Monopoly vs. Competition in Light of Extraction Norms

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Abstract

This note demonstrates that whether the market is competitive or monopolistic need not be the result of ideology, political power or non-convexity of the technology. The answer can be determined by a government that maximizes the extracted resources from the alternative market structures. Our claim is illustrated by assuming that demand and supply are linear functions and that the government can extract the same share of the producers' profit under the alternative market structures. This share can be extracted from the actual producers or from the potential producers who take part in the contest to get a license to produce.

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1. Introduction

Suppose that social norms allow the use of political office for privileged distribution such that society has a political culture of extraction (Congleton, Hillman and Konrad 2008; Epstein and Nitzan 2007; Konrad 2008) or corruption (Ades and Di Tella 1999; Bliss and Di Tella 1997; Treisman 2000). This culture is represented by the extracted profit share R of the producers' profits. The resources can be extracted from the *n* existing actual producers who are required to give up this share of their profits in order to secure the government's approval of their production activity. Alternatively, the resources can be extracted from the potential producers who take part in the competition for the *n* licenses to be a producer in the market. In the monopoly case, there is a single producer (the government emits one license), n=1. In the competitive case, there exist *n* producers (the government emits *n* licenses), n>1. The objective of this note is to demonstrate the determination of market structure by the government. We first study the binary case where n=1 or n>1, assuming that *n* is given. We then allow the endogenous determination of *n* and specify the conditions for the optimal number of producers n^* to be equal to or larger than 1. Assuming that the cost and demand functions are linear, we examine the effect of the market characteristics on the government's choice between monopoly and competition.

2. Monopoly vs. competition

Suppose, first, that there are *n* identical producers in the industry. One option the government has is to let these producers get the profit of a competitive market, subject to the existing exogenous political or bureaucracy norm that allows the extraction of the proportion R of the profit, $0< R \leq 1$.[1] In such a case the government receives R*E*, where *E* is the total profit of the *n* competitive producers. The other possibility is to award the exclusive right of production to a single producer.[2] In this case, we assume that the government is also able to extract the proportion R of the monopoly profit A. Notice that R can be equal to 1. This can happen when the resources are extracted from the potential risk-neutral producers who take part in the contest for a single

[1] The endogenous determination of the norm of extraction is an interesting and important issue which is disregarded in our study. Given the exogenous extraction norm, we are able to demonstrate the endogenous determination of the market structure.

[2] The possible technological advantage of a monopoly due, for example, to his ability to invest more in research and development is disregarded. In other words, we assume that his cost function is identical to that of the competitive producers.

license or in the contests for the n production licenses the government emits. This assumption is plausible under certain conditions that are well known in the contest-theory literature (Higgins, Shughart, and Tollison 1985). For a recent study of the class of contests that satisfy this assumption see Alcalde and Dahm (2010).[3] The market structure determined by the government hinges on the relationship between A and E. If $E<A$, the government prefers the monopoly market structure. If $E>A$, the n-producer competitive industry is the preferred market structure of the government. In the former case, monopoly is not due to non-convexity of the technology (increasing returns to scale that rationalize the existence of a natural monopoly) or to the assignment of the monopoly license to a particular producer who is "close" to the government (sufficiently powerful politically to warrant the assignment of this privilege). In the latter case, competition among the existing n producers is not the result of ideology or the benevolence of the government. In both cases the preferred market structure reflects maximization of resources extracted from the producers. Market structure is determined then by the prevailing norm of extraction (the ability of the government to extract the profit share R from the single or from the n producers) and the characteristics of the supply and demand for the produced good. Note that the government need not restrict itself to the comparison between a single producer and some given number of producers, n. That is, the government can decide how many licenses to offer. In other words, the optimal number of licenses (and producers) n^* can be determined endogenously. In such a case, the monopoly (competitive) market structure is chosen if $n^*=1$ ($n^*>1$). To illustrate how demand and supply determine market structure, we consider the stylized case where demand and marginal cost functions are linear.

3. Linear demand and supply

Suppose that the demand function $p(x)$ is linear and the cost function $c(x)$ of every producer is quadratic and there are no fixed costs. That is, the demand and marginal

[3] Complete rent dissipation in a contest, where all monopoly profit is transferred to the government, has already been noted in the early studies of Krueger (1974) and Posner (1975) and in Tullock's (1980) rent-seeking contest, where the government applies the simple lottery contest success function and the number m of firms competing for the monopoly profit (rent) is sufficiently large. In the later case, the government actually extracts $(\frac{m-1}{m})A$. The same rate of extraction $(\frac{m-1}{m})$ is obtained in the n-prize contest assuming that m potential producers competing for each of the n contested licenses that yield the profit E/n for each of the n actual competitive producers. Although our complete dissipation assumption simplifies the illustration, it is inessential qualitatively as long as the same proportion R is extracted in the monopoly and the competitive cases.

cost function are linear, $p(x) = \delta - \kappa x,\ \kappa > 0$ and $c'(x) = \mu x,\ \mu > 0$. Figure 1 presents the demand curve, marginal revenue curve, marginal cost curve of the monopoly and the supply curve $c_{\Sigma}^{'}(x)$ of the *n*- producer industry (the horizontal sum of the marginal cost curves of the *n* producers. When the industry output is *x*, the share of every producer is (*x*/*n*) and therefore the industry marginal cost is equal to $(\mu / n)x$). The monopoly output x_m is determined by the intersection of the monopoly marginal cost and marginal revenue curves. The competitive equilibrium output x_e is determined by the intersection between the market demand and supply curves. The profit of a monopoly is represented by the trapezoid *A*. The total profit of the *n* competitive producers *E* is given by the triangle *E*. Let $\mathrm{K} = \dfrac{A}{E}$ and $\lambda = \dfrac{\mu}{\kappa}$. K is the relation between the profits of the monopoly and the competitive industry. λ, which represents the market characteristics, is the relation between the slopes in absolute terms of the marginal cost and the demand curves.

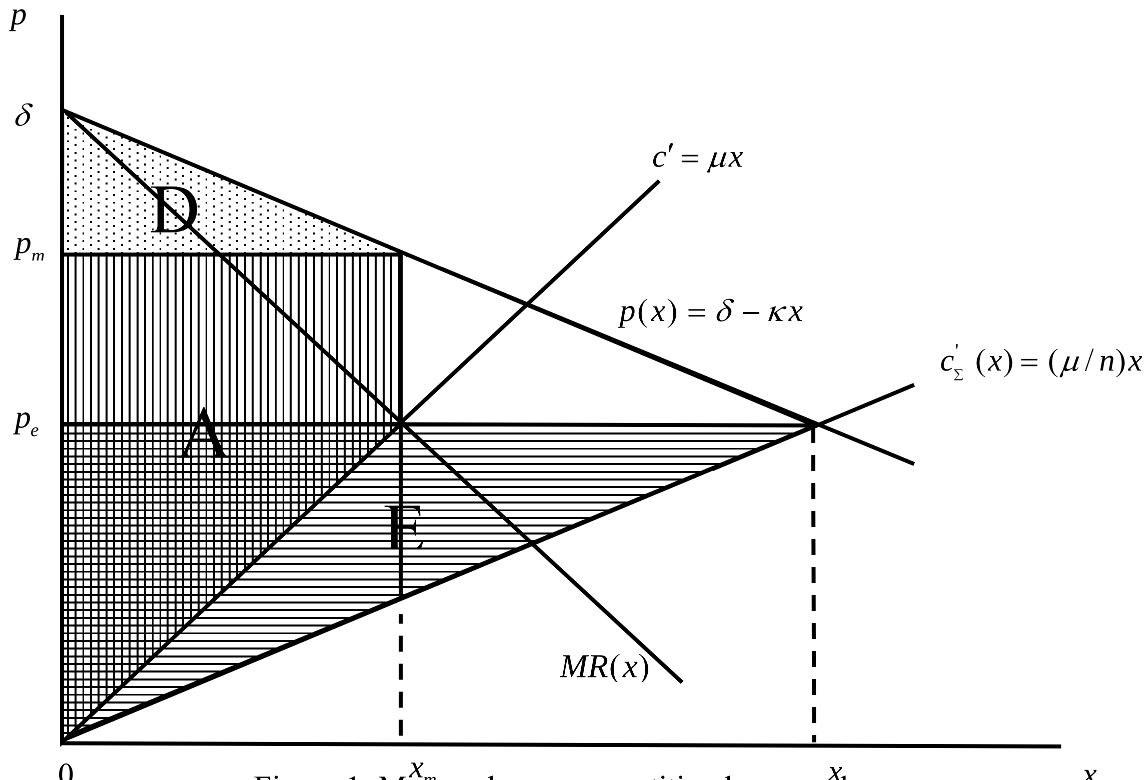

Figure 1: Monopoly vs. competition by *n* producers

The following result clarifies how market structure is determined by the given number of producers *n* and by the specific form of the demand and supply functions, represented by the parameter λ. Notice that the parameter δ is inconsequential in determining the selected form of market structure.

Proposition 1: The government sets the monopoly market structure rather than the competitive one where *n*>2, if $K = \frac{1}{n}\frac{(\lambda+n)^2}{(\lambda+2)\lambda} > 1 \Leftrightarrow \frac{n}{\sqrt{n-1}} > \lambda$. The government prefers the competitive market structure, if the inequality is reversed.

The proof of the proposition and its corollaries is relegated to the Appendix.

Proposition 1 implies that the monopoly is preferred to the competitive market provided that λ is sufficiently small; that is, the slope of the marginal cost function μ is sufficiently small or the absolute value of the slope of the demand function κ is sufficiently high (the demand is sufficiently inelastic). One implication of Proposition 1 relates to the effect of changes in λ and *n* on K. The effect of a change in λ (a change in μ or a change in κ) is unequivocal. However, the effect of a change in *n* on *K* is ambiguous. Specifically,

Corollary 1.1: K is decreasing in λ and increasing (decreasing) in *n*, provided that *n* is larger (smaller) than λ.

Corollary 1.1 implies that a less favorable technology (an increase in μ - the marginal cost becomes higher at any quantity *x*) or a more favorable market demand (a decrease in κ - the demand becomes larger at any price - the demand function becomes more elastic at any quantity) reduce $\mathrm{K} = \frac{A}{E}$. That is, such changes reduce the incentive of the government to prefer the monopoly market structure. If originally the government preferred the monopoly (competitive) structure, an increase in λ may (cannot) result in its preference reversal.

The economic intuition behind the ambiguity of the effect of a change in *n* on *K* is clear. Consider, for example, an increase in the number of the existing producers. Such a change increases the equilibrium quantity but reduces the equilibrium price. It also reduces the producers' marginal cost. Hence, the effect of a change in *n* on the profit of the competitive industry is ambiguous, depending on the relationship between n and λ. An increase in n may therefore induce the government to change the decision regarding its preferred market structure both when it originally preferred the competitive market or the monopoly.

Suppose now that the government does not take the competitive industry's size as given, but rather selects the number of producers that yields the maximal profit E. By Proposition 1 and the second part of its corollary we get the relationship between the optimal number of producers n* and the market (demand and supply) characteristics.

Proposition 2: If the government can set the optimal competitive industry size n^*, then it prefers the monopoly market structure, $n^*=1$, when $\lambda<2$ and a competitive structure, $n^*\geq 2$, when $\lambda>2$.

That is, if the slope of the marginal cost is smaller than two times of the absolute value of the slope of the demand function, $\lambda=\frac{\mu}{\kappa}<2$, then the government prefers a monopoly market structure. In other words, if the demand is sufficiently inelastic, $\kappa>\frac{\mu}{2}$, the government prefers the monopoly. If the slope of the marginal cost is larger than two times of the absolute value of the slope of the demand function, $\lambda>2$, (the demand is sufficiently elastic, $\kappa<\frac{\mu}{2}$), then the government sets a competitive market structure. In such a case the optimal number of producers is given by $n^*=\lambda=\frac{\mu}{\kappa}>2$.[4] In this case then the optimal number of producers n^* is decreasing in κ (increasing in the elasticity of the demand) and increasing in μ. Substituting n* into K(n, λ)= $\frac{1}{n}\frac{(\lambda+n)^2}{(\lambda+2)\lambda}$, see Proposition 1, we get $K^*(\lambda)=\frac{4}{\lambda+2}$. For $\lambda>2$, $K^*(\lambda)<1$, which is consistent with the inferiority of the monopoly market structure to the competitive market structure. Again, as in Corollary 1.1, we get that K^* is decreasing with λ.

[4] In fact, this claim is true when λ is an integer. In general, n* is equal to the larger or smaller closest integer to λ.

4. Summary

We demonstrated how technology and market characteristics together with the prevailing extraction norms (the ability to extract some share of the producers' profit) determine whether the market is monopolistic or competitive. The comparison between monopoly and competition with limited entry was based on the simplifying assumption of linear demand and supply functions. We first derived the criterion used by the government to decide which of the two possible market structures is preferred (Proposition 1). This criterion depends on the slopes of the demand and marginal cost curves and on the existing number of producers. Proposition 1 was applied to study the effect of changes in demand, supply and the existing number of producers on the applied criterion (Corollary 1.1). We then derived the criterion used by the government to decide which of the two possible market structures is preferred, when it can set the optimal industry size that yields the largest competitive profit (Proposition 2).

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Appendix: proofs

Proposition 1: The government sets the monopoly market structure rather than the competitive one where n>2, if $K = \frac{1}{n}\frac{(\lambda+n)^2}{(\lambda+2)\lambda} > 1 \Leftrightarrow \frac{n}{\sqrt{n-1}} > \lambda$**.** The government prefers the competitive market structure, if the inequality is reversed.

Proof: In Figure 1, x_m and x_e are determined, respectively, by the intersection of the marginal revenue and marginal cost curves and the demand curve and aggregate marginal cost curves of the *n* producers. Hence,

(A1) $$\delta - 2\kappa x = \mu x \Rightarrow x_m = \frac{\delta}{\mu + 2\kappa} ,$$

(A2) $$\delta - \kappa x = \frac{\mu}{n} x \Rightarrow x_e = \frac{\delta}{\frac{\mu}{n} + \kappa} .$$

We can now use x_m and x_e to compute A and E, the profits of the monopoly and the competitive industry. Notice that in Figure 1, *A= (A+D) –D*.

Since $(A+D) = \frac{1}{2} x_m \left[2\delta - x_m(\kappa + \mu) \right]$ and $D = \frac{x_m^2}{2}\kappa$,

(A3) $$\text{A= (A+D) –D} = \delta x_m - \frac{1}{2} x_m^2 (2\kappa + \mu) .$$

Since $E = \frac{1}{2} x_e^2 \frac{\mu}{n}$,

(A4) $$\frac{A}{E} = 2\delta \frac{x_m}{x_e^2(\mu/n)} - \left(\frac{x_m}{x_e} \right)^2 \frac{2+\lambda}{\mu + 2\kappa} .$$

Notice that

(A5) $$\frac{\delta x_m}{x_e^2} = \frac{\delta^2 / (\mu + 2\kappa)}{\delta^2 / (\frac{\mu}{n} + \kappa)^2} = \frac{\left(\frac{\mu}{n} + \kappa \right)^2}{(\mu + 2\kappa)} .$$

Hence, by (A4), (A5), (A1) and (A2), we have found that

$$\text{(A6)} \qquad \frac{A}{E} = 2\frac{(\frac{\mu}{n}+\kappa)(\frac{\mu}{n}+\kappa)}{(\mu+2\kappa)\frac{\mu}{n}} - \left(\frac{(\frac{\mu}{n}+\kappa)}{(\mu+2\kappa)}\right)^2 \frac{\lambda+2}{\lambda/n} =$$

$$= n\frac{(\frac{\lambda}{n}+1)^2}{(\lambda+2)\lambda}\{2-1\} = \frac{1}{n}\frac{(\lambda+n)^2}{(\lambda+2)\lambda} = K\,.$$

We have thus found that the government sets the monopoly market structure rather than the competitive one, if and only if $\frac{1}{n}\frac{(\lambda+n)^2}{(\lambda+2)\lambda} = K > 1$ and it prefers the competitive market structure if the inequality is reversed.

By (A6), therefore

$K > 1 \Rightarrow (\lambda+n)^2 > (\lambda+2)\lambda n$

or

$\lambda^2 + 2\lambda n + n^2 > \lambda^2 n + 2\lambda n$

or

$\lambda^2 + n^2 > \lambda^2 n \Rightarrow \lambda^2 < \frac{n^2}{n-1} \Rightarrow \lambda < \frac{n}{\sqrt{n-1}}$.

Q.E.D

Corollary 1.1: K is decreasing with λ and increasing (decreasing) with *n*, provided that *n* is larger (smaller) than λ.

Proof: The proof is directly obtained by differentiating $K = \frac{1}{n}\frac{(\lambda+n)^2}{(\lambda+2)\lambda}$ with respect to λ and *n*. Specifically, it can be readily verified that

$$\frac{\partial K}{\partial \lambda} = \frac{\left[\lambda^2+2\lambda-\lambda^2-\lambda-n\lambda-n\right]}{n^2(\lambda^2+2\lambda)^2} = \frac{\left[\lambda(1-n)-n\right]}{n^2(\lambda^2+2\lambda)^2} < 0\text{, since } n \geq 2 \text{ and}$$

$$\frac{\partial K}{\partial n} = \frac{1}{n^2\lambda(\lambda+2)}\left[n^2-\lambda^2\right] \underset{<}{\geq} 0 \Leftrightarrow n \underset{<}{\geq} \lambda\,.$$

Q.E.D

Proposition 2: If the government can set the optimal competitive industry size n^*, then it prefers the monopoly market structure, $n^*=1$, when $\lambda<2$ and a competitive structure, $n^*\geq 2$, when $\lambda>2$.

Proof: By the second part of Corollary 1.1, for $n\geq 2$, $K=\frac{A}{E}$ is minimized and so $\frac{E}{A}=\frac{1}{K}$ is maximized at $n=\lambda=\frac{\mu}{\kappa}$. Since n must be an integer, the optimal number of producers (licenses) $n^*=\lambda$ when λ is an integer larger than 1. When λ is not an integer and $\lambda>2$, n^* is equal to the closest integer larger than λ or the closest integer smaller than λ, depending on which of these integers yields the larger competitive profit. If $\lambda<2$ and n=2, $\frac{n}{\sqrt{n-1}}=\frac{2}{\sqrt{2-1}}=2>\lambda$. Therefore, by Proposition 1, when $\lambda<2$, $n^*=1$.

Q.E.D

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