Journal of Agricultural and Resource Economics 41(3):372–392 ISSN 1068-5502

Horizon and Free-Rider Problems in Cooperative Organizations

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This paper develops a model of heterogeneous individuals to analyze the interacting horizon and free-rider problems faced by cooperative organizations. Analytical results identify the conditions under which a cooperative will form despite these property rights problems and show that (i) differences in members' time horizons need not necessarily lead to short-term cooperative investments and (ii) free riding is not always a problem for cooperatives. The analysis also shows how a cooperative can use a membership fee to address these property rights problems and provides additional insights into the relationship between a cooperative's cost structure and membership fees.

Key words: collective action, cooperatives, free-rider problem, horizon problem, returns to size

Cooperative organizations, including clubs and professional partnerships, play an important role in the economy, often bridging the gap between the purely public and the purely private in the provision of goods (Buchanan, 1965). This has been particularly true in agriculture, where cooperative organizations have emerged to deal primarily with market failures such as oligopsonistic pricing (Sexton and J. Iskow, 1988).

The collective nature of cooperative organizations creates two key property rights issues: the free-rider problem (Olson, 1965) and the horizon problem (Furubotn and Pejovich, 1970). In agricultural cooperatives, free-rider problems emerge in raising investment funds at formation and later for growth and expansion during operation; in both cases, members prefer to let others make the investment but to nevertheless have access to the benefits of the investment (Caves and Petersen, 1986; Knoeber and Baumer, 1983).[1]

Horizon problems in agricultural cooperatives potentially arise when the period of time over which members have a claim on the benefits of an investment is less than the length of time over which the benefits are generated. The result of this horizon mismatch may be underinvestment in assets or investments in assets that generate short-run benefits but not the long-run benefits necessary to keep the cooperative efficient and viable (Rey and Tirole, 2007; Porter and Scully, 1987; Vitaliano, 1983; Jensen and Meckling, 1979). For instance, in almost all large-scale agricultural cooperatives, members pressure their board or management for a payout of equity, for cash payments instead of the retention of earnings for investment purposes, or for investment in projects that will yield immediate rather than long-term benefits. If this pressure is successful in reducing investment overall or in

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This article is based upon research partially supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2012–70002–19387.

Review coordinated by Tian Xia.

[1] While the focus of this paper is on free riding associated with raising capital from members, free-rider problems also exist in the pricing of agricultural products. For instance, agricultural cooperatives that are successful in restricting market output through pooling strategies will raise the price to all farmers, not just members, thus reducing the incentive to become a cooperative member (Saitone and Sexton, 2009).

limiting investment in things like product development/quality or variety improvement, then the lower investment can be attributed, at least in part, to a horizon problem (Cook, 1995; Saitone and Sexton, 2009).

Of course, the lower investment may also be a reflection of the free-rider problem discussed above, making it difficult to identify the precise cause of underinvestment. This is particularly the case because, as this paper will show, the two problems are linked and interact in important ways. For instance, free riding under decreasing returns to size reduces the returns to cooperative investment, further exacerbating the horizon problem. And reducing the horizon of cooperative investments to make them more attractive to individuals with shorter time horizons leads to increased incentives for free riding.

This paper formally examines the horizon and free-rider problems together, examining first the distinct differences between them and then showing how they interact. More specifically, the paper develops a model of differentiated individuals to examine the impact of the two problems on investment and patronage decisions and, in turn, on cooperative membership and member welfare. In undertaking this analysis, the focus is on the establishment of new cooperatives, although insights are obtained into the manner in which existing cooperatives finance on-going operations.

The paper makes a number of contributions to the literature on cooperative organizations. Two of these are highlighted here. First, the paper shows that cooperative formation depends on two things: (1) the presence of a set of members with sufficiently long time horizons to make investment the optimal strategy; and (2) the ability of this set of members to see itself as a distinct group. One of the important insights from the paper is that this social identification dimension is as critical to cooperative formation as the economic dimension. Moreover, if this group of members is able to finance the investment, then it opens itself up to free riding by new members, who benefit from the investment without being required to help finance it. In short, solving the horizon problem creates a free-rider problem.

The second key insight of the paper is that the response of the group that financed the investment to the presence of free riders depends on the cooperative's cost structure. The analysis shows that cooperatives with increasing returns to size can find it optimal to limit the fees paid by new members, effectively letting these members free ride on the investment made by others. Cooperatives with decreasing returns to size, however, will use membership fees to discourage free riders. Thus, in addition to reflecting different patterns of rent distribution (see Rey and Tirole, 2007), the cooperative fee structure can be linked to different ways of dealing with the free-rider problem under different cost structures. As will be seen, free-rider problems need to be addressed when capacity constraints are important, as they typically are in the processing of dairy, fruit, vegetables, and nut crops.

Overview of the Model

The literature on cooperative organizations contains a substantial discussion of both the free-rider problem and the horizon problem. As Jensen and Meckling (1979) stress, both of these problems emerge because of the nature of property rights in the cooperative. The free-rider problem arises because individual members have a claim on property that is common to all members; the horizon problem arises because of a lack of tradability of the claims that the members do have. Although these two problems are clearly linked (e.g., the lack of individual ownership is one reason that claims cannot be traded), the two problems have not been examined together.

While there has been considerable discussion of both problems, solutions have been proposed mainly for the free-rider problem (commonly viewed as a Prisoners' Dilemma). These solutions include monitoring; providing private or selective incentives; reducing group size; selecting the "right" partners (e.g., those that can be trusted); ensuring that the members are engaged in long-term, rather than short-term, activities; improving communication; and fostering a group identity among partners.[2] One of these strategies—the creation of long-term relationships—creates obvious horizon problems. In contrast, strategies to address the horizon problem have received little or no attention; one exception is Olesen (2007), who shows how equity redemption can be used to address this problem. In this paper we develop a model that treats the free-rider and horizon problems together. Due to differences in age and/or other personal characteristics (e.g., professional plans and ambitions, commitment to the cooperative, and valuation of its continued existence beyond a member's life span), individuals differ in the time horizon over which they expect to receive the benefits from a cooperative. As a result, individuals differ in their valuation of the perceived benefits from patronizing the cooperative and of contributing to an investment that has long-term consequences for the cooperative and its members.

Individuals with longer horizons will receive a larger share of the total benefits that are potentially available as a result of an investment. Thus, individuals with long horizons are more likely to make the investment than are individuals who have short time horizons. If there are insufficient individuals with long enough time horizons to make the investment, then the horizon problem emerges—the investment will not be undertaken and inefficiency occurs.

While differences in the members' horizons can create a horizon problem, they also create an opportunity to cope with the free-rider problem. Specifically, a member's time horizon determines whether that individual is part of a critical mass necessary to invest in the cooperative for it to begin operation. The model shows that this critical mass of members is made up of people with the longest time horizons. As a consequence, this group of people has an incentive to cooperate precisely because of the existence of differential time horizons.[3]

To capture these elements, consider an individual who has the choice of (a) investing in and patronizing a cooperative; (b) patronizing a cooperative without any investment (i.e., free riding on the investment of others); and (c) pursuing an alternative activity.[4] Although our analysis potentially applies to all types of cooperative investments requiring individual contributions, in what follows the investments are largely associated with the formation of the cooperative. However, as will be seen, the analysis also sheds light on the manner in which investments are financed once the cooperative has formed and is operating.

Let $\alpha \in [0,1]$ be the attribute that differentiates individuals; a larger α corresponds to an individual with a greater discount of the benefits accruing from the cooperative (e.g., because of a shorter time horizon). The net returns to an individual with differentiating attribute α are:

$$
\begin{aligned}
NR_c^I &= R_c - I_c - \lambda\alpha \quad \text{if the individual invests in and patronizes the cooperative} \\
NR_c &= R_c - \lambda\alpha \quad \text{if the individual patronizes the cooperative without investing} \\
NR_a &= R_a \quad \text{if the alternative activity is undertaken}
\end{aligned}
\tag{1}
$$

where NR_c^I, NR_c, and NR_a are the net returns associated with investing in and patronizing the cooperative, patronizing the cooperative without investing in it, and undertaking an alternative

[2] Dawes (1980) and Dawes, Van De Kragt, and Orbell (1988) provide an overview of "solutions" to the free-rider problem, including the role of group identity. Olson (1965) identified the importance of group size in addressing the collective action problem. He also stressed the use of selective private incentives in encouraging cooperation.

[3] As will be shown later, the members of this group must coordinate on making the investment. See Camerer and Knez (1997) for an overview of coordination problems applied to organizations.

[4] The alternative activity can take various forms. Members may personally undertake to provide a good or service that is similar to the one provided by the cooperative, or they may look to a third party—such as investor-owned firm (IOF)—to obtain the good or service. Irrespective of the form it takes, it is assumed that all members realize the same value of the alternative regardless of their value of α.

activity, respectively.[5] The parameter R_c is the base benefit associated with patronizing the cooperative, I_c is the cost of investing in the cooperative, and R_a is the benefit associated with the alternative activity (i.e., the opportunity cost to the individuals of patronizing the cooperative).[6] As will be discussed in more depth later, the base benefit R_c only exists if a sufficient number of members invest in the cooperative, while the individual contribution to the cooperative investment, I_c, depends on the scale/magnitude of the investment and the number of individuals investing in the cooperative. The parameter λ captures the pattern or timing of the benefits of the investment over time and is, therefore, affected by the horizon of the cooperative investment (i.e., the time over which the investment generates benefits for cooperative members). For instance, λ is small when the bulk of the benefits of the investment occur sufficiently early in time so that most members obtain something close to the full value of the potential benefits. In contrast, λ is large when the benefits occur relatively late in time and those with shorter time horizons (i.e., larger αs) see reduced benefits. Thus, λ captures the degree to which an investment is a short-run investment or a long-run investment.

Although the net returns, NR_c^I, NR_c, and NR_a, can be thought of in a number of different ways, one interpretation is that they represent the net present value (NPV) of the three options described above. On this interpretation, the inclusion of the $-\lambda\alpha$ term in net returns NR_c^I and NR_c captures the idea that members with shorter horizons (larger αs) have their future returns truncated to a greater degree, which means that their NPVs are smaller. Note also that since the alternative investment is not in a cooperative, NR_a is not subject to any horizon limitations and thus the full value of the investment can be captured.

For simplicity of exposition, it is assumed that individuals are uniformly distributed with respect to the differentiating attribute α. In addition, to focus on the horizon problem of the cooperative, individuals are assumed identical in everything but their time horizon with the cooperative. Finally, to focus the analysis on the essence of the free-rider and horizon problems, the model setup does not consider the role of retained member equity. Obviously, if this retained equity is not returned to members until they leave the cooperative, then members with long time horizons may discount such payments. The result is that long time horizons may weaken the incentive of members to make investments in the cooperative in cases where retained earnings are used in a significant way.

The Horizon Problem

Individual Decisions and Welfare

Although the horizon and free-rider problems are linked, it is useful initially to assume away the free-rider problem so that the specifics of the less-scrutinized horizon problem can be understood. As will be seen later in the paper, the free-rider problem can be solved by the use of an appropriate membership fee. Thus, the results of the analysis in this section are applicable in situations where the free-rider problem has been addressed.

In the absence of the free-rider problem, all members that patronize the cooperative also invest in the cooperative. Thus, an individual has only two choices: (a) invest in and patronize the cooperative

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[5] The net returns can be viewed in terms of the financial benefits provided to members (e.g., the farm-level profits of agricultural co-op members). More generally, however, the net returns can be viewed as the utility that members receive from undertaking the various activities, thus allowing the model to represent cases where the cooperative provides nonfinancial benefits to its members. Fulton and Giannakas (2001) show how nonfinancial benefits can be modelled, while Berlin, Lidestav, and Holm (2006) show that members and nonmembers of forest owner associations place different values on market versus nonmarket benefits.

[6] It should be noted that, formally, R_a is assumed to be independent of the number of people that undertake the cooperative activity. However, since the decision to undertake the cooperative (or the alternative) activity depends on the difference between R_c and R_a, the formulation in this paper does capture, at least partially, the case where undertaking the cooperative activity affects the incentives to undertake the alternative activity. However, instead of affecting R_a directly, the impact of participation would be captured in R_c.

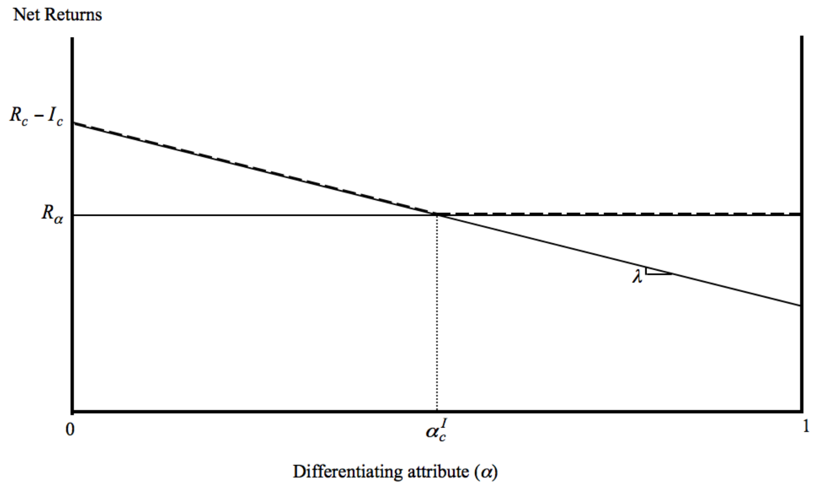

Figure 1. Individual Decisions in the Presence of the Horizon Problem

or (b) undertake the alternative activity. In addition, assume initially that R_c exists (i.e., sufficient members invest so that the investment is undertaken); the validity of this assumption is examined after determining the number of individuals who will invest in and patronize the cooperative.

Figure 1 graphs the net returns associated with the choices available to individuals (i.e., NR_c^I and NR_a in equation 1) when the return and investment parameters are such that only a portion of the individuals find it optimal to invest in and patronize the cooperative. More specifically, an individual with differentiating attribute

$$\alpha_c^I : NR_c^I = NR_a \Rightarrow \alpha_c^I = \frac{R_c - R_a - I_c}{\lambda} \tag{2}$$

is indifferent between investing in and patronizing the cooperative and undertaking the alternative activity. Individuals with longer time horizons (i.e., individuals with $\alpha \in [0, \alpha_c^I]$) invest in and patronize the cooperative, while individuals with $\alpha \in (\alpha_c^I, 1]$ prefer the alternative activity. Since individuals are uniformly distributed between the polar values of α, α_c^I determines the share of individuals who find it optimal to invest in and patronize the cooperative.

The greater the base benefits to investing in and patronizing the cooperative and/or the smaller the required contribution to the cooperative and the returns to the alternative activity, the greater the share of individuals who find it optimal to invest in and patronize the cooperative. The share of individuals investing in and patronizing the cooperative also increases with a reduction in the horizon of the cooperative investment (which reduces λ). Note that if λ were less than the difference $(R_c - I_c) - R_a$, NR_c^I would exceed NR_a $\forall$ α, and all individuals would find it optimal to invest in and patronize the cooperative (i.e., $\alpha_c^I = 1$).

In addition to depicting the decisions of different individuals in the net returns space, figure 1 also enables us to derive measures of the surplus of members and nonmembers of the cooperative. In particular, the expressions for NR_c^I and NR_a in equation (1) are direct measures of the welfare obtained by individuals with different values of α when they choose the cooperative or alternative activity, respectively. The overall welfare of cooperative members is given by the summation of the surpluses of the individuals who find it optimal to invest in and patronize the cooperative; that is,

$$PS_c^I = \int_0^{\alpha_c^I} NR_c^I d\alpha = \frac{1}{2}(R_c - I_c + R_a)\alpha_c^I, \tag{3}$$

while the welfare of those that undertake the alternative activity is given by

$$(4) \qquad PS_a = \int_{\alpha_c^I}^{1} NR_a d\alpha = R_a(1 - \alpha_C^I).$$

It is important to point out that the analysis above assumes that R_c exists; this assumption, however, needs to be examined. Suppose that the existence of R_c requires that at least α_c^+ individuals invest in the cooperative. Thus, for the solution presented in equations (2)–(4) to hold, the equilibrium α_c^I must be greater than or equal to the threshold value of α_c^+ (or the threshold number of individuals) required for the cooperative investment to take place (i.e., $\alpha_c^I \geq \alpha_c^+$). Thus, when $\alpha_c^I \geq \alpha_c^+$, the cooperative investment is undertaken despite the difference in the members' time horizon with the cooperative. For these differences to affect the cooperative investment, the threshold number of members, α_c^+, must exceed the equilibrium membership, α_c^I. When $\alpha_c^I < \alpha_c^+$, the cooperative investment is not undertaken, R_c does not exist, and all individuals receive a payment of R_a.

Finally, it should be noted that our analysis assumes that the cooperative requires at least $\alpha_c^+ I_c^+$ in capital to generate R_c where—due to liquidity, portfolio, and other financial constraints—I_c^+ is the maximum possible contribution a member can make. Any extra capital collected when $\alpha_c^I \geq \alpha_c^+$ is returned to the individuals making the investment. Thus, the equilibrium investment made by an individual patronizing the co-op when $\alpha_c^I \geq \alpha_c^+$ is given by $I_c = \alpha_c^+ I_c^+ / \alpha_c^I$, capturing the fact that the greater the number of individuals contributing to the cooperative investment, the smaller the individual contribution required for the investment to be undertaken.

Impact of Investment Horizon on Membership, Investment, and Welfare

The framework presented above allows the effects of different horizons of the cooperative investment on the equilibrium membership of the cooperative and the welfare of both members and nonmembers to be determined. Specifically, an increase in the horizon of the cooperative investment would increase λ and reduce the size of the cooperative membership. A decrease in the cooperative membership would, then, increase the individual contribution to the cooperative investment, I_c, and would reduce member welfare. Figure 2 illustrates how an increase in the horizon of the cooperative investment results in reduced cooperative membership (with an increase in λ, individuals with $\alpha \in (\alpha_c^{I'}, \alpha_c^I]$ find it optimal to undertake the alternative activity) and reduced welfare.[7]

The ramifications of the increased horizon of the cooperative investment for the cooperative investment itself (and the magnitude of the welfare loss for the members) depend on the relationship between the new equilibrium membership, $\alpha_c^{I'}$, and the threshold membership required for the cooperative investment to be undertaken, α_c^+. In particular, if $\alpha_c^{I'}$ exceeds α_c^+, the cooperative investment is undertaken and the increased horizon of the cooperative investment reduces welfare

[7] For simplicity of exposition, figure 2 is drawn on the assumption that a change in the size of the cooperative membership (caused here by the change in the investment horizon) does not affect the base returns to patronizing the cooperative, R_c. This, of course, will be the case for a cooperative facing constant returns to size. As will be discussed below, if the cooperative enjoys increasing (decreasing) returns to size, a reduction in its membership will cause R_c to decrease (increase). The assumption is also made that R_c is not a function of the horizon of the cooperative investment. As pointed out by an anonymous reviewer, however, longer-run investments could involve larger returns accruing over a longer period of time. Depending on the discount rate, R_c could thus either increase or decrease with the horizon of the cooperative investment. If R_c increased (decreased) with the horizon of the cooperative investment, then the magnitude of the effects of an increased horizon identified above would be weakened (strengthened). For the qualitative nature of our results to change, R_c would have to increase with the horizon of the cooperative investment, and this increase would have to be large enough to outweigh the impact of the increased λ. Obviously, in such a case, an increase in the investment horizon would lead to increased cooperative membership and welfare (i.e., the differences in the time horizon of cooperative members will not lead to short-term cooperative investments and the horizon problem is not really a problem for the cooperative).

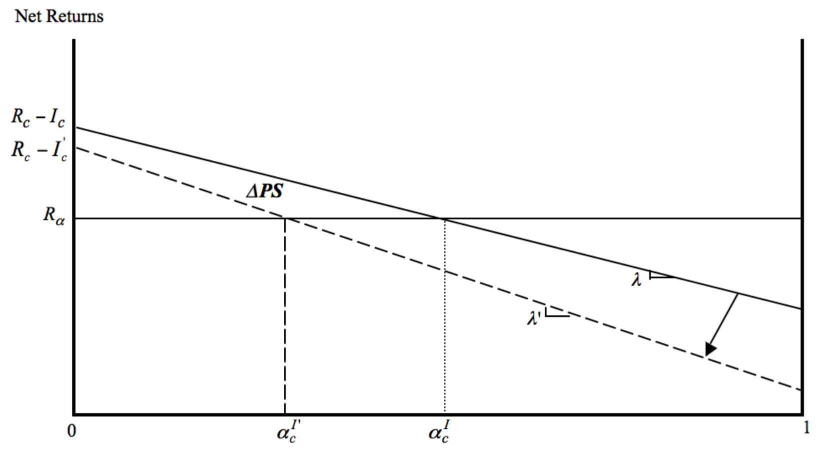

Figure 2. The Effects of the Cooperative Investment Horizon on Individual Decisions and Welfare

by the area ΔPS in figure 2, where area ΔPS equals

(5)
$$\begin{aligned}\Delta PS &= \int_0^{\alpha_c^{I'}} (NR_c^I - NR_c^{I'})d\alpha + \int_{\alpha_c^{I'}}^{\alpha_c^I} (NR_c^I - NR_a)d\alpha \\ &= \frac{1}{2}(R_c - I_c - R_a)(\alpha_c^I - \alpha_c^{I'}) + \frac{1}{2}(I_c' - I_c)\alpha_c^{I'}.\end{aligned}$$

If, on the other hand, the equilibrium membership under increased investment horizon $\alpha_c^{I'}$ is less than the threshold value α_c^+, the cooperative investment is not undertaken and the welfare loss due to the increased investment horizon equals

(6)
$$\Delta PS = \int_0^{\alpha_c^I} (NR_c^I - NR_a)d\alpha = \frac{1}{2}(R_c - I_c - R_a)\alpha_c^I.$$

The Free-Rider Problem

The previous analysis of the horizon problem assumes that individuals can choose to either invest and patronize the cooperative (and incur the innovation cost I_c) or undertake the alternative activity. In open-membership cooperatives, however, some individuals may find it optimal to wait until the cooperative investment has been undertaken (by other individuals) and then patronize the cooperative. The appeal of such a strategy is that it allows free riders to enjoy the benefits of the cooperative investment without incurring the costs associated with it. This strategy is of particular importance during a cooperative's start-up phase, when retained earnings cannot be used to finance investment and the cooperative must rely on direct contributions from members.

Individual Decisions and Welfare in the Presence of the Free-Rider Problem

When free riding is possible, the net return functions of the individual with differentiating attribute α are given by

$$(7)\quad \begin{aligned} NR^{I}_{c,fr} &= R_c - I_c - \lambda\alpha && \text{if the individual invests in and patronizes the cooperative} \\ NR_{c,fr} &= R_c - \lambda\alpha && \text{if the individual patronizes the cooperative without investing} \\ NR_a &= R_a && \text{if the individual undertakes the alternative activity} \end{aligned}$$

where all variables are as defined previously.[8]

Since $NR_{c,fr} > NR^{I}_{c,fr}$, all individuals prefer to patronize the cooperative without investing in it (compared to investing in and patronizing the cooperative). The result is the well-known free-rider problem—the investment does not occur, the cooperative does not form, and individuals are left with $R_a < R_c$.

A solution to the problem exists if those individuals with $\alpha \in [0, \alpha_c^+]$ know their horizon location relative to the threshold value of α_c^+ and identify with this group. In particular, assuming that $R_c - I_c - \lambda\alpha_c^+ \geq R_a$, then each of the individuals in this group realizes that she belongs to a critical mass. If all members of this critical mass were to make the investment, then R_c would exist and everyone in the group would earn a return at least as large as what they would have earned had they not made the investment. Alternatively, if any one of the group were to not make the investment, then R_c would not exist and everyone would be worse off (with the exception of the person with $\alpha = \alpha_c^+$, who is indifferent in the case where $R_c - I_c - \lambda\alpha_c^+ = R_a$). Expressed differently, the individuals with the longest horizons in the co-op recognize that their individual contribution I_c is *necessary* for the cooperative investment to be undertaken (and R_c to exist).

In this context, the investment is undertaken and the cooperative forms when the individuals with $\alpha \in [0, \alpha_c^+]$ recognize that their net return functions are not given by equation (7) but are given instead by

$$(8)\quad \begin{aligned} NR^{I}_{c,fr} &= R_c - I_c - \lambda\alpha && \text{if the individuals invest in and patronize the cooperative} \\ NR_a &= R_a && \text{if an individual does not invest in the cooperative} \end{aligned}$$

When $R_c - I_c - \lambda\alpha_c^+ > R_a$, the individuals with $\alpha \in [0, \alpha_c^+]$ find it optimal to invest in the cooperative. If $R_c - I_c - \lambda\alpha_c^+ = R_a$, then the member with $\alpha = \alpha_c^+$ is indifferent between investing or not, while those members with $\alpha < \alpha_c^+$ are all better off investing than not investing. It follows that, if $R_c - I_c - \lambda\alpha_c^+ \geq R_a$, then none of the members in the investor group (i.e., those with $\alpha \leq \alpha_c^+$) finds it optimal to deviate from the investment choice since they are either worse off or no better off by doing so. Obviously, if $R_c - I_c - \lambda\alpha_c^+ < R_a$, then the investment does not take place and all individuals earn a return equal to R_a.

Overall, there are two possible outcomes for the problem that the group members face. One outcome involves all the members of the critical mass identifying themselves as part of this group and making the investment (a Pareto-superior outcome), while the other involves at least one individual with $\alpha \in [0, \alpha_c^+]$ not making her individual investment, which, in turn, means the cooperative investment is not undertaken and R_c does not exist. For the remainder of this paper, we focus on the case where individuals can correctly identify with the relevant group and make the investment.

Before proceeding with the analysis, it is important to note that implicit in the above formulation is the assumption that if an individual member of the critical mass ends up not making the

[8] For simplicity and without loss of generality, the analysis in this section assumes that R_c is not dependent on the number of people that patronize the cooperative (i.e., the cooperative experiences constant returns to size). This assumption is subsequently relaxed.

investment, a mechanism exists for the members that have contributed to the cooperative investment to recover their individual contribution I_c (i.e., to not lose I_c). If this assumption is relaxed and the possibility of lost investment capital is introduced into the analysis, then uncertainty about the decisions of the other members of the critical mass becomes important since this uncertainty can lead members of the critical mass to not make the investment and the cooperative investment not being undertaken (see Van Huyck, Battalio, and Beil, 1990).

Larger group size creates more strategic uncertainty; indeed, this uncertainty may be sufficiently large that even leadership in the form of exhortations to select the efficient strategy may not be successful (Weber et al., 2001). Other mechanisms for securing the Pareto efficient outcome exist, including conventions, norms, reliance on common traits, and the generation of collective reputations (Tirole, 1996). As Winfree and McCluskey (2005) show, the use of collective reputations is also subject to size of group influences, with larger groups being less likely to build and sustain a collective reputation.

Despite these challenges, coordination problems can be solved and the Pareto superior strategy selected. Weber (2008) outlines a number of ways in which this may occur, including the use of communication, starting with small groups, establishing trust and confidence in other settings, and creating group identity, while Winfree and McCluskey (2005) discuss the use of trigger strategies. Cooperatives have adopted most, if not all, of these methods.

For instance, the start-up phase is typically characterized by frequent communication with potential members/investors and with the creation of strong and shared commitment among the original members (Patrie, 1998). Trigger strategies are also used to induce investment. For instance, individual investments are typically put in an escrow account prior to the actual formation of the cooperative. The money is only transferred from escrow to the cooperative if all the required funding is raised by a particular date; if it is not, then the money is returned to the investors.[9] Such mechanisms provide assurance to each member that he or she will only contribute if others also contribute; they also help to identify the group of would-be investors that would benefit from the investment or project being undertaken.

The discussion above suggests that the standard free-rider problem that exists during a cooperative's start-up phase can, at times, be addressed because of the presence of different member time horizons. Some members, whether because of age or other characteristics, have a longer horizon with the cooperative and, thus, see greater value from the investment. As pointed out by an anonymous reviewer, heterogeneity in individual time horizons makes coordination between individuals more likely both by reducing the number of people that are necessary for the cooperative investment to be undertaken and by making these members more easily identifiable. If the cooperative investment occurs, it is because the individuals who see the greatest value in the cooperative realize that they are essential to ensuring that the investment occurs. As mentioned above, for the remainder of the paper we focus on the case that the investment does occur and is financed by individuals with $\alpha \leq \alpha_c^+$.

Effect of Free Riding

When R_c exists, the decision for those individuals with $\alpha > \alpha_c^+$ is one of either patronizing the cooperative (i.e., free riding on the investment made by the individuals with $\alpha \leq \alpha_c^+$) or undertaking

[9] A similar approach is used on some of the so-called "crowd-sourcing" websites where strict deadlines are often set for the pledging of financial support and pledges are only transferred to the project initiator if the pledge target is met (see for instance, Kickstarter, 2016).

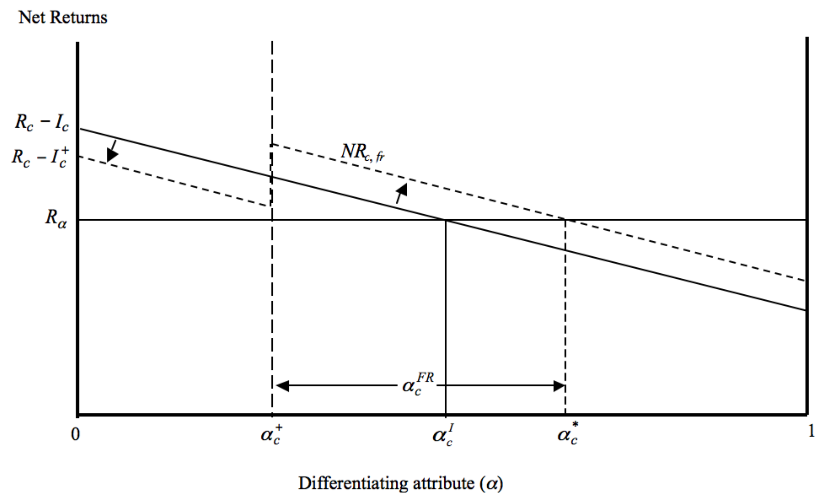

Figure 3. The Effects of the Opportunity to Free Ride on Individual Decisions and Welfare

the alternative activity. Recall from earlier that, unless an individual is critical to ensuring that the investment takes place, free riding on the investment is always preferred to making the investment.[10]

Figure 3 graphs the relevant net returns and illustrates the decisions of the different individuals. Individuals with $\alpha \in [0, \alpha_c^+]$ find it optimal to invest in and patronize the cooperative despite the anticipated free riding by other individuals, since the returns associated with doing so exceed those associated with the alternative activity. Individuals with $\alpha \in [\alpha_c^+, \alpha_c^*]$, where

(9) $$\alpha_c^* : NR_{c,fr} = NR_a \Rightarrow \alpha_c^* = \frac{R_c - R_a}{\lambda},$$

find it optimal to free-ride and patronize the cooperative after the cooperative investment has been made, while individuals with $\alpha \in (\alpha_c^*, 1]$ prefer the alternative activity.

Overall, the share of individuals who patronize the cooperative and incur the investment costs is α_c^+, the individual investment of these individuals is I_c^+, and the total investment is $\alpha_c^+ I_c^+$. The total cooperative patronage (or membership) is given by α_c^*, and the share of free riders is

(10) $$\alpha_c^{FR} = \alpha_c^* - \alpha_c^+ = \frac{R_c - R_a - \lambda \alpha_c^+}{\lambda}.$$

Figure 3 also illustrates the impact of free riding on cooperative membership and the benefits obtained by the members. In comparison to the situation outlined in figure 1 (where free riding was not allowed), free riding (i) reduces the size of the *ex ante* membership (i.e., the number of individuals who contribute to the investment activity of the cooperative falls from α_c^I to α_c^+ in figure 3) and (ii) increases the size of the *ex post* membership (the number of members after the cooperative investment occurs increases from α_c^I to α_c^*). The reduction in the number of individuals investing in the co-op increases the individual contribution required for the cooperative investment to be undertaken which, in turn, reduces the welfare of the critical membership (i.e., individuals with $\alpha \in [0, \alpha_c^+]$). The members that are no longer investing in the cooperative (those between α_c^+ and α_c^I) save their investment costs, I_c (which are now incurred by the individuals with $\alpha \in [0, \alpha_c^+]$), while the members between α_c^I and α_c^* gain from the presence of free riding, since they are now

[10] The analysis assumes that individuals are selfish and choose their activity to maximize their own net returns. As Ostrom (2000) notes, there are likely to be other types of individuals besides rational egoists, including willing punishers and conditional cooperators (see also Ben-Ner, 2013, for examples of other types of agents). While these other types play an important part in creating and ensuring cooperation, understanding the role played by rational egoists is an important part of the puzzle.

able to obtain the benefits associated with patronizing the cooperative; the size of this benefit is $I_c(\alpha_c^* - \alpha_c^I)/2$.

Effect of Size Economies

The analysis to this point has assumed that R_c is constant (i.e., that the investment exhibits constant returns to size). This section examines the effect of relaxing this assumption. To keep the analysis simple and yet capture the essence of the problem, it is assumed that $R_c = R_c(\alpha_c^*)$, where $R_c(\alpha_c^*)$ is the return to patronizing the cooperative when α_c^* individuals patronize the cooperative. If $\partial R_c(\alpha_c^*)/\partial \alpha_c^* = 0$, the investment exhibits constant returns to size. If $\partial R_c(\alpha_c^*)/\partial \alpha_c^* > 0$, the investment exhibits increasing returns to size. Finally, if $\partial R_c(\alpha_c^*)/\partial \alpha_c^* < 0$, the investment exhibits decreasing returns to size. Note that in all cases $\partial^2 R_c(\alpha_c^*)/(\partial \alpha_c^*)^2 \leq 0$.

The number of members that patronize the cooperative α_c^* is given by the following:

$$(11) \qquad \alpha_c^* = \frac{R_c(\alpha_c^*) - R_a}{\lambda}.$$

Noting that $\alpha_c^* = \alpha_c^+ + \alpha_c^{FR}$, the expression for α_c^{FR}, the fraction of the membership that free rides, is given by

$$(12) \qquad \alpha_c^{FR} = \frac{R_c(\alpha_c^+ + \alpha_c^{FR}) - R_a}{\lambda} - \alpha_c^+.$$

If the cooperative is operating with increasing returns to size, free riding could benefit all of the individuals who patronize the cooperative, including the critical investors who provide the financing. The critical investors (i.e., the individuals with $\alpha \in [0, \alpha_c^+]$) benefit because the free riders raise the return associated with the investment in the cooperative, since with increasing returns to size, $\partial R_c(\alpha_c^{FR})/\partial \alpha_c^{FR} > 0$. At the same time, however, the presence of free riding results in the critical membership incurring the entirety of the investment cost required for the cooperative investment to be undertaken. The net effect of free riding on the critical membership is determined, then, by the relationship between the benefits (i.e., increased R_c) and costs (increased I_c) of free riding under increasing returns to size. While the critical investors will dislike free riding when $|\Delta R_c| < |\Delta I_c|$, when faced with free riding as a given (i.e., when elimination of free riding is not an option) they will always prefer more extensive free riding. The free riders, of course, benefit as free riding increases, since each additional free rider increases the returns over the base level. Thus, when the cooperative operates in the range of increasing returns to size, the optimal membership policy could entail the tolerance (if not the attraction) of free riders.

In contrast, if the cooperative operates in the range of decreasing returns, then free riding would result in lower returns, R_c, for everyone that patronizes the cooperative. Although the presence of lower returns implies that those already in the cooperative (i.e., the critical investors) would prefer to restrict membership (on this point, see Domar, 1966; Robinson, 1967), restricting membership is not desirable if the problem is considered from the perspective of the individuals who would have otherwise patronized the cooperative.[11]

To see this, consider the impact of free riding in a cooperative that operates with an open-membership rule. Open membership is common among cooperatives and is one of the so-called cooperative principles (International Co-operative Alliance, 2012). Figure 4 depicts the effects of

[11] When decreasing returns are in effect, it has been argued that the optimal membership size—that is, the size that maximizes the sum of member benefits calculated over all members—is the one at which the returns are greatest. Instead of increasing membership beyond this point (and thus decreasing the returns), individuals who are not members of an existing cooperative should form a new cooperative and get the benefits of the maximum returns (Sexton, 1986). In the model considered in this paper, this conclusion may not hold, since individuals with $\alpha > \alpha_c^+$ would not be able to form a cooperative and thus would not be able to get the benefit of the maximum returns. Thus, the possibility exists that maximizing total member benefit may involve a membership beyond α_c^+.

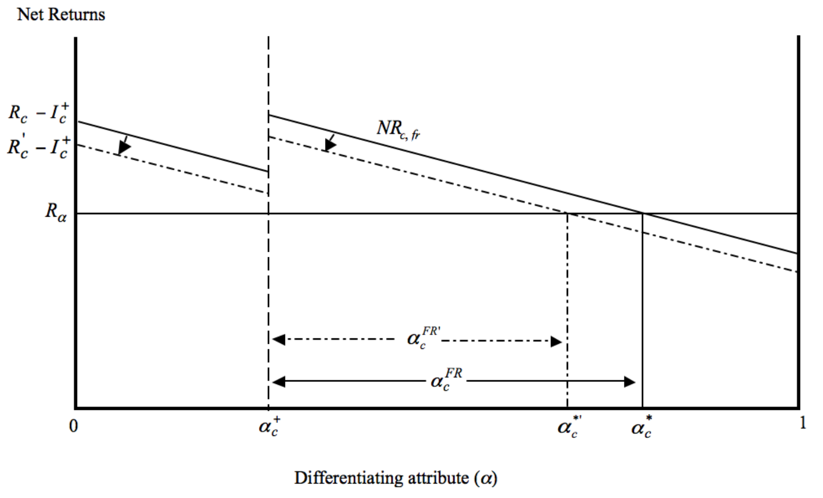

Figure 4. Free Riding under Decreasing Returns to Size

free riding on individual decisions and welfare when the cooperative technology is characterized by constant and decreasing returns to size (the solid (dashed) line represents the net returns under constant (decreasing) returns to size).[12]

With constant returns to size, the presence of free riders has no effect on the returns earned by the critical investors (i.e., individuals with $\alpha \in [0, \alpha_c^+]$, while providing the free riders (those that patronize the cooperative but do not finance its operation) with a benefit. With decreasing returns to size, the presence of free riders lowers the welfare of the critical investors by $(R_c - R_c')\alpha_c^+$. Additionally, while free riders gain by an amount equal to the area under $NR_{c,fr}$ and to the right of α_c^+, the gain is not as large as it would have been with constant returns to size. The smaller gain occurs because $R_c' < R_c$ and because the lower return means that fewer members patronize the cooperative. From an aggregate perspective, welfare rises if the benefit to the free riders is greater than the costs to those that have financed the cooperative.

In summary, when taken as given, free riding benefits all cooperative members under increasing returns to size and has a differential impact on different members under decreasing returns to size (in this case, free riding creates a negative externality with welfare losses for those that financed the cooperative). Indeed, from the perspective of the critical investors, the optimal membership size under decreasing returns to size is $\alpha_c = \alpha_c^+$.

Coping with the Horizon and Free-Rider Problems

The previous analysis identified the factors affecting cooperative membership and member welfare in the presence of the horizon and free-rider problems as (i) individual heterogeneity with respect to the horizon with the cooperative organization, (ii) the horizon of the cooperative investment, (iii) the benefits associated with patronizing the cooperative, (iv) the individual contribution to the cooperative investment, (v) the cost structure of the cooperative, (vi) the benefits associated with an alternative activity, and (vii) the threshold membership required for the cooperative investment to take place. Taking the individual heterogeneity, threshold membership, cost structure, and opportunity cost as given (exogenous to decision makers), we focus on ways of affecting individual

[12] Since the focus is on the impacts of free riding, figure 4 is drawn on the assumption that the base returns from patronizing the cooperative, R_c, are the same under constant and decreasing returns to size in the absence of free riding (i.e., when the cooperative membership is α_c^I). The increased cooperative membership due to free riding therefore reduces these returns under decreasing returns to size while leaving R_c unaffected under constant returns to size.

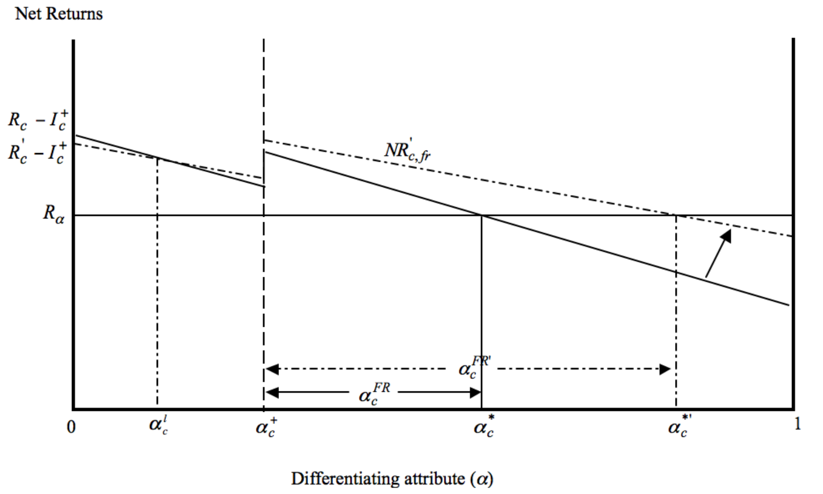

Figure 5. The Effects of Reducing the Horizon of Cooperative Investment

behavior and welfare through the horizon of the cooperative investment and the benefits and costs of patronizing the cooperative.

Horizon of Cooperative Investment

A reduction in the horizon of the cooperative investment—an "obvious" way of dealing with the horizon problem—might not be desirable, and indeed may not be chosen, when the free-rider problem is taken into account. Such a reduction in the horizon of cooperative investment exacerbates the free-rider problem and, under decreasing returns to size, results in welfare losses for those individuals who fund the investment activity of the cooperative.

Specifically, reducing the horizon of the cooperative investment has both direct and indirect effects on individual decisions and welfare. The direct effect of a reduction in the horizon of the cooperative investment is a reduction in the parameter λ, which rotates upward both $NR_{c,fr}$ and $NR_{c,fr}^I$. The rotation in $NR_{c,fr}$ and $NR_{c,fr}^I$ increases the welfare of the cooperative members who incur the cost of the investment, W_m, the welfare of those individuals who choose to free-ride, W_{mfr}, as well as the number of individuals who find it optimal to free ride, α_c^{FR}.

The indirect effect of a reduction in λ—an increase in the number of free riders—reduces the benefits associated with patronizing the cooperative under decreasing returns to size, which, in turn, results in welfare losses for some of the individuals who financed the cooperative (i.e., those with values of $\alpha < \alpha_c^I$) and reduces the extent of free riding.[13] Figure 5 graphs the effects of a reduced investment horizon on individual decisions and welfare and depicts both the increase in free riding (compare $\alpha_c^{FR'}$ to α_c^{FR} in figure 5) and the welfare losses to those who finance the cooperative and have long time horizons.

Since, with decreasing returns, a decrease in λ has the effect of reducing the returns for some of those making the investment, these members may have an incentive to not undertake investments that have shorter horizons. Instead, these members may have incentive to push for investments with longer horizons.

As a result, the presence of members with shorter time horizons does not necessarily lead the cooperative to undertake short-term projects. Instead, since the members with the longer time horizons are the ones that are often pivotal when investment decisions are being made, the

[13] When the cooperative operates under increasing returns to size, the increased free riding that follows a reduction in the horizon of the cooperative investments increases the returns associated with patronizing the co-op, R_c, and, through this, increases the incentives for more individuals to enter the co-op after the investment has been undertaken.

cooperative may, in fact, undertake projects with longer horizons. Thus, the conclusion that the limited horizon of cooperative members leads to a situation where the cooperative focuses on projects that generate short-run benefits need not always apply.

Investment Costs and Benefits of Patronizing the Cooperative

Changing the benefits and costs associated with patronizing the cooperative (i.e., R_c and I_c) solves neither the horizon nor the free-rider problem. Moreover, the effects of changes in R_c and I_c on individual decisions and welfare are not symmetric; while an increase in R_c increases free riding and affects the welfare of all members of the cooperative (the magnitude of this welfare change depends on the nature of the size economies), a reduction in I_c increases the welfare of members who fund the cooperative investment while leaving the number and welfare of free riders unaffected. The reason for this discrepancy is that, while all members enjoy the benefits of patronizing the cooperative, the free riders do not, by definition, incur the costs of investment and are therefore immune to changes in this cost.

Under increasing returns to size, the increased cooperative membership that results from an increase in R_c and the subsequent increase in free riding causes a further increase in the returns to patronizing the cooperative. In contrast, with decreasing returns to size, the increase in the number of free riders reduces the benefits of patronizing the cooperative and thus reduces the magnitude of the increase in R_c.

The free-rider problem thus either amplifies or dampens the impact of a change in R_c, depending on whether the cooperative is operating with increasing or decreasing returns to size.[14] As a consequence, the incentive to undertake an investment that increases R_c is greater with increasing returns to size than it is with decreasing returns to size. In contrast, the incentive to undertake an action that would reduce the cost of the investment I_c is the same across all technologies.

Membership Fees: A Solution to the Free-Rider Problem

The purpose of this section is to consider the effect of introducing a membership fee on cooperative patronage and member welfare. The analysis is carried out for the case of an open-membership cooperative, in part because this organizational form is quite common and in part because the analysis is trivial in the case of a closed-membership cooperative.[15]

Consider the case where the cooperative charges a membership fee to those individuals who choose to enter the cooperative after the investment has been undertaken; the proceeds from the fee are returned to the individuals who have funded the cooperative investment.[16] The introduction of a membership fee for free riders, m_c^{FR}, reduces $NR_{c,fr}$, which in turn reduces the welfare and number of individuals who choose to free ride. Depending on the co-op's cost structure, this reduction in free riding either increases or decreases the base returns to patronizing the cooperative, R_c, which, along with the return from the membership fee paid by free riders, m_c, changes $NR^I_{c,fr}$ and the welfare of members funding the cooperative investment. Figure 6 graphs the effects of this membership fee

[14] The degree to which this amplification or dampening occurs depends on the horizon of the cooperative investment, further establishing a link between the free-rider problem and the horizon problem. The link is such that both the amplification and the dampening are greater the smaller is λ.

[15] In the closed-membership case, those forming the cooperative do not want to see any more members than the minimum required to finance the operation and to have it run at full capacity. Conceptually, this is equivalent to and could be achieved by setting the membership fee at a sufficiently high level such that no new members have an incentive to join. Practically, the same outcome can be obtained by issuing a fixed number of shares and requiring new members to purchase the shares of existing members if they wish to join. This is the practice followed by the so-called new generation cooperatives (Harris, Stefanson, and Fulton, 1996).

[16] The assumption made here is that the same membership fee is charged to all members that join after the cooperative is formed. Rey and Tirole (2007) stress the importance of equal fees for the achievement of economic efficiency in nondiscriminatory cooperatives, although imposing such fees does mean that the nondiscriminatory cooperative may be less likely to form.

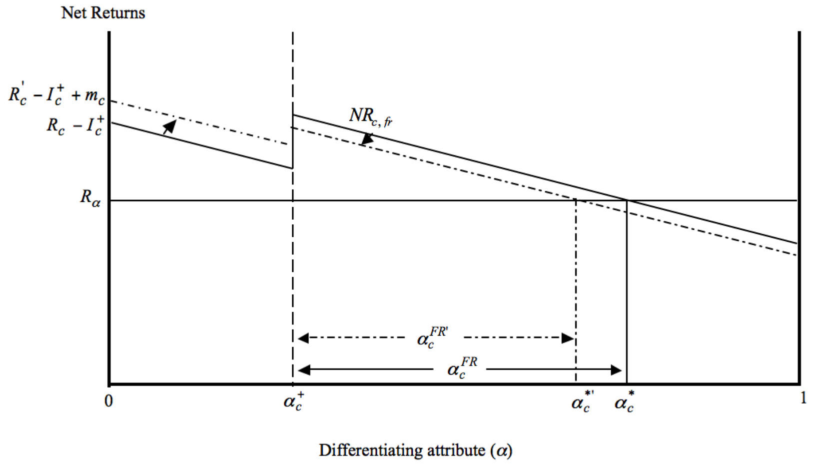

Figure 6. The Effects of a Membership Fee on Free Riders

mechanism on free riding and the welfare of the different groups when the co-op operates under decreasing returns to size (i.e., when the reduced number of free riders increases R_c and, along with m_c, the welfare of members funding the cooperative investment).

While the cost structure of the co-op affects the impact of the membership fee mechanism described above on the welfare of individuals funding the cooperative investment, it does not affect the design of the mechanism that solves the free-rider problem. Indeed, regardless of the cost structure of the open-membership cooperative, the membership fee that solves the free-rider problem is the one that eliminates the incentives for free riding; that is, the fee that equalizes the returns from investing in and patronizing the cooperative with the returns from patronizing only (i.e., free riding). Equalizing returns for both types of members is also consistent with the fair and equal treatment of members that underlies an open-membership policy. Such a fee ensures that

$$(13) \qquad m_c^{FR*} : NR_{c,fr}^I = NR_{c,fr} \Rightarrow R_c(\alpha_c^{*'}) - I_c^+ - \lambda\alpha + m_c^* = R_c(\alpha_c^{*'}) - \lambda\alpha - m_c^{FR*},$$

which implies that $I_c^+ - m_c^* = m_c^{FR*}$. In addition, the amount raised by the membership fees from those entering the cooperative after the investment has been undertaken, $m_c^{FR}\alpha_c^{FR}$, has to equal the amount returned to those contributing to the cooperative investment, $m_c\alpha_c^+$ (i.e., $m_c\alpha_c^+ = m_c^{FR}\alpha_c^{FR}$). Solving this last equation simultaneously with $I_c^+ - m_c^* = m_c^{FR*}$ gives the fees that solve the free-rider problem, namely[17]

$$(14) \qquad m_c^{FR*} = \frac{\alpha_c^+}{\alpha_c^{*'}} I_c^+;$$

$$(15) \qquad m_c^* = \frac{\alpha_c^{*'} - \alpha_c^+}{\alpha_c^{*'}} I_c^+.$$

Under this mechanism, those individuals with $\alpha \in [0, \alpha_c^{*'}]$ in figure 7 find it optimal to patronize the cooperative and contribute to the cooperative investment an amount given by $I_c^* = I_c^+ - m_c^*$. Utilizing the expression for m_c^* in equation (15), we can express I_c^* as

$$(16) \qquad I_c^* = \frac{\alpha_c^+}{\alpha_c^{*'}} I_c^+,$$

[17] Since $\alpha_c^{*'}$ is a function of m_c^{FR*}, the solution expressed in equations (14) and (15) has to be viewed as an implicit solution.

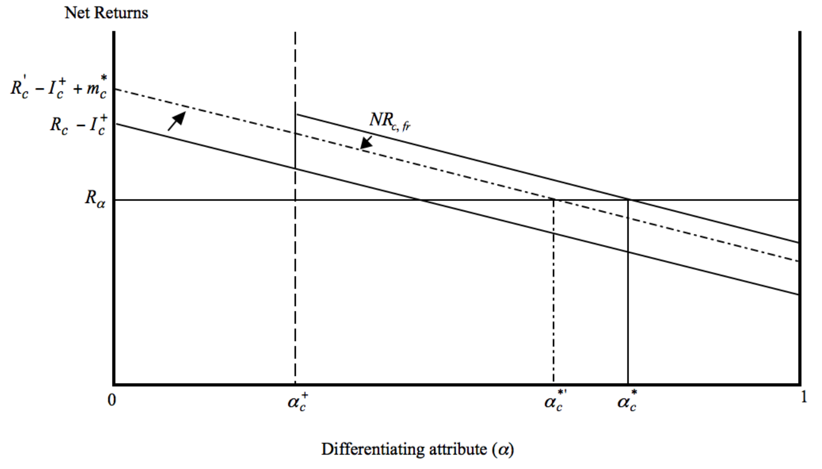

Figure 7. Equilibrium Decisions and Welfare under a Membership Fee that Solves the Free-Rider Problem

which is, of course, equal to m_c^{FR*} in equation (14). While the total capital raised by the cooperative in this case is equal to that in the presence of free riding,

$$(17) \qquad I_c^{T^*} = \alpha_c^{*'} I_c^* = \alpha_c^+ I_c^+,$$

the financing cost is divided over a greater number of members.

In addition to addressing the free-rider problem, the mechanism can increase the welfare of the eventual membership of the cooperative (i.e., individuals with $\alpha \in [0, \alpha_c^{*'}]$ in figure 7) in the case of decreasing returns to size technology. By eliminating free riding, the membership fee reduces the size of the cooperative membership, which, given decreasing returns to size, increases the base returns, R_c, and the welfare of all members of the cooperative.[18] Formally, the welfare changes from solving the free-rider problem using this mechanism under decreasing returns to size are

$$(18) \qquad \begin{aligned} \Delta W &= \int_0^{\alpha_c^+} (NR_c^m - NR_{c,fr}^I)d\alpha - \int_{\alpha_c^+}^{\alpha_c^{*'}} (NR_{c,fr} - NR_c^m)d\alpha - \int_{\alpha_c^{*'}}^{\alpha_c^*} (NR_{c,fr} - NR_a)d\alpha \\ &= [m_c + (R_c' - R_c)]\alpha_c^+ - [m_c^{FR} - (R_c' - R_c)]\alpha_c^{FR'} - \frac{1}{2}[m_c^{FR} - (R_c' - R_c)](\alpha_c^* - \alpha_c^{*'}) \end{aligned}$$

where NR_c^m are the net returns from patronizing the cooperative in the presence of this mechanism. Using the relationship $m_c^{FR}\alpha_c^{FR} = m_c\alpha_c^+$, the welfare change in equation (18) can be rewritten as

$$(19) \qquad \Delta W = (R_c' - R_c)\alpha_c^{*'} - \frac{1}{2}\left[m_c^{FR} - (R_c' - R_c)\right](\alpha_c^* - \alpha_c^{*'}).$$

[18] Restricting membership under increasing returns to size reduces R_c and through this the total welfare of individuals who patronize the cooperative (i.e., the total welfare of the original members and those that are free riding). Since total member welfare would be increased if membership were unrestricted, the membership fee in an open-membership cooperative that maximizes aggregate welfare can be expected to be either zero or some token amount.
However, if the original membership wishes to maximize its own welfare rather than aggregate welfare, then membership restriction through a membership fee can be desirable. The reasoning is as follows. Although the imposition of a fee introduces a cost (i.e., a reduction in returns, R_c, that occurs because of the restriction in membership under increasing returns to size), it also introduces a benefit (i.e., the revenue collected from the fees). If the original members are not committed to open membership, then they can be expected to introduce a membership fee, the optimal size of which equates the marginal benefit and the marginal cost of the fee. The introduction of such a fee is inefficient, of course, since the benefits available to all the members decrease. The result is that even in the increasing returns to size case, the free-rider problem can be an issue when attempts by the original membership to increase returns via a membership fee (which curtails free riding) impose an overall cost on the cooperative organization.

While solving the free-rider problem can, indeed, result in net welfare gains for the cooperative membership that exists after the fee is introduced (i.e., individuals with $\alpha \in [0, \alpha_c^{*'}]$), the social optimality of the mechanism depends on the relationship between the welfare gains of the members (given by $(R_c^{'} - R_c)\alpha_c^{*'}$ in equation 19) and the costs to the individuals with $\alpha \in [\alpha_c^{*'}, \alpha_c^*]$ that would have become members if they could free ride (given by $\frac{1}{2}[m_c^{FR} - (R_c^{'} - R_c)](\alpha_c^* - \alpha_c^{*'})$ in equation 19).

It is important to note that introducing a membership fee as outlined in equation (14) also allows the cooperative to address the horizon problem without creating adverse incentives for free riding (similar to those discussed above). Since the optimal mechanism in equations (14) and (15) is adaptable to all values of λ, changes in the horizon of the cooperative investment (to cope with the horizon problem) do not diminish the effectiveness of this mechanism and therefore have no effect on the incentives for free riding. What a change in λ would affect, however, is the size of the total membership and, through this, the individual investment costs and returns to the cooperative investment (and, thus, its desirability for the existing membership of the cooperative).

Finally, although the analysis pertains particularly to cooperatives in their formation stages, it is important to discuss how the analysis applies to cooperatives that are already established. As authors such as Knoeber and Baumer (1983) have pointed out, established cooperatives that wish to raise capital for new investments typically do so by retaining a portion of the patronage payments that would otherwise be paid to members. This retention of patronage solves the free-rider problem, since all members that patronize the cooperative effectively contribute to the investment.

The impact of patronage retention can be modeled by assuming cooperative members face two options. One option is to patronize the cooperative, the benefits of which are captured by a net returns line $R_c - P_c$, where P_c is portion of the patronage payment that is retained. The other option is to undertake an alternative activity with benefits R_a. This case is captured by the analysis in figure 1, with I_c changed to P_c. The conclusions obtained from that earlier analysis apply. As long as $\alpha_c^I > \alpha_c^+$, the investment will be undertaken and the cost will be shared over all the members. This sharing of the cost makes it more likely that the horizon problem will be overcome—by spreading the investment cost over a greater number of people, the net returns $R_c - P_c$ are increased and it is more likely that $\alpha_c^I > \alpha_c^+$.

In addition, the analysis in figure 1 shows that the individuals who patronize the cooperative are those with the longer time horizons. In effect there is a built-in selection process that results in cooperative members having longer time horizons than nonmembers, which in turn makes the horizon problem less likely to be an issue. Whether this selection process is actually at work in cooperatives is an empirical question that requires further investigation.

Application of the Results

The membership fee pattern predicted by the model developed in this paper matches practices observed among cooperative organizations. For instance, credit unions and retail cooperatives typically require only nominal membership fees for new members. Similarly, shared-service cooperatives (e.g., cooperatives that supply a range of goods and services to member organizations such as hospitals, schools, local governments, hardware stores, and fast-food restaurants) rely more on annual user fees than membership fees (Crooks, Spatz, and Warman, 1997). These membership fee patterns suggest that these cooperatives operate under increasing returns to size. Indeed, it is likely that all of the above cooperatives have significant economies of size over the relevant range of output.[19] These economies of size emerge from the large fixed costs that these businesses have incurred and because these businesses do not have significant capacity constraints (except

[19] Although many examples exist, a recent newspaper article highlights the point being made: Mountain Equipment Co-operative (MEC), which started operation in the early 1970s, is still charging its original membership fee of $Cdn 5.00 (Mountain Equipment Co-operative, 2015).

occasionally at very specific times). The large fixed costs are associated with such things as the construction of physical stores, the negotiation of supplier contracts according to detailed production specifications, and the construction and maintenance of online banking and merchandising systems (which themselves rarely have capacity constraints).

On the other hand, recreational clubs (e.g., golf clubs) typically charge large membership fees to new members, a pattern that is consistent with the significant potential for congestion that comes with a large membership. Congestion, of course, is effectively a diseconomy of size (i.e., as more members join, the benefits to all members fall). Professional partnerships, such as law practices, also rely heavily on large membership fees for new members/partners. As Levin and Tadelis (2005) stress, the value created by a professional partnership depends on the quality, not the number, of partners (i.e., economies of size have historically not been that important). Joint ventures in areas such as IT likely exhibit a similar characteristic: what creates value is not merely the dollars spent and the number of people involved in the joint venture but the ideas brought to the venture and the way they are put together. Large entry payments for new members are consistent with this cost structure (see, for example, Rey and Tirole, 2007).

Among agricultural cooperatives, the use of the base-capital plan of equity retention/redemption has historically been higher for dairy cooperatives, fruit, vegetable, and nut cooperatives and other marketing cooperatives; the base-capital plan has rarely been used by grain, cotton, and farm-supply cooperatives (Rathbone and Wissman, 1993). Base-capital plans are designed to prevent free riding by requiring members to adjust their investments in the cooperative in order to bring their equity percentage in line with their patronage percentage. Conceptually they do this by ensuring all members pay the same unit cost of investment (i.e., effectively a uniform "membership fee" is applied to all members). Since grain, cotton, and farm-supply cooperatives typically exhibit constant or increasing economies of size, while dairy, fruit, vegetable, and nut cooperatives exhibit decreasing returns to size, the use of the base-capital plan aligns very well with the predictions emerging from the analysis in this paper.[20]

Concluding Remarks

This paper developed a model of heterogeneous individuals to analyze the horizon and free-rider problems faced by collective-action institutions such as cooperatives. The framework captures the different horizons of alternative cooperative investments and the heterogeneity that individuals possess in their planning horizons and allows the interlinked horizon and free-rider problems to be considered together.

Capturing the interaction of these two property rights problems is critical to identifying the factors affecting individual decisions and welfare and the conditions under which cooperative investments are undertaken when the potential for horizon and free-rider problems is present. A full understanding of the linkage between these two property right problems is also crucial for determining policies and strategies that can be used to address them.

Our study offers new insights on the horizon and free-rider problems in cooperative organizations. Specifically, our study reveals that (i) the horizon problem need not necessarily lead to short-term cooperative investments, (ii) free riding is not necessarily a problem for cooperative organizations, (iii) the source of the horizon problem, namely different member time horizons, can help cope with the free-rider problem, (iv) a properly designed membership fee can address the free-

[20] One of the reasons for the different cost structures is storability; while grains, cotton and farm supplies can be stored (in some cases longer than others), dairy, fruit, vegetables, and nut crops are much more perishable and typically need to be processed immediately. Given the fixed capacity of most processing plants, significant dis-economies of size exist once this capacity has been reached. The result is that unit returns for dairy, fruit, vegetables, and nut crops can fall quickly once this capacity is reached. In contrast, grain, cotton, and farm-supply operations can typically handle additional throughput through proper scheduling; in many cases, this additional throughput is advantageous because it makes better use of fixed assets and thus lowers average cost.

rider and horizon problems, and (v) the optimal membership fee depends on the cooperative's cost structure.

Our analysis shows that although individuals differ in their valuation of the perceived benefits from forming or patronizing the cooperative because of factors such as age, these differences in valuations also create an opportunity to cope with the free-rider problem. Specifically, a member's time horizon determines whether that individual is part of a critical mass that must invest in the cooperative for it to begin operation. The model shows that this critical mass of members is made up of people with longer time horizons. As a consequence, at least part of the membership is provided with an incentive to cooperate precisely because of the existence of differences in members' time horizons.

While this critical mass of members will cooperate and invest in the cooperative under the right circumstances, the other members will find it optimal to free ride. If the cooperative exhibits decreasing returns, then free riding is detrimental to all members. One way of reducing the free-rider problem is through the use of membership fees to members that are not part of the original critical mass. By equating the returns from investing in and patronizing the cooperative with those from patronizing alone, a properly designed membership fee eliminates the incentive to free ride and raises the benefits generated by the cooperative under decreasing returns to size.

Free riders, however, need not be bad for the organization and the original members. For instance, if the cooperative exhibits increasing returns to size, then free riding can benefit all members by lowering costs and creating greater benefits. Thus, allowing different members to pay different amounts to join the cooperative organization can be advantageous.

In addition to providing insights into the membership fee structure of cooperative organizations, the paper shows that the impact of the horizon problem may differ from what is typically expected. While it is usually argued that the limited horizons of its members will lead to a cooperative undertaking projects that generate short-term rather than long-term projects, the model developed in this paper shows that this need not always be the case because the individuals who decide to patronize and finance the cooperative are likely to have relatively longer horizons, which attenuates the short-sightedness of the cooperative to some degree. This result may be one reason why some cooperatives have been able to make long-term investments and thus remain competitive over time.

Meaningful extensions of the framework developed in this paper could include the consideration of optimal membership in closed-membership cooperative organizations; the impact of usage fees, perhaps based on membership status, that could be used to make cooperative formation more likely and that would not overly reduce the benefits provided by nondiscriminatory cooperatives (Rey and Tirole, 2007); the effect of revolving equity or base capital plans that return equity to members on member investment decisions; and the role of retained patronage in the financing and size of cooperative organizations in the presence of horizon and free-rider problems. These topics are left open for future research.

[Received October 2015; final revision received May 2016.]

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