

Evolution of Inter-regional Costs and Market Structure

A Theoretical Model of Oligopolistic Competition by Advertising

Pedro Cosme Costa Vieira
Faculdade de Economia do Porto
R. Dr. Roberto Frias, s/n
4200 - 464 Porto, Portugal
Email: pcosme@fep.up.pt

Abstract:

While inter-regional costs cause the closing of regions to trade, firms are locally competitive even if they aren't competitive elsewhere. But the historical tendency is the opening of markets.

My work is a theoretical study of the evolution of the market structure and the competitiveness of the "country" with the decrease of inter-regional costs. The model I present is a non-linear model of oligopolistic competition by advertising that is manipulated by computational methods.

The principal result of the model is that, if markets are perfectly open, there are only two firms, a duopoly. This result is in accord, for instance, with the existence of only the "Coca Cola" and "Pepsi" firms on the cola market and only the "Intel" and "AMD" firms on the personal computers processors market. Another property of the model is that the "country" as a whole becomes more competitive with the decrease of inter-regional costs.

Keywords: Oligopoly; Informative advertising; Opening of markets; Regional advantages.

1. Introduction

The informative advertising seminal paper is Butters (1977) that considers sellers that compete by aleatory sending ads to buyers with information about their prices. As the distribution of the ads is aleatory, some of buyers don't receive any ad, not buying the

good, and others receive several, of the same or of different seller, buying to the one that advertise the smallest price.

The space competition seminal paper is Hotelling (1929) in that the buyers are distributed evenly along a linear line and two salespersons decide its location that maximises the amount of buyers that each one serve.

In my work, I present a theoretical model in that sellers located in different regions compete through advertising. In the model, sellers have a regional cost and an inter-region costs, transportation costs or tariffs, if they sell in a region different from that of their location. The objective of my work is to analyse the impact of the decrease of those inter-region costs in the market structure and in the competitiveness of the "country" as a whole.

2. Informative advertising model

The model I consider is a non-co-operative advertising game, (about non-co-operative games see, e.g., Rasmusen, 1989), between sellers of a good that are located in different regions.

H1. There are R regions, with one seller in each region.

H2. There are M_R buyers in each region.

H3. There is a regional variable cost C_R , different in each region R .

H4. Each seller advertises its prices sending ads to buyers, being possible to set a different intensity of advertising in each region. The seller located in region R_L sends $g(R_L, R_V, P)$ ads to buyers of region R_V , advertising the price P .

H5. The price advertised in the ads includes the transportation cost and tariffs $C(R_L, R_V)$ that must be pay so that goods produced in region R_L may be sell in region R_V .

H6. Each seller incurs in the cost ξ for each ad it sends to a buyer that is chosen in an aleatory and independent way.

H7. A seller will just have opportunity to sell to a buyer that receives an ad. However, if a buyer receives several ads, he acquires the good to the seller that advertises the smallest of the price.

H8. The monopoly price is M .

H9. There is common knowledge of the strategy of sellers

H10. Sellers have expectations *a la* Cournot in the sense that each seller assumes that the intensity of advertising of other sellers doesn' t change with the changing of his strategy (e.g. Pepall, Richards and Norman, 2002).

Considering the price advertised as a continuous variable, the amount of ads in the region R_V advertising a price equal or smaller than P is the sum of ads send by all firms, whenever located, in region R_V :

$$G(P, R_V) = \int_0^P \left[\sum_{R_L} (g(R_L, R_V, x)) \right] dx. \quad (1)$$

The probability that a buyer of that R_V region receives n ads advertising a price equal or smaller than P as distribution binomial:

$$B(n | R_V, P) = \begin{cases} \frac{G(P, R_V)!}{n!(G(P, R_V) - n)!} \left(\frac{1}{M_{RV}}\right)^n \left(1 - \frac{1}{M_{RV}}\right)^{G(P, R_V) - n} & \text{se } n \leq G(P, R_V) \\ 0 & \text{se } n > G(P, R_V). \end{cases} \quad (2)$$

In this expression, $B(0 | R_V, P)$ quantifies the probability of a buyer to receive no ads advertising a price equal or smaller than P :

$$S(P | R_V) = B(0 | R_V, P) = \left(1 - \frac{1}{M_{RV}}\right)^{G(P, R_V)}. \quad (3)$$

The buyer acquires the good at a price equal or smaller than P if he receives at least one ad advertising such price that has the probability $(1 - S(P | R_V))$. Multiplying this probability by the total number of buyers in the region, we have the integral of the expected market demand function (Axell, 1977):

$$W(P | R_V) = M_{RV} (1 - S(P | R_V)) = M_{RV} \left[1 - \left(1 - \frac{1}{M_{RV}}\right)^{G(P | R_V)} \right] \quad (4)$$

Deriving this expression in order to the price (if sellers advertises just one price, this integral function is the expected market demand function), it results the expected market demand function:

$$\begin{aligned}
E[D(P|R_V)] &= w(P|R_V) \\
&= -M_{RV} G(P|R_V) \left(1 - \frac{1}{M_{RV}}\right)^{G(P|R_V)} \ln\left(1 - \frac{1}{M_{RV}}\right) \left(\sum_{R_L} g(P|R_L, R_V, P)\right)
\end{aligned} \tag{5}$$

The expected demand function in the region R_V of a seller located in region R_L results from the division of the expected market demand function by all sellers, proportionally to the quantities of ads advertising price P each seller sends to the region R_V :

$$\begin{aligned}
E[q(P, R_L, R_V)] &= w(P, R_V) \frac{g(R_L, R_V, P)}{\sum_{R_L} g(R_L, R_V, P)} \\
&= -M_{RV} G(P, R_V) \left(1 - \frac{1}{M_{RV}}\right)^{G(P, R_V)} \ln\left(1 - \frac{1}{M_{RV}}\right) g(R_L, R_V, P)
\end{aligned} \tag{6}$$

A seller located in region R_L will chose the function $g(R_L, R_V, P)$ that maximise his expected profit that results of the sum of sales in all regions, subtracting the regional cost of production and the advertising costs:

$$E[\pi(R_L)] = \int_{P=0}^M \sum_{R_V} \{E[q(P, R_L, R_V)](P - C_{RL} - C(R_L, R_V)) - \xi g(P, R_L, R_V)\} \tag{7}$$

The model of the global market has R_L equations like (7) and it has no algebraic solution. Because of that difficulty, it' s necessary to observe the properties of the theory using a set of particular solution that we derive using computational calculus.

3. Computation of the model

When entry barriers isolate firms, they behave locally as monopolist and cannot "export". In reality of my model, I will present, in comparative static terms, the evolution of the market structure with the decrease in those entry barriers.

First, I consider there are five regions with 1000 buyers and one firm at each region and a regional cost of $C_1 = 0$, $C_2 = 20$, $C_3 = 40$, $C_4 = 60$ and $C_5 = 80$. Second, it costs 1 monetary unit for each ad sent to buyers and firms' monopoly price is 100 monetary units.

In the first picture, I illustrate the evolution of the average price that the good is transacted in each region:

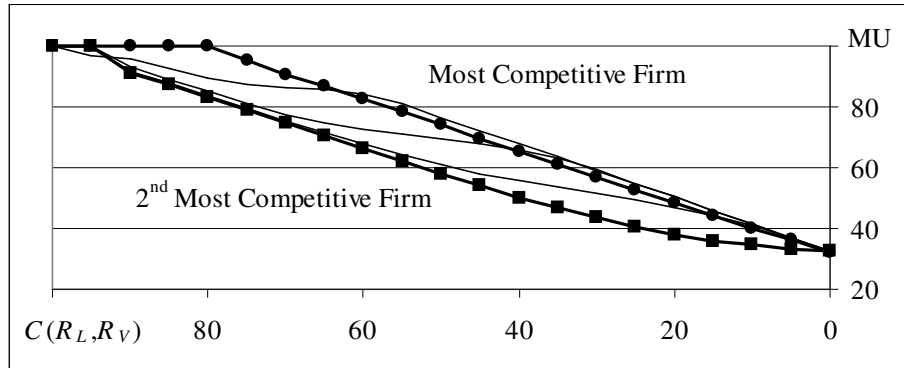


Fig. 1 - Average price evolution in each region

This figure illustrates two properties of the evolution of average price.

Property 1: The average price the good is transacted is decreasing with the reduction of inter-regional costs.

Property 2: The most competitive firm fixes the highest price and the 2nd most competitive firm fixes the lowest price. Less competitive firms fix an intermediate price that is decreasing with firms' competitiveness.

In the second picture, I illustrate the evolution of the quantity sell by each firm:

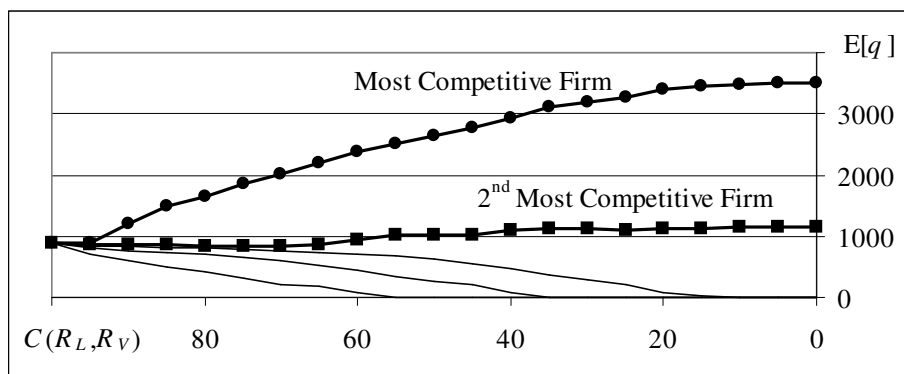


Fig. 2 - Evolution of quantity sell by each firm

This figure illustrates two properties of the evolution of quantity sell by each firm.

Property 3: The quantity sell by the most competitive firm expand, the quantity sell by the 2nd most competitive firm stands and the quantity sell by other firms decrease

until zero, with the reduction of inter-regional costs. As less competitive is the firm as quickly its quantity sell becomes zero.

Property 4: For small inter-regional costs, the market evolves to a duopoly (only two firms in market).

This last property is the most important of the model because is in accordance with some "global market". For instance, in the cola market there are only the "Coca Cola" and "Pepsi" firms and in the personal computers processors market there are only the "Intel" and "AMD" firms.

In the third picture, I illustrate the evolution of the competitiveness of the "country" as a whole:

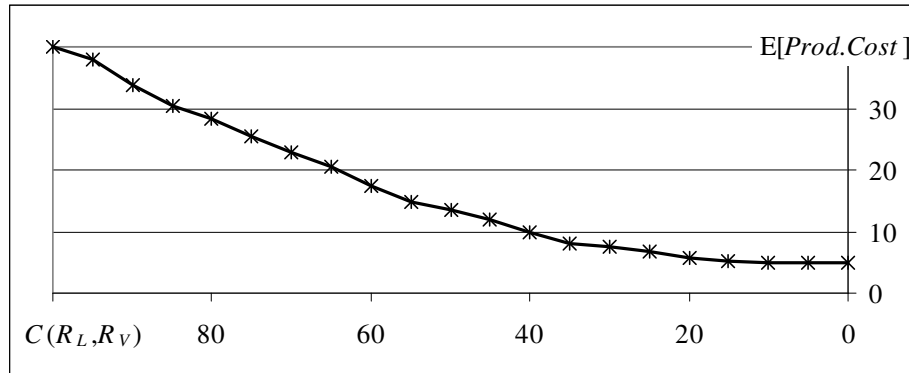


Fig. 3 - Evolution of the competitiveness of the "country"

This figure illustrates the last property of the model.

Property 5: The competitiveness of the "country" increases with the decrease of the inter-regional trade barriers.

4. Conclusion

When there are high transportation costs or tariffs between regions, regions are closed to trade and firms can only sell in its region of location. In this situation, firms are locally monopolists, being competitive even if they aren' t globally competitive.

But the historical tendency is the decrease of transport costs and tariffs that cause the opening of markets.

In this work, I study the evolution of the market structure and the competitiveness of the "country" with the openness of markets. I present a non-linear model of oligopolistic competition by advertising which results are obtained by computational methods.

The principal result of the model is that, if markets are perfectly open, there are only two firms competing in the market, a duopoly. This result is in accord, for instance, with the existence of only the "Coca Cola" and "Pepsi" firms on the cola market and only the "Intel" and "AMD" firms on the personal computers processors market.

Another property that results from the model is that the most competitive firm fixes the highest price and the 2nd most competitive firm fixes the lowest price.

Finally, the "country" as a whole becomes more competitive with the decrease of the inter-regional trade barriers.

Bibliography

Axell, Bo (1977), "Search Market Equilibrium", *Scandinavian Journal of Economics*, vol. 79, pp. 20-40.

Butters, Gerard R. (1977) "Equilibrium Distributions of Sales and Advertising Prices", *Review of Economic Studies*, vol. 44(3), pp. 465-91

Hotteling, H. (1929). "Stability in competition", *Economic Journal*, vol. 36: 41-57.

Pepall, Lynne, Daniel J. Richards and George Norman, 2^a ed., 2002, *Industrial Organization - Contemporary Theory and Practice*, South-Western, Mason.

Rasmusen, Eric (1989), *Games and Information, An Introduction to Game Theory* (2nd ed.), Blackwell, Cambridge MA.