An Endogenous Group Formation Theory of Cooperative Networks: The Economics of La Lega and Mondragon

Sumit Joshi and Stephen C. Smith*

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*George Washington University. We would like to thank John Bonin, Terence Martin, Fred Freundlich, Panu Kalmi, Laixiang Sun, and participants at the Conference on "Property Rights Regimes, Microeconomic Incentives, and Development," UN-WIDER, Helsinki, April 2001 for helpful comments and discussions. Terence Martin and Fred Freundlich provided generous assistance in organizing field visits at Mondragón. Support from WIDER for this research is gratefully acknowledged. A special thanks to Adrian Celeya, General Secretary of Mondragon Cooperative Corporation, for the time and effort he generously devoted to the Mondragon field visits. Smith also acknowledges support from an earlier Fulbright Research Scholarship and a Jean Monet Research Fellowship, and other support from the European University Institute, Florence, during field visits in Italy. Address correspondence to: Stephen C. Smith, Dept. of Economics, 624 Funger Hall, George Washington University, Washington DC 20052, USA; e-mail, scsmith@gwu.edu.

1. Introduction

In the Mondragon cooperatives in the Basque country, and La Lega coops concentrated in North Central Italy, tens of thousands of workers operate competitive self-managed industrial enterprises, which in turn are grouped together in leagues that enable them to reap economies of scale in key services such as R&D, marketing, and finance. These networks are rare – there are fewer than a dozen of them globally–but not unique even in these countries (notably the Valencia network in Spain and three others in Italy). How do such networks of unconventional firms come to exist? Although each has its own history and idiosyncratic features, in this paper we develop a game theoretic model to capture some of the general strategic incentives of individuals to form labor-managed cooperatives, such as those in Italy and Spain, and for these cooperatives to further organize themselves into a league.

We consider a two-stage model. In the first stage, ex-ante identical players make a decision to either work in a conventional firm in return for an exogenously determined payoff or participate in a labor-managed cooperative in return for an (uncertain) share in revenue net of capital costs. We allow multiple symmetrically-sized coops to be formed endogenously. In the second stage, the cooperatives can form a league with other cooperatives. The formation and maintenance of such a league is assumed to impose costs on the participating coops, to pay for the services provided by the leagues (institutional details are given in the next section). Our objective is to characterize the equilibrium composition of the cooperative league and the size of the conventional sector. Ours is the first paper to apply the recent research on endogenous group formation in a non-cooperative framework to the analysis of cooperatives and labor managed firms (LMFs).

In our model, coalitions emerge endogenously as the Nash equilibria of an announcement game. In the first stage, individual players form labor-managed cooperatives through a well-defined coalition formation game. For example, players may form such cooperatives through an open membership game (Yi and Shin, 2000), an exclusive membership game (Hart and Kurz, 1983) or coalition unanimity game (Bloch, 1995, 1997). Each corresponds to alternative traditions in the literature and institutions. Once the players have made a decision to commit to join one of the coops, it is irreversible and they cannot change their decision in the second stage to withdraw from one coop and join another coop or work in the conventional sector.[1] For technical reasons, as well as for tractability, we restrict ourselves to symmetric equilibria; therefore, the coops from the first stage form the symmetric "players" for the second stage league formation game. We assume that a league is formed according to the dominant coalition open membership game of D'Aspremont et al (1983). This is a plausible representation of the institutions: organizational constitutions and external legal restrictions act to ensure that coop leagues do not behave so as to maximize rents of existing members only, and admit new coop members provided that basic requirements are met. Finally, since the players are assumed to be rational and forward-looking, the two-stage game is solved through standard backward induction techniques.

In addition to contributing to the literature on LMFs and coop leagues, the special nature of the problems at hand also lead us to contribute to game theory. In the received literature on the endogenous formation of coalitions, ex-ante symmetric players first form coalitions according to some well-defined rule and then play a non-cooperative game in the second stage contingent on the coalition structure from the first stage. In contrast, in our paper the players play two distinct coalition formation games in the two stages. The two stages are then linked through backward induction: the players look forward to the second stage Nash equilibrium when making their first stage decision.

The model is helpful in understanding problems of cooperative formation in developing countries, and in suggesting strategies for selective government assistance in the formation of cooperative leagues.

2. Mondragon and La Lega: An Overview.

The Mondragon Cooperative Corporation in the Basque region of Spain and La Lega cooperative network in Italy are probably the most striking examples of globally competitive labor managed cooperatives. These networks offer a wide range of specialized services to their member coops. This section offers a brief review of some of their key attributes.[2]

2a. La Lega. La Lega Nazionale delle Cooperative e Mutue (The National League of Cooperative and Mutual Societies, or La Lega) was founded in 1886, and is the oldest and largest cooperative organization in Italy, and among the largest in the world. It is an outgrowth of the Italian labor movement. La Lega includes some 5000 worker cooperatives, a fully autonomous grouping which is the subject of this study, as well as thousands of agricultural consumer coops, housing and other specialized coops in fields such as fishing and transportation. This autonomy is in sharp contrast to developing countries' typical government organized coop sectors, which group different types of coops under a single ministry dominated by growers and similar cooperative forms rather than labor coops, despite their sometimes competing interests (Abell, 1988). For example, in India, the sugar growers processing coops have never considered developing their factories as labor coops, because this might compete with the growers' profitability.

The explicit purpose of La Lega has been to promote the development of cooperatives, and the diffusion of cooperative principles in society. La Lega's current mission statement emphasizes three main goals: global competitiveness of member enterprises, the social role of coops in solving social problems and improving the general quality of life, and the expansion of workplace democracy. La Lega defines itself as a network of autonomous cooperative enterprises. In addition to individual coops as listed above, it includes autonomous regional associations, industrial sector associations, specialized consortia, and a national association that engages in research, lobbying, and other activities of benefit to its members. Participation in La Lega is voluntary; any coop may secede and become fully independent. The fact that coops rarely do so despite required payment of dues and other fees is evidence that La Lega provides valued services to its members. La Lega performs the watchdog role of ensuring that La Lega standards are met by all members. At a national level, the cooperative movement runs different types of specialized services through a number of subsidiaries, especially in the fields of finance, training and consulting.

In La Lega, many functions are delegated to consortia and second-level cooperatives.[3] Some thirty specialized institutes and consortia are affiliated with La Lega. Inforcoop coordinates these activities, and also raises funds from public sources for activities such as special training classes, seminars and workshops. SMAER is the in-house organizational development consulting group, which plays an active role in helping the large coops maintain a participatory style and cooperative labor- management relations. Comunicazione Italia is the public relations arm of La Lega, which both promotes the image of La Lega as a whole and serves as an advertising agency for coops and consortia in the network, and offers an additional arena for the coordination of marketing strategies. The SINNEA group focuses on training coop managers. Editrice Cooperativa is La Lega's publishing group. Il Consorzio Nazionale Approvviggionamenti (ACAM) is primarily a purchasing consortium, oriented to lowering costs of intermediate goods through negotiation on behalf of consortium members. In addition to receiving the usual declining purchase price with larger orders, ACAM works to achieve additional discounts, in part by negotiating long-term relationships with suppliers who agree to such discounts. Concoop is an industrial consortium that engages in subcontracting across coops when large orders are received; it is self-supporting through its 2% commission on the value of subcontracted work. ICIE is the innovation and technology transfer group; it is only mentioned here because it is described in greater detail below in the section on innovation. Promosviluppo (which roughly means development promotion) is the second-level coop charged with starting new coops. It conducts feasibility studies on conversions of private firms to La Lega coops. It also works extensively in the less developed Mezzogiorno regions, offering coops as development strategies in underserved areas. The source of funds for La Lega organizations derives primarily from membership fees, and commissions from consortia participation. Consortia and other groups receive a commission for their services; we list four examples here. The financial arms, notably Fincooper, receive interest payments and other standard intermediation fees; marketing consortia may receive a share of sales value of products marketed; and coop purchasing agent consortia receive commissions on the savings they engender. In addition, some outside contracts also provide sources of revenue; for example, the consortium ICIE (Institute for Cooperative Innovation) receives funds from public sources to do contract innovation work.

2b. Mondragon. The precursors to today's Mondragón Cooperative Corporation (MCC) were established through the efforts of an influential parish priest, Don José María. After more than a decade of preparatory work in community organizing and establishing a technical school on democratic principles, under Don José María's guidance in 1956 five engineering graduates of the school founded ULGOR (now known as Fagor), the first industrial coop in what became the

Mondragon system.[4] Don José María suggested the original guidelines of the Mondragón cooperative enterprises, which continue to exist in modified form. The Mondragón credit union, known as the Caja Laboral Popular (CLP), was established in 1959, which played a crucial role in the rapid development of the Mondragón system. In the decade that followed, dozens of additional industrial cooperatives were developed under the rubric of the CLP; later, most of the cooperatives, and other activities were grouped under what is now known as the Mondragón Corporación Cooperativa (MCC). As David Ellerman (1984) memorably put it, the CLP Entrepreneurial Division functioned in these years as "a factory factory." Today, following extensive consolidation and rationalization, the MCC is comprised of some 75 coops organized into financial, industrial, and distribution groups, together with administrative services, marketing, research and training bodies, and foreign subsidiaries, which brings the total number of entities in the group to about 120 (about equal to the maximum number of coops prior to the consolidation of the 1990s). Although the coops are independent, profit sharing takes place both MCC-wide and at the level of the industrial groupings (such as FAGOR and Donovat).

MCC employed a total workforce of 46,861 as of the end of 1999, with nearly 23,000 cooperative members in 75 core coops, and several thousand more probationary members (largely in the fast-expanding Eroski retail group), making it the largest industrial group in the Basque region, and eighth-largest in Spain. The MCC contributes about 5% of the GDP of the Basque region, excluding indirect contributions of the CLP through housing and its other non-MCC investments. Mondragón coops get their investment funds from retained earnings, membership capital fees, loans (and in the case of CLP, return from loans), and some outside contracts.

Although substantial rationalization of product lines has occurred particularly in the 1990s, MCC remains a highly diversified conglomerate. Part of this may be viewed as a strategy to mitigate worker-member risks (Smith and Ye, 1987); it may also be understood as stemming from a loan diversification strategy of the CLP itself, which made many of the initial investments in an increasingly diversified group of coops in the 1960s. However, as with La Lega, there are substantial interlinkages between MCC coops. According to Clamp (2000), "The household goods division is treated separately but has close ties in the MCC to the components division. Ties to the automotive industry closely relate machine tools and automotive sectors as well as the components division. The division heads meet with one another on a regular basis to facilitate coordination of their activities."

Some other coops that were once part of the Mondragon group are no longer part of the modern MCC but still thrive as cooperatives, most prominently the 7-coop ULMA group (however, this group is currently negotiating to reenter MCC). In the Mondragon system as a whole (beyond MCC), the CLP financial arm remains very important, although it no longer plays the dominant entrepreneurial and administrative role it played in the earlier years of the group.

The core administrative group MCC has now assumed some of the former explicit and implicit authority of the CLP. It is in charge of conceptualizing overall strategy, and it has at its disposal two significant funds, the Central Inter-cooperation Fund (FCI), which collects about 10% of net earnings for investment in coops, temporary subsidies, and the like, and the FEPI education, research, and coop development fund, with about 2% of net earnings. However, its real powers are limited. Its board is controlled by member coops; and except in the most egregious of cases, it cannot expel coops or replace managers. The historically central Entrepreneurial Group, which was formerly a division of MCC, and before that a division of the CLP, is now an independent coop within the network. Lagun-Aro operates the social insurance scheme (including unemployment insurance, the pension system, and health care). Ularco is the coop group handling legal, administrative and some financial functions, founded in 1965. Ikerlan undertakes research and development functions, founded in 1973; it is a coop in itself, that now provides services to conventional firms throughout Europe. In addition, Ideko provides R&D for the machine tool grouping, and now gets about 25% of its revenue from outside contracts. Lankide is the export group. The consumer durables group FAGOR grew out of Ularco, which was an early (mid-1960s) experiment in extensive inter-coop cooperation. Also significant is the role of FAGOR as a consolidated brand name, reducing marketing costs, and allowing all to benefit from joint efforts to raise quality–an important area in which coops can take advantage of strong complementarities

The Mondragon system has ten basic "principles," that have been adhered to since its founding.[5] The first principle is "open admission," which means that membership "is open to all men and women who accept the basic principles and can prove themselves professionally capable..." given "the practical needs and business requirements." Second, "democratic organization," meaning that the general assembly is sovereign, and operates on the basis of "one member, one vote." Third, sovereignty of labor, meaning that "Labor is granted full sovereignty" in the coop organization, and "the wealth created is distributed in terms of the labor provided and there is a firm commitment to the creation of new jobs." Moreover, "wealth generated by the coop... is distributed among the members in proportion to their labor and not on the basis of their holding in share capital." Fourth, the "instrumental and subordinate nature of capital" principle, meaning that capital receives only limited remuneration. Fifth, the principle of participatory management. Sixth, the payment solidarity principle, which to some degree limits the pay of managers in relation to that of production workers. Seventh, "Inter-cooperation," meaning cooperation within the MCC network, such as risk pooling across coops, and joint research and training. Eighth, social transformation, through support of creation of new coops, education and other community development initiatives, and a social security system. Ninth, universality, meaning membership in and support of organizations sharing similar goals. Tenth, the principle of education, support for continuous improvement of skills and knowledge of coop members and those of the surrounding community. In sum, MCC is held together by a set of shared principles, reinforced with the provision of valued services and other organizational safeguards that are analogous to, but in some ways stronger than, those found in La Lega.

2c. Coop Clusters: General Issues. From these overviews, certain general themes suggest themselves. First, coop density matters. In addition to Spain and Italy, coops are generally found in clusters. Smith (2001) presents arguments that geographic proximity to other coops is important for coop success even when coops are not grouped formally into a league, among them a) new managers will more likely have had experience with cooperative management when they take a new managerial job at a coop; b) employees will encounter similarly empowered counterparts in joint ventures, sales, or other market activities, maximizing the benefits of such decentralized authority[6]; c) banks will have experience lending to such firms; lending transaction costs are always highest when a bank first lends to a borrower with a very different structure or set of internal or external governing regulations,[7] and similar arguments may apply to insurance and other services; d) there are more examples of coop organizational and other relevant experiments to absorb lessons from in the region or sector; e) in addition to pure spillovers, there will be a "thick market" of specialized suppliers to coops, such as consultants in organizational development, improving the probability of a good match; f) in the case of involuntary separations, it will be easier for coops and workers with relevant coop experience to find each other, lowering training costs[8]; and g) some process innovations may fit with the organizational comparative advantage of coops, such as operations utilizing knowledge and skills impacted in the work team, that is, unobservable to management. Such innovations would be selected against when workers have an incentive to shirk; but if coops can overcome this problem, through a combination of financial incentives of ownership and the incentive for mutual peer monitoring, they may be efficiently used in coops. The more coops present, the greater the incentive to invest in such innovations.[9]

Beyond coop density, an organized league plays several important roles, internalizing some of the externalities, and enabling coops to take advantage of economies of scale and scope in provision of such services as finance, R&D, training, organizational development, procurement, and marketing, as well as development of new coops, which itself provides benefits to existing ones.

3. The Basic Model

In this paper, we model the formation of cooperatives and leagues as *coalitions*. A *coalition structure* is a partition of the set of players; an element of the partition is called a coalition. Therefore, a player can belong to one, and only one, element of the coalition.

We consider a model of endogenous formation of coalitions in order to analyze the strategic incentives of individual players to establish labor-managed coops, and these coops to further organize themselves into cooperative leagues. We address these issues in the context of non-cooperative games of coalition formation. While at first it may seem ironic to study cooperative formation as a non-cooperative game, we think it is highly appropriate: while successful coops, once formed, likely behave internally in ways better modeled as a cooperative game, the problem of establishing cooperatives in the first place presents numerous problems that are better conceptualized as elements of a non-cooperative game.

There is also a technical reason why the tools of cooperative game theory - in particular the characteristic function approach - cannot be used here. The coalition function attaches to each coalition its worth, i.e. what the coalition can achieve irrespective of the behavior of other coalitions. But in our framework the formation of a coalition creates positive externalities for other players; therefore the cooperative approach cannot be applied since the worth of a coalition is influenced by the actions of other coalitions. There has been an attempt to address this through the notion of a partition function but some of the problems persist (please see Bloch 1997 for an excellent overview).

The equilibrium coalition structure is a function of the rules according to which players form coalitions. While our models do not capture the full richness of the institutional structures described in the previous section, they do reflect the basic problems of the endogenous formation of cooperatives among potential conventional sector workers, and the further agglomerations of such coalitions into leagues, showing the impact of alternative rules of coalition formations on the resulting equilibria. Thus, our models represent a significant advance over the assumption of exogenous creation of such coops and leagues found in the literature to date. We consider interpretations of the alternative models in light of the overview of section 2 throughout the remainder of the paper.

Let N denote a finite set $N=\{1,2,...,n\}$ of ex-ante identical workers, or players. A representative player from this set is denoted by i. For simplicity we will assume that each player $i \in N$ has a perfectly inelastic supply of one unit of labor. Players have two choices about their labor endowment. One possibility before each player is to supply their unit of labor in the conventional profit-maximizing sector in exchange for a fixed exogenously given wage, $w>0$. The second possibility before the player is to pool their labor endowment with those of other players in a labor-managed coop in exchange for a share of the revenue net of the cost of capital. Let n_0 denote the number of players who have chosen to work for a conventional firm; therefore $m = n-n_0$ are the number of players who have agreed to form cooperatives.

Consider a labor-managed coop of size h. Let X denote the output produced by the coop (and PX the value of output) using labor, $L=h$, and the vector of capital inputs, $\boldsymbol{K}$ from the production function, $X = f(h,\boldsymbol{K})$. Recall that a coop with h members will have h units of labor by assumption. The capital inputs are purchased in a competitive market at input prices given by the vector $\boldsymbol{R}$. Letting $x = X/h$ denote the output per coop member, we can define $c(x,h)$ as the minimum capital cost per player (potential member) required to produce x, i.e.:

$$c(x,h) = \min \{\boldsymbol{R}.\boldsymbol{K}/L : f(L,\boldsymbol{K})/L = x,\ L=h\}$$

If the constraint $L=h$ is binding, and the production shows increasing returns to scale, then the inclusion of new members will imply that $c(x,h) \geq c(x,h')$ if $h \leq h'$.

Example: Suppose the production function is Cobb-Douglas and given by $f = L^{\alpha}K^{\beta}$ where $0<\alpha,\beta<1$. We let $\alpha+\beta>1$, i.e. there are increasing returns to scale in production. It can be verified that:

$$c(x,h) = rx^{\frac{1}{\beta}}\frac{1}{h^{\xi}}, \quad \xi = \frac{\alpha+\beta-1}{\beta}$$

Therefore, the cost function of the coop is decreasing in membership size.

In contrast to a worker in the conventional sector, a coop member may face uncertainty on the demand side and thus risk in net income (we assume away employment risk in the conventional sector). We can capture this by allowing demand $P(X)$ to be uncertain and represent the random demand by $\tilde{P}$; therefore, the value of output per coop member, $y \equiv Px$, is uncertain. Further, it is plausible that a larger coop may face less uncertainty than a smaller one. This can be accommodated by letting the uncertainty be a function of the size of the coop. Formally, let $F(h,\tilde{P})$ denote the distribution function of $\tilde{P}$ faced by a member of a coop coalition of size h. Further, being a part of a larger coalition reduces the risk to a player in the sense of either first degree or second degree stochastic dominance.

Let u be any increasing concave function. The payoff to player i who belongs to a coalition of size h is given by:

$$\pi(h,\tilde{P}) = \int_0^P [u(y) - c(x,h)]\, dF(h,\tilde{P})$$

Since the players (members) are ex-ante identical, all players in the same coop receive the same payoff.[10] This also implies that payoffs do not depend on the identity of the player; all that matters is the size of the coop to which the player belongs and the level of output. Under our assumptions, payoffs of player i are increasing in the size of the coalition to which she belongs, i.e. if $h' > h$ then:

$$\begin{aligned}\pi(h',\tilde{P}) &= \int_0^P [u(y) - c(h',x)]\, dF(h',\tilde{P}) \\ &\geq \int_0^P [u(y) - c(h,x)]\, dF(h',\tilde{P}) \\ &\geq \int_0^P [u(y) - c(h,x)]\, dF(h,\tilde{P}) = \pi(h,\tilde{P})\end{aligned}$$

where the second inequality follows from the fact that u is increasing and concave, and F shows first or second order stochastic dominance.

Example: (continued) Consider the Cobb-Douglas production function once again and the certainty case with $u(Px) = Px$ and P is constant. The coop's problem is to maximize value of output per worker net of (minimum) capital costs of production:

$$\underset{x}{Max}\ Px \ - \ Rx^{\frac{1}{\beta}}\frac{1}{h^{\xi}}$$

Solving for the optimal value of output and substituting in the objective function, the coops payoffs are given by:

$$\frac{A}{R^{\beta/(1-\beta)}}P^{1/(1-\beta)}h^{\zeta}, \quad \zeta = \frac{\alpha+\beta-1}{1-\beta}$$

where A is a constant. Therefore, gross payoff to a coop is increasing in the size of the coop. It can be verified that gross payoffs to the coop are concave if $\alpha + 2\beta < 2$ and convex otherwise. The gross payoff to any member i in the coop is given by:

$$.\pi(h) \ = \ \frac{A}{R^{\beta/(1-\beta)}}P^{1/(1-\beta)}h^{\zeta-1}$$

As described in Section 2 for the cases of Mondragon and La Lega, an important aspect of the formation of coops is the (positive) externality, or spillovers, created for other coops. We can incorporate spillovers from other coalitions quite easily in this framework. Quite generally, let player i belong to a coalition of size h_q and $0<\theta<1$ denote the spillover parameter. Then let:

$$g_q = h_q + \theta \sum_{r \neq q} h_r \ = \ (1-\theta)h_q + (n-n_0)\theta \ = \ (1-\theta)h_q + m\theta$$

We can interpret g_q as the *effective* coalition size for player i. Therefore, in the symmetric case, gross payoff to player i can now be written as a function of own coalition size and m as (where reference to the parameters n and θ is suppressed):

$$\pi(h,\tilde{P},m) \ = \ \int_0^P \left[u(y) - c(g)x\right] dF(g,\tilde{P}) \qquad (1)$$

Each coop chooses output per member to maximize the (expected) payoffs of the members. This yields the reduced form payoffs $\pi(h,m)$ for each member of the coop and a total gross payoff of

$h\,\pi(h,m)$ to the coop.

The coops then organize themselves into a league. Let L denote the number of coops who are members of the league. Since all coops are symmetric, with a slight abuse of notation we also let L denote the set of coops in the league. Define the indicator function $\chi_i(L)$ for any coop i as $\chi_i(L)$ $=1$ if $i \in L$ and $\chi_i(L)=0$ otherwise. Players who are members of the league benefit from an increase in the size of the league; this direct benefit can be captured generally by a function $\mu(L)$. The literature on cooperatives has noted that non-members also gain from the formation of a league; these indirect spillovers can be captured generally by a function $\lambda(L,h,m)$. Therefore, payoff to a coop i in the second stage can be written quite generally as:

$$\psi\left(h\pi(h,m), \chi_i(L)\mu(L) + [1-\chi_i(L)]\lambda(L,h,m)\right) \tag{2}$$

In the next section, we consider the endogenous formation of a dominant league.

4. Endogenous Formation of Leagues

In this section, we consider the incentives of individual coops to organize themselves into a league. We take it as given that m players have formed symmetrically-sized coops with h members in an earlier stage. This allows us to focus exclusively on the endogenous formation of a league. We assume that a dominant coalition of coops is formed via an open membership game due to D'Aspremont et al (1983). In this game, the message space is M={Y,N}. All coops announcing Y belong to the league while those announcing N signal their decision not to participate. Membership is open because any player can join the league by announcing Y. The dominant league is a Nash equilibrium of this game and is internally stable (no coop who has announced Y has an incentive to announce N) and externally stable (no coop who has announced N has any incentive to announce Y).

In this formulation of a game, only one league is allowed to form; multiple leagues are ruled out by assumption. We do not believe this to be a restriction of our model. One of our objectives is to highlight the potential for *multiple* Nash equilibria in the league formation game, some of which may be inefficient. We are able to show that even when we restrict ourselves to the formation of one dominant league, there are *two* Nash equilibria in the league formation game, one of which is inefficient. This would hold even if we allowed multiple leagues to form, and indeed in general a larger set of equilibria are likely.

Let L denote the number of coops who have announced Y and are participating in the league. To normalize for convenient graphical interpretation, we will follow the convention that if L=1, then there is one coop in the league (incurring all costs of league formation); if all coops choose to be singletons, then L=0. Consider the gross payoffs to a member in the league. As the arguments considered in section 2 suggest, gross payoffs may depend on the number of players who have agreed to participate in the cooperative sector, m, and or the number of players in each coop, h. In other words, there are spillovers or externalities generated by having more players in the cooperative sector and each coop in the sector being larger. Consequently, we write gross payoffs quite generally as $\Pi(L;h,m)$. It is given by substituting $\chi_i(L)$ =1 for a member coop i in (2):

$$\Pi(L,h,m) = \psi\big(h\pi(h,m), \mu(L)\big) \qquad (3)$$

In Figure 1, we graph the gross payoffs to a member coop as a function of the number of coops participating in the league. The only modest restriction that we impose is monotonicity: gross payoffs to a league member weakly increase as more coops join the league; no restrictions are imposed on the rate at which payoffs increase. The parameters (h,m) that we are taking as given fix the position of the gross payoff function; any change in one or both parameters will shift the gross payoff for the member coop. We also allow that payoffs to coops may increase when more coops are formed, even if they do not join the league.

With regard to costs, it is assumed that the formation of a league requires some initial fixed investment; as the league expands, this fixed cost is distributed equally over all members. Thus, costs for a member decreases as the size of the league increases. In Figure 1, we have shown the costs to a member as a function of the league size to be monotonically decreasing. But our analysis also holds for the case where there is some minimum efficient league size after which costs for a member can increase. For example, administrative costs may rise as the league expands and becomes a more complex organization.

Figure 1 about here

In Figure 2 we plot the *net* payoff to a member of the league. In this figure, we also compare it to the payoff of a non-member. Note first of all that for a non-member, we do not have to distinguish between gross and net payoffs because the non-member does not share any costs of league formation. Second, non-member payoffs will also depend on the tuple (h,m) because of the presence of spillovers. Third, non-member coops can also gain from the presence of a league due to strategic complementarities, as discussed in section 2. Therefore, non-member payoffs are a function of the league size as well and written quite generally as $\Phi(L;h,m)$. They are given by substituting $\chi_i(L)=0$ in (2):

$$\Phi(L,h,m) = \psi\big(h\pi(h,m), \lambda(L,h,m)\big) \qquad (4)$$

These payoffs are shown in Figure 2. Since non-members benefit through positive spillovers from the formation of a league, and the spillover benefits are presumably smaller than direct benefits from participating in a league for small league size, the function Φ may intersect Π at least twice. In such a case, it is clear that a coop would join a league only if its size was in the interval $(L_1(h,m),L_2(h,m))$; otherwise, it would prefer to be a non-member.[11]

Figure 2 about here

After analyzing this case, we will consider some other possibilities for non-member payoffs. In Figure 2, there are two Nash equilibria: no league is formed at all, or a league of size $L_2(h,m)$ is formed. To see this quite transparently, consider the mapping $T:I_+ \rightarrow I_+$, where I_+ is the set of positive integers, such that $T(L) > L$ if $\Pi(L;h,m) > \Phi(L;h,m)$ and $T(L) < L$ if $\Pi(L;h,m) < \Phi(L;h,m)$. This mapping is shown in Figure 3.

Figure 3 about here

It is clear that if the league size is less than $L_1(h,m)$, then no coop would agree to participate in a league. Therefore, L=0 is a Nash equilibrium of the game: if all coops are announcing N, then no coop has any incentive to deviate unilaterally from its message and announce Y instead. If the league size is in the interval $[L_1(h,m),L_2(h,m))$, then a non-member coop has an incentive to change the message from N to Y; likewise, if the league size is strictly greater than $L_2(h,m)$, then each member coop has an incentive to change the message from Y to N. The league size $L_2(h,m)$ is the other Nash equilibrium of the game because no member has any incentive to announce N and no non-member has any incentive to announce Y, i.e. the league size is internally and externally stable.

It is interesting to note that with multiple Nash equilibria, payoffs to players in one equilibrium dominate those in another. Only one Nash equilibrium, where a league of size $L_2(h,m)$ is formed, is efficient. However, our analysis shows that an inefficient equilibrium could arise if all coops expect that no league is going to be formed. Even if the efficient league is formed, it is possible given the parameters of the model that all coops do not participate in the league. In the case being considered, $L_2(h,m)$ coops are members of the league while $(m/h)-L_2(h,m)$ coops are non-members. Depending on (h,m) and the shapes of the functions Π and Φ, the equilibrium league size could be small and we may have a large number of free-riding non-member coops.

There are other possibilities for non-member payoffs as well which are shown in Figure 4. First consider the case where non-member payoffs are given by $\Phi_1(L;h,m)$. Since member payoffs dominate non-member payoffs, all coops would announce Y and join the league. Therefore, the league would be the grand coalition with all m/h coops as members. In this case, the equilibrium outcome is the efficient outcome as well.

Next consider the case where non-member payoffs given by $\Phi_3(L;h,m)$. Here, non-member payoffs dominate the member payoffs indicating that spillover effects dominate the direct effects from participating in a league. There is only one Nash equilibrium in this case: no league is formed. All coops would like to free ride and announce N. In this case, we see a conflict between the equilibrium outcome and the efficient outcome. In the Nash equilibrium, all coops get a payoff equal to $\Phi_3(0;h,m)$. But, this is clearly dominated by the member payoffs if the league size is large enough. A non-degenerate league cannot be sustained however. Once any league is formed, each member will have an incentive to defect given that non-member payoffs increase monotonically due to positive spillovers from the formation of a league and dominate member payoffs.

The last case is where non-member payoffs are given by $\Phi_2(L;h,m)$. As in Figure 2, there are 2 possible equilibria, one where no league is formed and the other efficient equilibrium where a league of size $L_2(h,m)$ is formed. The difference from Figure 2 is that the outcome of all non-members in the inefficient equilibrium get a negative payoff. In the next section we endogenize the choice of being in a cooperative sector and forming a coop. Then we will see that if players anticipate that no league will be formed, then they will not form any coops either and prefer to work in the conventional sector instead for a fixed wage. We have proved the following general proposition:

Proposition 1: *Let (h,m) be given and assume that a league is formed through the open membership game of D'Aspremont et al. Then, there can be at most two Nash equilibria of the league formation game. If there are two Nash equilibria, then payoffs to coops in one Nash equilibrium dominate payoffs in the other.*

Proof: We have already argued that there can be at most two Nash equilibria under our assumptions (refer to Figures 3 and 4) at L=0 and $L_2(h,m) > 0$. Note that payoffs to the coops, whether they belong to the league or not, are equal in the two equilibria, that is:

$$\Pi(0,h,m) = \Phi(0,h,m), \quad \Pi(L_2(h,m),h,m) = \Phi(L_2(h,m),h,m)$$

From the monotonicity of net payoffs for members and non-members (refer to Figure 2), it follows that:

$$\Pi(0,h,m) \leq \Pi(L_2(h,m),h,m), \quad \Phi(0,h,m) \leq \Phi(L_2(h,m),h,m)$$

with a strict inequality if the net payoffs for members and non-members is strictly increasing with respect to the size of the league. ■

5. Endogenous Formation of Coops

In the last section, we took the number of players in the cooperative sector as well as the size of each coop as given in order to focus on the multiple equilibrium problem in the league formation game. In this section we consider the endogenous formation of coops. Our objective is to analyze how different rules of coalition formation - in particular, whether membership is exclusive or open - can impact on the equilibrium size of the coops.

We now consider the complete two-stage game. In the first stage, ex-ante players decide to either work for a conventional sector for a fixed wage, or join the cooperative sector. If they join the cooperative sector, then they have to decide the size of the coop. We will restrict ourselves to symmetric equilibria and focus on coalition structures composed of equal-sized coops. These symmetric coops then become the "players" for the second stage league formation game. In the second stage, given the number of players in the cooperative sector and the size of each coop, the coops play the dominant league formation game discussed in the previous section.

We consider subgame-perfect equilibria. Therefore, using the principle of backward induction, players in the cooperative sector can anticipate the Nash equilibria of the second stage and take these payoffs into account when making their decision in the first stage. The equilibrium outcome in general depends on the rule according to which players form coops. We consider three different rules based on how actively the players engage in the process of coalition formation. Since the players are ex-ante symmetric, we only need characterize the number of coalitions formed in equilibrium and their sizes; the identity of the players in any coalition is irrelevant.

(i) *The Open Membership Game*

The open membership game was put forward by Yi and Shin (2000). Their construction uses the notion of a message space to coordinate the decisions of the players. Let $\boldsymbol{M}$ be any arbitrary set with at least n elements; any $m \in \boldsymbol{M}$ is called a message. The players simultaneously announce a message from the set $\boldsymbol{M}$, i.e. the strategy set of each player is $\boldsymbol{M}$. All players who choose the same element m belong to the same coalition $C(m)$. The (Nash) equilibrium coalition structure results when no player has any incentive to unilaterally deviate from its announcement given the announcements of the other players. In the open membership game, the players do not actively maintain the exclusivity (i.e. the size) of the coalition (coop) to which they belong. Any non-member who announced m' can potentially join a coalition $C(m)$ by changing the message from m' to m.

The open membership structure of this game conforms to an important tradition within the cooperative movement, sometimes associated with Theodor Hertzka's (1891) utopian novel Freeland, and reflecting Mondragon's first principle of Open Admission. Although Mondragon's individual coops probably do not use purely open membership rules in practice, this game provides a relevant benchmark for analysis.

(ii) *The Exclusive Membership Game*

The version of the exclusive membership game examined here was put forward by Hart and Kurz (1983).[12] In this game, the message space is more specialized and consists of all subsets of the set of players, i.e. $\boldsymbol{M} = 2^N-1$. All players simultaneously announce coalitions of players to which they wish to belong. Players who have announced the same message m form a coalition $C(m)$.

Consider an example where $N=\{1,2,3,4,5\}$. Players 1,2 and 3 have announced $m=\{1,2,3,4\}$ and players 4 and 5 have announced $m'=\{1,4,5\}$. Then the coalition structure that is induced from these choice of messages is $\{\{1,2,3\},\{4,5\}\}$.

In this game, players have a more active role in determining the coalition structure. The messages that are announced by the players restrict the size of their coalition and prevent outside players from joining. Consider once again the example of the previous paragraph and note that player

5 cannot join the coalition {1,2,3} by deviating from *m*' to *m* unless players in the coalition are willing to include player 5 by changing their announcement to *m*''={1,2,3,4,5} or *m*''={1,2,3,5}.

This game reflects the way many coops are actually formed in practice. A group of potential members self-selects as a group to form a coop, without knowing with certainty what the payoff to their coalition will be. As long as the realized payoff, determined after the potential group is formed, at least matches the alternative (conventional firm) wage w, the outcome is an equilibrium. Formally, recall from Section 3 our distribution function $F(h,\tilde{P})$ reflecting the uncertainty in demand and therefore the value of output. Therefore, $\pi(h)$ is the *expected* payoff to each member in the coop. If the state of nature is such that realized payoffs, given the size of the coop, are less than w, then clearly all players will withdraw from the coop. On the other hand, if realized payoffs is greater than w, then players have no incentive to withdraw. Therefore, as we will see, the result is a range of equilibrium firm sizes, that may or may not maximize income per member.

(iii) *The Coalition Unanimity Game*

The coalition unanimity game was proposed by Bloch (1995,1997). In this game players move sequentially instead of simultaneously and a coalition is formed if and only if all the potential members of the coalition agree to its formation. The order in which the players move is given exogenously and is common knowledge among the players. Consider for the purpose of illustration the case where N={1,2,3}. Player 1 moves first and announces a coalition of which it is a member such as {1}, {1,2}, {1,3} or {1,2,3}. Suppose player 1 announced {1,2,3}. The other two players now respond in the order 2,3. If both agree, then the coalition is formed. If player 2 disagrees, then 2 proposes a coalition to which it belongs and players 3 and 1 respond sequentially. If player 2 had agreed to the coalition {1,2,3}, but player 3 had disagreed, then 3 gets to announce a coalition to which 1 and 2 respond sequentially. In this game, a coalition structure corresponds to a (subgame perfect} equilibrium if there is no player who wishes to deviate and join another coalition.

Since the players are initially symmetric, the coalition unanimity game is equivalent to the following size announcement game: player 1 announces the size of the coalition of which it is a member. Each prospective member of this coalition responds to the offer by either accepting or rejecting the offer. If all the prospective members accept the offer, the coalition is formed and the procedure is repeated with the excluded players now getting the opportunity to propose the coalition (proceeding sequentially again with the player with the smallest index). If any of the prospective members rejects the offer, then they get an opportunity to propose the size of the coalition they wish to belong to.

The coalition unanimity game requires the most active role by each player in the organization of the coalition. A coalition can only be formed by the unanimous agreement of prospective members. Once players have agreed to participate in a coalition, they are obliged to remain in it and not accept new members at later stages of the game. Further, since the game is sequential (or dynamic), each player looks forward into the game and takes into account the coalition proposals of players who move later. Given that players will therefore be in a position to choose a membership size that maximizes their assumed objective, namely their (equal) share of net income, this game solution concept corresponds to the Ward-Vanek neoclassical analysis of the LMF. However, unanimity might not be reached to lay off members in response to a price increase, under some sets of rules for coalition formation. Note also that the structure of this game also lends itself to an analysis of an "inegalitarian" coop of the type introduced by Meade (1972).

Recall from Proposition 1 that there are at most two possible equilibria of the league formation game. Note that in the two second stage equilibria, payoffs to a member and non-member are equalized, i.e. $\Pi(0,h,m) = \Phi(0,h,m)$, $\Pi(L_2(h,m),h,m) = \Phi(L_2(h,m),h,m)$. We can therefore consider payoffs to a coop member as a function of the coop size h and the number of players in the cooperative sector, m, without having to differentiate whether the coop will participate in the league or not. Suppose the coops anticipate that they will form a league $L(h,m)$ where $L(h,m)=0$ or $L(h,m) = L_2(h,m)$ Then, the payoffs to each member in the coop will be $\pi(h,m) = \Pi(L(h,m);h,m)/h$. This function can be quite non-linear. It is plausible however that the payoff to each coop member will increase initially as a function of h and then decrease (holding m constant). In addition to plausibility, the basic problems associated with multiple Nash equilibria can be addressed quite transparently with this formulation, as shown in Figure 5.

Figure 5 about here

The number of players in the cooperative, m, fixes the position of $\pi(h,m)$; a change in m will shift the payoff function for the player. In line with the observations in Section II, an increase in m (and therefore in cooperative density) can be expected to shift the function upwards. Note that the case of π_3(h,m), in which payoffs may exceed those of the conventional firm wage, are plausible given the extensive evidence that such coops as do enter the market produce at a higher level of productivity than conventional firms (Bonin, Jones, and Putterman, 1993). We now prove a general result that applies to any second stage Nash equilibrium in the league formation game. We then apply it to the special cases discussed in the previous section. The three cases we consider are shown in Figure 6.

Figure 6 about here

Proposition 2: *Consider the payoff function for a member of a coop that is initially increasing in h and then decreasing. If:*

(i) $\pi(h,n) < w$ *for all h, then all three rules of coop formation yield the same outcome: no coop will be formed and all players will work in the conventional sector, i.e. m=n.*

(ii) $\pi(H^*,n) = w$ *for a unique value of H*, then open membership and exclusive membership yield the same outcomes: either no coop will be formed or all coops formed will have H* players. The coalition unanimity game has a unique outcome: only coops of size H* will be formed.*

(iii) $\pi(h,m) > w$ *for some h and* $m \leq n$*, then the three rules of coop formation yield different outcomes. In the open membership game, if the stated condition holds for m<n, then coops will be of size* H_2*; on the other hand, if the stated condition holds only for m=n, then all coop sizes in the interval* $H^{**} \leq h \leq H_2$ *are equilibria. In the exclusive membership game, all coop sizes in the interval* $H_1 \leq h \leq H_2$ *are equilibria. Finally, in the coalition unanimity game, only coop sizes equal to H** are equilibria.*

Proof: (i) If $\pi(h,n) < w$, then clearly no player has any incentive to enter the cooperative sector irrespective of the rule of coop formation.

(ii) This corresponds to the tangency case shown in Figures 5 and 6. In the open membership game, if all players have announced to be singletons, then clearly no player has any incentive to deviate and change his announcement. Similarly, if players have announced a coop of size *H**, then players inside the coop have no incentive to change their message and players outside the coop have no incentive to change their announcement either. The argument for the exclusive membership game is identical. No player can unilaterally increase the size of the coop; a player can however unilaterally withdraw from the coop. But if each coop is a singleton or composed of *H** players, then any player will not have any incentive to withdraw from the coop. Finally consider the coalition unanimity game. The first player to move will announce the size H^*; all prospective players in the coop have no incentive to reject this offer. Since the incentives for player H^*+1 is the same as that for player 1, all coops will be of size H^*.

(iii) Consider the open membership game. If the stated condition holds for $m<n$, then payoffs have to be equated in the conventional and cooperative sectors. If the equilibrium coop size belongs to $[H_1,H_2)$, then players in the conventional sector will have an incentive to move to the cooperative sector. Therefore, the only equilibrium size is H_2. On the other hand, if the stated condition holds only for $m=n$, then payoffs in the conventional and cooperative sector do not have to be equalized. Further, the equilibrium size cannot be in the interval $[H_1,H^*)$ because net payoffs for each player are monotonically increasing over this range; therefore, players in such coops will have an incentive to move to another coop by changing their message. Next consider the exclusive membership game. As in part (ii), players will have no incentive to unilaterally withdraw from a coop in the range $[H_1,H_2]$, nor can they increase the size of the coop by changing their own announcement. Finally, as in part (ii), under coalition unanimity, the players announcing the coop size will always have an incentive to announce H^{**}. ■

Note that only the coalition unanimity membership game providing the final equilibrium in part iii corresponds to the standard Ward-Vanek neoclassical analysis of the LMF, although even there under some rules of the game outcomes could be closer to those in Steinherr and Thisse (1979), Bonin (1981), and Miyazaki and Neary (1983), that existing memberships would not lay off members among themselves in response to changes in the economic environment, such as a price increase. This lack of correspondence to results not allowing for endogenous membership formation is not necessarily a drawback: the empirical evidence to date has not been supportive of the Ward-Vanek neoclassical analysis (for a survey, see Bonin, Jones, and Putterman, 1993).

We can now apply this result to the two extreme subcases discussed in Section 4 where there is a unique Nash equilibrium in the league formation game; the multiple Nash case incorporates both these subcases. Consider first the case where there is a unique second stage equilibrium at L=0. If $\Phi(0,h,m)<0$, then under all three rules of coop formation, no coops will be formed and all players will work in the conventional sector. What if $\Phi(0,h,m)>0$? We will then have three possibilities for net payoffs as shown in Figures 5 and 6. In cases (ii) and (iii) discussed in Proposition 2, we will see some players in the coop sector forming non-singleton coops even though they anticipate that no league will be established in the second stage. Further coop sizes are in general larger under open membership even though net payoffs for each member are maximized under coalition unanimity.

Now consider the case where there is a unique second stage Nash equilibrium at the efficient league level, $L_2(h,m)$. In this case, it is clearly efficient for coops to form and for coops to establish a league. However, it is possible if case (i) in Proposition 2 holds for no coops to form at all (even though it is clearly efficient) and for all players to work in the conventional sector. If cases (ii) or (iii) apply, then coops will form. Suppose for the sake of argument that a larger coop size increases the equilibrium league size $L_2(h,m)$ which in turn increases the net payoffs for the member coops. In this situation, it is clear that open membership will strictly dominate coalition unanimity. Under coalition unanimity, the first mover chooses the coop size that maximizes each member's payoff; however, this may not coincide with the coop size that maximizes the coop's payoff in a league. (Of course, the strict domination would work in the other direction if a larger coop size decreases the equilibrium league size $L_2(h,m)$). Also, open membership weakly dominates exclusive membership (it strictly dominates over the range $[H_1,H^{**})$; over $[H^{**},H_2]$ the outcomes from the two games coincide).

6. Conclusions and Directions for Further Research.

In this paper, we have generalized from features found in the two most prominent coop leagues, Mondragon and La Lega, to develop the first formal model of the endogenous formation of cooperative networks and of their constituent member coops. We show that if the coop league is formed through an open membership game, there can be two Nash equilibria. In one equilibrium a coop league is formed; in the other, it is anticipated that no coop league will be formed, and hence no coops are formed. We show that in this case, the former equilibrium with a coop league Pareto-dominates the latter, in which no league is formed.

In addition, in examining the formation of the constituent individual cooperative firms. we show that, when payoffs to joining a coop for potential worker-members are initially increasing in the number of members and then decreasing, then the outcome of the game depends on the rules of coop formation. If the payoffs to individual coop members are less then the conventional wage, then all three rules of coop formation yield the outcome that no coops will be formed. If the payoffs are exactly equal to the alternative wage at a single, unique membership size, then open membership and exclusive membership rules of the game yield the same outcomes: either no coop will be formed, or all coops formed will have the same number of members. On the other hand, in this case the coalition unanimity game has a unique outcome: only coops of that unique size will be formed.

But if payoffs to coop membership strictly exceed the alternative wage for some membership sizes, then our three alternative rules of coop formation yield different outcomes. In particular, in the open membership game in the case in which at least some workers continue to work for conventional firms, then coops will be formed at the largest size for which coop payoffs are equal to the alternative wage. However, if coop payoffs exceed the conventional wage only when all workers join coops, then equilibrium coop sizes can potentially include a wide range of membership sizes. In the exclusive membership game, all coop sizes in the interval for which coop payoffs are at least as large as conventional wages are equilibria. Finally, in the coalition unanimity game, only coop sizes at which the highest income per member is achieved are equilibria. Only the latter result corresponds closely to the traditional neoclassical Ward-Vanek literature (though not necessarily with its comparative statics implications).

In future work we believe that it would be valuable to extend the model to allow for multiple leagues, such as are present in Italy. One way to examine this possibility would be to allow for variable costs of league operation that cause average costs to member coops to eventually rise as the number of member coops increase.

Alternatively, in particular coop leagues often make strenuous efforts to start new coops, an observation not considered in our model. Coop leagues may have an incentive to do so when efficient league scale has not been reached. Allowing for this phenomenon would add an additional stage to the game. We anticipate that a useful modeling strategy would be to examine coops whose upfront organizational costs are high to potential members but lower to an outside entrepreneurial force, such as a coop league. Alternatively, some potential coops might attempt to free ride on the league, to have their organizational costs borne externally.

If the government can support the formation of independent leagues, the analysis suggests that this can encouragė potential members to form coops that otherwise would not emerge. More speculatively, active assistance to such leagues in creating a larger number of constituent coops could lead to an improvement in welfare of potential members.

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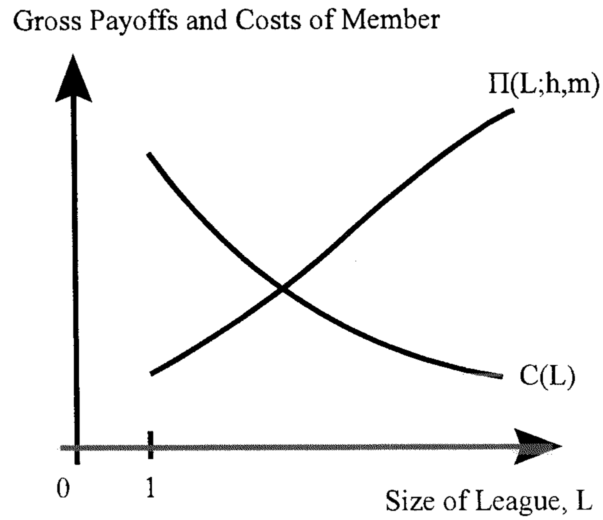

Figure 1: Gross Payoffs and Costs of a League Member as a Function of League Size

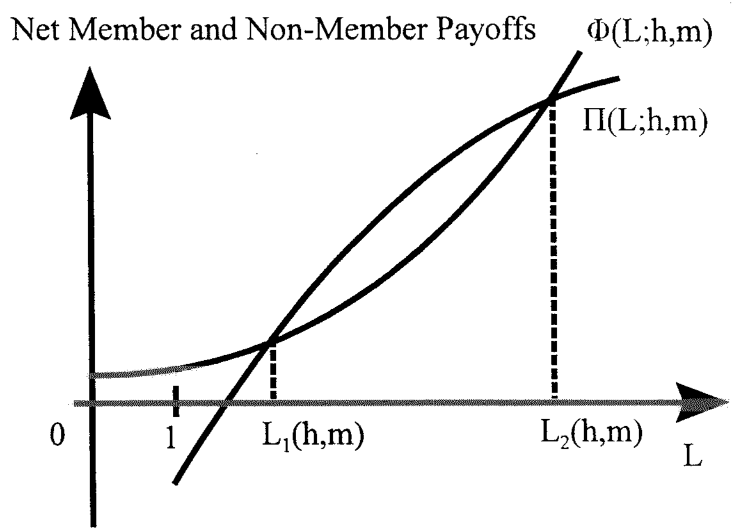

Figure 2: Net Payoffs to Member and Non-Member

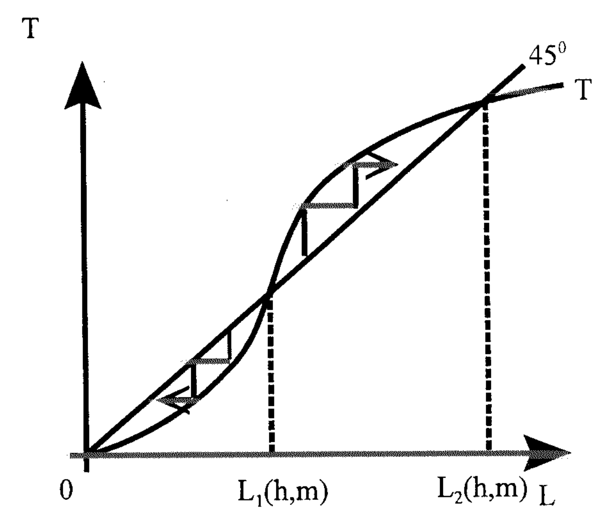

Figure 3: The T-function

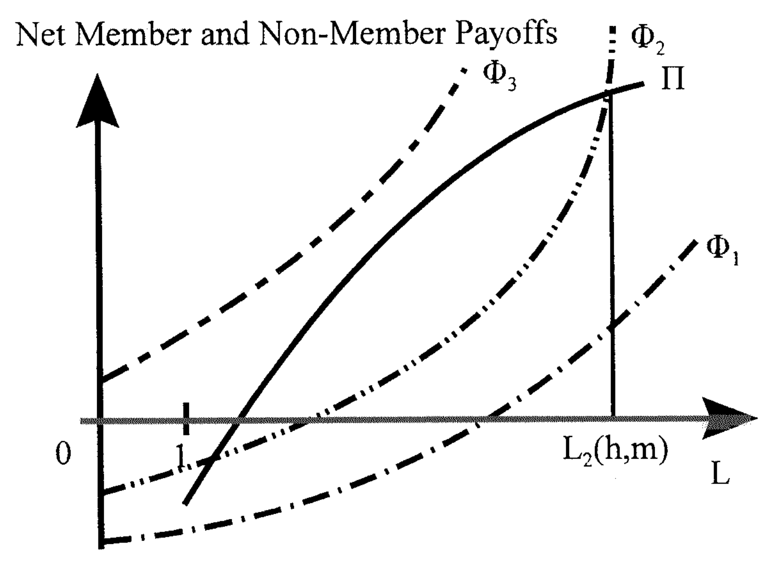

Figure 4: Alternative Payoffs to Non-Members

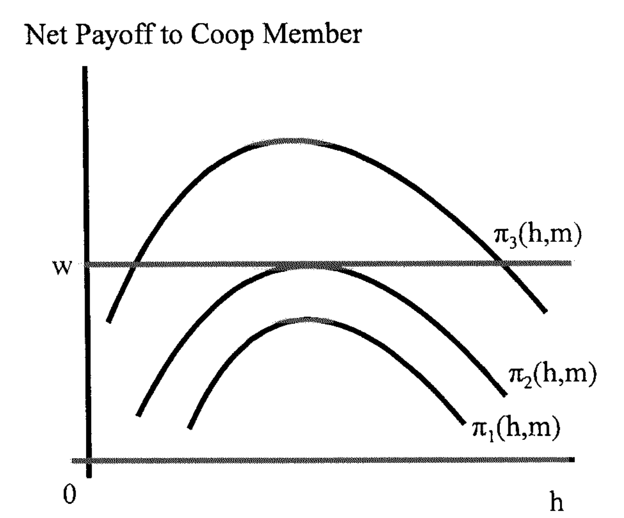

Figure 5: Payoff for Coop Member

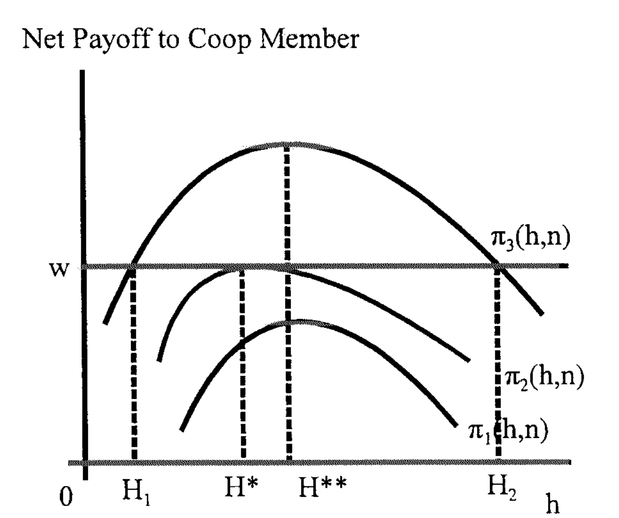

Figure 6: Payoff for Coop Member