h/\sigma)$ and $t < t'''$, then $(x_f^{BC} - x_f^{BB}) < 0$. As for the low-quality local variety, comparing x_h^{BB} given in eq. (9) to x_h^{BC} given in eq. (14), we can show that $\partial(x_h^{BC} - x_h^{BB})/\partial t < 0$ and that $(x_h^{BC} - x_h^{BB}) = 0$ at $t = \hat{t} \equiv u_f - \hat{u}_f$ where $\hat{u}_f \equiv (32 - 56\sigma^2 + 31\sigma^4 - 5\sigma^6)u_h/2\sigma(2 - \sigma^2)^2$. Note that $\hat{u}_f$ is only slightly below the permissible threshold ($\overline{u}_f$). Nevertheless $\hat{t} < 0$ if $u_f < \hat{u}_f$, or $\hat{t} > 0$ if $u_f > \hat{u}_f$. Hence, $(x_h^{BC} - x_h^{BB}) < 0$ if $u_f < \hat{u}_f$, or if $u_f > \hat{u}_f$ and $t > \hat{t}$. If, however, $u_f > \hat{u}_f$ and $t < \hat{t}$, then $(x_h^{BC} - x_h^{BB}) > 0$.

A.4 Proof of Proposition 5

For the high-quality foreign variety, comparing x_f^{CC} given in eq. (5) to x_f^{CB} given in eq. (15), we can show that $\partial(x_f^{CB} - x_f^{CC})/\partial t < 0$ and that $(x_f^{CB} - x_f^{CC}) = 0$ at $t = \tilde{t}''' \equiv u_f - (2u_h/\sigma)$. It is clear that $\tilde{t}''' < 0$ if $u_f < (2u_h/\sigma)$, or $\tilde{t}''' > 0$ if $u_f > (2u_h/\sigma)$. Thus, for any $t \geq 0$, $(x_f^{CB} - x_f^{CC}) < 0$ if $u_f < (2u_h/\sigma)$, or if $u_f > (2u_h/\sigma)$ and $t > \tilde{t}'''$. If, however, $u_f > (2u_h/\sigma)$ and $t < \tilde{t}'''$, then $(x_f^{CB} - x_f^{CC}) > 0$. As for the low-quality local variety,comparing x_h^{CC} given in eq. (5) to x_h^{CB} given in eq. (15), we can show that $\partial(x_h^{CB} - x_h^{CC})/\partial t > 0$ and that $(x_h^{CB} - x_h^{CC}) = 0$ at a negative trade cost threshold (given $u_f < \overline{u}_f$), and thus for any $t < \bar{t}$, $(x_h^{CB} - x_h^{CC}) > 0$. Also comparing x_f^{BB} given in eq. (9) to x_f^{CB} given in eq. (15), we can show that $\partial(x_f^{CB} - x_f^{BB})/\partial t > 0$ and that $(x_f^{CB} - x_f^{BB}) = 0$ at $t = \bar{t}$, and thus for any $0 \leq t < \bar{t}$, $(x_f^{CB} - x_f^{BB}) < 0$. Similarly, for the low-quality local variety, comparing x_h^{BB} given in eq. (9) to x_h^{CB} given in eq. (15), we can show that $\partial(x_h^{CB} - x_h^{BB})/\partial t < 0$ and that $(x_h^{CB} - x_h^{BB}) = 0$ at $t = \bar{t}$, and thus for any $0 \leq t < \bar{t}$, $(x_h^{CB} - x_h^{BB}) > 0$

A.5 Proof of Lemma 2

The following inequalities hold $\partial[CS^{CC} - CS^{CB}]/\partial t < 0$, $\lim_{t \to \bar{t}}[CS^{CC} - CS^{CB}] < 0$, $\partial[\lim_{t \to 0}[CS^{CC} - CS^{CB}]]/\partial u_f > 0$ and $\lim_{u_f \to \overline{u}_f}[\lim_{t \to 0}[CS^{CC} - CS^{CB}]] < 0$ (and thus $\lim_{t \to 0}[CS^{CC} - CS^{CB}] < 0$), and are sufficient to complete the proof of $CS^{CB} > CS^{CC}$. Similarly, the following inequalities hold $\partial[\pi_h^{CC} - \pi_h^{CB}]/\partial t > 0$, $\lim_{t \to \bar{t}}[\pi_h^{CC} - \pi_h^{CB}] > 0$, $\partial[\lim_{t \to 0}[\pi_h^{CC} - \pi_h^{CB}]]/\partial u_f < 0$ and $\lim_{u_f \to u_h}[\lim_{t \to 0}[\pi_h^{CC} - \pi_h^{CB}]] > 0$, $\lim_{u_f \to \overline{u}_f}[\lim_{t \to 0}[\pi_h^{CC} - \pi_h^{CB}]] > 0$ (and thus $\lim_{t \to 0}[\pi_h^{CC} - \pi_h^{CB}] > 0$), and are sufficient to complete the proof of $\pi_h^{CC} > \pi_h^{CB}$. As for local welfare, we can show that $\partial W^{CC}/\partial t < 0$, $\forall t < \bar{t}$ and $\forall u_h < u_f < \overline{u}_f$, whereas $\partial W^{CB}/\partial t > 0$ if $u_f < \sigma(12 - 7\sigma^2)u_h/(8 - 6\sigma^2 + \sigma^4)$ (which requires $\sigma > 0.627$, or if $u_f > \sigma(12-7\sigma^2)u_h/(8-6\sigma^2+\sigma^4)$ and $t > u_f - \sigma(12-7\sigma^2)u_h/(8-6\sigma^2+\sigma^4)$; otherwise $\partial W^{CB}/\partial t < 0$. Note that $\partial W^{CB}/\partial t = 0$ at $t = u_f - \sigma(12-7\sigma^2)u_h/(8-6\sigma^2+\sigma^4)$, and that $\partial^2 W^{CB}/\partial t^2 > 0$. Also we can show that $\partial[W^{CB} - W^{CC}]/\partial t$ equals zero at a negative trade cost threshold, and that $\partial^2[W^{CB} - W^{CC}]/\partial t^2 < 0$ implying that, for any $0 \geq t < \bar{t}$, $\partial[W^{CB} - W^{CC}]/\partial t < 0$. Given this welfare difference is negatively related with t and $\lim_{t \to \bar{t}}[W^{CB} - W^{CC}] > 0$, we can conclude that $W^{CB} > W^{CC}$, $\forall t < \bar{t}$.

A.6 Proof of Proposition 10

To prove (i), we can show that $\pi_f^{T,CC} - \pi_f^{FDI,CC} = G - G_1$ where

$$G_1 = \frac{(t-\tau)(2u_f - \sigma u_h - (t+\tau))}{(4-\sigma^2)^2}.$$

Notice that $G_1 > 0$ only for $t > \tau$.

To prove (ii), we can show that $\pi_f^{T,CB} - \pi_f^{FDI,CB} = G - G_2$ where

$$G_2 = \frac{(2-\sigma^2)(t-\tau)((2-\sigma^2)(2u_f - (t+\tau)) - 2\sigma u_h)}{4(4-3\sigma^2)^2}.$$

Notice that $G_2 > 0$ only for $t > \tau$.

For (iii), we can show that $\pi_f^{T,CC} - \pi_f^{FDI,CB} = G - G_3$ where

$$G_3 = \frac{1}{4\left(16-16\sigma^2+3\sigma^4\right)^2}\left[\sigma^4\left(u_f - \frac{2u_h}{\sigma} - \tau\right) + \left(8-6\sigma^2\right)(t-\tau)\right] \\ \left[(16-12\sigma^2+\sigma^4)\left(u_f - \frac{4\sigma(2-\sigma^2)u_h}{16-12\sigma^2+\sigma^4}\right) - (8-6\sigma^2+\sigma^4)\tau - \left(8-6\sigma^2\right)t\right].$$

This case requires $(2u_h/\sigma) < u_f$ and $\tau < u_f - (2u_h/\sigma) < t < \bar{t}$ implying both the first and the second expressions in square-brackets are positive, and thus $G_3 > 0$.

Finally, to prove (iv), we can show that $\pi_f^{T,CB} - \pi_f^{FDI,CC} = G - G_4$ where

$$G_4 = \frac{1}{4\left(16-16\sigma^2+3\sigma^4\right)^2}\left[\sigma^4\left(u_f - \frac{2u_h}{\sigma} - t\right) + \left(8-6\sigma^2\right)(\tau-t)\right] \\ \left[(8-6\sigma^2)\tau + (8-6\sigma^2+\sigma^4)t - (16-12\sigma^2+\sigma^4)\left(u_f - \frac{4\sigma(2-\sigma^2)u_h}{16-12\sigma^2+\sigma^4}\right)\right]$$

This case requires $(2u_h/\sigma) < u_f$ and $t < u_f - (2u_h/\sigma) < \tau < \bar{t}$ implying the first expression in square-brackets is positive, whereas the second expression in square-brackets is negative, and thus $G_4 < 0$.

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