Monopolistic competition in the retail industry: the role of government regulation

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Abstract. The Dixit-Stiglitz monopolistic competition model with retailing is investigated. Retailer-monopolist deals with a continuum of producers and "representative" consumer. The behavior of each producer is described by the linear costs; each producer produces one type of goods and sets the price of the goods. Preferences of the representative consumer describes by a quadratic utility function that corresponds to the linear demand. The retailer is a market leader. He chooses a number of producers and retail premium. We study the various variants of the retailer behavior under "zero-profit condition" ("free entry and exit": producers are free to enter the market if their profit is positive, and may leave the market, as soon as their profit becomes negative). We study what kind of the retailer behavior is most favorable for each of the market players: for the retailer, for the representative consumer, as well as for the society.

Keywords. Dixit-Stiglitz model, Monopolistic competition, Public welfare, Entrance fee, Retailing.

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1 Introduction

The monopolistic competition model modified by the introduction of a two-level interaction "manufacturer-retailer-consumer" is investigated.

The monopolistic competition with the strategic behavior of the retailer is studied, when the retailer is the leader, and the producers is "driven". First, the retailer announces its policy of trade mark-ups and simultaneously chooses a variety of products purchased from manufacturers.

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Then each manufacturer chooses his wholesale price and decides whether to enter the market or not. The market determines the number of goods produced, taking into account the "profile" of demand generated by the quasi-linear utility function of a representative consumer. A retailer charges a fee for entering the market from each manufacturer.

The role of the state as a party regulating the activity of the retailer is considered. It is necessary to determine the value of the manufacturer fee to the retailer for entering the market.

During investigation of the model it was found on the basis of [1], [2] and [6] that the entrance fee optimal from the point of view of public welfare (i.e. chosen by the state), is strictly greater than the entrance fee optimal from the point view of the retailer.

2 Model

In the model of monopolistic competition, the retailer is considered, dealing with a continuum of manufacturers, evenly distributed on the interval and some representative consumers.

We assume that the retailer is a monopolist ([14]). Each producer produces one type of commodity variety and determines the price of this commodity variety. The manufacturer's costs are divided into fixed and variable costs. The consumer maximizes his utility function.

Thus the model of monopolistic competition can be considered as a three-stage model.

2.1 Consumers

We consider the Dixit-Stiglitz monopolistic competition model with representative consumer ([3], [4], [7], [8]). The representative consumer provides to the market units of labor and labor is the sole factors of production. There it is two types of products in the economy. The first type of product is a certain variety. The second type of products is aggregated other (absolutely competitive) products. The effect of income is not taken into account.

We denote the consumers utility function as $U(q, N, A)$. We model a homogeneous consumers population by a quadratic utility function

$$U(q,N,A) = \alpha \int_0^N q(i)di - \frac{\beta-\gamma}{2}\int_0^N [q(i)]^2 di - \frac{\gamma}{2}\left[\int_0^N q(i)di\right]^2 + A \qquad (1)$$

where $q(i) \geq 0$ is the consumption of i-th variety, $q = q(i)_{i\in[0;N]}$ is the infinite-dimensional vector, $p(i)$ wholesale price of i-th variety, A is the consumption of other aggregated products, α, β, γ are some positive parameters with the following meaning: α is a choke-price (maximal price that consumers tolerate), $\alpha > 0$ provides increasing of the function U, $\beta > \gamma > 0$ reflects satiability of demand.

Coefficients β and γ express commitment to diversity. If $\beta = \gamma$, then the utility is affected only by the volume of consumption, and the variety does not affect. Utility functions analogous to expression (1) are considered in [5], [10], [16], [18]. The quadratic utility function means, that the demand function depends on the prices of the products. Utility functions for nonlinear demand are considered in [11], [12], [13], [15]. The following inequality describes the budget constraint:

$$\int_0^N p(i)q(i)di + P_A A \leq \omega L + \int_0^N \pi_M(i)di + \pi_R, \tag{2}$$

where $p(i)$ is the price of variety i for the consumer, ω is the wage rate in the economy ($\omega \equiv 1$ in balance), P_A is the price of other products ($P_A \equiv 1$ in balance), $\pi_M(i)$ is the manufacturer profit, $\pi_R(i)$ is the retailer profit.

The right side of the budget constraint is the GDP of the economy, reduced to income. The left side is the amount of costs. Then the task of the representative consumer takes the form

$$U(q, N, A) = \alpha \int_0^N q(i)di - \frac{\beta - \gamma}{2} \int_0^N [q(i)]^2 di - \frac{\gamma}{2} \left[\int_0^N q(i)di \right]^2 + A \to \max_{q,A},$$

$$\int_0^N p(i)q(i)di + P_A A \leq \omega L + \int_0^N \pi_M(i)di + \pi_R,$$

2.2 Manufacturers

The problem of manufacturers profit maximization can be formulated as

$$\pi_M = p(i)q(i; p + r) - (dq(i; p + r) + F) \to \max_{p(i)},$$

where $r(i)$ is the retailer's trade margin, $p = (p(i))_{i \in [0;N]}$ and $r = (r(i))_{i \in [0;N]}$ are infinite-dimensional vectors, d is the number of units of labor required to produce a unit of product of each kind, F is fixed cost of manufacturing.

2.3 Retailer

The retailer maximizes his profit. But at the same time there is constraints in the form of the condition of freedom of entry: manufacturers enter the market as long as it is profitable for them (their profit is nonnegative).

$$\pi_M = \int_0^N [r(i) - d_R]q(i; p + r)di - \int_0^N F_R di \to \max_r,$$
$$\pi_M(p(r; N); r; N) \geq 0,$$

where d_R is the number of units of labor required by a retailer to sell a unit of a differentiated product, F_R is the fixed retailer costs required to start selling a differentiated product.

2.4 Social welfare function

We consider the social welfare function W. It is the utility of the product, taking into account the costs of production and sale:

$$W = \alpha \int_0^N q(i)di - \frac{\beta - \gamma}{2} \int_0^N [q(i)]^2 di - \frac{\gamma}{2} \left[\int_0^N q(i)di \right]^2 - \\ - \int_0^N (d + d_R) q(i) di - \int_0^N (F + F_R) di. \quad (3)$$

3 Unlimited market

In this section we consider the situation of an unlimited market [1], [9]. It means that fixed retailer costs on one product sale is more than two times less than fixed manufacturer costs for its production, i. e. $F_R \leq 2F$ or $\Psi = F_R/2F \leq 1$.

Then $\pi_M = 0$, i. e. the condition of freedom of entry is active.

In this case, the number of producers is determined not by the retailer. Manufacturers enter the market themselves as long as their profits are positive. First, we determine the number of firms-producers N as a function of the trade markup r:

$$\pi_M = 0 \Rightarrow N = N(r).$$

Next, from the optimal variety N retailer determines the trade markup profile $r = (r(i))_{i \in [0;N]}$ from the condition of maximizing its profit:

$$\pi_R = N[r(i) - d_R] q(i; p + r) di - N F_R \to \max_r .$$

The solution of the three-level problem takes the form:

$$q = \Delta, \ p = d + \Delta \cdot (\beta - \gamma),$$

$$\pi_R = \left(\widetilde{D} - 2(\beta - \gamma)(\Psi + 1)\right) \cdot \frac{F}{4\gamma(\beta - \gamma)}, r = d_R + \Delta \left(\frac{\widetilde{D}}{2} + (\beta - \gamma)(\Psi - 1) \right),$$

$$N = \frac{\widetilde{D} - 2(\beta - \gamma)(\Psi + 1)}{2\gamma},$$

$$W = \left(\widetilde{D} - 2(\beta - \gamma)(\Psi + 1)\right) \left(\widetilde{D} - \frac{4 + 6\Psi}{3} (\beta - \gamma) \right) \cdot \frac{3F}{8\gamma(\beta - \gamma)},$$

where

$$\Delta = \sqrt{\frac{F}{\beta - \gamma}}, \quad \widetilde{D} = \sqrt{\beta - \gamma} \cdot \frac{\alpha - d - d_R}{\sqrt{F}} = \frac{\alpha - d - d_R}{\Delta}.$$

4 Entrance fee

Suppose that a retailer charges a fixed entrance fee F_e to the market from each manufacturer. Then the fixed costs of the producer became equal $F + F_e$, and fixed costs of the retailer is equal $F - F_e$. It is necessary to determine the optimal amount of entrance fee from the point of view of the state. If entrance fee value is determined by the retailer, then it will be chosen equal to retailer's constant costs.

It follows from

$$\pi_M = p(i)q(i) - (dq(i) + F + F_e) \to \max_{p(i)},$$

$$\pi_R = \int_0^N \big((r(i) - d_R)q(i) - F_R + F_e\big)di \to \max_{r,N,F_e},$$

then $F_e = F_R$. Let's see if the entrance fee is too high.

Suppose that the amount of the entry fee is determined by a third party, the State. Then the entrance fee, optimal from the point of view of society, is the solution of the problem:

$$\left\{ \pi_M = 0 \Rightarrow N = N(r)\pi_R = N[r - d_R]q - NF_R \to \max_r W \; to \max_{F_e} \right.$$

where W is the social welfare function given by expression (3).

Proposition 1. *The value of the fee for entry of producers to the market, optimal from the point of view of social welfare, is strictly greater than the fixed costs of the retailer: $F_R < F_e$.*

Thus, the optimal value of fees for entry of producers on the market from the point of view of social welfare F_e is strictly higher than the fixed costs of the retailer F_R.

5 Conclusions

The model on the basis of the Dixit-Stiglitz monopolistic competition model is investigated. The case of retailer leadership in an unlimited market is studied. The regulatory role of the state in determining the fees of producers for entering the market is considered. The optimum payment of producers from the point of view of public welfare is found.

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