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Monopoly rents in contestable markets

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HIGHLIGHTS

- We analyze a contestable market using a model with pricing and entry decisions.
- Only one firm enters the market, and randomizes over multiple prices.
- The other firm stays out of the market in equilibrium.
- Undercutting is not profitable because of randomization.
- The entrant is able to charge high prices and collect positive rent.

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ABSTRACT

Random choices of prices and product characteristics can be used by a contestable monopolist to deter entry and fully extract the monopoly rent. We develop this idea in a model of Bertrand price competition. In equilibrium, one firm enters the market and makes choices that are unpredictable to its competitors. This prevents price undercuts and keeps other firms out of the market. The entrant firm collects the monopoly rent despite the existence of potential competitors. This result raises an alert for regulatory practices based on the conventional wisdom that contestability is associated with low prices and profits.

1. Introduction

Contestable markets are those in which the incumbent firms are permanently threatened by inactive firms willing to enter the market. The existing literature suggests that potential competitors may be as effective as actual competitors in restricting the market power of active firms. This general idea was introduced by Bain (1949) and Sylos-Labini (1956). It was further developed in a celebrated book by Baumol et al. (1982) which deeply impacted regulatory practices across the world. The following quotation from Baumol and Willig (1986, p. 22) summarizes a great deal of our current understanding on the topic:

> "when the number of incumbents in a market is few or even where only one firm is present, sufficiently low barriers to entry may make antitrust and regulatory attention unnecessary."

Based on this principle, economists have been widely concerned about legal and technical barriers that restrict the entry of new firms into a market. We contribute to this agenda by presenting environments in which apparently innocent randomness on prices and product characteristics may act as a powerful device to discourage entry and extract consumer surplus.

We study Bertrand models of price competition in which firms face fixed costs to produce differentiated goods. The structure of preferences and costs is such that there are multiple pure strategies (on prices and product designs) that generate the same monopoly profit. We derive an equilibrium in which an entrant firm randomizes across these monopoly pure strategies and all other firms stay out of the market. Price undercuts become impracticable since the contestant firms are not able to precisely anticipate which action

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will be taken by the entrant monopolist. Fixed costs pose a loss on contestant firms that undercut the *wrong* monopoly strategy. Thus, by being unpredictable to other firms, the monopolist deters entry and collects the entire monopoly rent.

Our main result is novel and not obvious from a theoretical point of view. Two related references are useful to illustrate this point. Sharkey and Sibley (1993) analyze the Bertrand model when identical stores face an entry cost and constant marginal costs to sell a given good. They derive a symmetric mixed-strategy equilibrium in which all stores enter the market with positive probability and make zero expected profits. Monopolistic profits do not arise in this single-good setting.

In another related work, Braido (2009) studies the existence of a Bertrand equilibrium for economies with multiple goods and continuous nonconvex costs. Consumers are restricted to purchase all products from the same store. An equilibrium exists under general assumptions. Moreover, when firms face identical linear costs and consumers hold the same preferences, the equilibrium displays random price dispersion and at least two stores enter the market with positive probability.[1] Our monopolistic result is also not possible in this homogeneous multiproduct setting. We show that it can arise when consumers hold heterogeneous preferences over different goods or characteristics (e.g., Section 2) or, alternatively, when the consumer can visit all stores and shop each product at the lowest price available (e.g., Section 3).

We argue that our main finding is also relevant from a practical point of view. Unanticipated choices of product characteristics and price rebates appear in most releases in fashion and electronics. This is usually intended to avoid that other potential suppliers offer the same product at a lower price. Unpredictability could be viewed as a not so innocent way to restrict competition.

The remainder of this paper is organized as follows. We introduce two different illustrations of our main point before discussing it in a general framing. Section 2 explores a simple case where consumers have heterogeneous preferences over a particular characteristic of the good. Section 3 considers an environment with two complementary goods where there are infinitely many monopoly prices. Section 4 discusses the issue in a general model with multiple goods. Concluding remarks appear in Section 5.

2. Heterogeneous consumers

Ms. White and Ms. Green plan to purchase a fancy coat. Two identical firms can produce the coat in two different models, say white and green. Each firm must invest \$3 to design the first unit of a given model. The marginal cost for producing the second unit of the same model is zero.

Preferences are quasi-linear in wealth, and each consumer is endowed with \$4. Ms. White is willing to pay up to \$3 for a white coat and up to \$2 for the green model. Analogously, Ms. Green's reservation price is \$2 for the white coat and \$3 for the green.

We write p^j_w and p^j_g for the prices of the white and green models produced by firm $j \in \{1, 2\}$. Each firm maximizes its expected profit by selecting a probability distribution over the set $\mathbf{P} \times \mathbf{P}$, where $\mathbf{P} \equiv \mathbb{R}_+ \cup \{p_{\text{out}}\}$ and p_{out} represents the decision of not offering the respective product.[2] By setting $p^j_w = p_{\text{out}}$ or $p^j_g = p_{\text{out}}$, firm j does not produce any unit of the respective model and does not bear the fixed design cost.

We use $x^j_{i,w} \in \{0, 1\}$ and $x^j_{i,g} \in \{0, 1\}$ to represent the amount of white and green coats purchased by agent $i \in \{\text{W}, \text{G}\}$ from firm $j \in \{1, 2\}$. Consumers are informed about the realization of firms' choices $p \equiv (p^1, p^2)$. The consumption set $X(p)$ that is available for each agent is given by the subset of $\{0, 1\}^4$ such that $x^j_{i,l} = 0$ when $p^j_l = p_{\text{out}}$.

Ms. White takes prices as given and chooses $x^*_{\text{W}}(p) \in X(p)$ to maximize

$$\max\left\{3\chi_{[x^1_{\text{W},w}+x^2_{\text{W},w}\geqslant 1]}, 2\chi_{[x^1_{\text{W},g}+x^2_{\text{W},g}\geqslant 1]}\right\} + \left(4 - \sum_{j\in\{1,2\}} (p^j_w x^j_{\text{W},w} + p^j_g x^j_{\text{W},g})\right),$$

where $\chi_{[\cdot]}$ is the indicator function that equals 1 when the statement in $[\cdot]$ holds. Analogously, Ms. Green chooses $x^*_{\text{G}}(p) \in X(p)$ to maximize

$$\max\left\{2\chi_{[x^1_{\text{G},w}+x^2_{\text{G},w}\geqslant 1]}, 3\chi_{[x^1_{\text{G},g}+x^2_{\text{G},g}\geqslant 1]}\right\} + \left(4 - \sum_{j\in\{1,2\}} (p^j_w x^j_{\text{G},w} + p^j_g x^j_{\text{G},g})\right).$$

Remark 2.1. Coats of the same color produced by different stores are perfect substitutes, and consumers do not enjoy having more than one coat. This is behind the $\max\{\cdot, \cdot\}$ representation of consumers' preferences. Notice also that preferences are quasi-linear in wealth. Consumers are endowed with \$4 and pay for every coat purchased (white or green from firm 1 or 2). Naturally, for positive prices, consumers will never buy more than one coat.[3]

On the production side, each firm j takes the pricing strategy of the other firm and the consumers' demand functions as given. If the realized vectors of prices is $p \equiv (p^1, p^2)$, firm j's profit is

$$p^j_w y^j_w(p) + p^j_g y^j_g(p) - 3\left(\chi_{[p^j_w \neq p_{\text{out}}]} + \chi_{[p^j_g \neq p_{\text{out}}]}\right),$$

where $y^j_w(p) = x^{*j}_{\text{W},w}(p) + x^{*j}_{\text{G},w}(p)$, $y^j_g(p) = x^{*j}_{\text{W},g}(p) + x^{*j}_{\text{G},g}(p)$, and $\chi_{[\cdot]}$ is the indicator function.

Classic monopoly For sake of clarity, let us initially consider the hypothetical case with a single firm in the market. If the firm could discriminate prices, it would offer only one color (say white) and charge \$3 from one consumer (Ms. White) and \$2 from the other (Ms. Green). Consumers earn no surplus in this context, and the firm extracts a revenue of \$5 and a surplus of \$2.

If forced to charge identical prices across consumers, the firm would offer only one color at \$2. This generates a revenue of \$4 and the monopoly rent of \$1. The consumer whose favorite color was produced obtains a surplus of \$1, while the other consumer earns no surplus. These scenarios (with and without price discrimination) are both Pareto optimal. Producing coats in two different colors is Pareto dominated in this economy.

Contestable monopoly Consider now the case in which two firms set per-unit prices for each coat model. We point out that there is an equilibrium in which one firm stays out of the market while the other plays a mixed strategy that poses equal probability over the

[1] The formal result also relies on the assumption that the monopoly profit (net of the entry cost) is positive and on the property that the monopolist profit function varies continuously with prices. The argument is as follows. Under positive monopoly profit, there is not a Nash equilibrium in which all firms stay out of the market. Furthermore, if a firm were to be alone in the market, it should necessarily select among the monopoly prices (using pure or mixed strategies). If agents ranked multiple monopoly prices with the same indirect utility function (or alternatively, if the monopoly price were unique), then any non-entrant firm could profit by undercutting the appropriate monopoly price. By doing so, it would attract all consumers and generate a positive profit (slightly smaller than the monopoly level).

[2] We require p_{out} to be any mathematical object outside $\mathbb{R}_+$ such that $0p_{\text{out}} = 0$.

[3] There are price vectors that leave consumers indifferent across different options of colors and firms. As usual in equilibrium theory, in case of multiple solutions for the consumer's problem, one is free to take any of them as the optimal choice $x^*_i(p)$.

two monopoly price vectors: $(2, p_{\text{out}})$ and $(p_{\text{out}}, 2)$. Given that one firm stays out of the market, any of these price vectors generates the monopoly profit of \$1 for the entrant firm. Analogously, given the mixed strategy of the entrant firm, the pure strategy $(p_{\text{out}}, p_{\text{out}})$ is a best response for the contestant firm, since the expected profit of any other strategy is at most zero.[4] In this equilibrium, the entrant firm obtains the monopoly rent of \$1, the contestant firm earns zero, and each consumer obtains an expected rent of \$1/2. This equilibrium is Pareto optimal, and its total surplus is \$2.

Remark 2.2 (*Relation with the Entry Game*)**.** The pure strategies involved in our Nash equilibrium are credible in the sense of not being weakly dominated (see footnote 4). We emphasize this feature because it is in sharp contrast with the entry-deterrence equilibrium derived in the classic entry game.[5]

3. Costless shopping around

We now analyze the case in which a consumer has unitary demand for two perfect complementary goods, say a white computer and a green software. A package with one unit of each product is worth \$4, but each product is worthless if consumed alone. The consumer is endowed with \$4, and their preferences are quasi-linear in wealth.

Two electronic stores can offer these goods. They select which products to offer, but cannot sell the two products in a bundle. The consumer can costlessly visit all stores and purchase each good at the lowest price. Stores face a fixed cost of \$3 to set up the facilities, and marginal costs are zero.

We adapt the notation used before by dropping the consumer's name from their consumption choices. Agents choose bundles in $X(p)$ to maximize

$$4 \min \left\{ \chi_{[x_w^1 + x_w^2 \geqslant 1]}, \chi_{[x_g^1 + x_g^2 \geqslant 1]} \right\} + \left(4 - \sum_{j \in \{1,2\}} (p_w^j x_w^j + p_g^j x_g^j) \right).$$

Notice first that the consumer will search for the best prices and shop one unit of each good if and only if the total cost does not exceed \$4. As a consequence, there are multiple monopoly prices. That is, if alone in the market, the entrant firm will set prices in $\mathbb{R}_+^2$ such that $p_w^j + p_g^j = 4$. It is then simple to verify that there is an equilibrium in which one firm stays out of the market while the other plays the price vectors $(3, 1)$ and $(1, 3)$ with equal probability.[6]

Mixed strategies are essential for supporting an equilibrium in which only one firm enters the market. If the contestant firm were able to anticipate the realized price vector, it would be willing to undercut it and take the entire market. We also stress that this Nash equilibrium does not involve weakly dominated strategies (see footnote 6). Its outcome is Pareto efficient, consumer surplus is zero, and the monopolist collects a rent as if there were no threats of competitors entering the market.

4. General framing

Once we understood the nature of the threats that sustain the monopoly profit in a contestable market, we can easily extend the discussion to a more general framework. This generalization allows for Pareto inefficiencies usually studied in monopoly models (with elastic demand functions) which did not appear in our previous illustrations.

Consider an economy with heterogeneous consumers and $L > 1$ consumption goods (or equivalently, L different models of the same good). To keep notation simple, we assume there are two identical firms which select (possibly random) actions in $\mathbf{P}^L$. Consumers observe the posted prices before making their choices.

In this section, we take the profit function as a primitive of the model and skip the description of preferences and technology behind it. We refer the reader to Braido (2009) for a description of a general model of multiproduct Bertrand competition with multiple firms facing nonconvex cost functions.[7] We define $\pi : \mathbf{P}^L \times \mathbf{P}^L \to \mathbb{R}$ as the profit function of a given firm when two stores enter the market (duopoly case), where $\pi(p, p')$ stands for the profit of a firm setting prices p when its competitor charges p'. We define the L-dimensional vector $\bar{p} \equiv (p_{\text{out}}, \ldots, p_{\text{out}})$ to represent the non-entry decision of a given firm and assume non-entrant firms always earn zero, i.e., $\pi(\bar{p}, p') \equiv 0,\ \forall p' \in \mathbf{P}^L$. We also stress that $\pi(p, \bar{p})$ represents the profit function of a firm acting alone in the market (monopoly profit function).

We assume there are at least $K \geqslant 2$ monopoly prices—that is, K vectors $p(k) \in \mathbf{P}^L$ such that $\pi(p(k), \bar{p}) > 0$ and $\pi(p(k), \bar{p}) \geqslant \pi(p, \bar{p}),\ \forall p \in \mathbf{P}^L$. We also assume there are positive weights $\alpha(k)$ such that $\sum_{k=1}^{K} \alpha(k) = 1$ and

$$\sum_{k=1}^{K} \alpha(k) \pi(p, p(k)) \leqslant 0, \quad \forall p \in \mathbf{P}^L. \tag{1}$$

This condition requires that each firm makes a loss when entering the market against a strategy that randomizes over the multiple monopoly prices. Its validity will typically depend on economies of scope such as the fixed costs introduced in Sections 2 and 3.

Economies satisfying condition (1) have a Nash equilibrium in which one firm stays out of the market and the other draws the price $p(k)$ with probabilities $\alpha(k)$, for $k \in \{1, \ldots, K\}$. Although contested, the entrant firm collects the entire monopoly profit in this equilibrium.

Mild fixed cost Like in the examples discussed before, undercutting each given monopoly price is profitable for the non-entrant store. That is, there exists a price $p'(k)$ in a neighborhood of each monopoly price $p(k)$, such that $\pi(p'(k), p(k)) > 0$. However, given

[4] Given the entrant's mixed strategy, no pure strategy yields a positive profit for the contestant. This implies that there is no profitable deviation in mixed strategies. To verify the first statement, notice that it is never profitable for a firm to produce the two models together. Moreover, when offering each of the two models separately, the contestant firm faces the following scenarios: (a) if it charged more than \$2 for the produced coat, it would make a sale to at most one consumer and earn at most zero; (b) if it charged a price between \$1 and \$2, it would sell to both consumers half of the time and to one consumer otherwise, earning at most zero; (c) if it charged less than \$1, it would sell to both consumers but still lose at least \$1. (The contestant's expected profit for prices equal to \$1 or \$2 depends on the specific tie-breaking rule imposed, but they do not generate a profit for this firm even in the most favorable case.)

[5] In the classic entry game, a contestant firm chooses between entering or not into a market. In case of entry, the incumbent firm chooses between fighting and accommodating. Payoffs are such that fighting is not a best response for the incumbent in case the contestant enters the market. In spite of that, the game has a Nash equilibrium in which the contestant firm stays out of the market fearing the fighting strategy announced by the incumbent. The strategy used by the incumbent to deter entry is weakly dominated in the normal form of the game. We refer to Dixit (1982) for a discussion about this problem.

[6] For each of the two products, we have that: (a) the contestant sells the product for sure when it charges less than \$1; (b) it sells the product with probability $\frac{1}{2}$ when the price is in between \$1 and \$3; and (c) it does not sell the product when the price is higher than \$3. Across these cases, the largest revenue earned with a given product is \$1.5. (The revenues when prices are \$1 or \$3 depend on the specific tie-breaking rule imposed, but are never larger than \$1.5.) Therefore, none of the contestant's pure strategies can rise a total revenue larger than the set-up cost (i.e., \$3). This implies that there is no profitable deviation in mixed strategies.

[7] Consumers in that paper are restricted to buy all products from the same store, but the framing can be easily adapted to other contexts.

the equilibrium strategy, the non-entrant firm cannot anticipate which monopoly price is going to be selected by the entrant monopolist. Condition (1) imposes a significant loss for firms undercutting the *wrong* monopoly price.

We stress that the loss associated with each *wrong* undercutting can be mild when K is large. For an illustration, consider the model discussed in Section 3, assume there are $L \geqslant 2$ goods, modify the fixed cost to be $1 + \frac{4}{L}$, and adjust individual utility to be $4\min(x^1 + x^2) + 4 - \sum_{j\in\{1,2\}}(p^j \cdot x^j)$, where p^j and x^j are L-dimensional vectors. It is simple to verify that this economy has an equilibrium in which one firm stays out of the market while the other firm draws the following L price vectors with equal probability: for $k \in \{1, \ldots, L\}$, let $p(k)$ be a vector with the value 3 in the k-th entry and the value $\frac{1}{L-1}$ in the remaining $L-1$ entries. The monopolist revenue remains equal to $4, and the entry cost can be taken to be arbitrarily close to one (i.e., about 25% of the monopoly revenue) for large enough values of L.

5. Conclusion

Prices and product characteristics seem to be randomly determined in many markets. Product releases are good examples of this. When releasing products with a high level of innovation, such as tablets and smartphones, companies try to keep the specifications in secret. After the announcement of a new model, products start to be sold in a matter of weeks. We argue that the model presented in Section 2 provides a rationale for this.

Similarly, supermarkets usually announce temporary price cuts in a way that is unpredictable to potential competitors. The model presented in Section 3 relates to this phenomena. The number of smartphone characteristics and supermarket products is large. Therefore, as argued in Section 4, the fixed costs required for generating rents in those contexts need not be too high.

This reasoning highlights an important point for policy regulation. Contrary to the conventional wisdom, the mere existence of contestant firms facing low entry costs is not sufficient to guarantee low prices and profits.

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References

Bain, Joe S., 1949. A note on pricing in monopoly and oligopoly. Am. Econ. Rev. 39 (2), 448–464.
Baumol, William J., Panzar, John C., Willig, Robert D., 1982. Contestable Markets and The Theory of Industry Structure. Harcourt College Pub, New York.
Baumol, William J., Willig, Robert D., 1986. Contestability: developments since the book. Oxf. Econ. Pap. 38, 9–36.
Braido, Luis H.B., 2009. Multiproduct price competition with heterogeneous consumers and nonconvex costs. J. Math. Econ. 45 (9–10), 526–534.
Dixit, Avinash, 1982. Recent developments in oligopoly theory. Am. Econ. Rev. Pap. Proc. 72 (2), 12–17.
Sharkey, Willian W., Sibley, David S., 1993. A Bertrand model of pricing and entry. Econom. Lett. 41 (2), 199–206.
Sylos-Labini, Paolo, 1956. Oligopolio e Progresso Tecnico. Giuffre, Milan.