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Cournot, Bertrand or Chamberlin: Market Structures and the Home Market Effect

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Abstract

Comparison among Cournot, Bertrand and (Chamberlin) monopolistic competition receives recent attention in industrial organization, but not in New Economic Geography (NEG). To fulfill this gap, we examine how the difference in market structures affects industry location in a footloose capital (FC) model of NEG. We find that the home market effect is strongest in Cournot competition, second strongest in Bertrand competition, and weakest in monopolistic competition.

Keywords: Cournot competition, Bertrand competition, monopolistic competition, Home market effect.

JEL: D43, F12, F21, L13.

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1 Introduction

Trade cost has been decreasing. OECD (2018, p. 45) shows that the global transportation cost index fell from 100 in 1990 to 75 in 2015. According to the website of World Bank, the mean of the world tariff rate on all products fell by more than 50% during 1990-2017.[1] New Economic Geography (NEG) studies the impact of trade cost reduction on the industry location. Since Krugman (1991), most NEG papers assume monopolistic competition.[2] What implication is derived in other market structures? This question is important empirically as well as theoretically because evidence suggests that the share of exporters is small.[3]

We address this question by developing a footloose capital (FC) model with Cournot, Bertrand or monopolistic competition. Our main conclusion is that the home market effect (HME) is strongest in Cournot competition, second strongest in Bertrand competition, and weakest in monopolistic competition. To summarize, the difference in market structures has a quantitative difference significantly.

Comparison between Cournot and Bertrand competition receives considerable attention in industrial organization. Cheng (1983) and Singh and Vives (1984) show that when the number of firms is fixed, the equilibrium price is lower and welfare is higher in Bertrand competition than in Cournot competition. Cellini et al. (2004) and Mukherjee (2005) allow for free entry and prove that this result is reversed if goods are sufficiently differentiated. These papers exclude monopolistic competition. Adding monopolistic competition, Parenti et al. (2017) and Chhy (2018) find that Cournot competition involves the largest number of varieties whereas monopolistic

[1] See https://data.worldbank.org/indicator/TM.TAX.MRCH.SM.AR.ZS?end=2019&start=1988&view=chart.

[2] Ludema and Wooton (2000) and Thisse (2010) assume homogeneous good Cournot competition.

[3] For example, Freund and Pierola (2015) find that the top five exporters account for one third of exports on average across 32 developing countries.

competition involves the smallest number.

This paper is organized as follows. Section 2 presents a model. Sections 3, 4 and 5 compute the Cournot, Bertrand and Chamberlin equilibrium, respectively. Section 6 proves the main result. Section 7 concludes. Supplement provides technical issues.

2 Model

We use the 'linear FC' model of Ottaviano (2004) and Baldwin et al. (2003, pp. 112-122). The world consists of Home and Foreign. Home has θL consumers, and Foreign has $(1-\theta)L$ consumers, where L is the world mass of consumers and θ is the share of Home consumers. We assume that Home has more consumers than Foreign, i.e. $1/2 < \theta < 1$. Each consumer consumes N varieties of differentiated goods and one numeraire good. And, each consumer inelastically supplies one unit of labor. We specify the utility function and budget constraint per consumer as follows.[4]

$$
\begin{aligned}
u &= a\sum_{i=1}^{N} x_i - \frac{1-b}{2}\sum_{i=1}^{N} x_i^2 - \frac{b}{2}\left(\sum_{i=1}^{N} x_i\right)^2 + x_0, \quad a > 0, \quad 1 > b > 0 \\
\text{per-capita income} &= \sum_{i=1}^{N} p_i x_i + x_0,
\end{aligned}
$$

where u is utility, N is the world number of differentiated goods, x_i is consumption of variety i, p_i is consumption of variety i, and x_0 is consumption of the numeraire good.

Maximizing the above utility function under the budget constraint, we obtain the following demand and inverse demand functions of variety i.

$$
x_i = \frac{(1-b)a - (Nb+1-b)p_i + bP}{(1-b)(Nb+1-b)} \tag{1}
$$

$$
p_i = a - (1-b)x_i - bX = a - (1-b)\frac{y_i}{\theta L} - b\frac{Y}{\theta L}, \tag{2}
$$

[4]While the monopolistic competition model usually uses an integral expression of utility function, but we assume discrete goods. So, we call N the number of varieties rather than the mass.

where y_i is output of variety i, $P \equiv \sum_{i=1}^{N} p_i$ is the price index, $X \equiv \sum_{i=1}^{N} x_i$ is the quantity index measured by consumption, and $Y \equiv \sum_{i=1}^{N} y_i$ is the quantity index measured by output. Similarly, we have the following Foreign demand and inverse demand functions.

$$x_i^* = \frac{(1-b)a - (Nb+1-b)p_i^* + bP^*}{(1-b)(Nb+1-b)} \tag{3}$$

$$p_i^* = a - (1-b)x_i^* - bX^* = a - (1-b)\frac{y_i^*}{(1-\theta)L} - b\frac{Y^*}{(1-\theta)L}, \tag{4}$$

where $P^* \equiv \sum_{i=1}^{N} p_i^*, X^* \equiv \sum_{i=1}^{N} x_i^*$ and $Y^* \equiv \sum_{i=1}^{N} y_i^*$. The goods market is internationally segmented. And, setting up one unit of firm requires one unit of capital. Given the demand or inverse demand functions in (3) and (4), firm i in Home maximizes the profit $p_i y_i + (p_i^* - \tau)y_i^* - r$, where r is capital rental in Home. The behavior of foreign firms is analogously defined. Henceforth, we consider three market structures.

(i) Cournot: firms choose outputs, taking account of their effect on Y and Y^*

(ii) Bertrand: firms choose prices, taking account of their effect on P and P^*

(iii) Chamberlin: firms choose prices, taking P and P^* as given.[5]

The subsequent sections find the spatial equilibrium in each market structure, and compare the locations. We will assume that the trade cost is below the prohibitive trade cost to ensure two-way trade.[6]

[5]Quantity-setting leads to the same equilibrium outcome.

[6]Supplement computes the prohibitive trade cost.

3 Cournot Competition

In Cournot competition, the objective of firm i in Home is

$$\max_{y_i, y_i^*} \quad \underbrace{y_i \left[a - (1-b)\frac{y_i}{\theta L} - b\frac{Y}{\theta L} \right]}_{\text{operating profit from Home}} + \underbrace{y_i^* \left[a - (1-b)\frac{y_i^*}{(1-\theta)L} - b\frac{Y^*}{(1-\theta)L} \right]}_{\text{operating profit from Foreign}} - r. \tag{5}$$

As noted earlier, firm i recognizes that y_i and y_i^* affect the quantity indices Y and Y^*. Then, the system of the first-order conditions yields the symmetric Cournot equilibrium outputs:

$$y = \frac{\theta L[\tau b n^* + (2-b)a]}{(2-b)(2-b+bN)}, \quad y^* = \frac{(1-\theta)L[-\tau b n^* + (2-b)(a-\tau)]}{(2-b)(2-b+bN)}.$$

The zero profit condition determines capital rental. From the profit maximization conditions and the zero profit condition, the Home equilibrium capital rental is obtained as

$$r = \frac{y^2}{\theta L} + \frac{y^{*2}}{(1-\theta)L},$$

where y and y^* are the Cournot equilibrium outputs derived before.

Since setting up one firm requires one unit of capital, market-clearing in the world capital market is given by $n + n^* = N = K$. Hence, we can write $n = \lambda K$ and $n^* = (1-\lambda)K$, where $\lambda \in [0,1]$ is the share of Home firms. Capitalists invest into the country with the higher capital rental. That is, λ increases if $r - r^* > 0$ and vice versa. Using the Home capital rental derived above and the Foreign counterpart, the capital rental difference becomes a function of λ as follows.

$$r - r^* = \frac{\tau L\left[-2\tau bK\lambda + \tau bK + (2\theta-1)(2-b)(2a-\tau)\right]}{(2-b)^2(2-b+bK)}. \tag{6}$$

The spatial equilibrium is defined by λ that satisfies $r - r^* = 0$. Setting (6) to zero and solving for λ yield

$$\lambda^C = \frac{\tau bK + (2\theta-1)(2-b)(2a-\tau)}{2\tau bK}, \tag{7}$$

where superscript C stands for Cournot. Subtracting θ from λ^C gives

$$\lambda^C - \theta = \frac{(2\theta - 1)[(2-b)(2a-\tau) - \tau bK]}{2\tau bK} > 0.$$

This is the HME: the share of Home firms is larger than the share of Home consumers.

4 Bertrand Competition

This section considers Bertrand competition in which firms choose prices. From (2) and (3), the objective of firm i in Home is[7]

$$\max_{p_i, p_i^*} \ \theta L p_i \frac{(1-b)a - (bK+1-b)p_i + bP}{(1-b)(bK+1-b)} + (1-\theta)L(p_i^* - \tau)\frac{(1-b)a - (bK+1-b)p_i^* + bP^*}{(1-b)(bK+1-b)} - r. \tag{8}$$

Solving the first-order conditions for profit maximization, the Bertrand equilibrium prices are

$$\begin{aligned} p &= \frac{bn^*(bK+1-2b)\tau + (1-b)[(2K-3)b+2]a}{[(2K-3)b+2][(K-3)b+2]} \\ p^* &= \frac{[(2K-n^*-3)b+2](bK+1-2b)\tau + [(2K-3)b+2](1-b)a}{[(2K-3)b+2][(K-3)b+2]}. \end{aligned}$$

The zero profit condition determines the capital rental. It follows from (8) and the equilibrium prices that

$$r = \frac{bK+1-2b}{(1-b)(bK+1-b)}\left[\theta L p^2 + (1-\theta)(p^* - \tau)^2\right].$$

The Foreign capital rental is similarly derived. Recalling that $n = \lambda K$ and $n^* = (1-\lambda)K$, and subtracting r^* from r, we have

$$\begin{aligned} r - r^* &= \frac{\tau L(bK+1-2b)A}{(1-b)(bK+2-3b)(2bK+2-3b)^2} \qquad (9) \\ A &\equiv -2\tau bK(bK+1-2b)\lambda + \tau bK(bK+1-2b) \\ &\quad +(2\theta-1)(1-b)(2bK+2-3b)(2a-\tau) \end{aligned}$$

[7] Here, we use K instead of N to denote the world number of firms.

The spatial equilibrium value of λ is obtained by setting (9) to zero and is given by

$$\lambda^B = \frac{\tau bK(bK+1-2b) + (2\theta-1)(1-b)(2bK+2-3b)(2a-\tau)}{2\tau bK(bK+1-2b)}, \quad (10)$$

where superscript B stands for Bertrand. Subtracting θ from λ^B leads to the HME:

$$\begin{aligned} \lambda^B - \theta &= \frac{(2\theta-1)B}{2\tau bK(bK+1-b)} \\ B &\equiv 2(1-b)(2bK+2-3b)a - (bK+1-2b)(bK+2-3b)\tau > 0. \end{aligned}$$

5 Monopolistic Competition

Finally, we consider monopolistic competition. Because Ottaviano (2004) has already characterized this case, we just sketch the core result. Firms choose prices as in Bertrand competition, but they ignore the effect of their price choice on the price indices. Then, the equilibrium prices become

$$\begin{aligned} p &= \frac{bn^*\tau + 2(1-b)a}{2(bK+2-2b)} \\ p^* &= \frac{(2bK-bn+2-2b)\tau + 2(1-b)a}{2(bK+2-2b)}. \end{aligned}$$

Substituting these prices into the definition of profit and setting the resulting expression to zero yield

$$r = \frac{\theta Lp^2 + (1-\theta)(p^*-\tau)^2}{1-b}.$$

This is the Home capital rental, and the Foreign capital rental is analogously derived. Taking the difference between r and r^*, we have

$$r - r^* = \frac{\tau L[-2\tau bK\lambda + \tau bK + 2(2\theta-1)(1-b)(2a-\tau)]}{4(1-b)(bK+2-2b)}. \quad (11)$$

Solving the equation $r - r^* = 0$ for λ, the spatial equilibrium value of λ is

$$\lambda^M = \frac{\tau bK + 2(2\theta-1)(1-b)(2a-\tau)}{2\tau bK}, \quad (12)$$

where superscript M stands for monopolistic competition. Subtracting θ from λ^M shows the HME:

$$\lambda^M - \theta = \frac{(2\theta - 1)[2(1-b)(2a-\tau) - \tau bK]}{2\tau bK} > 0.$$

Accordingly, we reach:[8]

Proposition 1. *The HME holds for all of Cournot, Bertrand and monopolistic competition.*

6 Comparison

This section examines how the difference in market structures quantitatively affects the HME. Our main result is:

Proposition 2. *The HME is strongest in Cournot competition, second strongest in Bertrand competition, and weakest in monopolistic competition.*

Proof. Subtracting λ^B from λ^C yields

$$\lambda^C - \lambda^B = \frac{b(2\theta - 1)(K-1)(2a-\tau)}{2\tau K(bK + 1 - 2b)} > 0.$$

Similarly, subtracting λ^M from λ^B yields

$$\lambda^B - \lambda^M = \frac{(1-b)(2\theta - 1)(2a-\tau)}{2\tau K(bK + 1 - 2b)} > 0.$$

Combining these inequalities leads to the proposition. ||

Proposition 2 clarifies how the difference in market structures affects the industry location. In order to get the intuition, we rewrite (7), (10) and (12)

[8] We explain the intuition of Proposition 1 after proving Proposition 2.

as follows.[9]

$$
\begin{aligned}
(7) \quad &\Rightarrow \quad (2-b)\alpha\left(\theta-\frac{1}{2}\right)-\tau bK\left(\lambda^{C}-\frac{1}{2}\right)=0 \\
(10) \quad &\Rightarrow \quad (1-b)(2-3b+2bK)\alpha\left(\theta-\frac{1}{2}\right)-\tau bK(1-2b+bK)\left(\lambda^{B}-\frac{1}{2}\right)=0 \\
(12) \quad &\Rightarrow \quad 2(1-b)\alpha\left(\theta-\frac{1}{2}\right)-\tau bK\left(\lambda^{M}-\frac{1}{2}\right)=0.
\end{aligned}
$$

The so-called market access advantage and market crowding disadvantage are the driving forces that determine the industry location. In the above equations, the first and second terms respectively represent these effects of locating in Home. Because the market size is larger in Home than in Foreign, profits tend to be higher in Home and firms have an incentive to locate in Home (market access advantage). However, the Home market is more competitive than the Foreign market. This induces firms to locate in Foreign so as to avoid tougher competition (market crowding disadvantage). The market access advantage dominates the market crowding disadvantage for all market structures, and hence the HME arises. This is the intuition behind Proposition 1.

Comparing the coefficient of $(\theta-1/2)$ divided by the coefficient of $(\lambda-1/2)$ in the above equations, we have

$$
\frac{(2-b)\alpha}{\tau bK} > \frac{(1-b)(2-3b+2bK)\alpha}{\tau bK(1-2b+bK)} > \frac{2(1-b)\alpha}{\tau bK}.
$$

These inequalities suggest that the market access advantage relative to the market crowding disadvantage is strongest in Cournot competition, second strongest in Bertrand competition and weakest in monopolistic competition. Then, our next question is why this ranking holds. Parenti et al. (2017) and Chhy (2018) provide a hint. These papers show that the mark-up and number of firms are largest in Cournot competition, second largest in Bertrand competition and smallest in monopolistic competition. Relating this observation to our context, locating in Home is most profitable in Cournot competition

[9] This decomposition draws on Ottaviano and Thisse (2004, pp. 2585-2586).

and least profitable in monopolistic competition. Therefore, more firms locate in Home in Cournot competition than in the other market structures.

7 Conclusion

Developing an FC model, we have explored how the difference among Cournot, Bertrand and monopolistic competition affects the industry location. We have shown that the HME is strongest in Cournot competition, second strongest in Bertrand competition and weakest in monopolistic competition. The limitations of this paper are as follows. First, we have used the FC model. However, it is unclear whether our result survives other NEG models, e.g. the core-periphery or footloose entrepreneur models. Second, we have assumed linear demand. Zeng and Peng (2021) develop an FC model with a general demand function. Finally, we have assumed away firm heterogeneity a la Melitz (2003). It is future research agenda to make a richer analysis by incorporating these theoretical developments.

References

[1] Baldwin, R., R. Forslid, P. Martin, G.I.P. Ottaviano and F. Robert Nicoud (2003), *Economic Geography and Public Policy*, Princeton: Princeton University Press.

[2] Cellini, R., L. Lambertini and G.I.P. Ottaviano (2004), 'Welfare in a Differentiated Oligopoly with Free Entry: A Cautionary Note,' *Research in Economics*, Vol. 58(2), pp. 125-133.

[3] Cheng, L. (1985), 'Comparing Bertrand and Cournot Equilibria: A Geometric Approach,' *RAND Journal of Economics*, Vol. 16(1), pp. 146-152.

[4] Chhy, N. (2018) 'A Simple Extension to the Dixit-Stiglitz Framework to Allow for Strategic Interaction,' *Economics Bulletin*, Vol. 38(2), pp. 1187-1197.

[5] Freund, C. and M.D. Pierola (2015.), 'Export Superstars,' *Review of Economics and Statistics*, Vol. 97(5), pp. 1023-1032.

[6] Krugman, P.R. (1991), 'Increasing Returns and Economic Geography,' *Journal of Political Economy*, Vol. 99(3), pp. 483-499.

[7] Ludema, R.D. and I. Wooton (2000), 'Economic Geography and the Fiscal Effects of Regional Integration,' *Journal of International Economics*, Vol. 52(2), pp. 331-357.

[8] Melitz, M.J. (2003), 'The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity,' *Econometrica*, Vol. 71(6), pp. 1695-1725.

[9] Mukherjee, A. (2005), 'Price and Quantity Competition under Free Entry,' *Research in Economics*, Vol. 59(4), pp. 335-344.

[10] OECD (2018), 'The Long View: Scenarios for the World Ecconomy to 2060'.

[11] Ottaviano, G.I.P. (2004), 'Footloose Capital, Market Access and the Geography of Regional State Aid,' in Mucchielli, J. and T. Mayer (eds.) *Multinational Firms' Location and the New Economic Geography*, Cheltenham UK: Edward Elger, pp. 156-177.

[12] Ottaviano, G.I.P. and J. Thisse (2004), 'Agglomeration and Economic Geography' in Henderson, J.V. and J. Thisse (eds.) *Handbook of Regional and Urban Economics Volume 4*, Amsterdam: Elsevier, pp. 2564-2608.

[13] Parenti, M., A.V. Sidorov, J. Thisse and E.V. Zhelobodko (2017), 'Cournot, Bertrand or Chamberlin: Toward a Reconciliation,' *International Journal of Economic Theory*, Vol. 13(1), pp. 29-45.

[14] Singh, N. and X. Vives (1984), 'Price and Quantity Competition in a Differentiated Duopoly,' *RAND Journal of Economics*, Vol. 15(4), pp. 546-554.

[15] Thisse, T. (2010), 'Toward a Unified Theory Of Economic Geography and Urban Economics,' *Journal of Regional Science*, Vol. 50(1), pp. 281-296.

[16] Zeng, D. and S. Peng (2021), 'Symmetric Tax Competition and Welfare with Footloose Capital,' *Journal of Regional Science*, Vol. 61(2), pp. 472-491.

Supplement (planned to be unpublished)

In the main text, we have assumed that the trade cost is below the prohibitive level to guarantee two-way trade. This supplement derives it in each market structure.

Cournot Competition

In Cournot competition, the Home firm's supply into the Foreign market is given by

$$y^* = \frac{\theta L[-\tau b n + (2-b)(a-\tau)]}{(2-b)(2-b+bN)} = \frac{\theta L[-\tau b(1-\lambda)K + (2-b)(a-\tau)]}{(2-b)(2-b+bK)}.$$

In order to ensure two-way trade, the terms in square brackets in the above fraction must be non-negative for any $1-\lambda \in [0,1]$. Therefore, substituting $1-\lambda = 1$ ($\lambda = 0$) into $\tau b(1-\lambda)K + (2-b)(a-\tau) = 0$ and solving the resulting equation for τ, the prohibitive trade cost in Cournot competition $\overline{\tau}^C$ becomes[10]

$$\overline{\tau}^C = \frac{(2-b)a}{bK+2-b}.$$

Bertrand Competition

In Bertrand competition and monopolistic competition, the prohibitive trade cost is given by the level of τ such that the export price net of trade cost is zero. The export price minus trade cost in Bertrand competition is

$$\begin{aligned}
& \underbrace{\frac{[(2N-3)b+2](1-b)a + [(2N-n-3)b+2](1+bN-2b)\tau}{[(2N-3)b+2][(N-3)b+2]}}_{\text{FOB export price}} - \tau \\
= \quad & \frac{\Delta}{(2bK+2-3b)(bK+1-3b)}, \\
\Delta \quad = \quad & \{[2K-(1-\lambda)K-3]b+2\}(bK+1-2b)\tau \\
& +(2bK+2-3b)(1-b)a - (2bK+2-3b)(bK+2-3b)\tau.
\end{aligned}$$

[10] This corresponds to Eq. (3) in Thisse (2010).

As in the Cournot case, we can obtain the prohibitive trade cost as follows. Substituting $1-\lambda=1$ ($\lambda=0$) into Δ and solving the equation $\Delta=0$ for τ, we get the prohibitive trade cost in Bertrand competition $\overline{\tau}^B$:

$$\overline{\tau}^B=\frac{(2bK+2-3b)(1-b)a}{(bK+2-3b)(bK+1-b)}.$$

Monopolistic Competition

Since Ottaviano (2004) has already covered the monopolistic competition case, we make the explanation as brief as possible. The export price net of trade cost becomes

$$\begin{aligned}&\underbrace{\frac{2(1-b)a+(2bN-bn-2b+2)\tau}{(N-2)b+2}}_{\text{FOB export price}}-\tau\\ =\ &\frac{-(b\lambda K+2-2b)\tau+2(1-b)a}{2(bK+2-2b)}.\end{aligned}$$

Substituting $\lambda=1$ into the numerator of the above fraction, setting the resulting expression to zero and solving for τ, we have the prohibitive trade cost in monopolistic competition $\overline{\tau}^M$ as follows.[11]

$$\overline{\tau}^M=\frac{2(1-b)a}{bK+2-2b}.$$

Subtracting $\overline{\tau}^B$ from $\overline{\tau}^C$ yields

$$\overline{\tau}^C-\overline{\tau}^B=\frac{b^3K(K-1)a}{(bK+2-b)(bK+2-3b)(bK+1-b)}>0.$$

The difference between $\overline{\tau}^B$ and $\overline{\tau}^M$ becomes

$$\overline{\tau}^B-\overline{\tau}^M=\frac{b^2(1-b)Ka}{(bK+2-3b)(bK+2-2b)(bK+1-b)}>0.$$

Therefore, we have a ranking that $\overline{\tau}^M<\overline{\tau}^B<\overline{\tau}^C$. If τ is smaller than $\overline{\tau}^M$, two-way trade is guaranteed in all market structures.

[11] This is Eq. (8.13) in Ottaviano (2004).