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Abstract

This paper proposes a new model of market structure determination. It demonstrates that market structure need not be the result of ideology, political power, collusion among producers or the nature of the technology. In our setting, it is determined by bureaucrats who maximize their share of the industry profits. The approach is illustrated by studying the relationship between industry size and the existing institutional norm and by identifying the bureaucrats' most preferred norm. In the latter context, we establish the fundamental inverse relationship between the costs of interaction with government officials and industry size.

Keywords
Institutional norms, bureaucracy costs, norm viability, industry size

JEL Classification
D72, D73

Contents

1. Introduction

Institutional norms can be represented by the preferences of bureaucrats (civil servants, government officials) who make or strongly affect economic policy or economic transactions. For example, such norms can be represented by the weights assigned to the public well being relative to more selfish interests, represented by the probability of remaining in office or by the amount of resources transferred from the consumers or producers to the bureaucrats, Epstein and Nitzan (2007), Esteban and Ray (2010), Grossman and Helpman (1994), Van Winden (1998). An alternative representation of the prevailing norm can be based on the revealed preference of the economic agents (government officials, producers and consumers), namely on their behavior as manifested in their interaction. For example, such a norm can be represented by the costs of interaction with government officials – the costs of consumers or producers who engage in economic activity that requires formal or informal endorsement by government officials. In many countries, and in particular, developing countries, low-level officials reduce the profit of firms by delaying different aspects of their operation (producing and selling their products). The firms transfer part of their profits, for instance, when paying 'speed money' to enhance their business activities and avoid bureaucratic friction or red-tapes, Lui (1985), Kahana and Nitzan (2002), Muhkerjee (2005). In the current study the second representation of institutional norms (henceforth 'bureaucracy norms') is adopted. Specifically, we assume that bureaucracy norms allow the use of government office for extracting resources, Konrad (2009). The bureaucracy norms result in the existence of bureaucracy costs. Specifically, an institutional norm is represented by the profit share producers are required to give up in order to secure the approval of government officials to produce and/or sell their desired quantity of output. In the simplest case this 'bureaucracy tax' rate is constant.

Market structure can be characterized by the number and strength of consumers and producers, degree of collusion among them, forms of competition and ease of entry into and exit from the market. In this study we focus on the number of price-taking producers assuming that there is no collusion (among buyers and sellers) and that there are many competitive consumers.

The main objective of the paper is to propose a simple new model of industry size determination. Rather than investigate the extent of bureaucracy costs under alternative market structures or how domestic market structure influences the political effectiveness of interest groups, Hillman, Long and Soubeyran (2001), we examine how bureaucracy norms affect market structure[1]. In our setting the decision on the number of active price-taking firms in an industry is made by government officials. The proposed approach is illustrated, first, by focusing on the relationship between the number of competitive firms and the existing institutional norm. We then identify the bureaucrats' most preferred relationship between industry size and the bureaucracy norm (recall that a bureaucracy norm specifies for any level of production the profit share transferred from the producer to the bureaucrat). In the proposed model, the number of firms is not determined by strategic entry barriers due to collusion among the sellers, by technological entry barriers (the different efficiency of the producers), by a competitive ideology of the regulator or by the political power of some sub-group of the producers. Rather, it is the optimal number for a bureaucrat who is interested in enhancing his own interest (maximize his share of the industry profits – the total costs of the producers' interaction with him), taking advantage of the existing market characteristics as well as the prevailing norm that allows a particular pattern of extraction of resources from the producers. If the bureaucrat can control the structural relationship between industry size and the institutional norm, then he would choose his most preferred relationship between industry size and the function relating bureaucracy costs to quantity of output.

The remainder of the paper is laid out as follows. In Section 2 we introduce the producer's problem, given a particular bureaucracy norm, present the equilibrium analysis of the producer's optimal output and identify sustainable or viable norms that ensure existence of equilibrium. The study of the relationship between bureaucracy norms and industry size is carried out in Section 3. The last section 4 contains a summary and some concluding remarks. The proof of all the results is relegated to an Appendix.

2. Optimal output and viable bureaucracy norms

Consider a producer of a certain good whose action, producing and/or selling a certain amount x of the good, hinges on the timely agreement of government officials. The producer is aware of this limitation as well as of the price of securing the necessary

[1] Market structure could be viewed as economic policy. However, this direction is not taken in Persson and Tabellini (2000). Our approach also differs from that of Horstmann and Markusen (1992) who view market structure as the outcome of plant location decisions.

endorsement of the bureaucrats. This price is associated with the efforts invested in coping with bureaucratic barriers and the direct and indirect payments that are usually involved in obtaining such government approval. One example is the case of quality control of the produced output by government inspectors. In other examples, producers of some military weapon, intelligence services, classified sophisticated technologies etc. face demands for special payments connected with import and export licenses or exchange controls. Producing and selling such goods to various countries requires the government's endorsement and the producer certainly takes into account the share of his profit that has to be transferred to the bureaucrat. This share, $(1\text{-}G(x))$, is assumed to be non-decreasing in the desirable output level x.[2] The precise relationship between the residual producer's share, $G(x)$, where $G(x)\in[0,1]$, $G(0)=1$ and $G'(x)\leq 0$ for $x\geq 0$, represents the prevailing bureaucracy norm. That is, the function $G(x)$ represents the actual effective norm that specifies the relationship between the producer's net profit share, and in turn the share of resources extracted by the government officials at any given output level. In other words, this function is based on the revealed preference of the economic agents (the government officials as well as the producers) and on the institutions and culture that govern the relationship between these agents. In our setting then the institutional norm can be considered as a political-economic environmental constraint that reflects the prevailing (equilibrium, steady state or evolutionary stable) behavior of the bureaucrats and of the producers in the interaction that determines the accepted known necessary price for approval of any output level desired by a producer. This means that the net profit of the price-taking producer is:

(1) $$\pi(x)=\left[px-c(x)\right]G(x) \ ,$$

Where p is the fixed price of the good and $c(x)$ is a convex cost function ($c'(x)>0$ and $c''(x)>0$)[3].

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[2] Whether (1-G(x)) is increasing or decreasing in x depends on the strength of the bureaucrat to extract resources from the producer relative to the strength of the producer to protect himself from such extraction as he gets bigger. In our model we implicitly assume that the difference between the strength of the bureaucrat and the strength of the producer increases with x.

[3] Our analysis is still valid when the cost function is linear or even concave. This point is further clarified in the remark at the end of this section.

The first order condition for an interior solution of the producer's problem, the maximization of his profit, is:

(2) $$\pi'(x) = [p - c'(x)]G(x) + [px - c(x)]G'(x) = 0.$$

The second order condition for an interior solution of the producer's problem is:

(3) $$\pi''(x) = -c''(x)G(x) + 2[p - c'(x)]G'(x) + [px - c(x)]G''(x) < 0 .$$

Notice that under the extreme case where $G(x) \equiv 1$, inequality (3) is satisfied. In general, however, this second order condition requires that a certain relationship holds between *G(x)* and *c(x)* for securing the producer's equilibrium. In fact, condition (3) can be used to characterize the necessary form of the bureaucracy norm that ensures the existence of an optimal output. In other words, it can be used to characterize *viable bureaucracy norms* - norms that are consistent with the existence of a solution to the producer's problem. This application of the second order condition yields the following result:

Proposition 1: A bureaucracy norm given by *G(x)* is viable, if it is a constant or bounded from above by the hyperbolic function $\overline{G}(x) = \frac{1}{D_1 x + D_2}$, where D_1 and D_2 are constants of integration obtained from the solution of the second order differential equation $\left[\frac{G''(x)}{G(x)} - 2\left(\frac{G'(x)}{G(x)}\right)^2\right] = 0$.

The Appendix contains the proofs of this and all other results.

Proposition 1 characterizes the set of viable bureaucracy norms. The exponential function G(x) = $e^{\alpha x}$ used in the sequel is an example of a viable norm. Proposition 1 implies that

Corollary 1.1: Any bureaucracy norm given by the general form $G(x)=\left(\frac{\beta}{x+\beta}\right)^{k}$, where $k\geq 1$, $D_2=1$ and $D_1=1/\beta$ is viable.

Remark: Suppose that the institutional norm is given by a function *G(x)*, that is non-constant and bounded from above by the hyperbolic function $\overline{G}(x)=\frac{1}{D_1x+D_2}$. Then the convexity of the cost function *c(x)* is a sufficient, but not a necessary second order condition for the maximization of the price-taking producer's problem (the proof of this claim is also given in the Appendix). By this claim, the set of cost functions that are consistent with the maximization of $\pi(x)$ contains the convex functions, but also non-convex and, in particular, concave cost functions. In light of Corollary 1.1, the claim implies, in particular, that any bureaucracy norm given by $G(x)=\left(\frac{\beta}{x+\beta}\right)^{k}$, where $k>1$ and $\beta=1/D_1$, allows non-convex and possibly concave cost functions that are consistent with the existence of a solution to the producer's problem. The fact that in our setting equilibrium may exist even for non-convex technologies that result in concave cost functions is of some significance for the comparison between the optimal output levels under the benchmark case where $G(x)\equiv 1$ and under other cases of viable norms. Let x_b and x_a denote, respectively, the selected output levels under the two situations. Then, by application of the first order condition (2), it can be shown that under a convex and continuously differentiable cost function, the norm of resource extraction in the interaction between a producer and bureaucrats induces the former to reduce his output. That is, if *c(x)* is convex, then $x_a<x_b$. If *c(x)* is concave, then, again, the bureaucracy norm induces the producer to reduce his output because in such a case x_a is finite, whereas in the benchmark case an interior solution x_b does not exist (the producer has an incentive to increase his output infinitely).

3. The size of a regulated competitive industry

In this study, market structure is characterized by the number of producers, assuming that there is no collusion (among buyers and sellers) and that there are many competitive consumers. Let us examine how the prevailing bureaucracy norm, which is taken into account in the objective function of the regulator, affects market size.

Suppose that the norm represented by *G(x)*, which has the general properties introduced in the preceding section, is viable and that the bureaucrat's control variable can take two forms; (i) The bureaucrat can select the number of identical competitive producers, given the cost function, demand function and the existing institutional norm (ii) The bureaucrat can select the function that relates the number of producers to the norm, given the cost and demand functions. In the latter case, the government official is assumed to play a more central role: he can affect the underlying structural relationship between market size and the norm of bureaucracy costs. This means that his position enables him to influence the norm not only by determining the number of producers, but by shaping the relationship between the norm and any number of producers.

3.1. Fixed output price

Let x^* denote the equilibrium output of the producers who face the fixed price *p* and the prevailing norm *G(x)*. Assuming that the second-order condition (3) is satisfied, x^* is the solution of the first order condition (2).

(i) The preferred market size n^*

Suppose that, anticipating the equilibrium of the producers, the bureaucrat can regulate entry to the industry and choose the number of producers *n*, given G(*x*), c(*x*) and *p*. His objective is to maximize the extracted profits from the industry preserving the optimality conditions of the producers. The objective function of the bureaucrat is therefore given by:

(4) $$U\left(n,x^*\right)=n\left(1-G(x^*)\right)\left[px^*-c(x^*)\right].$$

Notice that in this case of a perfectly elastic demand, the expression $\left(1-G(x^*)\right)\left[px^*-c(x^*)\right]$ is a constant, so the objective function of the bureaucrat is linear in *n*. This means that $U\left(n,x^*\right)$ cannot be maximized. In other words, in this case, the bureaucrat has an incentive to allow free entry and increase the number of producers infinitely. Alternatively, if n is bounded by $\bar{n}$, then the preferred market size is $n^* = \bar{n}$. Regardless of the prevailing norm, the bureaucrat never misses an opportunity to increase "income" by allowing exit of any producer.

(ii) The preferred relationship between n and G

Suppose now that, anticipating the equilibrium of the producers x^*, the bureaucrat can choose the function $n(G(x^*)$ that relates the number of identical competitive producers n to the existing institutional norm $G(x^*)$, given p and the cost function $c(x)$[4]. Again, the objective of the bureaucrat is to maximize his share of the industry profits, preserving the optimality conditions of the producers. Being aware of his ability to determine the industry size as a function of $G(x^*)$, the objective function of the bureaucrat is now given by:

$$(4') \qquad U\left(n(G(x^*))\right) = n\left(G(x^*)\right)\left(1 - G(x^*)\right)\left[px^* - c(x^*)\right] .$$

The bureaucrat is looking for the function $n(G(x^*))$ that maximizes this objective function, subject to the norm $G(x)$ and the corresponding equilibrium output of the producers.

By (1),

$$(5) \qquad (px^* - c(x^*)) = \frac{1}{G(x^*)}\pi(x^*) \ .$$

Substituting (5) in (4), we get that the problem of the bureaucrat is:

$$(6) \qquad \underset{n(G)}{Max}\ U(n(G)) = \left[n(G)\frac{1-G}{G}\right]\pi(x^*) = V(G)\pi(x^*) \ ,$$

where $G = G(x^*)$ and

[4] In fact, in this case the government official controls the function $\left[G(x^*)(n)\right]$ that relates $G(x^*)$ to the number of identical competitive producers n.

(7) $$V(G)=\left[n(G)\frac{1-G}{G}\right] \quad .$$

The first order condition for the solution of this problem is:

(8) $$U'(x^*)=V'(G)\;G'(x^*)\pi(x^*)+V(G)\pi'(x^*)=0 \;.$$

But, since $\pi'(x^*)=0$, $\pi(x^*)\neq 0$ and $G'(x^*)\neq 0$, (8) requires that

(9) $$V'(G)=n'(G)\left(\frac{1}{G}-1\right)+n(G)\left(-\frac{1}{G^2}\right)=0\,,$$

or

(10) $$\frac{n'(G)}{n(G)} \;=\; \frac{1}{G^2}.\frac{1}{\left(\frac{1}{G}-1\right)} \;=\; \frac{1}{G} \;+\; \frac{1}{1-G} \;.$$

The solution of this differential equation yields the optimal market size as a function of *G* computed at x^*.

Proposition 2: *n*(G)* = $\frac{MG}{1-G}$, where G=*G*(*x**) and *M* is a constant of integration obtained from the solution of (10).

The constant of integration *M* can be computed by substituting *n*=1 into the function *n*(G)*. This will result in $M{=}\frac{1-G_1}{G_1}$, where G_1 is the profit share of a single producer at his desired output and G_1 implies that the optimal number of producers for the bureaucrat is 1. Note that, by Proposition 2, $\frac{M}{n}=\frac{1}{G}-1\Rightarrow\frac{1}{G}=1+\frac{M}{n}\Rightarrow G=\frac{n}{n+M}$. That is, from the bureaucrat's point of view, given the number of producers *n*, the optimal bureaucracy norm must satisfy

(11) $$G^*(n)=\frac{n}{n+M}\,.$$

In light of (6) and (7), Proposition 2 also implies that the maximum amount of resources extracted by the bureaucrat, $U_{\max}$, is proportional to the maximum profit of every producer, $\pi_{\max}$. That is,

Corollary 2.1: $U_{\max} = U\left(n^*(G(x^*)\right) = M\pi\left(x^*, G(x^*)\right) = M\pi_{\max}$.

Proposition 2 implies that the number of producers the bureaucrat chooses is positively related to G (recall that $G = G(x^*)$). That is, if the bureaucracy norm becomes less expropriating (allows a smaller degree of producer exploitation in equilibrium), then the bureaucrat is induced to increase the number of producers.

Corollary 2.2: $\frac{\partial n^*}{\partial G} > 0$ or $\frac{\partial n^*}{\partial (1-G)} < 0$.

Suppose that the norm allows larger extraction of resources from the producers in equilibrium (G= $G(x^*)$ is reduced). Could it be rational for the bureaucrat to extinguish the source of his "income" by causing a producer under his control to exit the market? By Corollary 2.2, not only that it can be rational, such a policy is always rational for the bureaucrat. The fundamental inverse relationship between competition (represented by n^*) and the equilibrium profit share transferred to the bureaucrat (represented by 1-$G(x^*)$) is thus guaranteed, whenever the bureaucrat controls the relationship between n and G.

3.2. Variable output price

Let us dismiss with the initial assumption that the output price is fixed and assume that the price of the good is inversely related to its (total) quantity. That is, the demand function is $p(X)$, where $p'(X) < 0$. Note that given that entry to the competitive industry is controlled by the bureaucrat, the prevailing price hinges on the number n set by the bureaucrat and on the output x chosen by the identical competitive price-taking producers.

(i) The preferred market size n^c

Anticipating the equilibrium of the producers, the government official now chooses the number of producers *n* and the price *p*, given G(*x*), c(*x*) and $p(X) = p(nx)$. Its problem is therefore:

$$\text{(12)} \qquad \underset{n,p}{Max} \; U(n,p) = n\big(1 - G(x^*(p))\big)\big[p(nx)x^*(p) - c(x^*(p))\big],$$

where $x^*(p)$ is the supply function derived from the necessary condition for the solution of the problem of the competitive produces who take the price *p*, which is determined by the bureaucrat, as given (see (2)). The solution of this problem is the selected market size n^c and price p^c. The corresponding output produced by every producer is x^c. To illustrate the determination of the number of producers n^c (in the proof we also derive the equilibrium price p^c and the equilibrium output x^c), consider the case of a hyperbolic demand function, linear cost function and exponential bureaucracy norm. In this case we get:

Proposition 3: If the demand function is $p(nx) = \dfrac{a}{nx} + b$, the cost function is $c(x) = cx + d$, the bureaucracy norm is given by $e^{\alpha x}$ and $\alpha < 0$, a>0, b>c, d>(b-c) , αd+(b-c)<0 [5], then

$$n^c = -\frac{a}{d(b-c)}\left[\alpha d + (b-c)\right].$$

The sensitivity of the equilibrium market size n^c to the parameters of the demand, cost and institutional norm functions is directly obtained from Proposition 3.

Corollary 3.1: n^c is decreasing with α , *b* and (*b*-*c*) and is increasing with *c* and *d*.

Again, suppose that the prevailing norm allows larger extraction of resources from the producers (α is reduced, so G becomes smaller and (1-G) becomes larger, for any *x*) *or* the market situation becomes more favorable to the producer – the

[5] The requirements regarding the parameters α, a, b, c and d ensure that the equilibrium number of producers, price and output are positive.

technology is improved (the fixed cost d or the marginal cost c is reduced) *or* the demand increases (the shift parameter b becomes larger). Could it be rational for the bureaucrat to give up the source of his "income" in the above cases by causing a producer under his control to exit the market? By Corollary 3.1, the answer to these questions is unequivocal. Since there is an inverse relationship between the number of producers the bureaucrat selects and the parameter α, a decrease in α leads, as expected, to increased competition (n becomes larger).[6] Since there is a direct relationship between the number of producers and the parameters d and c, improved efficiency of the producers leads to reduced competition (n becomes smaller). Finally, since there is an inverse relationship between the number of producers chosen by the bureaucrat and the parameter b, increased demand also leads to reduced competition (n becomes smaller). An improvement in the market conditions of the producers (via the demand or cost functions) induces the bureaucrat to reduce their number.

Finally, Proposition 3 implies that the extracted profit share is quite substantial. It always exceeds 0.632. That is,

Corollary 3.2: For any feasible combination of the parameters α, a, b, c and d of the bureaucracy norm, demand and cost functions, $1-G(x^c) > 0.632$.

Note that although the bureaucrat controls both the number of producers and the output price, the fact that the producers are essentially competitive and the fact that the bureaucracy norm implies that the ability of the government official to extract resources from the producers is limited result in equilibrium net profits of the industry that can reach up to 0.36 of the competitive profits when entry to the industry cannot exceed n.

(ii) The equilibrium market size n^e and price p^e

Suppose that, anticipating the equilibrium of the producers $x*$, the bureaucrat can choose the function $n(G(x^*)$ that relates n to $G(x^*)$, given c(x) and $p(X) = p(nx)$. In this case, the price is determined by the bureaucrat who selects $n^*(G(x^*)$, the

[6] In this case, where the bureaucrat changes n in response to a change in the prevailing norm parameter α, increased profit extraction always leads to more competition (a larger number of producers), in contrast to the situation in subsection 3.1. (II), where the bureaucrat controls the structural dependence between n and G(x), see footnote 3.

producers who choose their preferred output $x^*(p)$ and the exogenous demand function $p(nx)$. Let us examine the determination of the equilibrium number of producers and equilibrium output price in this setting.

Proposition 2 and its corollaries are still valid when the fixed price *p* of the preceding sub-section is replaced by the demand function $p(X) = p(nx)$ (To verify this claim, substitute $p(nx)$ instead of *p* in (4) and (5) to obtain, again, (6) – (10) and then proceed with the proof of Proposition 2). Substituting (11) in the more general form of (5), we get that the maximum gross profit of a producer is given by:

$$\left[p(nx^*)x^* - c(x^*) \right] = \frac{\pi(x^*)}{G(x^*)} = \pi(x^*)\frac{(n+M)}{n} \quad . \tag{13}$$

Being aware of the dependence of the maximal profit of the producers and of his own maximal utility on *n*, *x* and the desired bureaucracy norm, the government official can derive the required relationship between the output price and *nx*. Specifically,

Proposition 4: The desirable price for the bureaucrat is

$$p^o(nx^*) = \frac{U_{\max}}{nx^*} + b,$$

where *b* is a constant of integration , $U_{\max} = U\left(n^*(G(x^*)\right)$ and $n = n^*(G(x^*)$.

Notice that since $p^o{}'(nx) < 0$, $b = p^o(\infty) = p_{\min}$. The maximum price is obtained when n=1, so $p_{\max} = \dfrac{U_{\max}}{x^*} + p_{\min}$. The desirable price for the bureaucrat can be expressed as a weighted average of the highest and lowest preferred prices.

Corollary 4.1: The desirable price for the bureaucrat is a weighted average of $p_{\max}$ and $p_{\min}$. Specifically,

$$p^o(nx^*) = \frac{1}{n} p_{\max} + \frac{(n-1)}{n} p_{\min}$$

Notice that $p^o(nx^*)$ depends on both *n* and *x** because $p_{\max}$ depends on them.

The equilibrium number of producers n^e, the equilibrium output of every producer x^e and the equilibrium price p^e are determined by the solution of the equilibrium conditions $\pi'(x^*) = 0$, $U'(x^*) = 0$ and the equality between the desirable price (the price that preserves the optimality conditions) and the demand function, $p^o(nx^*) = p(nx)$. In this extended setting then the equilibrium triple (n^e, p^e, x^e) is determined by a bureaucrat who anticipates the equilibrium behavior of the producers, taking into account the exogenous functional parameters namely, the demand function $p(X)$, the cost function *c(x)* and the norm *G*(*x*). Again, since Corollary 2.2 is still valid, the inverse structural relationship between n^e and (1-G(*x*)), that can be interpreted as the fundamental inverse relationship between the extent of competition and profit extraction is guaranteed.

4. Summary and concluding remarks

We have demonstrated that the institutional norm is a useful explanatory concept for understanding the diversity in market structures in different societies. In our study, this norm is represented by the profit share producers are required to transfer to a bureaucrat in order to secure his approval to produce and/or sell any desired quantity of output. Market structure is characterized by the number of producers assuming that there is no collusion among the producers.

In our setting, the industry size reflects the desire of the bureaucrat to maximize his share in the industry profits taking advantage of the existing bureaucracy norm and market characteristics. The number of firms is not determined by entry barriers due to collusion among the sellers, by the different efficiency levels of the producers, by some competitive ideology or by the political power of some interest group (sub-group of the producers).

The proposed approach was illustrated by examining the determination of the number of competitive producers as a function of demand, supply and the prevailing bureaucracy norm: the function that relates the extent of production to the profit share that is transferred from the producers to the bureaucrat. Our study thus sheds light on the relationship between the equilibrium market structure (degree of competition) and the prevailing bureaucracy norm and on the relationship between the equilibrium number of producers and the parameters of their cost function and of the demand function they face.

We have started with the presentation of the producer's problem, given a particular bureaucracy norm and with the equilibrium analysis of the producer's problem that yields his optimal output. This analysis resulted in the characterization of viable norms; norms that ensure existence of equilibrium (Proposition 1). The study of institutional norms and market structure was then carried out assuming, first, that producers face a fixed price. Here we derived an explicit expression of the equilibrium number of producers set by the bureaucrat, dependent on whether he controls n or the relationship between n and the prevailing norm in equilibrium (Proposition 2). In the latter case, the bureaucrat is assumed to play a more central role: he can affect the underlying structural relationship between market size and the norm of bureaucracy costs. In other words, his status enables him to influence the norm not only by determining the number of producers, but by shaping the relationship between the norm and any number of producers. The effect of a change in the bureaucracy norm in equilibrium on the number of producers was clarified in Corollary 2.2. The relationship between the resources extracted by the bureaucrat and the maximal residual profit of the producer was presented in Corollary 2.1. Finally we examined the determination of market size and output price by the bureaucrat in the more general case of a variable price (negatively sloped demand function). Again, this has been done assuming that the bureaucrat controls n (Proposition 3 and its Corollaries 3.1 and 3.2) or the relationship between n and the prevailing bureaucracy norm. (Proposition 4 and its Corollary 4.1). In both cases we have clarified how market structure (the equilibrium number of producers) is determined by a bureaucrat who takes into account the exogenous functional parameters; the demand function $p(X)$, the cost function $c(x)$ and the norm $G(x)$.

The institutional norm can be interpreted as the corruption norm of low-level government officials. That is, $(1-G(x))$ can be interpreted as the characteristic pattern of this type of corruption. In our setting, such corruption is common knowledge and not secret as typically assumed in the corruption literature, Treisman (2000). Another difference is that in our setting the decision on the number of active price-taking firms in an industry is made by government officials and is not determined endogenously in a competitive rent-seeking model, as in Bliss and Di Tella (1997). Interpreting the bureaucracy norm as the prevailing corruption pattern of low-level bureaucracy, the relationship between competition and corruption has been established in three cases. Under a fixed output price (a perfectly elastic demand), the degree of competition is invariant to corruption; the government official has an incentive to increase the number of producers as much as possible. Under a variable output price, increased corruption always leads to more competition (a larger number of producers). However, under a fixed or a variable output price, if the bureaucrat controls the structural relationship between the degree of competition (represented by *n)* and the profit share extracted from the producers (represented by the function (1-G(x)), then increased extraction rate always leads to less competition and vice versa, reduced competition leads to increased extraction of resources from the producers.[7] These different conclusions vividly demonstrate that, under different circumstances, the *same* bureaucracy may *truthfully* declare that it is a determined and unconditional supporter of competition (as in the case where the output price is fixed) or that it supports increased competition when corruption increases (as in the case of a negatively sloped demand curve and no bureaucracy control on the structural relationship between market structure and the prevailing bureaucracy norm). But the basic truth is that, if the bureaucrats can control the structural relationship between market size and corruption, then they always ensure that there is an inverse relationship between market size and corruption; in particular, an increase in corruption is always associated with a decrease in competition (the number of producers).

[7] In the model applied by Ades and Di Tella (1999), the effect of competition on corruption is ambiguous. However, their empirical findings prove that less competition fosters corruption.

Appendix

Proposition 1: A bureaucracy norm given by G(x) is viable, if it is constant or bounded from above by the hyperbolic function $\overline{G}(x)=\frac{1}{D_1 x+D_2}$, where D_1 and D_2 are constants of integration obtained from the solution of

$$\left[\frac{G''(x)}{G(x)}-2\left(\frac{G'(x)}{G(x)}\right)^2\right]=0 .$$

Proof:

By (1),

(A1) $$\left[px-c(x)\right]=\frac{\pi(x)}{G(x)} \quad ,$$

Hence, the first order condition (2) is equivalent to:

(A2) $$\left[p\text{-}c'(x)\right]=-\frac{G'(x)}{\left(G(x)\right)^2}\pi(x)\Rightarrow\left[p\text{-}c'(x)\right]G'(x)=-\left(\frac{G'(x)}{G(x)}\right)^2\pi(x) \quad .$$

By multiplying (A1) by $G''(x)$, we get that:

(A3) $$\left[px-c(x)\right]G''(x)=\frac{G''(x)}{G(x)}\pi(x) \; .$$

To examine the required relationship between $G(x)$ and $c(x)$, let us substitute (A2) and (A3) in the second order condition (3) to obtain the combined condition (the first and second order conditions) for the maximization of $\pi(x)$:

(A4) $$-c''(x)G(x)-2\left(\frac{G'(x)}{G(x)}\right)^2\pi(x)+\frac{G''(x)}{G(x)}\pi(x)<0,$$

or

(A5) $$c''(x)>\phi(x)\pi(x) \quad ,$$

where

$$\text{(A6)} \qquad \phi(x) = \frac{1}{G(x)}\left[\frac{G''(x)}{G(x)} - 2\left(\frac{G'(x)}{G(x)}\right)^2\right] \quad .$$

To examine inequality (A5), let us look at the solution of the non-linear second order differential equation:

$$\text{(A7)} \qquad \overline{\phi}(x) = \left[\frac{G''(x)}{G(x)} - 2\left(\frac{G'(x)}{G(x)}\right)^2\right] = 0 \ .$$

Note that

$$\left\{\frac{1}{G}\right\}' = \left\{G^{-1}\right\}' = -\frac{1}{G^2}G' = -G^{-2}G' \ ,$$

and

$$\left\{\frac{1}{G}\right\}'' = \left[2G^{-3}G'G' - G^{-2}G''\right] \ .$$

Hence,

$$-\left\{\frac{1}{G}\right\}'' = \frac{1}{G}\left[\frac{G''}{G} - 2\left\{\frac{G'}{G}\right\}^2\right] = \phi(x) \ .$$

This implies that (A5) can be written as:

$$c''(x) > -\left\{\frac{1}{G}\right\}'' \pi(x) \ .$$

Solving the equality: $\phi(x) = -\left\{\frac{1}{G}\right\}'' = 0$, we get that *G(x)* is either a constant or:

$$-\left\{\frac{1}{G}\right\}' = -D_1 \text{ and } -\frac{1}{G} = -D_1 x - D_2 \Rightarrow G = \overline{G}(x) = \frac{1}{D_1 x + D_2} \ ,$$

which means that G(x) is viable, if it is bounded from above by $\overline{G}(x)$.

Q.E.D.

Corollary 1.1: Any bureaucracy norm given by $G(x) = \left(\frac{\beta}{x+\beta}\right)^k$, where $k \geq 1$ and $\beta = 1/D_1$, is viable.

Proof:

Consider norms of the form:

$$G(x) = G_k(x) = \left(\frac{\beta}{x+\beta}\right)^k = \beta^k (x+\beta)^{-k} \quad ; \ (k>0, \beta>0) \ .$$

Then

$$G'(x) = \beta^k (-k)(x+\beta)^{-k-1} \Rightarrow \frac{G'}{G} = -\frac{k}{x+\beta} \Rightarrow \left(\frac{G'}{G}\right)^2 = \frac{k^2}{(x+\beta)^2} \ ,$$

and

$$G'' = \beta^k k(k+1)(x+\beta)^{-k-2} \Rightarrow \frac{G''}{G} = \frac{k(k+1)}{(k+\beta)^2} \ .$$

Since
$$\overline{\phi}(x) = \left[\frac{G''(x)}{G(x)} - 2\left(\frac{G'(x)}{G(x)}\right)^2\right],$$

$$\overline{\phi}(x) = \frac{k(k+1) - 2k^2}{(x+\beta)^2} = -\frac{k(k-1)}{(x+\beta)^2} = G\phi(x) \quad ; \ (G>0) \ .$$

Hence,

$k = 0,1 \Rightarrow \overline{\phi}(x) = \phi(x) = 0$

$k > 1 \Rightarrow \overline{\phi}(x), \phi(x) < 0$

That is, any norm given by $G(x)=\left(\dfrac{\beta}{x+\beta}\right)^k$, where $k \geq 1$ and $D_1 = 1/\beta$, is viable.

Q.E.D.

Remark: Suppose that the bureaucracy norm is given by a function G(x) that is bounded from above by the hyperbolic function $\overline{G}(x)=\dfrac{1}{D_1 x + D_2}$, where D_1 and D_2 are constants of integration obtained from the solution of $\left[\dfrac{G''(x)}{G(x)} - 2\left(\dfrac{G'(x)}{G(x)}\right)^2\right] = 0$. Then the convexity of the cost function c(x) is a sufficient, but not a necessary second order condition for the maximization of the producer's problem.

Proof:

Since $\phi(x) = -\left\{\dfrac{1}{G}\right\}'' < 0$**,** the optimality condition (A5) directly implies that the convexity of the cost function c(x) is a sufficient but not a necessary second order condition for the maximization of the producer's problem.

Q.E.D.

Proposition 2: *n*(G)* = $\dfrac{MG}{1-G}$, where G=$G(x^*)$ and M is a constant of integration obtained from the solution of (10).

Proof:

The solution of the bureaucrat's problem requires that

(10) $$\frac{n'(G)}{n(G)} = \frac{1}{G^2}.\frac{1}{\left(\frac{1}{G}-1\right)} = \frac{1}{G} + \frac{1}{1-G}.$$

or

$$\frac{1}{n}\frac{dn}{dG} = \frac{1}{G} - \frac{1}{G-1} .$$

Hence,

$$\frac{dn}{n} = \frac{dG}{G} - \frac{dG}{G-1} \Rightarrow \ln n = \ln G \text{ - } \ln\ (G\text{ - }1) + \ln\ M = \ln G \text{ - } \ln(1\text{ - }G) + \ln M = \ln \frac{G.M}{1\text{ - }G}\,.$$

We therefore obtain that *n*(G)=* $\frac{M\ G}{1-G}$, where *M* is the constant of integration obtained from the solution of (10).

Q.E.D.

Corollary 2.1: $U_{\max} = U\left(n^*(G(x^*)\right) = M\,\pi\left(x^*, G(x^*)\right) = M\,\pi_{\max}$

Proof:

Substituting *n*(G)=* $\frac{MG}{1-G}$ in (7) yields:

$V(G) = \left[n(G)\frac{1-G}{G}\right] = \frac{M\,G}{(1-G)}\frac{(1-G)}{G} = M$. Hence, by (6),

$$U(n^*(G(x^*))) = \left[n(G)\frac{1-G}{G}\right]\pi(x^*) = M\ \ \pi(x^*)\,.$$

Q.E.D.

Corollary 2.2: $\frac{\partial n^*}{\partial G} > 0$ or $\frac{\partial n^*}{\partial(1-G)} < 0$**.**

Proof:

This is directly obtained by differentiating *n*(G)* = $\frac{M\,G}{1-G}$ with respect to *G*:

$$(n^*)'(G) = \frac{M}{(1-G)^2} > 0\ .$$

Q.E.D.

Proposition 3: If the demand function is $p(nx)=\frac{a}{nx}+b$, the cost function is $c(x)=cx+d$, the bureaucracy norm is given by $e^{\alpha x}$ and $\alpha<0$, a>0, b>c, d>b-c , αd+(b-c)<0 , then

$$n^c=-\frac{a}{d(b-c)}\left[\alpha d+(b-c)\right],\ \mathrm{p}^{\mathrm{c}}=\frac{\alpha db+c(b-c)}{\alpha d+(b-c)}\ \text{and}\ \mathrm{x}^{\mathrm{c}}=\frac{d}{(b-c)}.$$

Proof:

To derive $x^*(p)$ from the necessary condition for the solution of the problem of the competitive produces, let us substitute *p*, $c(x)=cx+d$ and G(*x*)= $c(x)=cx+d$ in (2) to obtain:

$$\alpha\left[px^*-cx^*-d\right]+(p-c)=0,$$

which yields:

(A8) $$x^*(p)=\frac{d}{p-c}-\frac{1}{\alpha}\quad\text{or}\quad p(x^*)=\frac{d}{x^*+(1/2)}+c.$$

Substituting $c(x)=cx+d$ and $p(nx)=\frac{a}{nx}+b$ in the objective function of the bureaucrat, we get:

(A9) $$\begin{aligned}U(n,p)&=n\left(1-G(x^*)\right)\left[p(nx)x^*-c(x^*)\right]=\\&=1-G(x^*)\left[a+bnx^*-cnx^*-dn\right]=\\&=1-G(x^*)\left[a+(b-c)nx^*-dn\right].\end{aligned}$$

A necessary condition for the maximization of $U(n,p)$ is:

(A10) $$U_n^{'}=1-G(x^*)\left[(b-c)x^*-d\right]=0,$$

which yields the equilibrium output x^c :

(A11) $$x^{c}=\frac{d}{b-c}.$$

Substituting (A11) in (A8), we get p^{c} :

(A12) $$\mathrm{p}^{\mathrm{c}}=\frac{d}{\frac{d}{b-c}+\frac{1}{\alpha}}+c=\frac{\alpha db+c(b-c)}{\alpha d+(b-c)}$$

Using $p(nx)=\frac{a}{nx}+b,$ we get that

(A13) $$\frac{a}{n^{c}x^{c}}=p^{c}-b\Rightarrow n^{c}=\frac{a}{(p^{c}-b)x^{c}}.$$

Applying (A12), we find $(p^{c}-b)$,

$$(p^{c}-b)=\frac{\alpha db+bc-c^{2}}{\alpha d+b-c}-b=\frac{-(b^{2}-2bc+c^{2})}{\alpha d+b-c}=\frac{(b-c)^{2}}{\alpha d+b-c}.$$

Substituting $(p^{c}-b)$ and x^{c} (see (A11)) in (A13), we get the optimal number of producers n^{c} :

(A14) $$n^{c}=\frac{a}{(p^{c}-b)x^{c}}=-\frac{a}{d(b-c)}\left[\alpha d+(b-c)\right]$$

Q.E.D.

Corollary 3.2: For any feasible combination of the parameters α, a, b, c and d of the bureaucracy norm, demand and cost functions, $1-G(x^{c})\geq 0.632$.

Proof:

Notice that, by assumption, αd+(b-c)<0, that is, $-\alpha > \frac{b-c}{d}$, which ensures that n^c is positive. Since, by (A11), $x^c = \frac{d}{b-c}$, $-\alpha > \frac{1}{x^c}$ or $\alpha x^c < -1$. This means that $G(x^c) = e^{\alpha x^c} < e^{-1} = 0.368$ which establishes that $1 - G(x^c) > 0.632$.

Q.E.D.

Proposition 4: The desirable price for the bureaucrat is

$$p^o(nx^*) = \frac{U_{\max}}{nx^*} + b$$

where *b* is a constant of integration and $U_{\max} = U\left(n^*(G(x^*)\right)$.

Proof:

Recall that that the maximum gross profit of a producer is given by:

(A15) $$\left[p(nx^*)x^* - c(x^*)\right] = \frac{\pi(x^*)}{G(x^*)} = \pi(x^*)\frac{(n+M)}{n} \quad .$$

Differentiating (A15) with respect to *n*, we get that $p'(nx^*)(x^*)^2 = -\pi(x^*)\frac{M}{n^2}$, or:

(A16) $$p'(nx^*) = -\pi(x^*)\frac{M}{(nx^*)^2} < 0 \quad .$$

By Corollary 2.1,

(A17) $$p'(nx^*) = -\frac{U_{\max}}{(nx^*)^2} .$$

Integrating (A17) by the variable (*nx**), we obtain that the bureaucrat's desired price as a function of *nx** is given by:

(A18) $$p^o(nx^*) = \frac{U_{\max}}{nx^*} + b ,$$

where *b* is a constant of integration and $U_{\max} = U\left(n^*(G(x^*)\right)$.

Q.E.D.

Corollary 4.1: The desirable price for the bureaucrat is a weighted average of $p_{\max}$ and $p_{\min}$. Specifically,

$$p^{o}(nx^{*}) = \frac{1}{n}p_{\max} + (\frac{n-1}{n})p_{\min}$$

Proof:

Since $p_{\max} = \frac{U_{\max}}{x^{*}} + p_{\min}$ and $p_{\min} = b$,

$$p^{o}(nx^{*}) = \frac{U_{\max}}{nx^{*}} + b = \frac{1}{n}(p_{\max} - p_{\min}) + p_{\min} = \frac{1}{n}p_{\max} + (1-\frac{1}{n})p_{\min} = \frac{1}{n}p_{\max} + (\frac{n-1}{n})p_{\min}$$

Q.E.D.

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