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Allocation of Common Resources With Political Bargaining

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Brill Eyal and Eithan Hochman *

Hebrew University, Faculty of Agricultural,
Department of Agricultural Economics and Manegement
Rehovot, P.O.B 12, 76100.

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Abstract

This paper analyses the problem of the allocation of common resources within a situation of political bargaining. Using Zusman's cooperative bargaining framework the effects of property rights and policy tools (prices&quantities) on the efficiency of the allocation, are examined. It shows that the Coase theorem holds when political power is equally distributed and price is the policy tool of the decision maker. When aggregate quantity is the policy tool, the efficiency depends on the distribution of the property rights. Likewise, it demonstrates that when property rights are not well defined, the efficiency of the allocation process depends on both elasticity of demand and supply. Finally it proves that when property rights are not defined, using price as a policy tool results in a higher quantity allocation than in the situation when quantity is the policy tool.

Keywords: Bargaining, Common property, Property rights, Political power, Price&quantity.

JEL classification: D23,L23.

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* The authors are respectively a Ph.D. student and a Professor of Agricultural Economics, in the Department for Agricultural Economics and Management, Hebrew University, Israel.
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Email: Hochman@HUJI.AGRI.AC.IL

1. Introduction.

The problem of pricing and allocating an economic resource, commonly owned, has received extensive attention in the literature during the last half century. The "invisible hand" of the decentralized competitive market fails to operate efficiently within a group that collectively owns an economic resource. The group may consist of a small number of shepherds who commonly own grazing land (Harding 1968), or the sovereign state which owns its land and water. The allocation in such, cases requires group decisions which involve the well known *primal* and *dual* problems of the calculation of quantities and prices of the resource as was presented in the seminal papers by Arrow and Hurwitz (1962) and Dantzig and Wolfe (1961).

The role of political power in centralized economic decision making within a framework of game theory received some attention by Shubik (1987). A recent work by Zusman and Rausser (1994) analyzed the failure of collective action to function efficiently in an environment where political pressure is applied on the decision maker. Grosseman and Helphman (1994) introduced a framework in which "politicians respond to incentives they face",.i.e. they choose social sub-optimal policies in order to gain the support of voters. Ostrom (1993) argued that collective action for the management of natural resources is likely to fail in part due to the "prisoner's dilemma" problem, i.e. individuals who benefit from disobeying collective agreements.

An important corner-stone in the economy of commonly shared resources is the issue of property rights. A variety of institutions and constitutions were generated for handling property rights of common resources. To mention a few the Riparian vs. Appropriate water rights (Anderson 1984), the use of shared tenancy vs. fixed rent tenancy in land rent contracts (Hayami and Otsuka 1993) and the distribution of costs generated in collective agricultural settlement (Zusman 1988).

The presence or absence of property rights affects the efficiency of resource allocation as well as the income distribution. According to Coase (1960), an efficient allocation of resources can be achieved in spite of existing externality, whenever property rights are well defined and transaction costs are relatively low. However, the conditions of low transaction costs are violated in the case of common resources, such as monitoring the fishing activities in the open sea (Hartwick and Olewiler 1986), constructing conveyance systems of canals for surface water delivery (Zilberman and Shah 1994), or uncertainty and irreversible damage in underground water (Tsur 1995). In these cases public regulation is needed, but then intra group politics must be taken into account.

The purpose of this paper is to examine whether a central allocation system of common resource may be efficient, in spite of political pressure by its members. Following Nash (1950), Harsanyi (1962) and Zusman (1976) the allocation process of the resource commonly owned is modeled as a bargaining game. Within the framework of a bargaining model, administrative allocation of quantities vs. a regulatory price regime are examined with or without the existence of property rights.

The main results are:

a) The Coase theorem is preserved only in the case when property rights are well defined, the transaction costs are low and the political power is equally distributed between the peripheral participants in the bargaining. In this case, a supporting *dual* price mechanism can be designed to achieve a "first best" allocation [1].

b) On the other hand, the Coase theorem does not hold when property rights are well defined if the bargaining is over the aggregate quantity[2] and/or the political power is unequally distributed.

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[1] It is assumed that under the balanced budget constraint an external lump-sum transfer is not feasible.

[2] Note that there is one exception, when the distribution of the property rights exactly matches the primal solution of (a).

c) When property rights are not defined, for a given elasticity of supply and an equal distribution of political power, a price mechanism yields better (inferior) allocation than a quota mechanism, whenever the demand is relatively elastic (inelastic).

d) When property rights are not defined, price mechanism allocates a larger aggregate quantity of the resource than an administrative quota mechanism.

The structure of the paper is made up as follows: Section 2 models the allocation problem as a bargaining problem; Section 3 analyzes the bargaining problem when property rights are well defined; Section 4 analyzes the same problem in the absence of property rights; Section 5 discusses some aspects of the Coase theorem which are related to the bargaining problem and concludes the paper.

2. The Conceptual Framework.

Consider an organization which consists of n members. A homogenous resource is allocated between the members. The resource is used in the production of a uniform good, the price of which is normalized to one [(3)]. The individual producers have different production structure. Let $f_i(q)$ be the production function of the i^{th} individual (i=1,....,n) where q_i is the quantity of the homogenous resource used by the individual producer. Also $f(.)$ is a well behaved twice differentiable function with $f_i(0)=0, f^{'}>0, f^{''}<0$. The individual demand function for the resource is derived from the production function to yield,

$$w = f_i^{'}(q) \tag{1}$$

where w is the price of the resource. The aggregate demand for the resource D(Q) is the horizontal summation of the individual demand functions, where

[3] The problem is modeled as allocation of production factor. The same problem can be described for

$Q = \sum_{i=1}^{n} q_i$. Also, C(Q) is the cost function of supplying Q units of the resource with C'>0 and C">0 [4].

It is also assumed that the resource is commonly owned by all the members of the organization. Such a resource could be a common grazing field or water in a lake in the case of a natural resource or a supply of capital for a farmer's credit cooperative. The collective ownership forces collective action by central management in order to allocate the resource among the organization members. Assuming that the management fully internalizes the producers' welfare, its objective can be stated as,

$$\text{Max} \qquad u_0 = \sum_{i=1}^{n} f_i(q_i) - C(Q) \tag{2}$$

On the other hand, it is assumed that the producers pursue their own interest with the objective of maximizing their individual profit function. Hence the i[th] individual seeks,

$$\text{Max} \qquad u_i = f_i(q_i) - wq_i \tag{3}$$

The allocation problem of the commonly owned resource is viewed as n+1 bargaining game played by the management and the n peripheral participants of the organization. The solution to such a cooperative bargaining problem is based on the standard axioms (symmetry with respect to individuals, individual rationality, invariance with respect to affine transformation of utility and

the allocation of private good with utility function of consumers.

4 Note that the discussion is within a static framework. However, C(Q) can be considered as social cost function which takes into account dynamic aspects such an inter-temporal shadow prices of water in an aquifer.

independence of irrelevant alternatives) as was first formulated by Nash (1950) by:

$$\text{Max} \quad \prod_{i=0}^{n}[u_i(x) - \bar{u}_i] \tag{4}$$

where $\bar{u}_i$ is the allocation generated as a result of disagreement between the parties. The endogenous variable in this game is the level of the policy instrument (x), i.e., the variable which determines the allocation of the resource among the members. The management can choose between two different policy regimes. In the first case, quotas are allocated administratively, while, in the second, the management establishes the price of the resource and the individual quantities are determined according to the individual demands in (1).

The Nash bargaining solution does not contain an explicit explanation of the bargaining power of each participant. Harsanyi (1962) introduced an interpretation of the social power in a bargaining situation, according to which a participant is expected to have a relatively high bargaining power if his expected gains from the cooperative solution are relatively small. Zusman (1976), suggested a measure for this social power. According to him, in the case of a barganing situation with a central player the solution to the problem formulated in (4) can be obtained by solving the following additive objective function:

$$\underset{x \in X}{Max} \qquad u_o(x) + \sum_{i=1}^{n} b_i u_i(x) \tag{5}$$

where X is a set of feasible policies and b_i is a positive coefficient which measures the marginal strength of members i's political power over the policy maker. One should note that in the case where the participants have no political power (i.e. $b_i=0$), the choice of policy will be the one which maximizes the utility of the central player. On the other hand, when the participants do have political power (i.e. $b_i>0$), the allocation policy will be influenced by the participants, and therefore can be expected to be sub-optimal [Zusman and Rausser (1994)].

The literature is vague in the discussion of the influence of the bargaining form on the efficiency of the allocation process. This forms the main topic of this paper. The bargaining environment is characterized by two main criteria, the first of which is whether property rights exist or not, while the second is the type of policy instrument used by the management, i.e. prices or quantities. Using these two criteria, four different forms of bargaining are analyzed.

3. Bargaining when property rights are well defined.

When property rights are well defined, each individual user has a right to receive a given share of the aggregate quantity Q against a payment of similar share in the total organizational costs of acquiring the resource. These property rights are also the basis for residual claims to the surplus generated from the collective activity, it being assumed that the residual claims ensure a balanced budget.

The bargaining between the management and the users is either in regard to the aggregate amount Q to be used, or its price, w.

3.1 Bargaining on the aggregate quantity - Q.

When the issue at hand is the aggregate quantity to be used, one can assume the following form of bargaining between the management and the N participant members: The central player (the management) suggests an aggregate quantity Q. In terms of the grazing problem analyzed by Shubik (1987), Q is the total amount of animals permitted to graze. The price per unit of resource is determined, subject to the balanced budget constraint, by the average costs of generating Q units of the resource. Thus, given the quantity Q, the corresponding average costs AC(Q), and the distribution of well defined property rights, each member can calculate his profits. In terms of equation (5) the political problem is,

$$\max_{Q} \quad V = \sum_{i=1}^{n} f_i(Q\alpha_i) - C(Q) + \sum_{i=1}^{n} b_i[f_i(Q\alpha_i) - AC(Q)Q\alpha_i] \tag{6}$$

where α_i is the share of each member in the total quantity and $\sum_{i=1}^{N}\alpha_i = 1$.

The necessary condition for the maximization of the bargaining problem in (6) with respect to Q results in,

$$\sum_{i=1}^{n} \frac{\partial f_i(Q\alpha_i)}{\partial Q}\alpha_i - \frac{\partial C}{\partial Q} + \sum_{i=1}^{n} b_i\{\frac{\partial f_i(Q\alpha_i)}{\partial Q}\alpha_i - \frac{\partial AC(Q)}{\partial Q}Q\alpha_i - AC(Q)\alpha_i\} = 0 \tag{7}$$

Simplifying the bargaining problem by assuming equal political power of each of the peripheral participants, (i.e. $b_i = b > 0$ for all i) and rearranging terms [5], results in

$$\sum_{i=1}^{n} \frac{\partial f_i(Q\alpha_i)}{\partial Q}\alpha_i = MC(Q) \tag{8}$$

Equation (8) can be interpreted as follows: The aggregate quantity of Q units of the resource are consumed according to fixed shares α_i of property rights. Therefore the results obtained are similar to those of the consumption of a public good. The marginal cost of producing the aggregate quantity Q, is equated to the weighted sum of values of the individual marginal product. A simple case of a central planner bargaining with two users is depicted in Fig 1.

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[5] Note that $\frac{\partial AC}{\partial Q} = \frac{MC(Q)Q - C(Q)}{Q^2}$.

Figure 1

The bargaining solution depicted in Figure 1a and 1b consists of the use of the individual quantities $q_i=Q\alpha_i$ and $q_j=Q\alpha_j$ at the corresponding prices $w_i = \frac{\partial f^i(q_i)}{\partial Q} = f_q^i(q_i)$ and $w_j = \frac{\partial f^j(q_j)}{\partial Q} = f_q^j(q_j)$. As in the case of a public good, the aggregate demand function is obtained by a *vertical* summation of the two individual demands. The equilibrium aggregate quantity Q^{QB} depicted in Figure 1c equals to q_i+q_j at the weighted average price $w^{QB} = w_i\alpha_i + w_j\alpha_j$. where $\alpha_i+\alpha_j=1$.

Note, however, that in the case of a pure public good, the aggregate quantity is consumed simultaneously by all users, .e.g. the use of water for recreation in common property lake. In our case, the aggregate quantity of the resource is consumed according to a fixed shares determined by property rights, e.g. the use of water quotas for irrigation. Thus, in the case of public good the marginal cost is equated to the sum of individual prices (marginal values), in the case of bargaining the marginal cost is equated to the weighted average price.

Note also that Q^{QB} is a second best solution which differs from the efficient first best solution Q_e (depicted in Figure 2) where the aggregate demand curve D(Q) intersects the MC(Q). The equilibrium Q^{QB} will be equal to the efficient first best solution quantity in the special case where all participants have identical demand functions, and the property rights are distributed equally.

3.2 Bargaining over the price of the resource - w.

In many cases, as with entrance fees to a club, the price of the resource in a water cooperative, or the interest rate in the case of saving and loan cooperative, the bargaining is over the price of the resource. For example, in terms of a grazing problem the grazing area management collects grazing fees and the bargaining is over the fee level. If the agreed level of the fee is greater than the average cost of generating the resource, there is a surplus R defined by,

$$R = wQ - C(Q). \tag{9}$$

The balanced budget constraint requires redistribution of this surplus between the participants by the management. Several mechanisms for the redistribution of such a surplus appear in the literature. They may include equal distribution of a lump-sum or more elaborate payment functions as described in Zusman (1988). The following discussion adopts a payment function suggested by Brill et al (1994), which redistributes the surplus according to exogenous shares α_i determined by the property rights. The payment by the i^{-th} participant is,

$$c_i = wq_i - R\alpha_i \qquad \text{for all i.} \tag{10}$$

Noting that $Q = \sum_{i=1}^{n} q_i$, $C(Q) = \sum_{i=1}^{n} c_i$ and $\sum_{i=1}^{n} \alpha_i = 1$, and introducing (9) into (10) yields,

$$c_i=w(q_i-q_i^*)+AC(Q)q_i^* \tag{11}$$

where $q_i^*=Q\alpha_i$ and $AC(Q)=C(Q)/Q$.

The optimal solution for such an allocation problem is obtained by simultaneously solving the following two stage maximization problem:

a. At the aggregate level, the maximization by the central player of the welfare function of the collective, denoted by u_0.

b. At the individual level, the maximization by the individual participants of his utility function u_i. The conditions for optimal pareto are,

$$f_q^i=MC(Q_e)=w \qquad \text{for all i.} \tag{12}$$

where Q_e is obtained by the intersection of the aggregate demand curve D(Q) with the MC(Q). The central player determines the price of the resource w. Each participant facing the price w determines the quantity used by him q_i according to his demand function. His share in the total quantity q_i^* is determined as a result of the aggregate quantity used by all participants. Each participant can be "buyer"("seller") according to whether the sign of q_i-q_i^* is positive (negative). "Buying" ("Selling") are done *ex-post* depending on the actual quantity used. The optimality conditions (12) together with the application of the payment function (11) forms a "passive" market mechanism (in contrast with the conventional "active" market mechanism). The "passive" market mechanism ensures clearance of the market without violation of the budget constraint and with low transaction costs. The imputed (shadow) price of each unit of property rights equals to r=w-Ac(Q_e). Note that in the case of sub-optimal allocation, the central player can adjust the value of w in the next period to the optimal one according to whether r $\lesseqgtr$ MC(Q)-AC(Q).

If the central decision maker is influenced by the political power of the peripheral participants the bargaining problem in terms of (5) is,

$$\underset{w}{\text{Max}} \quad \sum_{i=1}^{n} f_i(q_i) - C(Q) + \sum_{i=1}^{n} b_i \{ f_i(q_i) - w(q_i - q_i^*) - AC\,(Q) q_i^* \} \tag{13}$$

Introducing the individual optimization condition $f_q^i(q_i) = w$ for all i into the necessary conditions for the solution of (13) yield,

$$(w - MC)\frac{\partial Q}{\partial w} + \sum_{i=1}^{n} b_i \{ -q_i + q_i^* + w\frac{\partial q_i^*}{\partial w} - \frac{\partial q_i^*}{\partial w} AC - q_i^* \frac{\partial AC}{\partial w} \} = 0 \tag{14}$$

Adopting the assumption of equal distribution of political power, i.e. b_i=b, yields,

$$(w - MC)\frac{\partial Q}{\partial w}(1+b) = 0. \tag{15}$$

Note that condition (15) holds, if and only if, w = Mc(Q_e). At a quantity Q_e the "passive market mechanism" is such that the political "weight" of the "buyers" equal to that of the "sellers".

Thus, in the case of well defined property rights and equally distributed political power, a first best solution (pareto-optimal allocation) can be achieved. This result does not depend on the distribution of the individual demands or the cost structure of the resource supply. The impact of the assumption of equal distribution of political power of the participants will be discussed at a later stage. However, it should be pointed out that this assumption is reasonable in an organizational setup, where the central management is not corrupt and a set of honest rules allow equals opportunity for all the participants.

In such a social environment, the political power is orthogonal to the efficient allocation of the resource, and affects the income distribution alone. This outcome is analogous to the operation of a modern corporation where the competitive capital market ensures the separation between efficient production allocation done by the management and the distribution of profits to the share holders.

3.3 Prices vs. Quantities in a bargaining model with property rights.

In the preceding two subsections (3.1, 3.2) the case of bargaining with equal political power is discussed (b_i=b for all i). The main result in this case is that, when property rights are well defined, the price regime always leads to a pareto-optimum solution. On the other hand, the efficiency of the quantity regime depends on the distribution of the property rights and the solution is not necessarily a first best solution.

In the current sub-section the two regimes are compared under two different scenarios. In the first, the bargaining is between the central player and a single interest group, while in the second, the central player bargains with several interest groups endowed with different strengths of political power.

It should be pointed out that an interest group may include a number of users, well organized and represented by a single aggregate demand curve of its members.

a. *Single interest group*. In the case of a single interest group, the bargaining problem can be formulated by rewriting equations (8) and (15):

$$\frac{\partial f(q)}{\partial q} = Mc(q) \tag{8'}$$

$$(w - MC)\frac{\partial q}{\partial w}(1+b) = 0 \tag{15'}$$

where Q=q. Thus, when property rights are well defined, in the case of a single interest group, both regimes yield the first best solution, i.e. w=MC(q).

b. *Many interest groups*. In the case of several interest groups with a distribution of unequal political power [(6)], bargaining over quantity (equation 6) vis-a-vis bargaining over price (equation 13), yield after rearranging (7) and (14) the corresponding solutions [(7)]:

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[6] Heterogeneous distribution of political power is possible among a group with a small amount of participants. Within a group of a large number of participants it is difficult for a single user to acquire political power that is significantly greater than that of the others.

[7] Without affecting the comparison outcomes the term $\dfrac{1}{(1+\sum_{i=1}^{n} b_i\alpha_i)}$ which appears as a multiplier in both RHS of the equations is deleted.

$$\tilde{Mc}^{Q}(Q) = \{v + \sum_{i=1}^{n} b_i \alpha_i f_q^i\} \tag{16a}$$

where $v = \sum_{i=1}^{n} f_q^i \alpha_i$ and

$$\tilde{Mc}^{p}(Q) = \{w + \frac{w}{\eta}\sum_{i=1}^{n} b_i(\alpha_i - s_i) + w\sum_{i=1}^{n} b_i \alpha_i\} \tag{16b}$$

where η is the aggregate demand price elasticity and s_i is the actual share of each participant in the total quantity.

In order to compare the efficiency of the two solutions, assume that the bias of the actual from the optimal shares is sufficiently small to justify a first order approximation of the marginal cost functions around the optimal values. Therefore the marginal cost function under the two regimes are of the following linear form within an appropriate neighborhood of $\alpha_i = s_i$,

$$\tilde{Mc}^{Q} = V + \sum_{i=1}^{n} b_i f_g^i (\alpha_i - s_i) + \sum_{i=1}^{n} b_i \alpha_i \frac{\partial f_q^i}{\partial \alpha_i}(\alpha_i - s_i) \tag{17a}$$

and

$$\tilde{Mc}^{p} = w + \sum_{i=1}^{n} b_i w(\alpha_i - s_i) + \frac{w}{\eta}\sum_{i=1}^{n} b_i(\alpha_i - s_i) \tag{17b}$$

Note that when the distribution of property rights matches the distribution of the actual shares, i.e. $\alpha_i = s_i$, both the price control and the quantity control yield an optimal allocation regardless of the distribution of political power, i.e. $v=w=Mc^Q=Mc^P$.

The comparison between the behavior under the two regimes is derived by subtracting (17b) from (17a) and introducing the optimality conditions both at the individual and the aggregate level,

$$Mc^Q - Mc^P = w\sum_{i=1}^{n} b_i(\lambda_i - \mu)(\alpha_i - s_i) \tag{18}$$

where $\mu = \frac{1}{\eta}$, $\lambda_i = \frac{\partial f_q^i}{\partial \alpha_i}\frac{\alpha_i}{f_q^i}$.

The economic intuition behind equation (18) is gained by considering the simple case of a two participants resource allocation problem. Figure 2 depicts a situation in which the decision maker faces two interest groups indexed by 1 and 2 (i.e. n=2). The demand functions of both participants (interests groups) are depicted in Figure 2a as f_q^1 and f_q^2. The two demand functions are summed up horizontally to yield the aggregate demand function D depicted in Figure 2b. The demand curve D intersects the supply curve Mc at the optimal price w_e and the optimal quantity Q_e.

Accordingly, the optimal distribution of the resource between the two groups is obtained at a price w_e by $s_1Q_e=q_1^e$ and $s_2Q_e=q_2^e$ ($s_1+s_2=1$) as shown in Figure 2a.

Figure 2

It can be verified that $\mu = s_1\lambda_1 + s_2\lambda_2$, and therefore the following inequalities hold: $\lambda_2 > \mu > \lambda_1$. Let $\overline{\alpha} = \frac{1}{2}$ represent an equal distribution of the property rights between the two participants, i.e. $\bar{q} = \frac{Q}{2}$. Also the actual property rights α_1 and α_2 yield $q_1^r = \alpha_1 Q$ and $q_2^r = \alpha_2 Q$.

Using the above results, equation (18) yields two possible outcomes in the case of two participants:

a. $|\alpha_i - \bar{\alpha}| < |s_i - \bar{\alpha}|$, ***i=1,2.***

In this case, the assigned quotas of property rights q_1^r and q_2^r are closer to $\bar{q}$ than the corresponding optimal quantities demanded q_1^e and q_2^e. Therefore the more efficient group is a potential *buyer* while the less efficient group is a potential *seller* of property rights. It is easy to verify that $(\lambda_i-\mu)(\alpha_i-s_i)>0$ for i=1,2, and therefore $MC^Q > MC^P$. The following results are of interest:

1. The aggregate quantity of the resource allocated, when the price is the policy tool, is *smaller* than the aggregate quantity allocated when the quantity itself is the policy tool.
2. If the relatively efficient participant is also politically stronger, i.e. $\sum_{i=1}^{N} b_i(\alpha_i - s_i) < 0$, then it can be verified from (17a) and (17b) that the aggregate quantity of the resource allocated under both regimes will be *greater* than the optimal quantity and the price regime is more efficient than the quantity regime.

b. $|\alpha_i - \bar{\alpha}| > |s_i - \bar{\alpha}|$, **i=1,2.**

In this case the assigned property rights q_1^r and q_2^r are further from $\bar{q}$ than the optimal quantities demanded q_1^e and q_2^e. Thus, the more efficient group is a potential *seller* while the less efficient group is a potential *buyer* of property rights. Note that in this case $(\lambda_i-\mu)(\alpha_i-s_i)<0$ for i=1,2 and therefore $MC^Q<MC^P$. Thus, for the second outcome the results change as follows:

1. The aggregate quantity of the resource allocated when price is the policy tool is *greater* than the aggregate quantity allocated when the quantity itself is the policy tool.
2. If the more efficient participant is also politically stronger, i.e. $\sum_{i=1}^{N} b_i(\alpha_i - s_i) > 0$ then it can be verified from (17a) and (17b) that the aggregate quantity of the resource allocated under both regimes will be *smaller* than the optimal quantity and the price regime is more efficient than the quantity regime.

An extension of the analysis to more then 2 interests groups, i.e. n>2, add a third feasible outcome : where $|\alpha_i - \overline{\alpha}| < |s_i - \overline{\alpha}|$ for some of the n participants and $|\alpha_i - \overline{\alpha}| > |s_i - \overline{\alpha}|$ for the others. An example of a computer simulation model for the case of n>2, using normal distributions for b_i,λ_i and α_i, is depicted in the appendix.

4. Bargaining when property rights are not defined.

In the preceding section, the bargaining environment was characterized by the existence of well defined property rights. In this section, the bargaining problem is applied to the case where the users have no property rights. As an example, let us consider the case of urban consumers of a utility such as water, gas or electricity. In the absence of well defined property rights, the individual users do not have predetermined claims for the surplus generated by the collective action. Again, two bargaining processes are examined: In the first, the bargaining is over the quantities used by each of the members, while in the second, the bargaining is over the price charged for using the resource.

4.1 Bargaining over quantities.

When the individual claims of the resource are not predetermined, the bargaining is over the allocation of the individual quantities rather than over the aggregate quantity of the resource (see for comparison section 3.1). It is assumed that each of the participants conducts a separate bargaining with the management, but, the solution of the cooperative game dictates a simultaneous agreement by all the participants. In this case also, the assumption of a balanced budget results in charging each unit of the resource the average cost of generating the resource. The political problem that was formulated in (4) yields,

$$\max_{q_1,\dots q_n} \quad \sum_{i=1}^{N} f_i(q_i) - C(Q) + \sum_{i=1}^{N} b_i[f_i(q_i) - AC(Q)q_i] \tag{19}$$

The necessary conditions for the maximization of the bargaining problem (19) with respect to the set of q_i's result after summing over i, in

$$\sum_{i=1}^{N} \frac{\partial f_i}{\partial q_i} - n\frac{\partial C}{\partial q_i} + \sum_{i=1}^{N} b_i[\frac{\partial f_i}{\partial q_i} - \frac{\partial AC}{\partial q_i} q_i - AC(Q)] = 0 \tag{20}$$

Adopting the assumption of equal distribution of the political power as in sections 3.1 and 3.2, also assuming that the individual consumer impact on the average costs of generating the resource is negligible, i.e. $\frac{\partial AC}{\partial q_i} \approx 0$, yield after collecting terms in (20),

$$\frac{1}{n}\sum_{i=1}^{n} \frac{\partial f_i}{\partial q_i} = \frac{MC + bAC}{(1+b)}. \tag{21}$$

Equation (21) can provide insight into the allocation of the administrative quotas through a cooperative game type bargaining. Figure 3 depicts the geometric equilibrium solutions for (21) in the v-Q plane (Figure 3a) and in the v-b plane (Figure 3b). In both figures $v = \frac{1}{n}\sum_{i=1}^{n} f_q^i$ is measured on the vertical axis, while the aggregate quantity Q and the political power b are depicted, respectively, on the horizontal axis.

Figure 3

Thus, in the absence of political power (b=0), the equilibrium solution $[v_0, Q_0]$ is obtained by the intersection of MC with V, i.e. the LHS of (21) equals to MC. In Figure 3b this equilibrium is described by the intercept of U^Q curve. Another equilibrium solution is depicted by the values $[v_1, Q_1]$ obtained by the intersection of AC and V, i.e. the LHS of (21) equals to AC. The equilibrium solution $[v_1, Q_1]$ is obtained asymptotically as the political power increases ($b \to \infty$). Note that as political power increases, the efficiency of the allocation decreases. The same result was obtained by Zusman and Rausser (1994).

4.2 Bargaining over the price of the resource - w.

In the absence of property rights, the bargaining process over the price of the resource results in undistributed surplus. For example, in the case of a public utility, the price of the resource is determined by the management, while the consumers determine the individual quantities demanded. If the bargaining results in a price higher then the average cost, the generated surplus is retained by the public utility [(8)]. In such cases the formulation of the political problem in terms of (5) yields,

[8] A surplus if generated, is redistributed as lump sum, e.g. the municipal authority may use the surplus generated by its water distribution system to finance part of its education system.

$$\underset{w}{\text{Max}} \quad \sum_{i=1}^{N} f_i(q_i) - C(Q) + \sum_{i=1}^{N} b_i[f_i(q_i) - wq_i] \tag{22}$$

The optimal policy is determined from the necessary condition for (22),

$$(w - MC)\frac{\partial Q}{\partial w} - \sum_{i=1}^{n} b_i q_i = 0. \tag{23}$$

Assuming equal polititical power among the participants (b_i=b for all i), equation (23) can be rewritten,

$$w = \frac{Mc}{(1 - \frac{b}{\eta})}, \tag{24}$$

where η is the aggregate demand price elasticity of the resource.

Inspection of equation (24) indicates the relative impact of each of the two components - the consumers' political power and their demand elasticity. In the absence of political power, efficient allocation of the resource is assured by the equality of its price to the marginal cost of generating the resource, i.e w=MC. However, if political power exists, equation (24) indicates that the efficiency of the allocation of the resource deteriorates as the quotient $\frac{b}{|\eta|}$ increases. If the political power is relatively strong and influential, rent seeking will result in low (subsidized) prices for the resource. (In the case of water see discussion in Tsur and Dinar 1995).

The geometric locus of the solutions for (24) is depicted in Figures 4a and 4b at the w-Q and the w-b planes respectively. In the absence of political power, the management determines the price of the resource at w_0, which results in a pareto first best solution with an aggregate quantity demanded Q_0.

Figure 4

In Figure 4b the U^p curves are the geometric locus of all the equilibrium solutions to equation (24) in the w-b plane. Note, that when there is no political power (b=0), the intercept for the U^p curves start at the same value of the efficient price w_0. Note also, that the impact of a change in the demand elasticity on the slope of U^p curve can be calculated from (24) to yield,

$$\frac{\partial w}{\partial \eta} = \frac{bMC}{\eta(1-\frac{b}{\eta})^2} < 0. \tag{25}$$

Equation (25) verifies that the slope of the U^p curve decreases as the absolute value of the demand elasticity increases. The curves U^p_1,U^p_2 and U^p_3 in Figure 4b illustrate the impact of a decrease in the absolute value of η on their respective slopes. Therefore, a relatively low demand elasticity and strong political interest groups, result in waste and inefficiency in the allocation of the resource.

4.3 Prices Vs Quantities when property rights are not defined

The main conclusion from the preceding subsections (4.1 ,4.2) is that in the absence of well defined property rights, the existence of political power results in inefficient allocation. Moreover, the stronger the political power of the peripheral players the greater is the waste of the resource. This subsection compares the performance of the two regimes, prices vs quantities, when political power exists. Two paradigms are considered:

a. The policy maker faces a single well organized interest group.

b. The policy maker faces many interest groups.

a. One interest group. In such a case the demand curve D coincides with the V curve, i.e. v=w for any given Q. Hence, equating the RHS of (21) with the RHS of (24) and rearranging terms yield,

$$\hat{b} = \eta - \eta\lambda - \lambda \tag{26}$$

where $\lambda = \dfrac{Mc}{Ac}$ is the elasticity of the supply function of the resource. This result is demonstrated in Figure 5. The value $\hat{b}$ defines a "critical" b that equates the efficiency of the price and the quantity regime. The higher the absolute value of the demand elasticity and/or the supply elasticity the higher is the critical $\hat{b}$. Note that the effect of both elasticities on the value of $\hat{b}$ is symmetric. Moreover, the more elastic the demand curve and/or the supply curve, the more efficient is the direct use of prices vs administrative allocation of quantities.

Figure 5

In Figure 5 the derivation of $\hat{b}$ is demonstrated by the intersection of U^Q with U^P. If the actual power of the interest group b is greater (smaller) then the "critical" value of $\hat{b}$, quantity regime is more (less) efficient then price regime.

It is worth noting that in the case where Q is supplied by a competitive industry and the supply curve is horizontal, prices are superior (inferior) to quantities if $\eta<(>)-1$ independently of the political power. If $\eta=-1$ the price regime results with the same efficiency as quantity regime. This can be verified by examining

$$\lim_{\lambda \to \infty} \eta = \frac{b+\lambda}{1-\lambda} = -1$$

b. Many interest groups. Assume an economy with n interest groups, each of them with a demand function specified by the linear relation $w=a_i - m_i q$, where a_i and m_i are distributed normally.

The intercept and the slope of the aggregate demand function can be calculated respectively by

$$A = \frac{\sum_{i=1}^{n} \prod_{j=1, j\neq i}^{n} a_j m_j}{\sum_{i=1}^{n} \prod_{j=1, j\neq i}^{n} m_j} \qquad (27a)$$

$$M = \frac{\prod_{j=1}^{n} m_j}{\sum_{i=1}^{n} \prod_{j=1, j\neq i}^{n} m_j} \qquad (27b)$$

Calculating expected value of A and M and intreducing their value into the LHS of (21) the following can be verified:

a. V and D have an identical intercept.

b. The slope of D equals the geometric mean of the m_i, while the slope of V approaches the arithmetic mean of the m_i. Thus, V is steeper then D. (See proofs for a and b in the appendix).

Q_0^Q and Q_0^P in Figure 6 depict the allocated aggregate quantities under quantity regime and price regime respectively in the absence of political power.

Figure 6

An increase in the political power results in an increase in the allocated quantity under both regimes. It is proved in the appendix that for any given value of b>0 , $Q_0^Q < Q_0^P$. Hence, in the absence of property rights the aggregate quantity allocated under quantity regime is less than that under price regime.

5. Allocation, bargaining and the Coase theorem - concluding remarks.

The Coase theorem (1960) states that well defined property rights and low transaction costs can solve the problem of market failure, i.e., the failure of the competitive market to achieve a pareto efficient allocation of the economic resources. Coase theorem does not include the impact of political power. This paper points out that in the case where political power is distributed equally among the participants (see section 3.1 and 3.2) well defined property rights is a remedy for the political influence. This is illustrated by the elimination of the b_i's from the solution. However, if the political power is distributed unequally, the allocation is sub-optimal even when property rights are well defined.

It is proved also that when political power is equally distributed and the property rights are well defined, the price regime is more efficient than quantity regime. The economic intuition is as follows: Under the quantity regime each participant is willing to pay a different price according to his demand function and according to his property rights. Under asymmetric information this creates high transaction costs. The price mechanism which separates between the allocation of the resource and the distribution of income, eliminates these costs.

More insight into the nature of the political process can be gained from the results of section 3.2. An individual who invests efforts in trying in lowering the price of the resource shares his success with all the other participants. On the other hand, a participant who directs his efforts in the increase of his property rights, will be the only benefactor from his success. Therefore, in such a system, individuals are expected to invest more efforts in achieving property rights than in trying to alter the price of the resource.

Finally, two main conclusions can be drawn for the allocation of common resource under bargaining. The first one which results from section 3 is that property rights can be used as a remedy when political power affects the allocation process. The second conclusion, which results from section 4, is that price regime is more efficient than quantity regime whenever the demand is elastic. These results differ from those obtained by Weitzman (1974) who did not include political power in his analysis.

Appendixes

I. A numerical example.

In the following a simple numerical example is used in order to illustrate the framework presented in the paper. Consider three users sharing a natural resource. The total costs function of generating the resource is given by,

$TC(Q) = K + 0.25Q^2$

Where K=0.1 are the fixed costs and Q are the total quantity units of the resource. The marginal and average functions are respectively,

$MC(Q) = 0.5Q$ and $AC(Q) = \frac{K}{Q} + 0.25Q$.

The individual demand functions of each one of the users for the resource, and the aggregate demand function are given by:

user a: $P = 2 - q_a$ user b: $P = 1.1 - \frac{1}{2}q_b$ user c: $P = 1 - \frac{1}{3}q_c$ aggregate demand: $P = 1.2 - \frac{1}{6}Q$ where $Q=q_a+q_b+q_c$

Using the framework presented in sections 3.1,3.2 and 3.3, table 1 depicts the outcome of the following scenarios.

(1) An optimal allocation.

(2) Bargaining over price when property rights are equally assigned.

(3) Bargaining over the total quantity when property rights are equally assigned

(4) Bargaining over the price when the first participant property rights are smaller than his optimal use of the resource, i.e. $\alpha_1 < s_1$.

(5) Bargaining over the price when the first participant property rights are greater than his optimal use of the resource, i.e. $\alpha_1 > s_1$.

(6) Bargaining over the quantity when the first participant property rights are smaller than his optimal use of the resource, i.e. $\alpha_1 < s_1$.

(7) Bargaining over the quantity when the first participant property rights are greater than his optimal use of the resource, i.e. $\alpha_1 > s_1$.

Table 1: Outcomes of Different Bargaining Scenarios

	Mc	Q	W	q_1	q_2	q_3	α_1	α_2	α_3	b_1	b_2	b_3
1	0.09	1.8	0.90	1.1	0.4	0.3						
2	0.90	1.8	0.90	1.1	0.4	0.3	0.33	0.33	0.33	1	1	1
3	0.97	1.96	0.64*	0.647	0.647	0.647	0.33	0.33	0.33	1	1	1
4	0.91	1.82	0.89	1.1	0.41	0.31	0.50	0.22	0.28	2	1	1
5	0.96	1.93	0.54*	0.96	0.42	0.54	0.50	0.22	0.28	2	1	1
6	0.89	1.79	0.91	1.1	0.40	0.29	0.70	0.22	0.08	2	1	1
7	0.84	1.69	0.48*	1.66	0.37	0.13	0.70	0.22	0.08	2	1	1

* The price is the average costs.

** The optimal shares are ($s_1 = 0.61$, $s_2=0.22$, $s_3=0.16$).

Using the results obtained in table 1 from the numerical simulation the following can be verified:

a. The outcomes of scenarios 1 and 2 are identical. As was pointed out in section 3.2 , when property rights are well defined and the political power is distributed equally, the price regime results in a first best allocation.

b. The outcomes of scenario 3 are inferior to the first best allocation of scenario 2. As was pointed out in section 3.1, the efficiency of allocation under quantity regime depends on the distribution of property rights. Since property rights in scenario 3 differ from the optimal shares.

c. When the property rights of the first participant are smaller than the optimal one ($\alpha_1 = 0.5 < 0.61$ the optimal share for participant 1) the price regime results in lower marginal costs than in the quantity regime. This can be seen by comparing scenarios 4 and 5.

d. When the property rights of the first participant are greater than the optimal one($\alpha_1 = 0.7 > 0.61$), the quantity regime results in lower marginal costs than price regime. This can be seen by comparing scenario 6 with scenario 7.

e. The absolute diversion from the optimal solution depends on the values of the political pressure coefficients (b_i's). Hence, ranking two second best is impossible without explicit information on the magnitude of the political power.

<u>II. Proof that V is steeper then D (Section 4.3).</u>

Let A and M be the intercept and the slope of the aggregate demand function as described in section 4.3.

$$E(A) = \frac{E[\sum_{i=1}^{n} \prod_{j=1, j\neq i}^{n} a_j m_j]}{E[\sum_{i=1}^{n} \prod_{j=1, j\neq i}^{n} m_j]} = \frac{\bar{a} n \hat{M}^{n-1}}{n \hat{M}^{n-1}} = \bar{a}$$

where $\hat{M}$ is the geometric mean of m.

$$E(M) = \frac{E[\prod_{j=1}^{n} m_j]}{E[\sum_{i=1}^{n} \prod_{j=1, j\neq i}^{n} m_j]} = \frac{\hat{M}^n}{n \hat{M}^{n-1}} = \frac{\hat{M}}{n}$$

From the LHS of (18) the V curve equals,

$$\frac{1}{n}\sum_{i=1}^{n}(a_i - m_i q) = \bar{a} - \bar{m}q$$

Since $\frac{\hat{M}}{n} < \bar{m}$ V is steeper then D. **Q.E.D.**

<u>III Proof that $Q^Q < Q^P$ for any value of b (Section 4.3).</u>

Assume the following explicit function

$$C(Q) = K + \beta Q^2$$

$$D(Q) = 1 - LQ$$

$$V(Q) = 1 - GQ$$

Q^Q is equal to Q^P if and only if the following system has a solution:

(I) $1 - LQ = \dfrac{2\beta Q}{(1 - \dfrac{b}{\eta})}$

(ii) $1 - GQ = \dfrac{2\beta Q + b(\dfrac{K}{Q} + \beta Q)}{(1 + b)}$

(iii) $\eta = (\dfrac{1}{L})(\dfrac{1 - LQ}{Q})$

(iv) $G=L\alpha$

(v) $b>0, \alpha>1, K>0$.

It can be verified by using a computer program for solving nonlinear systems that the above system has no feasible solution for any set of $(Q,L,\eta,b,\beta,K,\alpha)$.

Q.E.D.

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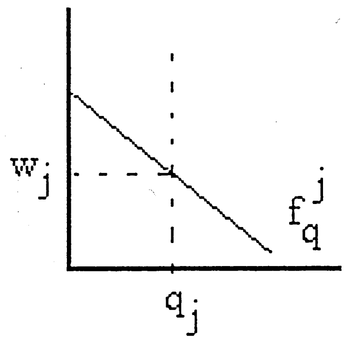
[1a]



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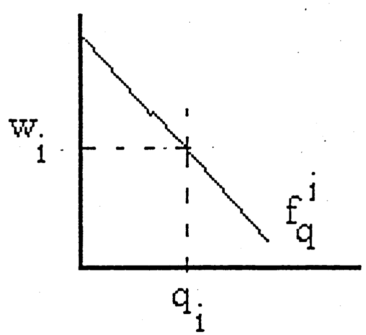

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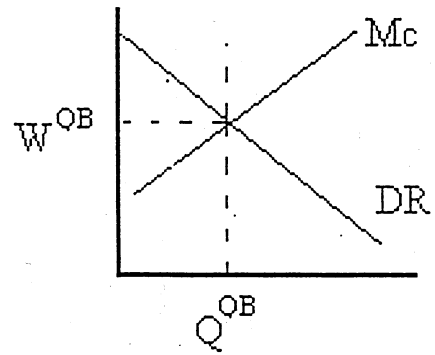

Figure 1

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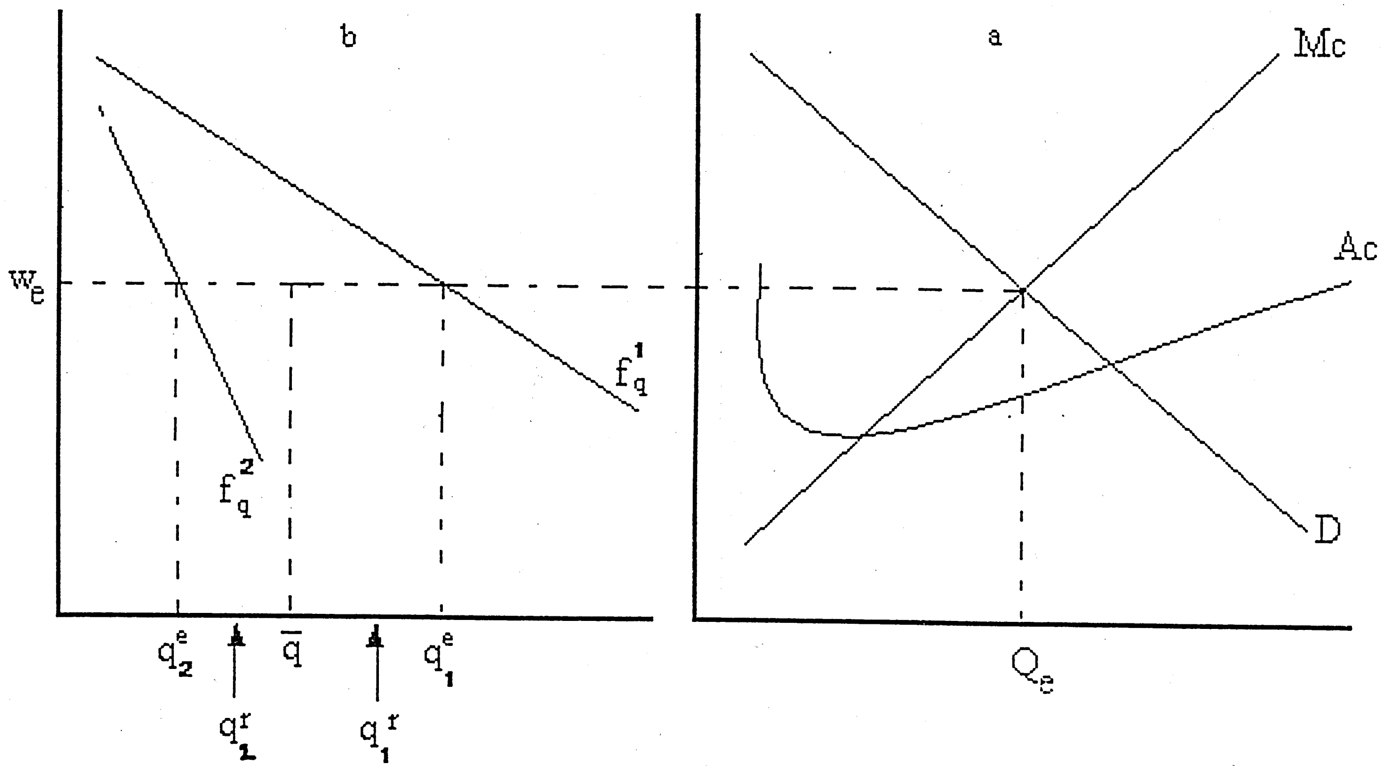
Figure 2



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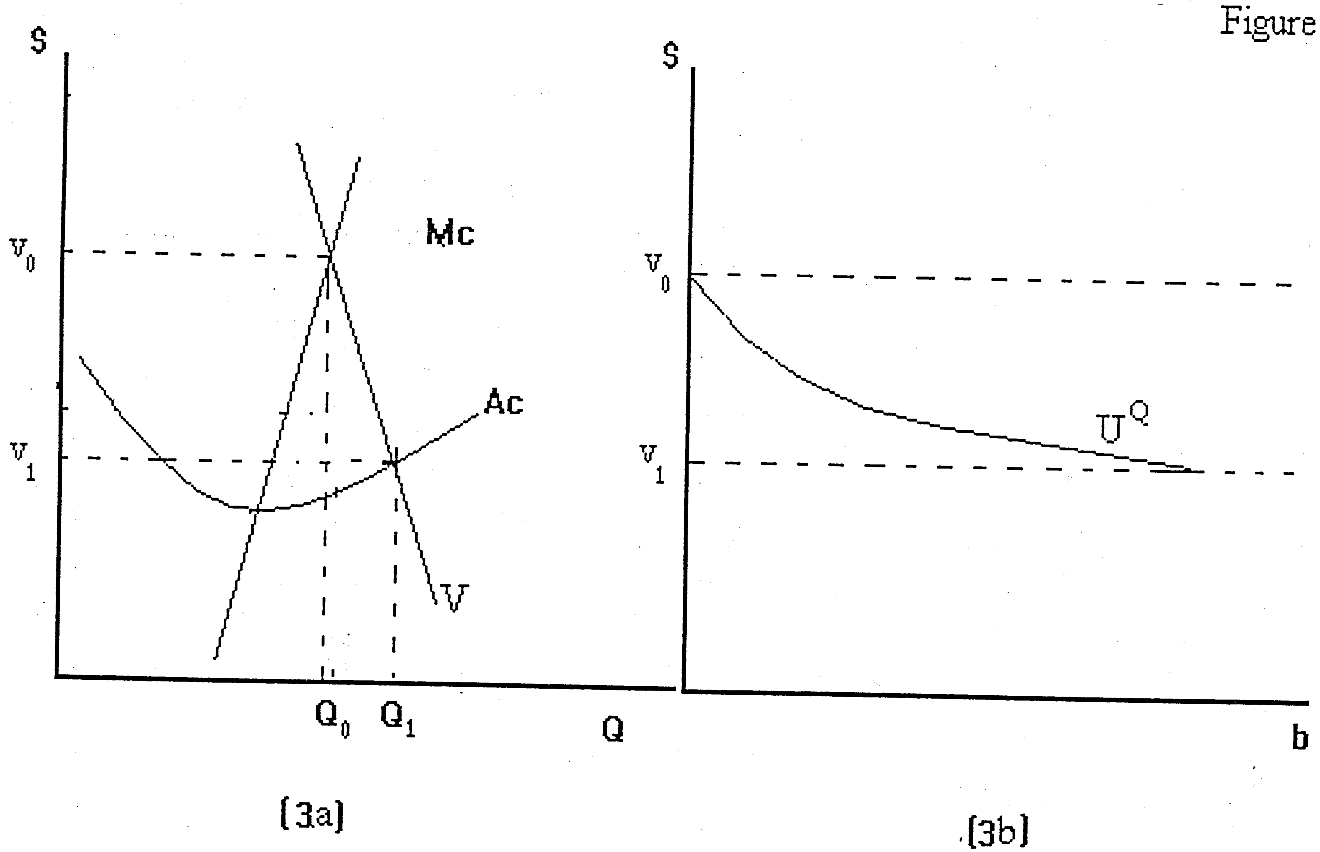

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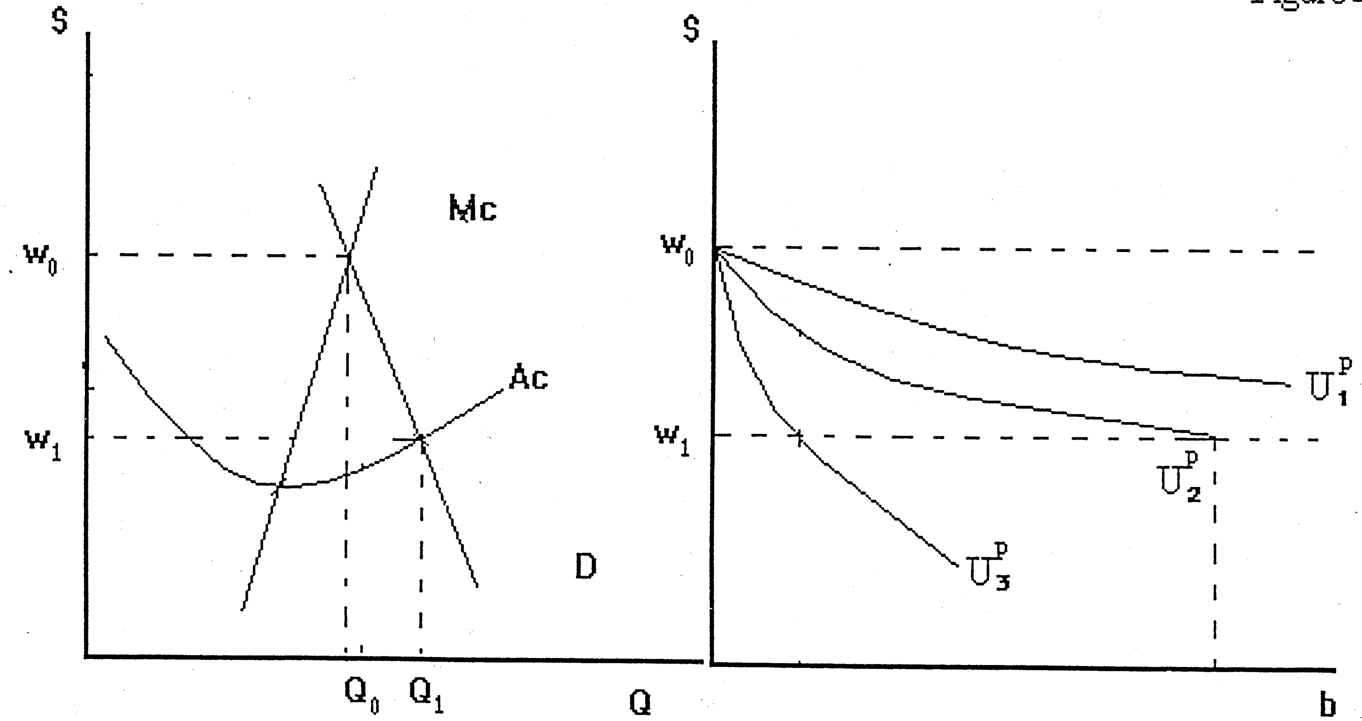

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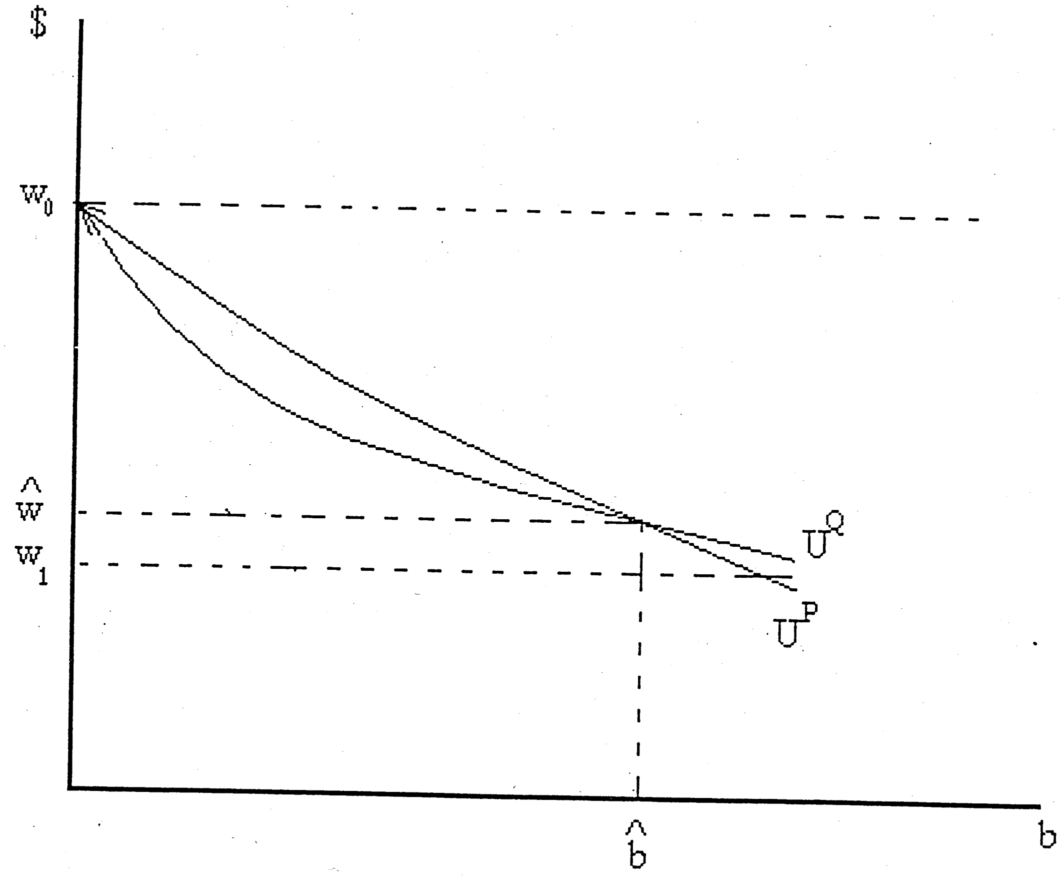
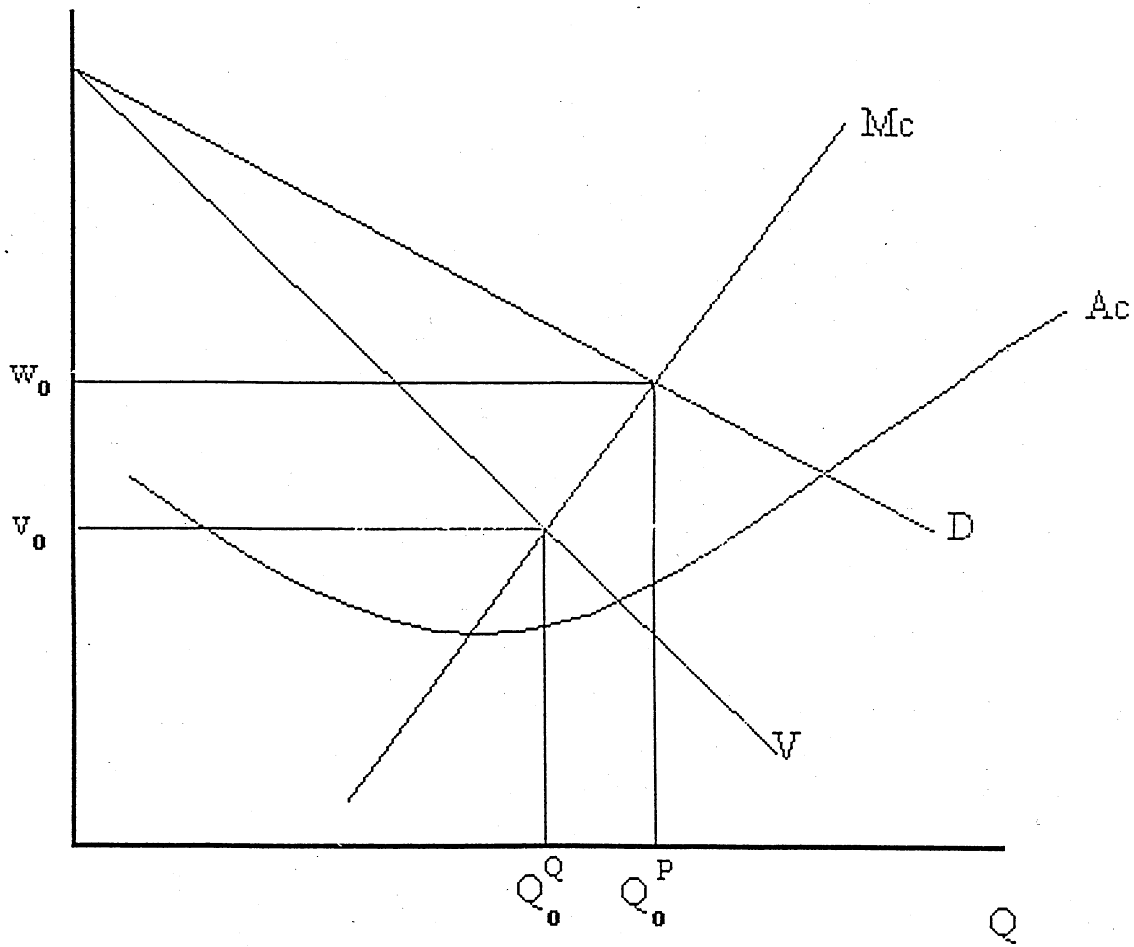


Figure 5

Figure 6



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