

CEO Compensation in Cooperatives versus Publicly Listed Firms

Li Feng

George Hendrikse¹

Abstract

A cooperative differs from a publicly listed enterprise in at least two dimensions. First, it does not have a public listing. Second, a cooperative has to bring the enterprise to value as well as to serve member interests, while a publicly listed enterprise has to do only the former. These differences have an impact on the composition of the performance measure, and therefore the optimal incentive intensity for a CEO. The results regarding the optimal incentive intensity and the nature of the CEO activities, additional information, and member size and heterogeneity are formulated. Moreover, strategic considerations are incorporated in the choice of performance measure weights.

Keywords: CEO compensation, performance measurement, cooperatives.

¹ The authors are at Rotterdam School of Management, Erasmus University, Office T8-56, P.O. Box 1738, 3000 DR Rotterdam, 00-31-10-4088660, The Netherlands, lfeng@rsm.nl, ghendrikse@rsm.nl.

Few factors are more important for a cooperative's success than the manager.

Trechter et al, 1997

1 Introduction

Since the last decade, CEO compensation has received tremendous attention in both the business and academic community. The large number of high-publicity scandals, the enormous salaries paid to CEOs (Chief Executive Officers), and their celebrity status have created unprecedented public interests in corporate governance (Weisbach, 2007). Inasmuch as the agency approach captures the inherent divergence between the interests of the firm's investors and the professional management (Bebchuk and Fried, 2003), CEO compensation is often cited as a real-world example of a principal-agent problem. Conceivably, writing a complete contingent contract governing the behavior of the CEO is not possible. A partial solution to this problem is to utilize an incentive contract designed to pay the agent more when he performs better. A lot of research has focused on how executive compensation schemes can help rectify the agency problem in IOFs (Investor Oriented Firms), especially publicly listed companies, whereas the CEO compensation in other governance structures, for example cooperatives, is underresearched.

The members-CEO relationship in cooperatives is similar to the investors-CEO relationship in IOFs. It can also be characterized by the features of the principal-agent model. Traditionally, the cooperative board of directors, democratically chosen by and from the membership, was the main body governing the activities and investments of the cooperative firm (Bijman, Hendrikse & van Oijen, 2008). As the cooperative grows, the tasks facing the cooperative management call for strategies or judgment far beyond the experience and competence of most members, professional qualified management is hired to operate the firm. As a result, the members exercise their authority mainly by critically following the policies of their professional management, rather than by giving it directions (Trifon, 1961), which surely invites the conflict of interests. Members would like to maximize their benefits derived from the cooperatives, while the management is likely to pursue objectives of organizational growth maximization, subject to continuity and employment security (Vitaliano, 1983).

Despite of the similarities, the situation in cooperatives is more complex than a standard principal-agent relationship. First of all, there is a group of principals whose interests differ. The variety of members embodies their sizes, farm locations, risk aversion, organizational forms, attitudes towards innovation, growth potential, member involvement, and financial contributions to the cooperative, and so on. Due to the member heterogeneity, the cooperative does not have one locus for profit maximization but a separate locus for each member, giving rise to a host of problems that attend collective choice (Statz, 1987). These problems are manifested in debates not only about pricing, financing and pooling policies, but also about the way of motivating the management. When colliding interests exist among principals, the agent's task may

involve devising workable compromises and acting as a neutral guardian of everybody's interest (Trifon, 1961).

Secondly, the task delegated to the CEO is not one-dimensional. The cooperative members are users in addition to being the owners of the firm. They have at least two sets of concerns: owner concerns and user concerns. Owner concerns revolve around the security and overall profitability of their investment in the cooperative. User concerns include issues of product quality and the pricing of member services, which influence the profitability of their individual farm enterprise (Staatz, 1987). These two concerns are reflected in the members' expectation regarding the management.

Thirdly, owners of a cooperative have difficulty in devising simple indicators of managerial performance and automatic incentive systems (such as stock options) to close the gap in interests. Giving the CEO equity in the business, a common way to tie the CEO's wealth to firm performance and thus to alleviate the principal-agent interests conflict in IOFs, is not feasible. The reason is that a cooperative CEO is not eligible to hold equity in the business and receives only limited benefits from such ownership given the fact that most cooperative stock does not appreciate in value (Trechter et al, 1997).

It is difficult to assess the top manager's contributions to a company due to the complexity of his tasks (Blanchard et al, 1996). Given those additional complexities of a cooperative CEO's tasks, designing a contract that helps overcome the principal-agent problem in cooperatives has to be even more difficult. Besides the easily measurable index stock price or ROI (Return on Investment), more dimensions of the CEO's outputs concern the farmers and require efforts from him. Some researchers point an accusatory finger at the efficiency of cooperatives and argue that cooperatives suffer from a host of problems unique to this specific form of governance, including the horizon problem that pushes the cooperative to pursue short-term benefits at the expense of long-term earnings. But still cooperatives and IOFs coexist in many industries. We aim to answer in the current paper the following question: How is the cooperative CEO compensation determined by the special features of its governance structure? How do cooperatives counterbalance the horizon problem?

One way to position the article in terms of the principal-agent model is that it is in line with the current developments. The classic principal-agent model highlights the trade-off between the incentives (regarding one task) and risk. One development has been that nowadays a trade-off is considered between the incentives intensity and the allocation of attention among various activities. The other development is that repeated principal-agent relationships are considered. This paper is to be positioned in the first development as we consider a model where the agent allocates his attention over upstream and downstream activities. Another way to position the article is that most studies regarding contract choice in agrarian economies using the principal-agent model are geared to the relationship between a landowner and a farmer (Hayami and Otsuka, 1993). We address the relationship between farmers and the CEO of a cooperative.

This article is organized as follows. Section 2 distinguishes cooperatives from IOFs. Section 3 uses a multi-task principal-agent model to characterize CEO compensation schemes in cooperatives and IOFs. Section 4 thru 7 formulate various extensions. Finally, section 8 concludes.

2 Members in cooperatives

This section delineates the various components of cooperative member value (2.1), CEO activities (2.2), and governance structure differences between cooperatives and IOFs (2.3).

2.1 Member value

Members join a cooperative to achieve certain commercial and social objectives (LeVay, 1983; Barton, 1989). They are owners as well as users of a cooperative. As the owners and investors, they want to bring the downstream stage of production to value in order to receive dividends. As input suppliers or users, they derive benefits from their transaction relationship with the cooperative firm. Therefore, the members are concerned with both the value added at the cooperative firm and at their own farm enterprises, and want to motivate their CEO to bring the outputs at both stages jointly to maximum value. They care not only about the financial performance of the cooperative enterprise in the same way as the investors of an IOF, but also about the impact of the cooperative on their own farm portfolios, their positions in social structure, community development, and so on. The German council of cooperatives (DGRV, 2008) specifies that a cooperative has to serve joint economic, social, and cultural interests.² We distinguish member value into two categories, namely, value added at the cooperative firm and value added to the farm enterprises.

Value added at the cooperative firm³

The financial performance of the cooperative concerns its members since they are the residual claimants. The net income of a cooperative is distributed to its members in the form of patronage refunds. On this aspect, members are happy with the cooperative's and CEO's performance in the same sense investors in an IOF are happy with their firm's performance (Staatz, 1987). They pay attention to the cooperative's financial performance in various aspects: revenues, total assets, sales, local net income, return on assets, production volume, or its performance relative to neighboring enterprises.

Moreover, the flow of information between patrons and the firm may be better in cooperatives than in IOFs, leading cooperatives to be more responsive to members' needs or to better product specifications. A cooperative usually has a patron list and collects a substantial amount of information about member's preference, needs, production practices, and advice about products and service through periodic member surveys. The

² 'Allgemeines Ziel von Genossenschaften ist, gemeinsame wirtschaftliche, soziale und kulturelle Bedürfnisse zu Befriedigen' (DGRV, 2008).

³ The value added at the downstream cooperative firm is similar to the "owner value" defined by Staatz (1987).

members may be more willing to provide higher quality, more frequent, and more truthful information to the cooperative than they would to an IOF (Cook, 1994). One reason is that as owners they are more assured that the cooperative would not use the information to act opportunistically toward them (Staatz, 1987). Another reason lies in the fact that “exit” is a more expensive option for cooperative members than the patrons of IOFs (Cook, 1994). Furthermore, an IOF CEO is usually in a position of strong control over both setting and implementing company policies, while in cooperatives, the board of directors, as representatives of members, are significantly more independent and would go a long way towards monitoring the CEO. They do not feel beholden to question management decisions and to reject its recommendations (USDA, 2002, p11).

Value added to the upstream farms and their owners

Staatz (1987) observes that the user-owners are vitally interested in the cooperative’s pricing of goods and services, not simply in its overall financial performance. Being users, they are able to exert a higher influence on the operation and management of the cooperative firm than the investors of an IOF, and consequently can receive more favorable prices. Members benefit from the cooperative also in terms of product quality and other technical aspects of products and services, which affect the profitability of their individual farm enterprise. For instance, when an individual farmer cannot afford to do consumer preference research related to characteristics of farm commodities, it may be feasible for a large cooperative to do such research. An investor-owned marketing agency has little incentive to do it because it cannot capture the benefits which accrue to farmers, whereas an investor-owned processor is not interested either in a particular farm commodity but its own products (Shaffer 1987). Moreover, cooperatives prove to be an assured source of supplies (Barton, 1989) and a reliable “home” for farm produce, reducing risk to members (Lang, 1994). Members’ value as users can be reflected in the cooperative’s diversification behavior. A cooperative never abandons the activities concerning the majority of its members. Farmer cooperatives concentrate their investments in agribusiness and their assets are closely tied to the assets of their members as the members might suffer substantial capital losses if their farming activities were not adequately supported.

It has long been recognized that value added to the upstream farms is likely to attract more attention from the members since they take into consideration the fixed costs of their farms when making decisions at the cooperative level (Lang, 1994). “The income that a stockholder derives from an IOF depends on the firm’s ‘bottom line’, but the income of a cooperative’s stockholder often depends more on the prices of the individual goods and services purchased from the cooperative than on the organization’s overall profitability” (Staatz, 1987). There are various possible explanations for the dominance of user value in the perception of members. On the one hand, the limitation on dividend payments and the members’ inability to capture capital gains in a cooperative may account for member’s preference to direct benefits in the form of transfer prices (Staatz, 1987). On the other hand, the frequency of transactions may play a role. Cooperative members are users of the organization’s goods and services on an almost daily basis, while owner-investors only several times a year (tax day, equity redemption day, dividend day). This frequent-use interface relative to investor interface reinforces a

constant message that price and quality of the cooperative's services and goods affect the members' bottom line, which is more important (in the short run and for the individual member) than the bottom line of the cooperative (Cook, 1994).

Besides user value, members also derive social value from being "a member of an association". Although members join the cooperative primarily for economic reasons, "cooperatives may pursue some noneconomic objectives as well. Benefits of social value include all noneconomic results or outcomes of major interest or importance to stakeholders, including the satisfaction many of them experience through the association, unity, and involvement characteristics of member-controlled organizations. Some members like being involved with others to achieve a common purpose. Some members also like electing or serving as directors" (Barton 1989, p7). Members' social value takes various forms. First, the fact of membership and the possibility of holding directorial office yield satisfaction, particularly for farmers who could not have contemplated running single-handed an extra business next to their farms but feel more secure in a shared corporate undertaking (LeVay, 1983). Second, identity preservation can be a source of member value (Lang, 1994). Identity influences economic choices and outcomes and accounts for many phenomena that go beyond a standard economic explanation. A cooperative member has a different orientation in life than an IOF shareholder. Forming a community of cooperative members may appear to be a way of bolstering a sense of self or salvaging a diminished self-image (Akerlof and Kranton, 2000). The result is that members feel more cheerful, more confident and stronger, both in the market and in the society. Third, cooperation is known to appeal to people not merely as a means of running a business but also as an instrument of social amelioration (LeVay, 1983). Human beings have a strong need to belong, either to a society or to a profession. Through various socialization processes like member training programs and member relations programs, members work together, learn together, celebrate together, and share their experiences together, generalizing "feelings of family" to the entire membership. Cooperatives also help to create a territorially based forum for information exchange (LeVay, 1983) where members can more easily communicate among each other.

2.2 CEO activities

A CEO achieves the goals of his organization via planning, organizing, leading, and controlling. His tasks include setting long-term goals, establishing policies and standards, determining long-term financing needs and sources, and setting strategies (Blanchard et al, 1996). According to Merchant (1990), CEOs allocate their time over six different categories of activities: 1) new product development, 2) improvement of existing products/services, 3) adjusting/improving production processes, 4) employee development, 5) capacity expansion, 6) improvement of information systems, 7) execution of current production processes, and 8) advertising and sales promotion. Of these eight categories, we classify 1 through 6 as actions attempting to build long term value of the firm, and categories 7 and 8 to actions aiming at short term gains.

In addition to the activities mentioned above, a cooperative CEO is responsible also for actions that create value for the upstream members because of the user-owner uniqueness of cooperatives. Three extra categories are specified:

9) Improvement of member involvement and member loyalty

Compared with his IOF counterpart, the cooperative CEO is more interdependent and interactive when coping with the user-owners. As a leader of a community-based organization, he needs to be particularly effective in fostering group cohesiveness, a key component in improving member loyalty.

10) Vertical information exchange

A cooperative CEO once informed us that he spent at least half of his time communicating with members. Members have different preferences as to price, cost allocation, and equity retirement policies, which affect both the member enterprises and the cooperative firm. The cooperative CEO must actively acquire useful information in discovering the optimal choice (Cook, 1994). Meanwhile members have more formal and informal channels to communicate their desires to the CEO than do patrons of an IOF and thus are able to exercise cheaper “voice” (Staatz, 1987).

11) Member coordination and improvement of member relations

A cooperative CEO takes a more integrated view of the fixed costs of the members when attempting to optimize the vaguely defined objective function of the association. Both collective choice option identification and coalition building take considerable time. Cooperatives have a higher potential for conflict among stakeholders than IOFs because of the unique way they resolve residual claims, property rights, and control issues. The more heterogeneous the membership, the more will be the difficulty for the CEO to form consensus and viable internal coalitions. The CEOs of cooperatives, particularly those of large, diversified cooperatives, need to spend considerable time and effort in negotiating and meeting the expectation of members. They are required to reduce the increasingly heterogeneous interests to more homogeneous interests to capture the benefits of coordination (Cook, 1994).

2.3 Governance structure of cooperatives versus IOFs

Most public-listed firms mitigate principal-agent conflicts through offering the CEO incentive contracts that link pay to performance, whereas the complexity in measuring cooperative performance often creates vagueness and lack of clarity in the eyes of members (Cook, 1994). Designing and implementing an optimal incentive contract for cooperative CEOs entails difficulties due to the following reasons.

First of all, the ‘plethora of objectives’ of members who differ in various aspects makes the identification of the cooperative’s objective function one of the cooperative CEO’s most challenging tasks (Cook, 1994). Yamay (1950) realizes that “the manager of a capitalist enterprise knows what it should try to maximize and for whom, the management of a co-operative society has a choice of what it should try to maximize (or minimize) and for whom”. The shareholders of an IOF may be a diverse group as well,

but capital markets with a sufficiently rich menu of assets align their interests (Dixit, 1997). They are mostly interested in the appreciation of their shares whereas the value of input suppliers is not included in the value maximization of an IOF. In cooperative, as membership grows more heterogeneous, different groups within the organization pressure management to respond to their particular interests. Because of the broader, more diffuse scope of optimization in a cooperative (Staatz, 1987), single indicators such as ROI are less meaningful as measures of organizational and managerial performance (Cook, 1994). Consequently, evaluating whether a cooperative is achieving its objectives is far more complex and delicate an undertaking than comparing ROI for IOF performance.

Secondly, there is no objective third-party indicator (besides members and CEO) such as secondary markets for cooperative-issued stock to assist shareholders to evaluate performance (Cook, 1994). Investors of IOFs want to receive the highest possible return on their investment, and this return can be expressed in the stock price. In other words, an IOF CEO's total contribution to firm value is equivalent to the change in the shareholders' wealth through appreciation of the firm's stock. Fluctuation in the stock price serves as an influential disciplining mechanism on management, indicating the extent to which the stockholders are content with current managerial policies. Many firms reinforce the potency by offering stock options to CEOs, making their earnings contingent on the stock's value. Cooperatives lack these external mechanisms for disciplining management. There is no public financial assessment of the performance of the cooperative and therefore of its CEO. Even though members are radically concerned with the prices the cooperative pays for the goods from members or it charges for its services, the prices cannot be used as the sole performance measure, otherwise the CEO may be induced to decapitalize the firm in an attempt to increase his current earning, simply reinforcing the horizon problem (Staatz, 1987). Market requirements that best serve profitability goals of an IOF may not directly serve the immediate interests of all cooperative members due to member heterogeneity. If a pure market-driven approach is taken, members with less marketable inputs may not, compared to other members, feel their needs are well met (Lang, 1994).

According to Abernethy et al (2008), accounting return measures can improve contracting efficiency and motivate managers to undertake actions with longer-term managerial focus and consequences. They claim that accounting return measures well capture the value impact of the managerial behavior since they provide a measure of economic value generated from specific resources and are thus a reasonable proxy for firm value creation. We will in the current paper investigate the effect of adding accounting data in the performance measure of the cooperative CEO.

3 Cooperatives versus IOFs

This section employs a multi-task principal-agent model (Gibbons, 1998) to compare CEO compensation schemes in two governance structures, i.e. cooperative and IOF. The specification of the model and equilibrium results are in appendix 1.

We assume that the CEO in governance structure i (c for a cooperative and f for an IOF) can take two actions: a_{1i} denoting the CEO's action to advance the value of the downstream firm, and a_{2i} denoting the CEO's action to add value to the upstream suppliers. Then we explore the differences between a cooperative and an IOF regarding the production function and performance measure.

Firstly, the CEO's total contribution to firm value depends on organizational form. In cooperatives, it is equivalent to the change in total member value. Members want to bring both upstream farms and the downstream stage of production to value, i.e., $f_{1c} \neq 0, f_{2c} \neq 0$. Investors of an IOF care only about the firm value and consequently the CEO's action that increase firm value, i.e., $f_{1f} \neq 0, f_{2f} = 0$.⁴

Secondly, the performance measures of IOFs and cooperatives differ. It is common in IOFs that the CEO's bonus is paid in the form of firm shares, i.e., $g_{1f} \neq 0, g_{2f} = 0$. However, cooperative members have no simple indicator like stock price by which they can evaluate how well management has enhanced the future earnings capacity of their cooperative firm (Staatz, 1987). Members evaluate and then pay the CEO only based on his contribution to the other component of member value, i.e., the supplier benefits. This results in $g_{1c} = 0, g_{2c} \neq 0$. Production volume and input price are examples of this performance measures.⁵

To summarize, members' plurality of interests is represented by $f_{2c} \neq 0$, while the absence of patron-members, and therefore serving their interests, in an IOF by $g_{2f} = 0$. The absence of public listing of a cooperative is embodied by $g_{1c} = 0$ ⁶, while the use of stock price in an IOF's performance measure is captured by $g_{1f} > 0$. The distinct features of both governance structures are characterized in table 1.

⁴ Notice that there may still be a difference in terms of short run value creation versus long run value creation.

⁵ One cooperative has been willing to provide us with the details of the determinants of the CEO bonus. On October 14, 2008 the head of the personnel department of a dairy cooperative communicated to us that the bonus of the CEO has a long run and a short run component. The long run component is exclusively related to the milk price relative to a peer group of 6 other cooperatives. It captures two features of the interests of the members. First, it captures that the price received by the dairy farmers is a crucial aspect of the relationship of the farmers with the processor. Four levels of the bonus are specified, related to ranking first, second, third, or lower in the peer group. Second, continuity of the processor is important to the dairy farmers. This is captured to a certain extent by the fact that the ranking is determined as an average over 3 years. The short run component consists of three measurable performance indicators. They are all related to the EBIT and goals formulated with respect to costs.

⁶ We are not stating that a cooperative has no information at all about the downstream activities, but our model will focus on the impact of lacking certain information.

i \	f	c
f_{1i}	$\neq 0$	$\neq 0$
f_{2i}	0	$\neq 0$
g_{1i}	$\neq 0$	0
g_{2i}	0	$\neq 0$

Table 1: Marginal products and performance measure parameters of two governance structures

As shown in figure 1, the production function and performance measure are perfectly aligned in an IOF, that is, the f and g vector overlap, so the performance measure has no distortion. In this case the efficient bonus rate depends solely on the comparative scales of f_{1f} and g_{1f} . Imagine that g_{1f} is much larger than f_{1f} . Then the CEO could greatly increase p_f by choosing high value of a_{1f} but this would result in a much smaller value of y_f . As a result, the efficient contract should put a small bonus rate on p_f .

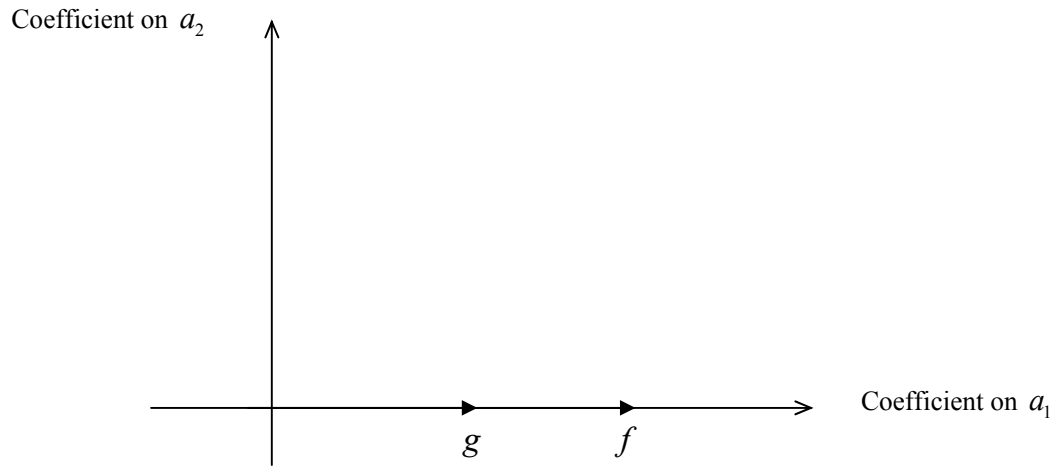


Figure 1: The scale and alignment effect in an IOF

Notice that f and g are not aligned in a cooperative (figure 2). The performance measure depends only on one action while the production function depends on both.

Coefficient on a_2

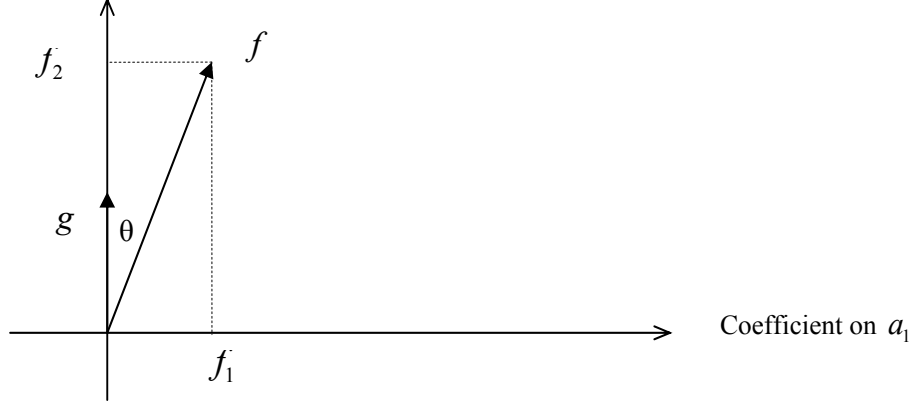


Figure 2: The scale and alignment effect in a cooperative

The formula of cooperative efficient bonus rate $b_c^* = f_{2c} / g_{2c}$ is rather interesting. Our specification of the cooperative case is equivalent to a situation where $f_{1c} = 0$ and $g_{1c} = 0$, that is, production function and performance measure both compose of only one action, just like an IOF. We can easily show in that case, the efficient bonus rate equals f_{2c} / g_{2c} . The appearance of a_{1c} in the production function does not make any difference in the efficient bonus rate and the CEO's equilibrium actions are not affected either. In other words, when an action increases the member value without simultaneously increasing the performance measure, the CEO has no incentives to undertake it.

Proposition 1: When performance measure is based on a single action, the efficient bonus rate and the equilibrium actions are determined by the marginal product and the performance parameter of the same action, regardless of the other components in the production function and performance measure.

In equilibrium, an IOF CEO has incentives to undertake only a_{1f} , i.e., $a_{1f}^* > 0$, because the investors of an IOF care only about a_{1f} and make the CEO's pay dependent on a_{1f} . Members of cooperatives, however, appreciate the CEO's actions on both dimensions but only compensate for a_{2c} . Thus, only an incentive to increase a_{2c} is created ($a_{2c}^* > 0$) and no incentive for a_{1c} exists even though it would increase firm value.

Proposition 2: The misalignment between members' value and the cooperative CEO's interest results in the CEO's failure to add value to the downstream cooperative firm while the perfect interests alignment between the investors and the IOF CEO creates an incentive for the CEO to advance the firm value.

Therefore, we expect that activities 9-11 specified in section 2.2, the actions that add value to the upstream member farms, would consume most time of a cooperative CEO.

4 Substitutable/complementary tasks

We turn now to analyzing the substitutes or complements effects of actions by relaxing the assumption that there is no interaction between the CEO's two actions (Dixit 2002). The main result is that a_{2f} and a_{1c} are not zero anymore. Their actual levels will depend on the nature and the strength of the interaction effects.

Assume again that the CEO can take only two actions a_{1i} and a_{2i} , and the cost function takes the form

$$c_i(a_{1i}, a_{2i}) = \frac{a_{1i}^2}{2} + ka_{1i}a_{2i} + \frac{a_{2i}^2}{2}, \text{ where } -1 < k < 1.$$

When $0 < k < 1$, two tasks are substitutes, i.e., more effort in a_{1i} increases the marginal cost of effort in a_{2i} , therefore enhancing the marginal incentive payment for greater output of a_{1i} draws effort away from a_{2i} . For instance, a_{1i} can be the time the CEO spends in communicating with the input suppliers while a_{2i} can be the time the CEO spends on the business strategies of the downstream enterprise. When the workload of the CEO is fixed, the more he works with the suppliers, the less time left for him to spend on the firm strategies.

When $-1 < k < 0$, two tasks are complements, implying that the interaction between two tasks strengthens incentives for both. Examples of complementary tasks can be the CEO's coordination between the upstream supplier and the downstream enterprise. More knowledge of the supplier side facilitates coordination with the downstream enterprise and vice versa.

With the new cost function, the efficient bonus rates for a firm and a cooperative are:

$$b_{f(k)}^* = \frac{f_{1f}}{g_{1f}} \text{ and } b_{c(k)}^* = \frac{(f_{2c} - kf_{1c})}{g_{2c}}.$$

Plugging these results in the expressions for the CEO's equilibrium actions results in

$$a_{1f(k)}^* = \frac{f_{1f}}{1-k^2}, \quad a_{2f(k)}^* = \frac{-kf_{1f}}{1-k^2},$$

$$a_{1c(k)}^* = \frac{-k(f_{2c} - kf_{1c})}{1-k^2}, \quad a_{2c(k)}^* = \frac{f_{2c} - kf_{1c}}{1-k^2}.$$

Observe that, like in the basic model, the performance parameters do not enter into the expression of the equilibrium actions, which implies the impact of the performance parameters on the equilibrium actions is cancelled out by the efficient bonus rate.

In the model with no interaction effects, an IOF CEO will in equilibrium take no action a_{1f} . However, the marginal cost of a_{1f} decreases with a_{2f} in the complementary case and increases in the substitutes case. If a_{2f} can make a_{1f} less costly, the CEO will optimally choose to take some actions a_{2f} . The stronger is the complementary effect, the more actions will be taken on a_{2f} . If a_{2f} makes a_{1f} more costly, he will take a negative action on a_{2f} since it will decrease the marginal cost of action a_{1f} .

Proposition 3: When tasks are complementary, the IOF's CEO will take actions to increase the upstream supplier's value, i.e., $a_{2f(k)}^ > a_{2f(0)}^* = 0$ and $a_{2f(k)}^*$ decreases with k . When tasks are substitutes, he will take actions to decrease the upstream supplier's value, i.e., $a_{2f(k)}^* < 0$.*

As discussed above, in the complements case, the IOF CEO will take positive action on a_{2f} despite $f_{2f} = 0$, because it makes a_{1f} less costly. This will further increase the equilibrium level of $a_{1f(k)}$ as compared with $a_{1f(0)}^*$. In the substitutes case, the negative action taken by the CEO on a_{2f} decreases the marginal cost of action a_{1f} , thus raising his equilibrium level of $a_{1f(k)}$.

Proposition 4: The interaction between the CEO's two actions in an IOF increases the CEO's action advancing the downstream value, i.e., $a_{1f(k)}^ > a_{1f(0)}^*$, regardless the nature of the interaction between tasks.*

In the basic model with no interaction effects, a cooperative CEO will in equilibrium take no action to increase the downstream enterprise's value. However, if two actions are complementary, he will optimally choose to take positive action on a_{1c} , which in turn increases the equilibrium level of $a_{2c(k)}$ as compared with $a_{2c(0)}^*$. The stronger is the complementary effect, the higher are the equilibrium levels of $a_{1c(k)}$ and $a_{2c(k)}$.

Proposition 5: When the cooperative CEO has two complementary tasks, he will take actions to boost the value of the downstream stage and his equilibrium action to bring the upstream farm to value will also increase, i.e., $a_{1c(k)}^ > a_{1c(0)}^* = 0$, $a_{2c(k)}^* > a_{2c(0)}^*$, and both $a_{1c(k)}^*$ and $a_{2c(k)}^*$ decrease with k .*

Because $f_{2f} = 0, g_{2f} = 0$, the vectors $f(f_{1f}, 0)$ and $g(g_{1f}, 0)$ are perfectly aligned, the efficient bonus rate of an IOF's CEO is determined entirely by the scale of $f(f_{1f}, 0)$ and $g(g_{1f}, 0)$, i.e., f_{1f} / g_{1f} .

Proposition 6: The interaction between the CEO's two actions has no influence on the efficient bonus rate in an IOF, i.e., $b_{f(k)}^ = b_{f(0)}^*$.*

When the cooperative CEO has two complementary tasks, a high bonus rate leads to a high level of the equilibrium action a_{2c}^* , which will result in higher equilibrium action a_{1c}^* due to the complementation effect. Therefore, a principal valuing both actions has incentives to increase the bonus rate of a_{2c} so as to increase both actions. When the two tasks are substitutes, a high bonus rate on a_{2c} drives the CEO to exert as much effort as possible to a_{2c} while taking no action or even negative action on a_{1c} . Therefore, the principal will cut down the bonus rate. Since $\partial b_{c(k)}^* / \partial k = -f_{1c} / g_{2c} < 0$, regardless of the nature of the tasks, the efficient bonus rate decreases with k . That is, the stronger is the complementary (substituting) effect, the larger (smaller) is the efficient bonus rate.

Proposition 7: The efficient bonus rate in a cooperative increases (decreases) when the CEO's two tasks are complementary (substitutes), i.e., $b_{c(k)}^ > b_{c(0)}^*$ when $-1 < k < 0$; $b_{c(k)}^* < b_{c(0)}^*$ when $0 < k < 1$. Furthermore, $b_{c(k)}^*$ decreases with k .*

5 Additional information in the performance measure

The breath of scope in cooperative goals makes defining task achievement more difficult (Cook, 1994). The absence of the stock price increases the difficulty in measuring the CEO performance. Here as elsewhere, significant inefficiencies invite corrective action by others. Many cooperatives try to correct for this incompleteness by using more than one measure. In other words, besides a_{2c} , there are other components included in the performance measure p_c . We investigate two ways of adding extra information in p_c . Subsection 6.1 captures the positive vertical externality between actions a_{1c} and a_{2c} , and introduces in the performance measure an additional action a_{3c} that is positively related to a_{1c} and a_{2c} . Subsection 6.2 decomposes the cooperative CEO's action a_{1c} into two aspects, one aiming at long-term value and the other aiming at short-term benefits.

5.1 Positive vertical externality

The positive vertical externality generated in a cooperative entails that there are dimensions of CEO tasks that concerns both upstream members and the downstream cooperative firm.

Suppose $p_c = g_{2c}a_{2c} + g_{3c}a_{3c}$, where $a_{3c} = F(a_{1c}, a_{2c})$ denotes the CEO's action on the third dimension which positively relates to a_{1c} and a_{2c} . An example of a_{3c} can be actions to increase sales growth in a new market. When the correspondence between a_{3c} and

member benefits is potentially close and direct, the inclusion of this extra performance measure is meaningful.

Table 2 illustrates the distinctions between cooperatives with or without an extra performance measure component, where c' stands for a cooperative evaluating its CEO on both a_{2c} and a_{3c} .

i \	f	c	c'
f_{1i}	$\neq 0$	$\neq 0$	$\neq 0$
f_{2i}	0	$\neq 0$	$\neq 0$
f_{3i}	0	0	0
g_{1i}	$\neq 0$	0	0
g_{2i}	0	$\neq 0$	$\neq 0$
g_{3i}	0	0	$\neq 0$

Table 2: The differences between cooperatives with (c) or without (c') an extra performance measure component

When other conditions remain unchanged, the addition of a new component to the performance measure leads to new equilibrium results. The efficient bonus rate is now

$$b_{c'}^* = \frac{f_{2c}g_{2c}}{g_{2c}^2 + g_{3c}^2}.$$

The CEO's optimal actions are

$$a_{2c'}^* = \frac{f_{2c}g_{2c}^2}{g_{2c}^2 + g_{3c}^2}, \quad a_{3c'}^* = F(a_{1c}, a_{2c}) = \frac{f_{2c}g_{2c}g_{3c}}{g_{2c}^2 + g_{3c}^2}.$$

With extra information added in the performance measure, the CEO will be compensated if he takes actions on the third dimension that is positively related to the previous two actions. Therefore, he will divert some of his effort from the action advancing the upstream value to the third dimension.

Proposition 8: The CEO will reduce his action in bringing the upstream farm to value when there is more than one component in the performance measure, i.e., $a_{2c'}^ < a_{2c}^*$.*

Although we are not able to calculate the level of equilibrium actions without making further assumption, the influence of the additional performance measure on the CEO's equilibrium actions is shown in appendix 2 by looking at some special cases.

Recall that two effects determine the efficient bonus rate: scale and alignment. The efficient bonus rate increases with the comparative scale of the f vector compared with the g vector, and with the alignment of the two vectors. When an extra performance measure component positively related to the previous two actions is included, the scale of

the g vector is increased, consequently the scale effect leads to the decrease of the efficient bonus rate. Figure 3 provides an illustration.

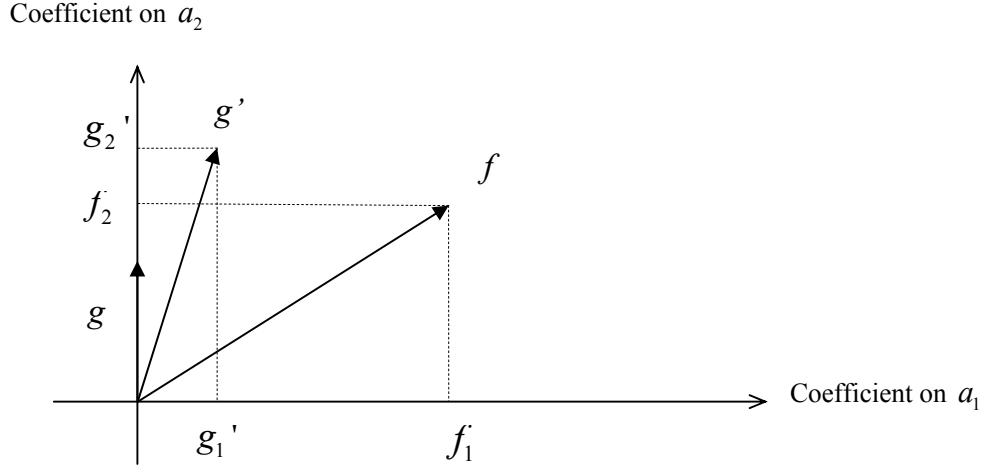


Figure 3: The scale and alignment effect with the additional performance measure component (1)

Meanwhile, the angle between f and g vector is also changed. If $f_1 \geq f_2$, i.e., $\theta \geq 45^\circ$ (figure 3), the increase of performance measure parameters on both dimensions with the additional performance measure component always reduces the angle between f and g vector. In other words, the alignment between f and g' is better than of f and g , leading to the increase of the efficient bonus rate.

If $f_1 < f_2$, i.e., $\theta < 45^\circ$ (figure 4), the alignment effect is not as determinate as in the previous case. The angle between f and g may increase or decrease with the additional performance measure component. To demonstrate this, we draw a line OA and let the angle between OA and f equal to θ . When the g' vector is flatter than OA , i.e., $g_2 \leq g_2' < g_1' * \tan(90 - 2\theta)$, the angle between f and g' is larger than θ , resulting in the decline of alignment, and consequently a decreased efficient bonus rate. The reason of the declined alignment is that the additional performance measure assigns too much weight on a_1 , resulting in an even worse balance of the two tasks. In other cases, when g' is steeper than OA , i.e., $g_2' \geq g_1' * \tan(90 - 2\theta)$ and $g_2' \geq g_2$, the angle between f and g' is smaller than θ , resulting in the melioration of alignment, and consequently the increase of the efficient bonus rate.

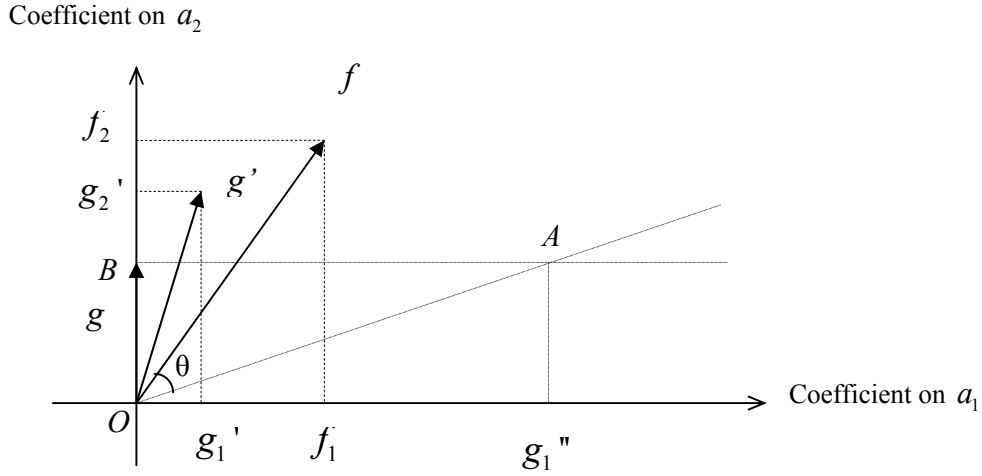


Figure 4: the scale and alignment effect with the additional performance measure component (2)

Nevertheless, from the derivation we know that scale and alignment effects adding together result in a decreased efficient bonus rate. This is obvious when the scale effect and alignment effect drive the efficient bonus rate towards the same direction, i.e., when $f_1 < f_2$ and $g_2 \leq g_2' < g_1' * \tan(90 - 2\theta)$. When the two effects drive the efficient bonus rate towards opposite directions, i.e., when either of these two conditions is satisfied, (1) $f_1 \geq f_2$, (2) $g_2' \geq g_1' * \tan(90 - 2\theta)$ and $g_2' \geq g_2$, the overall influence on efficient bonus rate can be understood as the scale effect dominating the alignment effect.

Proposition 9: With the additional information in the performance measure, the scale effect leads to the decrease of the efficient bonus rate and the alignment effect is indeterminate. Two effects combined result in a decreased efficient bonus rate, i.e., $b_c^ < b_c^*$.*

5.2 Public versus accounting data

Stock price and EPS (Earnings Per Share) are commonly used performance measures for public traded firms, though these stock related performance measures are often criticized for inducing costly myopic behavior. In an effort to mislead the market about their firms' worth so as to achieve a high stock price, the CEO can forsake good investments to boost current earnings at the expense of long term benefits (Stein, 1989). As a result, a stock listed enterprise is more likely to overly accentuate the short-run revenue, rather than the long-term interests. From this perspective, no public listing exempts a cooperative from this possible myopic managerial behavior. Using accounting return measures as basis of performance measure can "bring the future forward" and motivate the management to undertake activities that have a focus on long-run firm value (Abernethy et al, 2008). Meanwhile, temporary losses might be allowed to establish sustainable future gains, as the lack of a stock listing makes temporary losses less visible (Hendrikse and Veerman,

2001). Therefore, by excluding the stock related measures and using only accounting data to evaluate the CEO performance with regard to the cooperative firm, the cooperative commits itself to a more long-term orientation towards its business. This long-run focus of cooperatives can be strategically favorable because it provides a credible signal to its rival enterprises that the cooperative will stay in the market. A less competitive market may be the result (Hendrikse and Veerman, 2001).

Decompose a_{1i} into two actions, a_{1il} and a_{1is} , each denoting the CEO's action to boost long-term and short-term value of the cooperative firm. The marginal products and performance measure parameters of action a_{1il} and a_{1is} are respectively f_{1il} and f_{1is} , g_{1il} and g_{1is} . Table 3 shows the distinctions between cooperatives with or without a_{1il} accounting return measures in their CEO compensation measurement, where c'' stands for a cooperative using accounting return measures to evaluate its CEO's action.

$i \backslash$	f	c	c''
f_{1il}	$\neq 0$	$\neq 0$	$\neq 0$
f_{1is}	$\neq 0$	$\neq 0$	$\neq 0$
f_{2i}	0	$\neq 0$	$\neq 0$
g_{1il}	$\neq 0$	0	$\neq 0$
g_{1is}	$\neq 0$	0	0
g_{2i}	0	$\neq 0$	$\neq 0$

Table 3: The differences between cooperatives with (c'') or without (c) accounting return measures in their CEO compensation measurement

We show in table 3 that a publicly listed firm can use both long-term and short-term incentives; a cooperative using accounting data gives its CEO only long-term incentives regarding the cooperative firm, while a cooperative that does not use accounting data has neither. It can be easily shown that,

$$a_{1c''i} > 0 \text{ and } a_{2c''} > 0.$$

Proposition 10: By including accounting return measures, the CEO's performance measure are better aligned with his production function, and he has incentives to advance both the value of upstream member farms and the long-term goals of the downstream cooperative firm.

According to Cook (1995), horizon problem pushes the cooperative management to accelerate members' short-term benefits at the expense of long-term earnings. But still cooperative and IOFs coexist in many industries. We propose that the long-term goal orientation of cooperatives may counteract or at least reconcile the influence of the horizon problem that beset cooperatives. We thus expect that the outcome of deliberate

contract design is the cooperative CEO would spend more time on activities 1-6 that are specified in subsection 2.2 as actions attempting to build long-term value of the firm.

6 Society of Members

In the previous sections, we investigate the effect of alignment between CEO's production function and performance measurement on the efficient bonus rate and the CEO's choice of actions. Label this effect as measurement alignment. Measurement alignment can be understood as the extent to which the CEO's interest accords with the average member's interest. Now we turn to explore the impact of membership size (6.1) and member interest alignment (6.2) on the strength of incentives for a cooperative CEO.

6.1 Membership size

Here we relax the assumption made earlier that the CEO and the members are risk neutral. In the standard principal-agent model, the agent is usually assumed to be risk averse whereas the principal is assumed to be risk neutral. We abandon the risk neutrality assumption of the members because they are different from normal investors of an IOF who are more risk preferring or diversify their investment and portfolio to spread risks. Due to the immobility of cooperative capital, members usually exhibit financial commitment to a particular line of business, having all their eggs in one basket (Staatz, 1987).

Suppose there are n members in the cooperative who value the CEO's action a_2 identically. The CEO's contribution to member q is

$$y_{(q)} = \frac{1}{n} f_1 a_1 + \frac{1}{n} f_2 a_2 + \varepsilon .$$

Consequently the CEO's total contribution to the society of members is

$$\sum_n y_{(q)} = f_1 a_1 + f_2 a_2 + n\varepsilon .$$

As all members will agree on a single way of evaluating the CEO, the performance measure remains

$$p = g_1 a_1 + g_2 a_2 + \phi .$$

Assume errors are independent.

Let r denote the CEO's risk aversion, R the risk aversion of each member, v' the variance of ε , and v the variance of ϕ . Following Dixit (1997), the joint risk aversion of the members R_0 when they act collusively and pool risks is

$$\frac{1}{R_0} = \sum_n \frac{1}{R} = \frac{n}{R} .$$

It can be shown that the efficient bonus rate is

$$b^* = \frac{f_2 g_2}{g_2^2 + v(r - R/n)}.$$

The above formula manifests that the existence of multiple members in a cooperative decreases members' joint risk aversion, and in turn decreasing the efficient bonus rate because the membership is better able to bear risk.

Proposition 11: The managerial incentives of a cooperative CEO are weakened when the number of members increases.

6.2 Member interest alignment

The homogeneity of interests among the members furthers the efficiency of decision-making (Hansmann, 1996), however, cooperative members do not necessarily resemble each other in terms of their interests. Members, who produce or purchase different products, who differ in the amount of patronage or capital investment, will have different preferences regarding the decision made by the cooperative. Good performance for the inactive or over-invested member means the amount of returned equity, but good performance for the under-invested or new member means the competitiveness of current prices or services (Cook, 1994). We investigate in this subsection the effect of member interest alignment, the reverse of member heterogeneity, on the strength of incentives for a cooperative CEO. Member interest alignment is defined as the extent to which the production function of each member accords with that of the average member.

Suppose n cooperative members value the CEO's action a_2 differently. That is, the CEO's contribution to member q is

$$y_{(q)} = \frac{1}{n} f_1 a_1 + \frac{1}{n} f_{2(q)} a_2 + \varepsilon_{(q)},$$

where $f_{2(q)}$ denotes the value member q assigns to a_2 , and consequently the CEO's total contribution to the society of members is

$$\sum_n y_{(q)} = f_1 a_1 + f_2 a_2 + \sum_n \varepsilon_{(q)}, \text{ where } f_2 = \sum_q f_{2(q)}.$$

Now the joint risk aversion of the members R_0 becomes

$$\frac{1}{R_0} = \sum_n \frac{1}{R_{(q)}},$$

where R_q denotes the risk aversion of member q .

Other conditions remain the same as in the previous subsection⁷, the efficient value of b remains

⁷ Notice that members value the actions taken by the CEO differently but have to reach a consensus on the bonus rate of the CEO's payment scheme.

$$b^* = \frac{f_2 g_2}{g_2^2 + v(r - R_0)}.$$

It can be shown that when the sum of all member's risk aversions is fixed, R_0 reaches its maximum when members have identical risk aversions. That is, the heterogeneity of the members' risk aversions leads to lower joint risk aversion and consequently lower efficient bonus rate.

Proposition 12: Increasing heterogeneity in the members' risk aversions leads to impaired CEO incentives.

The proposition above provides an explanation for the phenomenon that compared with investors of an IOF, members of a cooperative usually are more homogeneous with regard to their social backgrounds, investment portfolios, attitudes towards risk, and so on. Our findings suggest that the negative relationship between member heterogeneity and the strength of CEO incentive might be one of the considerations regarding membership composition at the founding stage of cooperatives. Subsequent stages in the development of cooperatives are geared towards attracting more homogeneous members and encouraging heterogeneous members to leave. In this way, the obstacle of member heterogeneity is avoided.

7 Strategic choice of performance measure

The previous sections have focused on determining the optimal incentive intensity in various environments, while the production function and performance measure parameters were exogenously determined. However, the weights in the performance measure have to be chosen. Baker (2000, p419) observes that 'The choice of which performance measure to use (and the weights to place on them) depends on how the amount of distortion and the amount of risk change as one moves from one performance measure to another'. It is obvious in our model that the weights in the performance measure have to be chosen in order to establish alignment with the production function parameters. However, this result may change when the enterprise is facing a competitor. This section will argue that there may be a strategic rationale involved in the choice of the weights of a performance measure. An early contribution is Vickers (1985).

The strategic choice of performance measure can be incorporated in the two-stage game by adding an additional stage at the beginning of the game. That is, the principals decide first regarding the weight attached to each activity in the performance measure, and subsequently they choose the incentive intensity. Finally the CEO chooses the level of the various actions. The other ingredient needed for studying strategic performance measurement choice is that there is (potential) competition between enterprises, i.e., there have to be at least two enterprises.

According to Fudenberg and Tirole (1984), three variables have to be specified in order to determine the payoff maximizing choice of performance measure in a strategic setting:

the nature of investment, the nature of the competitive process, and the entry condition. First, define the investment as the extent of member focus in the performance measure. If the extent of member focus is large, i.e., g_2 is much higher than g_1 , then the profits of the rival firm will increase. The reason is that the CEO of the cooperative will dedicate a larger part of his time to activities related to the interests of members when the extent of member focus changes from small (S) to large (L), which goes at the expense of activities geared towards developing the cooperative enterprise. It entails that the investment is soft, because it establishes a positive relationship between investment in the weight of member focus in the performance measure and profits of the rival firm. Second, assume that the nature of the competitive process is characterized by strategic substitutes, i.e. reaction functions are downward sloping (figure 5). Third, two cases regarding the possibilities of market entry have to be distinguished (Fudenberg and Tirole, 1984): entry is inevitable or it is not. If entry is not inevitable, then a monopoly market structure arises endogenously by the choices of the two enterprises. Otherwise it is always a duopoly.

The profit maximizing investment profile of the cooperative is to be aggressive in order to elicit a passive response by the rival, i.e. underinvestment in the weight put on member focus in the performance measure. Notice that no distinction has to be made regarding the entry condition. The payoff maximizing investment choice is the same in both cases because the market is characterized by a soft investment and strategic substitutes. This result is summarized in the next proposition.

Proposition 13: A cooperative puts a low weight on member focus in its performance measure in order to elicit passive behavior from a rival enterprise.

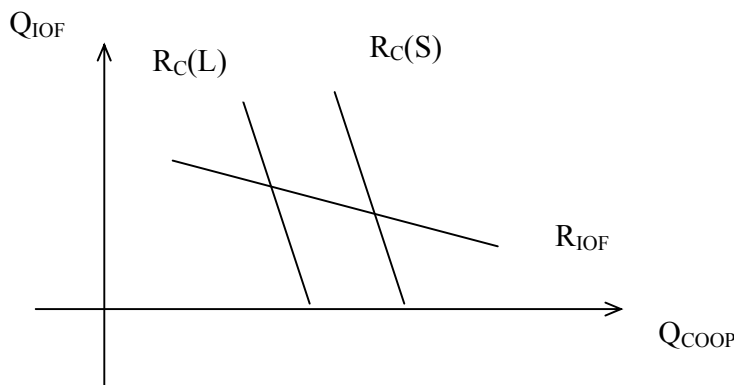


Figure 5: Performance measure choice and reaction functions

8 Conclusions and further research

The evaluation and measurement of CEO performance is complex, especially in cooperatives where members have differing preferences and no public listing can be used as performance indicator. While regulators and shareholders of an IOF may find it beneficial to encourage the use of equity-based compensation (Bebchuk and Fried, 2003),

a pay package that is very sensitive to any single performance measure will bring about distortion and inefficiency in cooperatives.

In reality, the CEO compensation schemes in cooperatives vary. Some use pre-set performance-based bonuses, some allow for bonuses paid on past performance, and others do not use bonuses (Trechter et al, 1997). Previous research has not considered the optimal choice of compensation contract for cooperative management. In the current paper, we study the principal-agent tension between a cooperative CEO and members capturing the stylized features of cooperatives. Then we identify their behavioral differences from an IOF as well as the different structures of the CEO compensation. A viable remedy for the interest misalignment of members and CEO is proposed: adding extra information in the performance measure. One way of adding extra information is including another activity that contributes to both upstream farms and downstream enterprise, which capture the positive vertical externalities. The other way involves utilizing accounting return measures to measure the value added to the downstream stage of production, and this helps commit the cooperative to a long-term benefit focus. We also formulate results regarding the sensitivity of the optimal incentive intensity to the nature of the relationship between the upstream and downstream activities, to additional information, and to member size and heterogeneity are formulated. In addition to measurement alignment, member interest alignment has also an impact on the incentives of a cooperative CEO. Moreover, strategic consideration is incorporated in the choice of performance measure weights and a strategic rationale is provided.

As far as we know, this paper is the first attempt to model the compensation scheme of cooperative CEOs. The next step can translate the CEO actions into more specific behaviors, for instance, diversification decisions or policies on innovation. Empirical examination of data on those specific behaviors of cooperative CEO may establish the effect of cooperative CEO compensation on the evolution of product portfolio, shedding more light on the cooperative research. Moreover, further research may incorporate in the current model the internal control mechanism in cooperatives. The board of directors consisting of members is usually elected by and from the membership, and is commonly representing member interests. They have more access to information inside the organization and have more at stake in the cooperative than their counterparts in IOFs have and are thus expected to be a more active monitor and participant. Lastly, we do not consider the intrinsic motivation of the cooperative CEO in making effort in managing the firm. It is expected that the cooperative management is more responsive to patron-owners and to patrons, especially if the board is successful in establishing an ideology emphasizing service to members as the objective of the cooperative firm (Shaffer 1987). Thus, it is meaningful to model the motivation to make effort driven by factors that are not economic.

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Appendix 1

The model consists of a two-stage non-cooperative game. In the first stage, the principal chooses the strength of incentives while the agent (i.e., the CEO)'s optimal choice of activities is determined in the second stage of the game.

The CEO's total contribution to the firm value is denoted by y_i , where i represents governance structure (c for a cooperative and f for an IOF). The CEO takes various actions to produce output. We denote action j in governance structure i by a_{ji} , and the marginal product of a_{ji} by f_{ji} . The production function

$$y_i = f_{1i}a_{1i} + f_{2i}a_{2i} + f_{3i}a_{3i} + \varepsilon$$

summarizes the production process: the agent's total contribution to the firm comprises the actions the agent takes to produce outputs and the noise in the production process that is beyond the agent's control.⁸ We assume that the expected value of ε is zero.

Given the difficulty in measuring the overall effect of the CEO's actions on firm value, especially the long-term consequences based on the observed short-term contribution, no compensation contract based on y_i can be enforced in court. Therefore, an alternative performance measure p_i becomes necessary. Suppose the technology of performance measurement takes the form

$$p_i = g_{1i}a_{1i} + g_{2i}a_{2i} + g_{3i}a_{3i} + \phi,$$

where g_{ji} denotes the performance measurement parameter, i.e., the weight attached to a_{ji} and ϕ denotes the noise. We assume the expected value of ϕ is zero.

Suppose the compensation contract in governance structure i specifies the wage w_i paid to the CEO as a linear function of p_i . The compensation contract takes the form

$$w_i = s_i + b_i p_i,$$

where s_i stands for the salary and b_i for the bonus rate. Notice that with this specification, the CEO's incentives are to produce a high value of p_i , not of y_i , whereas the principal does not directly benefit from increased realizations of measured performance p_i , rather, he benefits from increased realizations of the CEO's total contribution y_i . As a result, the compensation incentives may be distorted. To minimize the distortion the principal has to minimize the divergence between the CEO's incentives to increase p_i and the principal's desire for increases in y_i .

We assume now that both the principal and the agent are risk neutral and this assumption will be relaxed in section 7 where member heterogeneity is considered. The principal

⁸ We assume the actions taken by the CEO only have consequences for the principal, which excludes the possibility for the CEO to directly benefit from acting against the interests of the principal, i.e., the wealth transfer between the principal and the agent is zero.

receives the CEO's total contribution to firm value, but has to pay the CEO's wage. The principal's payoff is the difference between the value received and the wage paid:

$$\pi_i = y_i - w_i.$$

The CEO receives the wage but has to take costly actions to produce output. Let $c_i(a_{1i}, a_{2i}, a_{3i})$ be the amount necessary to compensate him for taking the actions, a_{1i}, a_{2i}, a_{3i} .⁹ The CEO's payoff is the difference between the wage received and the cost of the actions taken:

$$U_i = w_i - c_i(a_{1i}, a_{2i}, a_{3i}).$$

We use backward induction to solve the two-stage non-cooperative game. We start from the second stage of the game. The CEO's optimal action is determined by maximizing his expected utility, i.e.,

$$\max_{a_1, a_2, a_3} E(U_i) = E[w_i - c_i(a_{1i}, a_{2i}, a_{3i})] = s_i + b_i(g_{1i}a_{1i} + g_{2i}a_{2i} + g_{3i}a_{3i}) - c_i(a_{1i}, a_{2i}, a_{3i}).$$

Setting the first derivative of the expected utility with respect to a_{ji} equal to zero results in the first order condition

$$b_i g_{ji} = \frac{\partial c_i}{\partial a_{ji}}, j = 1, 2, 3.$$

This characterizes the CEO's optimal actions $a_{ji}^*(b_i)$.

The payoff-maximizing reply in the second stage of the game is anticipated in the first stage when the principal determines the efficient intensity of incentives b_i . The efficient b_i is determined by maximizing the expected total surplus

$$\max_{b_i} E(\pi_i + U_i) = E[y_i - c_i(a_{1i}, a_{2i}, a_{3i})] = f_{1i}a_{1i}^* + f_{2i}a_{2i}^* + f_{3i}a_{3i}^* - c_i(a_{1i}^*, a_{2i}^*, a_{3i}^*).$$

When the CEO takes only two actions, it can be shown that

$$a_{ji}^*(b_i) = b_i g_{ji}$$

and

$$b_i^* = \frac{f_{1i}g_{1i} + f_{2i}g_{2i}}{g_{1i}^2 + g_{2i}^2}.$$

The efficient bonus rates of an IOF and a cooperative are therefore

$$b_f^* = f_{1f} / g_{1f}, \quad b_c^* = f_{2c} / g_{2c}.$$

Plugging these results in the expressions for the CEO's equilibrium actions results in

$$a_{1f}^*(b_f) = g_{1f}b_f = f_{1f}, \quad a_{2f}^* = 0$$

and

⁹ Notice that the CEO's action on one dimension do not have an influence on the cost of making effort on the other dimension. This assumption rules out, for instance, the potentially important case where the actions compete for the agent's attention (i.e., increasing the level of one action increases the marginal cost of the other) (Gibbons 2005).

$$a_{1c}^* = 0, a_{2c}^*(b_c) = g_{2c} b_c = f_{2c}.$$

Following Gibbons (2005), the efficient bonus rate can be rewritten as

$$b_i^* = \frac{f_{1i}g_{1i} + f_{2i}g_{2i}}{g_{1i}^2 + g_{2i}^2} = \frac{\sqrt{f_{1i}^2 + f_{2i}^2}}{\sqrt{g_{1i}^2 + g_{2i}^2}} \cos(\theta),$$

where θ is the angle between the two vectors $f(f_{1i}, f_{2i})$ and $g(g_{1i}, g_{2i})$ as depicted in figure 6 (Gibbons, 2004).

Coefficient on a_2

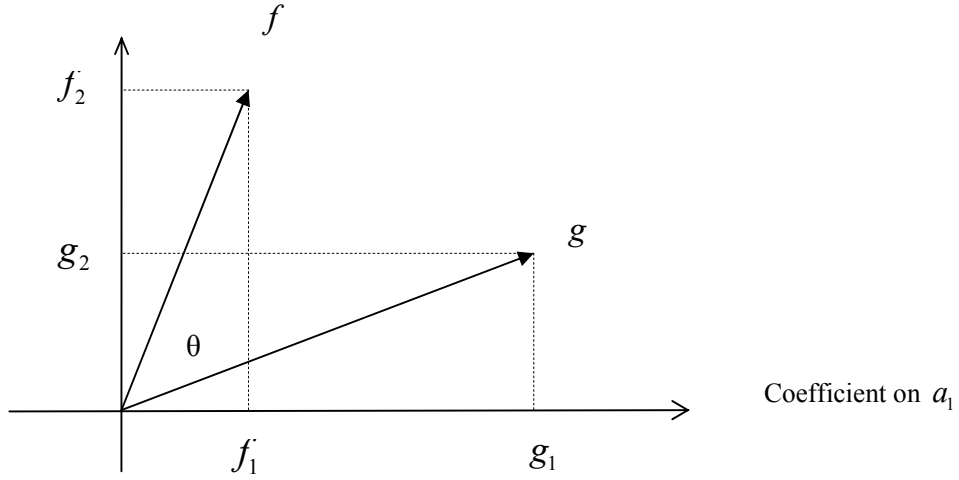


Figure 6: The scale and alignment effect

There are two important features in the expression of the efficient bonus rate, scale and alignment. More specifically, $\frac{\sqrt{f_{1i}^2 + f_{2i}^2}}{\sqrt{g_{1i}^2 + g_{2i}^2}}$ reflects the relative scales of the vectors

$f(f_{1i}, f_{2i})$ and $g(g_{1i}, g_{2i})$, a high value of $\frac{\sqrt{f_{1i}^2 + f_{2i}^2}}{\sqrt{g_{1i}^2 + g_{2i}^2}}$ indicates that the weights of actions

is higher in the production function than in the performance measure. Furthermore, $\cos(\theta)$ captures the alignment effect. To the extent that the performance measure responds to the CEO's actions differently from how firm value responds to these same actions, θ , the angle between the two vectors $f(f_{1i}, f_{2i})$ and $g(g_{1i}, g_{2i})$ will increase, and the performance measure will distort incentives (Baker 2002). As a result, the firm will optimally reduce the slope of the incentive contract based on such a performance measure. In an extreme situation where two vectors are orthogonal to each other in a poorly designed incentive contract, the incentives created by paying on p are useless for increasing y , leading to a bonus of zero. In contrasts, if the margins vectors are closely aligned, $\cos(\theta)$ is nearly 1 and the optimal bonus rate is large.

Appendix 2

Case 1:

Suppose a_{1c} and a_{2c} are two additive components of a_{3c} . That is, the CEO's effort on a_{3c} can be decomposed into two aspects, one involving the elements that boost the value of the downstream cooperative firm, the other concerning bringing the upstream farm to value. For example,

$$a_{3c} = \frac{1}{\alpha}(a_{1c} + \beta a_{2c}),$$

where α and β are arbitrary positive constants.

Then we have

$$a_{1c} = \alpha a_{3c} - \beta a_{2c}.$$

Subsequently,

$$a_{1c}^* = \alpha a_{3c}^* - \beta a_{2c}^* = \frac{f_{2c} g_{2c} (\alpha g_{3c} - \beta g_{2c})}{g_{2c}^2 + g_{3c}^2}.$$

In this case, the CEO's equilibrium action on a_{1c} does not have to be zero. It can be positive or negative depending the compensable factors' weights and a_{3c} 's association with a_{1c} , a_{2c} .

Case 2:

Suppose a_{1c} and a_{2c} are complementary factors that constitute a_{3c} , for instance,

$$a_{3c} = \frac{1}{\gamma} a_{1c} a_{2c},$$

where γ is an arbitrary positive constant. Then we have

$$a_{1c} = \frac{\gamma a_{3c}}{a_{2c}}.$$

Subsequently,

$$a_{1c}^* = \frac{\gamma a_{3c}^*}{a_{2c}^*} = \frac{\gamma g_{3c}}{g_{2c}} > 0.$$

In this case, the CEO's equilibrium effort on a_{1c} will be larger than zero. Namely, he can be motivated to take action to promote the value of the downstream cooperative firm if the principal brings into his compensation contract a_{3c} , a performance measure component mediating between a_{1c} and a_{2c} . In this way, the divergence between the CEO's incentives to increase p_c and the principal's desire for increases in y_c is abated.

Notice that when $a_{1c}^* = \frac{f_{2c} g_{2c} (\alpha g_{3c} - \beta g_{2c})}{g_{2c}^2 + g_{3c}^2} = f_{1f} = a_{1f}^*$ in case 1 and

$a_{1c}^* = \frac{\gamma g_{3c}}{g_{2c}} = f_{1f} = a_{1f}^*$ in case 2, the cooperative CEO will put as much effort on

advancing the downstream firm value as an IOF CEO will do. In other words, it is possible to make a cooperative CEO resemble an IOF CEO by manipulating the performance measure parameters.