

Foreign Market Entry, Upstream Market Power, and Endogenous Mode of Downstream Competition

John Gilbert

Department of Economics & Finance
Utah State University

Onur A. Koska^{*†}

Department of Economics & Finance
University of Canterbury

Reza Oladi

Department of Applied Economics
Utah State University

Abstract

In a differentiated duopoly model of trade and FDI featuring both horizontal and vertical product differentiation, we examine whether globalization and trade policy measures can generate welfare gains by leading firms to change their mode of competition. We show that when a high-quality foreign variety is manufactured under large frictions due to upstream monopoly power, a foreign firm 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). Our results suggest that such strategic asymmetry is welfare improving and that the availability of FDI as an alternative to trade can make welfare-enhancing 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.

JEL: D43; F12; L13

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

*Correspondence address: University of Canterbury, Department of Economics and Finance, Private Bag 4800, Christchurch 8140 New Zealand. Email: onur.koska@canterbury.ac.nz

†Earlier versions of this paper were distributed under the title "International Trade, Upstream Market Power, and Endogenous Mode of Downstream Competition". We are grateful for very useful comments and suggestions from seminar and conference participants.

1 Introduction

Can globalization and trade policy measures generate welfare gains by leading firms to change their mode of competition? We address this novel and interesting question using a differentiated duopoly model of trade and foreign direct investment (FDI) with both horizontal and vertical product differentiation. Our focus is on quality inputs that are highly customized according to the needs of a downstream foreign firm (either an exporter or a multinational). A high-quality foreign variety requires high-quality inputs, which are supplied by an upstream monopoly, and thus are costly due to double marginalization. Relative product quality, product substitutability, trade, and fixed investment costs determine not only the foreign firm's market entry mode and competitive position in terms of sales in the downstream product market (as in the related literature on trade and FDI), but also how much high-quality input prices will be distorted by the upstream monopoly. In contrast to the related literature on foreign market entry and strategic asymmetry which we discuss below, we show that when a high-quality foreign variety is manufactured under large frictions due to upstream monopoly power, the foreign firm (rather than the local firm) can have an incentive to become a Bertrand competitor against a Cournot rival. Such strategic asymmetry can be an equilibrium outcome when the foreign firm 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 foreign firm in our model also implies higher input price distortions due to double marginalization. Thus, as manufacturing the high-quality foreign variety becomes more costly, the foreign firm behaves more aggressively by choosing prices over quantities.

We show that strategic asymmetry increases consumer surplus by more than the decrease in local profits, and thus welfare improves in this case. Our results confirm that strategic asymmetry has potentially important implications for trade policy and for the welfare implications of globalization, in that decreasing trade costs not only increases welfare for a given optimal mode of competition, but can also 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 even higher. By extending the analysis to endogenous foreign market entry modes (trade versus FDI), we show that the availability of FDI as an alternative foreign market entry mode can make welfare-enhancing 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.

[Maggi \(1996\)](#) notes that adopting asymmetric strategies is applicable in the context of international trade. Given the lack of firm-level data, it is difficult to construct a direct

measure on the competitive strategy.¹ This, however, does not imply a lack of evidence on strategic asymmetry. On the contrary, several studies have already provided evidence (each different in nature) that can be used to infer that firms competing in asymmetric strategies (i.e., price versus output) is far more prevalent than the theoretical literature's focus on strategic symmetry would suggest.² Flath (2012), for example, looks at variations in industry price-cost margins with temporal changes in the Herfindahl index using annual Japanese data for 1961-1990, and finds that, of the 70 four-digit SIC manufacturing sectors, 43% were a hybrid of Cournot and Bertrand. Looking at the frequency with which firms adjust prices can also provide us with indirect evidence, especially at the firm level. The evidence on the frequency of price changes by firms suggests that (i) price-setting responds asymmetrically to cost and demand changes, and the frequency significantly varies among firms (Fabiani et al., 2007); (ii) small firms change prices less frequently than medium-sized firms, which change prices less frequently than large firms (Coleman and Silverstone, 2007); and (iii) firms in the trade sector review prices more frequently than domestic firms (Parker, 2014). Strategic complementarity in prices appears to be the commonly cited reason for firms against frequent price changes, as they fear that following an own-price change, rivals may not follow suit (Blinder, 1991; Parker, 2014). For exporters, Donnenfeld and Zilcha (1991) argue that pricing exports in the importer's currency implies a precommitment in the price for both domestic and foreign sales, whereas invoicing exports in the exporters currency does not imply such a precommitment. In the terminology of Klemperer and Meyer (1986), pricing exports in the importer's currency and a commitment to satisfy demand at the prevailing price in the local currency determined by the exchange rate is equivalent to competing in quantities. The literature reports significant cross-country differences in the currency denomination of contracts of exporters and importers.³

The IO literature on strategic asymmetry shows that various factors, ranging from institutional asymmetry to contract-switching costs and delays, may lead firms to adopt asymmetric strategies.⁴ While this literature is predominantly focused on homogeneous

¹Ideal data that can be used to construct a direct measure on the competitive strategy would contain information not only on firm-level output, but also on competitor profits so as to measure marginal profit changes with output; see Sundaram et al. (1996) for further discussions.

²There is, for example, anecdotal evidence that supports asymmetric strategic choices of firms. As is observed by Tremblay and Tremblay (2005), in the U.S. markets for beer and distilled spirits, for example, the leading imported-brand, Heineken, competes in output, while Budweiser historically has been adopting price-setting behavior. Such asymmetric strategies have been observed also among exporters of mass-produced versus custom-made goods (Schroeder and Tremblay, 2015; Schroeder and Tremblay, 2016), as well as in the market for small cars and in the aerospace connector industry in the United States (Tremblay and Tremblay, 2011), and in the Japanese home electronics industry (Sato, 1996). See, Gilbert et al. (2022) for further details on the anecdotal and indirect evidence reported by the literature.

³See Grassman (1973) for evidence on invoicing practices of exporters in the context of bilateral trade between Sweden and the U.S.; Magee (1974) on the currency of denomination of contracts of Japanese and German exporting firms to the U.S.; Page (1977) and Carse et al. (1980) on invoicing practices of British exporters; and Van Nieuwkerk (1979) on invoicing practices of Dutch exports and imports.

⁴See, for example, Sato (1996), Tremblay and Tremblay (2011), Schroeder and Tremblay (2015), Schroeder

goods or horizontal product differentiation, there is a small emerging literature on endogenous mode of competition 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 an equilibrium. Foreign market entry modes and the corresponding welfare implications are, however, not considered. [Gilbert et al. \(2022\)](#) have demonstrated that analyzing asymmetric choices in strategic variables in the context of international trade is important. By the same token, [Gilbert et al. \(2020\)](#) 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, the exporter and the upstream supplier is vertically integrated from the outset, and thus there is no friction over high-quality manufactures, nor is there a formal analysis of endogenously determined foreign market entry modes and their welfare implications. They find that while sales expansion is an 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.

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 documents significant evidence that exporting firms tend to procure higher-quality inputs and produce higher quality products.⁵ 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 our main empirical motivation for explicitly modeling product quality differentiation and upstream market power in this paper.

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 welfare and policy implications. In Section 6, we introduce FDI as an alternative foreign market entry mode and solve the model for both the equilibrium mode of market entry and the competition modes. In Section 7 we offer some concluding remarks. For convenience, the proofs are relegated to the Appendix.

and Tremblay (2016), and [Chao et al. \(2018\)](#) and the recent survey by [Tremblay and Tremblay \(2019\)](#).

⁵See, for example, [Hallak and Sivadasan \(2013\)](#), [Kugler and Verhoogen \(2012\)](#), and [Manova and Zhang \(2012\)](#).

2 The model

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.⁶ 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).⁷ 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 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 via exports.

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

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

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 is required for stability in the final goods market - implying that the goods are substitutes.⁸ 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

⁶For discussions of the empirical relevance of modeling an asymmetric upstream industry structure, see [Koska \(2020\)](#).

⁷High-quality inputs produced by the upstream monopoly are highly customized according to the needs of the downstream exporter, whose exports to home shall be regarded as country specific: its production for another country (other than home) do not affect the price of this specific input.

⁸Each 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 $\sigma = 1$. We require $\sigma \in (0, 0.78)$ for stability of the equilibrium in the case of asymmetric strategies, such that $|\partial^2 \pi_i / (\partial s_i)^2| > |\partial^2 \pi_i / \partial s_i \partial s_j|$, $i \neq j \in \{h, f\}$, where s_i and s_j are, respectively, each firm's strategic variable; see [Tremblay and Tremblay \(2011\)](#) for further details.

product quality.⁹ 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 foreign firm makes the market entry decision. In the second stage, both firms procure their inputs to produce their varieties. In the third stage, the local firm and the exporter 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 backwards.

3 Upstream behavior and downstream competition

In the last stage of the game the local firm and the exporter compete in the differentiated downstream product market. The two firms' choices of their strategic variables and the 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, $\pi_i = (p_i(x_i, x_j) - c_i)x_i$,

⁹An increase in u_i increases the marginal utility of good $i = \{h, f\}$, ceteris paribus.

$i \neq j \in \{h, f\}$. 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:

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

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

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

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

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

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:

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

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:

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

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:

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

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 $\pi_i^* = (1 - \sigma^2)(x_i^*)^2$. Recalling again 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

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

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:

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

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 Cournot 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 [Lemma 1](#) and [Corollary 1](#).

Lemma 1. *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 [Lemma 1](#) 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 [Lemma 1](#) 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 degree of horizontal 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:

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

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

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

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

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

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). Again, $c_h = 0$ 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

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

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

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

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 than 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 2. *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:

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

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:

$$\begin{aligned} p_f^{CB} &= \frac{(3 - 2\sigma^2)((2 - \sigma^2)u_f - \sigma u_h) + (2 - \sigma^2)(1 - \sigma^2)t}{(4 - 3\sigma^2)(2 - \sigma^2)}; & x_f^{CB} &= \frac{(2 - \sigma^2)(u_f - t) - \sigma u_h}{2(4 - 3\sigma^2)}; \\ p_h^{CB} &= (1 - \sigma^2) \frac{(8 - 5\sigma^2)u_h - \sigma(2 - \sigma^2)(u_f - t)}{2(4 - 3\sigma^2)(2 - \sigma^2)}; & x_h^{CB} &= \frac{(8 - 5\sigma^2)u_h - \sigma(2 - \sigma^2)(u_f - t)}{2(4 - 3\sigma^2)(2 - \sigma^2)}, \end{aligned} \quad (15)$$

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 $u_h < u_f < \bar{u}_f = (8 - 9\sigma^2 + 2\sigma^4)u_h/\sigma(2 - \sigma^2)$. 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, leads to the following result:

Lemma 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 □

Lemma 3 shows 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:

Lemma 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:

Lemma 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. □

Lemmas 4 and 5 show 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, 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 trade costs, the low-quality local variety sells more under Bertrand than under Cournot competition, whereas for sufficiently low trade costs, this is reversed.

4 Equilibrium mode of competition

In this section we consider the two firm's optimal choice of the strategic variables. Recall that firm f (the exporter) has a cost disadvantage not only due to trade costs, but also due to frictions over manufacturing a high-quality good (due to upstream market power over high-quality inputs required for manufacturing the in that 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 2 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 $\pi_h^{BB} \equiv (1 - \sigma^2)(x_h^{BB})^2$ by committing to a price contract, or $\pi_h^{CB} \equiv (1 - \sigma^2)(x_h^{CB})^2$ by committing to a quantity contract. We have already established in Lemmas 3 and 5 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 $\pi_h^{BC} \equiv (x_h^{BC})^2$ by committing to a price contract, or $\pi_h^{CC} \equiv (x_h^{CC})^2$ by committing to a quantity contract. We have already established in Lemmas 3 and 4 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 2. *Irrespective of a potential exporter's strategic choice, the local rival always prefers to compete by quantities.*

Proposition 2 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. (2020), 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. Even if the local firm adopts an aggressive price-cutting strategy, this will be inconsequential in terms of input prices (see Lemma 2). Thus relaxing the competitive pressure by adopting the strategy of sales expansion will be the most effective way to put upward pressure on the exporter's costs.

We can show that, when the local firm is a Bertrand rival (committing to a price contract), an exporter earns $\pi_f^{BB} \equiv (1 - \sigma^2)(x_f^{BB})^2$ by committing to a price contract, or $\pi_f^{BC} \equiv (1 - \sigma^2)(x_f^{BC})^2$ by committing to a quantity contract. We have already established in Lemmas 3 and 4 that, while $p_f^{BC} > p_f^{BB}, \forall t < \bar{t}$, committing to a quantity contract earns a potential exporter more profits (because $x_f^{BC} > x_f^{BB}$) only if $t > \tilde{t}'''$. Similarly, when the local firm is a Cournot rival (committing to a quantity contract), an exporter earns $\pi_f^{CB} \equiv (x_f^{CB})^2$ by committing to a price contract, or $\pi_f^{CC} \equiv (x_f^{CC})^2$ by committing to a quantity contract. We have already established in Lemmas 3 and 5 that, while $p_f^{CB} > p_f^{CC}, \forall t < \bar{t}$, committing to a quantity contract earns a potential exporter more profits (because $x_f^{CC} > x_f^{CB}$) only if $t > \tilde{t}'''$. As we have already established in Proposition 2 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 3. *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 ($(2u_h/\sigma) < u_f < \bar{u}_f$) and trade costs are sufficiently low ($0 \leq t < \tilde{t}'''$). If, however, $(u_h < u_f < 2u_h/\sigma)$, or if $(2u_h/\sigma) < u_f < \bar{u}_f$ and $\tilde{t}''' < t < \bar{t}$, then both firms will be Cournot rivals setting output.*

Proposition 3 establishes that whenever 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 $t < \bar{t}$, 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 the following result holds.

Proposition 4. *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., 2020](#)), this paper shows that it would no longer be 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.

Before we examine welfare and trade policy implications of the model in the next section, we discuss here how the result in Proposition 3 can be related to the empirical evidence discussed in Section 1.¹⁰ In particular, [Coleman and Silverstone \(2007\)](#) and [Parker \(2014\)](#) show that larger firms and exporting firms tend to review prices more frequently than smaller and domestic firms. We can compare foreign and local firm size (i.e., foreign and local output given in eq.(15)) so as to see whether the model's prediction on firm size in equilibrium is consistent with this empirical evidence. We denote by Δ_f^h the difference between foreign and local output given in eq.(15), such that $\Delta_f^h = x_f^{CB} - x_h^{CB}$, and show that $\partial\Delta_f^h/\partial t < 0$ and $\partial^2\Delta_f^h/\partial t\partial\sigma < 0$. Also we can show that $\Delta_f^h = 0$ at $t = \hat{t}'$, and that $\Delta_f^h \geq 0$ for $0 \leq t \leq \hat{t}'$, or $\Delta_f^h < 0$ for $\hat{t}' < t < \bar{t}$.¹¹ As is clear from Proposition 3, strategic asymmetry (in the form of a Bertrand exporter competing against a Cournot local rival) emerges as the equilibrium competition mode when the exporter's relative product quality is sufficiently high ($u_f > (2u_h/\sigma)$) and trade costs are sufficiently low ($0 \leq t < \tilde{t}'''$). Clearly, at $u_f > (2u_h/\sigma)$, $0 < \tilde{t}''' < \hat{t}'$, that is, for all the parameter values for which Bertrand exporter competes against a Cournot local rival in equilibrium, the exporter's output is greater than local output, which is in concordance with the empirical evidence discussed in Section 1.¹²

¹⁰We thank the referee for pointing out this helpful connection.

¹¹It is straightforward to show that $\hat{t}' = u_f - ((8 + \sigma(2 - \sigma(5 + \sigma)))u_h / (2 - \sigma)(1 + \sigma)(2 - \sigma^2)) > 0$ so long as $u_f > ((8 + \sigma(2 - \sigma(5 + \sigma)))u_h / (2 - \sigma)(1 + \sigma)(2 - \sigma^2))$, and is below the permissible upper bound $\bar{t} = u_f - ((2 - \sigma^2)u_h / \sigma)$ insofar as $\sigma < 0.734$.

¹²In addition to firm output, we also compared the prices. Given $u_f > u_h$, for any constellation of parameter

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 3, 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 6. *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 $\partial CS^k / \partial c_f < 0$ and $\partial \pi_h^k / \partial t > 0$, $k \in \{CC, CB\}$. As for the change in local welfare with t , we can show that $\partial W^{CC} / \partial t < 0$, $\forall t < \bar{t}$, whereas $\partial W^{CB} / \partial t > 0$ if $t > \hat{t}''$, or $\partial W^{CB} / \partial t < 0$ if otherwise. Moreover $\partial[CS^{CB} - CS^{CC}] / \partial t > 0$, $\partial[\pi_h^{CC} - \pi_h^{CB}] / \partial t > 0$, and $\partial[W^{CB} - W^{CC}] / \partial t > 0$.*

Proof. See Appendix A.5. □

Lemma 6 shows that while consumers prefer a Cournot local firm competing against a Bertrand exporter (as compared to Cournot competition), the local firm is better off under Cournot competition. In addition, it is clear from Lemma 6 that while consumers gain less from a Bertrand exporter relative to a Cournot exporter as trade costs decrease, the local firm loses less, and the overall local welfare gain from having a Bertrand exporter competing against a Cournot local rival relative to Cournot competition decreases as trade costs decrease. That said, Lemma 6 also shows that for any constellation of permissible parameter values, local welfare with a Bertrand exporter competing against a Cournot local rival is greater than that under Cournot competition. This leads to the following trade policy implication.

Proposition 5. *When both trade costs and the quality index of the high-quality foreign variety is sufficiently high such that $(2u_h/\sigma) < u_f < \bar{u}_f$ and $\hat{t}''' < t < \bar{t}$, not only does decreasing trade costs increase local welfare, the local welfare impact is magnified by leading the exporter to become a Bertrand rival when competing against a Cournot local firm.*

values, the difference between the high-quality (foreign) and low-quality (local) product prices is positive, that is, there is no Alchian-Allen effect at play.

From Proposition 3, we know that the equilibrium mode of competition will be Cournot if $(2u_h/\sigma) < u_f < \bar{u}_f$ and $\hat{t}''' < t < \bar{t}$. 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 6 (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 \hat{t}''' , Proposition 3 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 6 that $W^{CB} > W^{CC}$, $\forall t < \bar{t}$, and that $\partial W^{CB}/\partial t < 0$ if $t < \hat{t}''$, where $\hat{t}''' < \hat{t}''$. 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 3), and thus, while decreasing trade costs will still increase local welfare (see the proof Lemma 6 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.

The same result as in the case of local welfare holds true also for global welfare, denoted GW , defined as the sum of local welfare and foreign downstream and upstream profits. That is, $GW^{CB} > GW^{CC}$, $\forall t < \bar{t}$, and $\partial GW^{CC}/\partial t < 0$, $\forall t < \bar{t}$, whereas $\partial GW^{CB}/\partial t > 0$ if $t > \hat{t}'''$, or $\partial GW^{CB}/\partial t < 0$ if otherwise. Moreover $\partial[GW^{CB} - GW^{CC}]/\partial t > 0$ if $t > \hat{t}$, or $\partial[GW^{CB} - GW^{CC}]/\partial t < 0$ if otherwise.¹³ This leads to the following result.

Proposition 6. *When both trade costs and the quality index of the high-quality foreign variety is sufficiently high such that $(2u_h/\sigma) < u_f < \bar{u}_f$ and $\hat{t}''' < t < \bar{t}$, not only does decreasing trade costs increase also global welfare, the global welfare impact is magnified by leading the exporter to become a Bertrand rival when competing against a Cournot local firm.*

Once again, it is useful at this point to relate our results to the empirical evidence. While a direct test for the prediction that as trade costs decrease, firms producing high-quality products switch from Cournot competition to Bertrand competition is hard to run given the general difficulty in teasing out information on firms' strategic choices, evidence hinting at such behavior may be observed indirectly. As described by Hout et al. (1982), Japanese auto producer Honda succeeded in global markets by simultaneously engaging an aggressive pricing strategy as well as supplying high quality products. At the same time, there is empirical evidence that trade liberalization has led to an increase in product quality (see e.g., Bas and Paunov, 2021, and Bas and Strauss-Kahn, 2015). Combining

¹³Note the following ranking of the thresholds: $\hat{t}''' < \hat{t} \equiv u_f - ((11\sigma^4 - 80\sigma^2 + 112)u_h)/(6\sigma^5 - 44\sigma^3 + 64\sigma) < \hat{t}'' \equiv u_f - ((\sigma(9 - 5\sigma^2)u_h)/(2 - \sigma^2)(7 - 3\sigma^2)) < \bar{t}$. Also note that $[GW^{CB} - GW^{CC}] > 0$ at $\lim_{t \rightarrow 0}$, at $\lim_{t \rightarrow \hat{t}''}$, and at $\lim_{t \rightarrow \bar{t}}$.

these observations, along with substantial tariff reductions during the past few decades, is certainly suggestive that multinationals, while supplying high quality products, have pursued aggressive pricing strategy during the trade liberalization era of the past four decades. Our theoretical results underscore the importance of further empirical research in this area.

6 Endogenous foreign market entry mode

In this section we extend our model to allow for horizontal FDI. In the initial stage, we consider the foreign firm choosing 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. In addition to fixed investment costs (denoted G), given that high-quality inputs are supplied only in foreign, we distinguish between input trade costs and trade costs in final goods. If the foreign firm becomes a 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, in 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 3 (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 $(2u_h/\sigma) < u_f < \bar{u}_f$, 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 $(2u_h/\sigma) < u_f < \bar{u}_f$, 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 $(2u_h/\sigma) < u_f < \bar{u}_f$ 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 Cournot rival to a Cournot local firm. Thus we need to compare $\pi_f^{T,CB}$ with $\pi_f^{FDI,CC}$.
4. If $(2u_h/\sigma) < u_f < \bar{u}_f$ 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 summarizes our results on each of the four cases above.

Proposition 7. *In equilibrium, the foreign firm's profits are such that:*

- (i) *If, for any $t < \bar{t} = \bar{\tau}$ and any $\tau < \bar{\tau}$, $u_h < u_f < (2u_h/\sigma)$, or if $(2u_h/\sigma) < u_f < \bar{u}_f$, 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 $(2u_h/\sigma) < u_f < \bar{u}_f$, 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 $(2u_h/\sigma) < u_f < \bar{u}_f$ and $\tau < \tilde{t}''' = \tilde{\tau}''' < t$, then $\pi_f^{T,CC} > \pi_f^{FDI,CB}$ only if $G > G_3$;*
- (iv) *If $(2u_h/\sigma) < u_f < \bar{u}_f$ 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 7 in Figure 1, where non-prohibitive trade costs are drawn on the vertical axis for inputs, and on the horizontal axis for final goods.

[Figure 1 about here.]

In Figure 1, the equilibrium market entry and competition modes are illustrated for a sufficiently high quality index of the high-quality foreign variety such that $(2u_h/\sigma) < u_f < \bar{u}_f$. 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 (the latter being both larger in size and heavier in weight as compared to inputs). In that region, 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 competition. This implies the following result.

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 $(2u_h/\sigma) < u_f < \bar{u}_f$ and $\tau < \tilde{t}''' = \bar{\tau}''' < t$.*

Clearly, the availability of FDI as an alternative to trade makes welfare-enhancing asymmetric strategies more likely.

7 Concluding remarks

In a differentiated duopoly trade and FDI model featuring both horizontal and vertical product differentiation, we have analyzed whether globalization and trade policy measures can generate welfare gains by leading firms to change their mode of competition. We have shown that when a high-quality foreign variety is manufactured under large frictions due to upstream monopoly power, a foreign firm 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, giving the foreign firm a favorable competitive position in terms of sales in the product market. Such a favorable sales position implies higher input price distortions due to double marginalization. Thus, as manufacturing the high-quality foreign variety becomes more costly, the foreign firm behaves more aggressively by choosing prices over quantities.

In particular, it is clear from the results that the local downstream firm switching from a Cournot to a Bertrand strategy (given the foreign firm is a Cournot rival) would lose on both its markup and sales, whereas the foreign firm losing its markup would gain on its sales. In contrast, if it is the foreign firm switching from a Cournot to a Bertrand strategy (given the local firm is a Cournot rival), then the foreign firm not only would gain on its sales (so long as foreign quality is sufficiently high and trade costs are sufficiently low) while losing on its markup, but such a switch in strategies would also lead the foreign upstream supplier to partially subsidize its markup loss through a lower input price. As for the local rival, a switch from a Cournot to a Bertrand strategy by the foreign rival would still imply a decrease in sales and markup.¹⁴ In addition, our results further suggest that such strategic asymmetry is welfare improving and that the availability of FDI as an alternative to trade can make welfare-enhancing 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.

¹⁴This follows discussions of the deep markup of a low-cost producer of a low-quality product, which help explain firm behavior in many IO models; see, for example, [Milgrom \(1986\)](#) and [Bandyopadhyay et al. \(2018\)](#) on signaling product quality. We thank the referee for this insightful point.

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 Lemma 1

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 Lemma 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 $u_f < \bar{u}_f$). 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 $u_f < \bar{u}_f$). 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 Lemma 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 $u_h < u_f < \bar{u}_f$. 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 Lemma 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 (\bar{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 Lemma 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 $u_f < \bar{u}_f$), 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 6

These inequalities hold: $\partial[CS^{CC} - CS^{CB}]/\partial t < 0$, $\lim_{t \rightarrow \bar{t}}[CS^{CC} - CS^{CB}] < 0$, $\partial[\lim_{t \rightarrow 0}[CS^{CC} - CS^{CB}]]/\partial u_f > 0$ and $\lim_{u_f \rightarrow \bar{u}_f}[\lim_{t \rightarrow 0}[CS^{CC} - CS^{CB}]] < 0$ (and thus $\lim_{t \rightarrow 0}[CS^{CC} - CS^{CB}] < 0$), and are sufficient to complete the proof of $CS^{CB} > CS^{CC}$. Similarly, the following inequalities hold $\partial[\pi_h^{CC} - \pi_h^{CB}]/\partial t > 0$, $\lim_{t \rightarrow \bar{t}}[\pi_h^{CC} - \pi_h^{CB}] > 0$, $\partial[\lim_{t \rightarrow 0}[\pi_h^{CC} - \pi_h^{CB}]]/\partial u_f < 0$ and $\lim_{u_f \rightarrow \bar{u}_f}[\lim_{t \rightarrow 0}[\pi_h^{CC} - \pi_h^{CB}]] > 0$, $\lim_{u_f \rightarrow \bar{u}_f}[\lim_{t \rightarrow 0}[\pi_h^{CC} - \pi_h^{CB}]] > 0$ (and thus $\lim_{t \rightarrow 0}[\pi_h^{CC} - \pi_h^{CB}] > 0$), 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 $\forall u_h < u_f < \bar{u}_f$, 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 $t > u_f - \sigma(12 - 7\sigma^2)u_h/(8 - 6\sigma^2 + \sigma^4)$ (where $\hat{t}'' \equiv u_f - \sigma(12 - 7\sigma^2)u_h/(8 - 6\sigma^2 + \sigma^4) > \tilde{t}''' \equiv u_f - (2u_h/\sigma)$ as $(2u_h/\sigma) > \sigma(12 - 7\sigma^2)u_h/(8 - 6\sigma^2 + \sigma^4)$); otherwise $\partial W^{CB}/\partial t < 0$. Note that $\partial W^{CB}/\partial t = 0$ at $t = \hat{t}''$, and that $\partial^2 W^{CB}/\partial t^2 > 0$, $\forall t < \bar{t}$. Also we can show that $\partial[W^{CB} - W^{CC}]/\partial t = 0$ at $t = u_f + ((16 + 13\sigma^4 - 32\sigma^2)u_h/2\sigma^3(2 - \sigma^2)) > \bar{t}$, and that $\partial^2[W^{CB} - W^{CC}]/\partial t^2 < 0$, $\forall t < \bar{t}$ implying that, for any $0 \leq t < \bar{t}$, $\partial[W^{CB} - W^{CC}]/\partial t > 0$. Moreover we can show that $[W^{CB} - W^{CC}] > 0$ at $\lim_{t \rightarrow 0}$, at $\lim_{t \rightarrow \hat{t}''}$, and at $\lim_{t \rightarrow \bar{t}}$, with which we can conclude that $W^{CB} > W^{CC}$, $\forall t < \bar{t}$.

A.6 Proof of Proposition 7

To prove (i), we can show that $\pi_f^{T,CC} - \pi_f^{FDI,CC} = G - G_1$ where $G_1 = (t - \tau)(2u_f - \sigma u_h - (t + \tau))/(4 - \sigma^2)^2$. 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 $G_2 = (2 - \sigma^2)(t - \tau)((2 - \sigma^2)(2u_f - (t + \tau)) - 2\sigma u_h)/4(4 - 3\sigma^2)^2$. 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

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

This 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

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

This 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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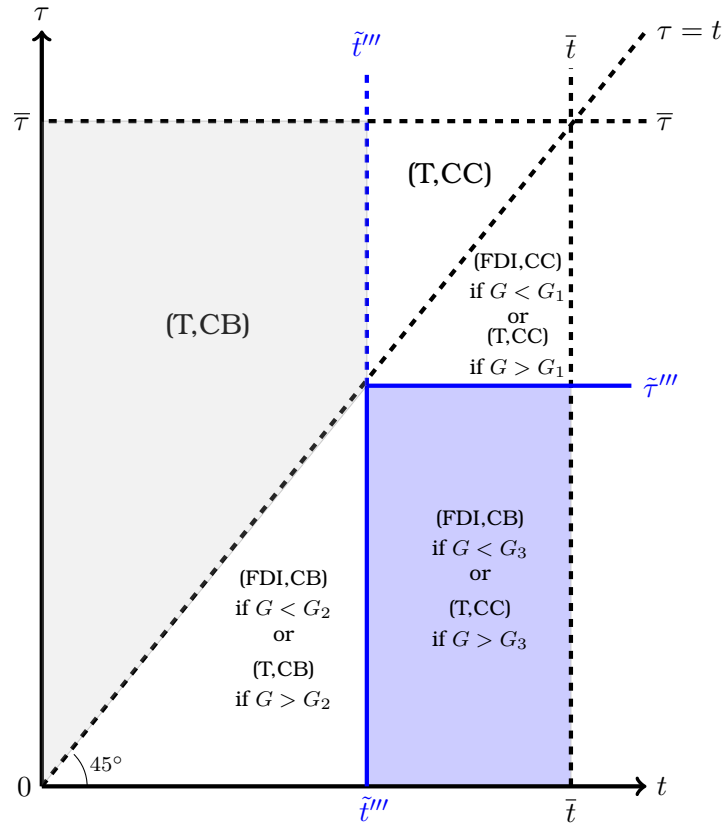


Figure 1: Equilibrium market entry and competition modes