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Who Governs Producer Controlled Research Organizations in the Agricultural sector, and Why?

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Abstract:

Producer controlled research organizations (PCROs) are charged with the task of investing hundreds of millions of dollars into research and development and promotion projects. In a series of interviews with the managers and directors of some of the key PCROs in Australia, the US, and Canada we observed that PCROs do not tend to separate management and oversight tasks. The producers elected directors of these organizations are involved in management decisions. This observed practice is in contrast with most of the theories and empirical studies focusing on the governance structure of non-profit (NP) and for-profit (FP) organizations (Brown & Guo, 2010; Fama & Jensen, 1983; LeRoux & Langer, 2016). Based on information gained from the interviews, observable characteristics of PCROs explained in the literature, and agency theory this paper develops a theoretical model to describe the unusual task assignment in the PCROs. The theoretical model suggests that because of the long investment horizons in the PCROs, the compensation of management teams based on their contributions to return on investments is not feasible. Therefore, the PCROs have to reward their executives on the basis of a measure of efforts exerted. Hence, the directors' involvement reduces the volatility of managers' compensation.

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Abstract: Producer controlled research organizations (PCRO)s are charged with the task of investing hundreds of millions of dollars into research and development and promotion projects. In a series of interviews with the managers and directors of some of the key PCROs in Australia, the US, and Canada we observed that PCROs do not tend to separate management and oversight tasks. The producers elected directors of these organizations are involved in management decisions. This observed practice is in contrast with most of the theories and empirical studies focusing on the governance structure of non-profit (NP) and for-profit (FP) organizations (Brown & Guo, 2010; Fama & Jensen, 1983; LeRoux & Langer, 2016; Miller-Millesen, 2003). Based on information gained from the interviews, observable characteristics of PCROs explained in the literature, and agency theory this paper develops a theoretical model to describe the unusual task assignment in the PCROs. The theoretical model suggests that because of the long investment horizons in the PCROs, the compensation of management teams based on their contributions to return on investments is not feasible. Therefore, the PCROs have to reward their executives on the basis of a measure of efforts exerted. Hence, the directors' involvement reduces the volatility of managers' compensation.

Introduction

Innovation is a key source of economic growth (Romer 1990; Solow 1957). In most economies, the agricultural sector has experienced remarkably higher and faster rates of growth than other sectors (Moschini and Lapan 1997). The notable growth rate of agricultural sector stems from the investments in agricultural research (Alston et al. 1995; Alston and Pardey 1996). However, in recent decades governments and the private sector have changed their agricultural research investment behaviors, which could negatively affect the growth of agricultural sector and endanger food security (Alston, Gray, and Bolek 2012).

The failure of governments and the private sector to invest both sufficiently and efficiently in agricultural research has provided catalyst for the establishment of producer-controlled research organizations (PCROs). The organizations investigated in this paper are different than agricultural cooperatives and agricultural producer associations in which farmers are present at directors. PCROs are different than cooperatives because, as we explain later, PCROs have the non-distribution constraint and are considered as NP organizations. The PCROs do not have any residual claimants, as the shares are not defined in these entities. However, cooperatives distribute their profits amongst their members (Hansmann 1980). The PCROs should be also distinguished from the agricultural producer associations that are NP organizations by nature. This is because the PCOs are typically granted taxing power by governments while agricultural producer associations, as NP organizations, do not have such a power. Furthermore, the PCROs are specially tasked with investing farmers' checkoff in agricultural R&D and promotion projects while the

tasks of agricultural cooperatives and agricultural producer associations include a wide range of activities including marketing, advocacy, distribution and so on.

Persistently very high rates of return to agricultural research (Hurley, Pardey, Rao, & Andrade, 2016), suggest that neither the private sector nor public sector has invested sufficient resources in agricultural research. In turn, the roles of industry groups such as PCROs have increased in agricultural research funding (Alston, Gray, and Bolek 2012; Alston, Pardey, and Smith 1998).

In Canada, Australia, the United States and a number of other countries, there are a considerable number of PCROs in the agricultural sector. Collectively, they have been charged with the task of investing hundreds of millions of dollars in R&D projects with the objective of increasing the profitability of farming for the broad spectrum of members they represent. These producer-led organizations are increasingly operating in an environment where both private and the public entities are making investments, with the implication that PCROs must consider how to create synergy in research investment across the agricultural sector.

Studies suggest PCROs investments have had significant impacts on agriculture innovation and the welfare of the producers and consumers (Alston et al. 2000; Alston, James, and Pardey 2011; Gray and Scott 2003; Hurley et al. 2016; Williams 1999). The studies also show that PCROs can improve the efficiency of resource allocation (Alston, Freebairn, and James 2004; Kangasime 2002). Because the board of directors of PCROs are farmers, they can respond to farmers' research interests (Klerkx and Leeuwis 2008; Röling et al. 2004). The PCROs are also considered new players in the national innovation system of countries. The presence of these organizations changes the dynamic of the innovation systems because their contributions result in new connections and knowledge flows affecting other parties behaviors in the system (Klerkx and Leeuwis 2008).

Increasingly PCROs may redirect the funds toward the projects benefiting the industry's stakeholders rather than society as a whole. This is specially the case if the PCROs and nations have different incentives in funding of agricultural research (Alston, Freebairn, and James 2003, 2004). In addition, the increasing role of PCROs in research funding could worsen the market and government failures by crowding out other parties interested in research investment (Alston, Freebairn, and James 2003, 2004).

The returns on investments made in PCROs are accompanied with a great deal of delay. In a comprehensive study of U.S. public agricultural research investments, Alston et al. (2011) showed public agricultural research has measurable impacts 40 year after the investment was made, and the peak impact occurs 25 years after the investment is made. Similarly, PCRO investment outcomes are also realized several years after research investments are made.

Furthermore, the governance structure of PCROs, difference in producers' innovativeness, agency problem due to difference in the interests of decisions makers (Alston and Fulton 2012), institutional lock-in (Froystad 2012), high rate of spillovers and negative attitudes of producers about the effectiveness of PCROs' investments due to long investment horizon of these organizations (Gray 2014) might results in the failure of these organizations to invest sufficiently and efficiently in agricultural research.

Despite the importance of PCROs, their impact on agricultural sector, described above and a generally strong record of past performance, reflected in many benefit/cost studies (Alston, James, & Pardey, 2011; Gray & Scott, 2003; Hurley, Pardey, Rao, & Andrade, 2016), the decision-making and governance structure of PCROs has been a subject of very little study.

To begin to fill this gap, we conducted a series of interviews with the managers and directors of fourteen PCROs across Australia, the United States and Canada to evaluate the governance structure and decision-making process of these organizations.¹ During these interviews, it became clear that the boards of directors play important roles in the governance of PCROs and are both involved in the management and oversight decisions. This observation is in contrast with most of the theories and empirical studies focusing on the governance structure of (non-profit) NP and (for profit) FP organizations (Brown and Guo 2010; Fama and Jensen 1983; Miller-Millesen 2003).

Given the apparent anomaly in task assignment of PCROs, this paper addresses the the following question: why do PCROs tend to assign managerial decisions to both management team and their boards of directors? To address this question, a theoretical model is developed based on agency theory with focus on task(s) delegation literature (Bester and Kräbmer 2008; Holmstrom and Milgrom 1991; Itoh 1994; Riordan and Sappington 1987). The model considers a PCRO whose primary job is to maximize the return on agricultural producers' levies by investing them

¹ The results of these interviews are presented in the previous paper.

into R&D and market promotion projects. Based on this objective function, the PCRO decides to assign the decision-making task to the manager or the board of directors.

In the model, the manager and the board of director are considered as the agents of the PCRO that have different motivations for exerting efforts. The directors of the PCROs as farmers or agricultural sector beneficiaries receive monetary benefits from the PCRO's investments proportional to their share of the industry. In addition, it is assumed that a director's utility can be positively affected through altruism and learning in the process of decision-making².

In contrast to the board of directors, the manager exerts effort in return for financial compensation. The compensation package of the manager in this model includes a base salary and a bonus. The bonus paid using some performance measure of output or expertise and effort of the manager. Arguably the very long research lags and the lack of a market valuation of the non-profit research portfolio could preclude any timely measurement of output for the PCRO. Therefore, manager's compensation based on a measure of PCRO's outcome(s) may not be a proper tool to incentivize the manager (Sappington, 1991). For organizations willing to measure the input of managers and reward them accordingly, the presence of a third party (e.g. the board of directors) could potentially improve the accuracy of such a measure by reducing the variance of the performance measure.

Given the PCRO's objective and the characteristics of the agents, the organization decides whether to assign the task of decision-making to directors or the manager. This choice is determined by several factors, including the characteristics of the directors, the knowledge levels of the manager and board members, and the ability to incentivize the effort of the manager based on the imperfectly measured output or decision-making input.

In the case of an output-based bonus, the results of the model suggest the PCRO decides to assign the task to either the almost perfectly incentivized manager or directors, depending on their relative effectiveness. A separation of decision-making and oversight would exist in this case, over a range of plausible parameter values. However, when the manager's reward is based on his input, given similar characteristics of the directors and the manager, the shared decision is more likely to be the norm if the directors are not significantly altruistic. However, if the board members are highly altruistic, the PCRO decides to share the decision-making contingent upon the

² Some PCRO's pay their directors a nominal per diem that is assumed to be trivial.

superiority of manager's input quality, including knowledge level or cost of exerting efforts. In these situations, the directors will generally also participate in management in order to both incentivize managerial effort and help the PCRO to reach its objectives. These results, which will be derived in the remainder of this paper, provide a useful theoretical framework to model PCROs governance.

The remainder of this paper is organized as follows: in Section 2, a brief review of related literature is presented, Section 3 presents some features of PCROs governance structures, based on our interviews with managers and directors of 14 PCROs. The theoretical model is presented in Section 4 and the paper conclusion is in Section 5.

2. Related Literature

The roles of directors in NP organizations have been investigated extensively in the literature. There are three different types of theories explaining the roles of board of directors in NP organizations, they are "agency theory", "resource dependency theory" and "instructional theory" (Miller-Millesen, 2003; Brown, 2005) .

Agency theory suggests that management and oversight are supposed to be separated in NP organizations even if they do not have residual claimants (Fama and Jensen 1983). Based on agency theory's implication, the role of board of directors in NP organizations is primarily limited to monitoring of managerial decisions and aligning organizational activities toward its objectives.

Resource dependency theory stresses on the role of board of directors in reducing the uncertainty of operations in NP organizations by providing different types of information and resources (Fligstein and Feeland 1995). Under resource dependency theory, the role of board of directors is more about providing resources for organizations such as advice, legitimacy, links to other organizations and "strategic directions" (Cornforth, 2001; Miller-Millesen, 2003; Brown, 2005). One of the main resources brought to the NP organizations by the board is strategic directions (Bradshaw, Murray, and Wolpin 1992; Stone and Cutcher-Gershenfeld 2001).

Finally, institutional theory focuses on the rules and norms defining the behaviors and roles of board of directors (Zucker 1987). Institutional theory predicts that organizations of similar type or environment (e.g. NP organization, PCROs, etc.) become isomorphic by adopting common rules and norms (DiMaggio and Powell 1983). Therefore, one could expect that the role of the board of directors in NP organizations may not be related to their characteristics and it is the results of the institutional arrangements.

Although resource dependency theory and institutional theory could provide some useful insights about the involvement of the PCROs' directors, it is suggested that the role of directors in these entities could be explained by agency theory³.

Agency theory implies that the roles of the board of directors in NP organization are primarily limited to monitoring of managers and aligning organizational activities toward its objectives (Fama & Jensen, 1983; Miller-Millesen, 2003). However, the broader principal-agent literature suggests the delegation of tasks can be influenced by information asymmetries. The literature suggests the principal would delegate a job to one agent if it was hard to measure the performance of each agent separately (Holmstrom and Milgrom 1991). The reason behind this choice is that agents are not motivated to exert optimal efforts if they cannot be incentivized based on their individual performances. On the other hand, if the principal can observe the inputs of each party in the team's production, she hires more than one agent to perform the tasks (Itoh, 1994). Moreover, the delegation of authority to an agent over choosing a project may not be an optimal choice, especially if the agent is secured against his action by limited liability constraint (Bester and Kräbmer 2008). Furthermore, if there is information asymmetry, the choice of the delegation of tasks to agents, is the function of the correlation between the costs of performing the tasks (Riordan & Sappington, 1987).

There are examples of unusual involvement of directors in FP organizations as well. One of these examples is related to the venture capitalists (VCs)' involvement in start-up companies. Start-ups may have promising ideas, however these ideas need considerable efforts and investments to be realized, thus the realization of revenue in start-ups is accompanied with considerable uncertainty. Therefore, one may suggest that the VCs are likely to look for higher levels of controls in start-ups especially where the returns on investments are accompanied with great deal of uncertainty.

³ Especially in the case of resource dependency theory, the directors are supposed to provide resources facilitating the managers' decision-making. It implies that directors and the management teams are in charge of two different tasks. However, in the case of PCROs, the directors and the managers are both involved in the fulfilling of one task that is making investment decisions. Furthermore, the "resource dependency theory" simply assumes that the board members do not have any personal agenda, while in "agency theory" one can incorporate personal and collective incentives into the behavior of the board of directors of NP organization. Therefore, we use agency theory that is more consistent with what we observed.

In this context, Kaplan and Stromberg (2002) show that VCs investments in start-ups give them voting rights, board rights and rights on cash flows. However, if the start-ups have proper performance, the VCs only keep the cash flow rights and give the other rights up. In addition, if the VCs find out that the companies are failing to achieve their goals, they are likely to gain the full control. In other words, the VCs' control over a company' management is negatively associated with the company' performance.

The authors also illustrate that the VCs usually use their voting rights to obtain higher levels of controls in comparison with the founders or entrepreneurs. In fact, the VCs controls are higher than the founding bodies where there is uncertainty concerning the investment results.

The study by Kaplan and Stromberg (2002) also indicates that as the start-ups' performances become more difficult to measure, the managers or founders' compensation by VCs become less sensitive to the performance measures. Especially in the case of companies in which the results might have considerable volatility, the managers' compensation package is more based on "time vesting" payments.

Fried, Bruton and Hisrich (1998) show that in comparison with other directors, the board members representing VCs play more active roles in the board of directors of start-ups. The same results can be found in Rosenstein, Bruno, Bygrave and Taylor (1993) showing that the involvement of directors representing VCs is significantly more than other board members where VCs are the lead investors of the start-ups. Similarly Deakins, O'Neill and Mileham (2000) suggest that the board's roles in small start-ups is not just limited to the oversight tasks.

Hansmann (1980) discusses that the patrons of NP organizations have tendency to exercise some degrees of control over the NP organizations because they can trace their contributions in these entities. This is specially the case where patrons consume the products of NP organizations on a regular basis. Hansmann (1980) differentiates between four types of NP organizations based on funding sources and the agent(s) who control(s) these entities. The parties that fund the NP organizations by their donations are called "patrons". According to Hansmann (1980) NP organizations can be controlled by their patrons or they can hire others to run the NP enterprises. The former, controlled by patrons, are classified as "mutual" and the latter as "entrepreneurial" NP organizations.

However, the patrons will not have the tendency to participate in NP organizations' control (i.e. the organization shifts from mutual to entrepreneurial governance structure) if the marginal

benefit of the participation in governance of NP organizations is smaller than the marginal cost of allocating time and resources (Ben-Ner 1994; Ben-Ner and Van Hoomissen 1991; Hansmann 1980).

3. Decision-Making Process and Governance Structure of PCROs

The primary purpose of the PCROs is to invest collected levies into R&D and market promotion projects to benefit the producers. Managers or elected/appointed directors run the PCROs. In other words, the PCROs are a combination of mutual and entrepreneurial NP organizations. These organizations rarely own any agricultural research facilities and primarily rely on research entities such as universities or private companies involved in the agricultural research. Therefore, the PCROs could be considered as funding bodies allocating their resources to proposed research. In other words, the PCROs do not have to incur substantial fixed costs for their investment decisions and their main cost component is the variable costs of their agents' compensations.

Although there might be some differences in the process of decision-making of PCROs interviewed, the investment decisions are usually made according to a similar process in these organizations. In most of the cases, the PCROs first determine their research priorities and then the researchers from universities or private research entities are invited to propose research projects. The proposals are evaluated by the research committees, encompassing directors (i.e. patrons) and research managers. The research committees use member expertise or external reviewers' reports to provide a recommendation for the board about each proposal.

Research committee recommendations are usually based on the PCRO's research priorities, the value of the projects in terms of the potential benefit to farmers, scientific feasibility and other criteria. By use of these guidelines, the board that only includes the elected or appointed patrons decides whether to fund a proposal or not.

Although the process of decision-making explained above might be similar to other organizations in terms of the stages of the decision-making, the outcomes of the interviews and comparison with other studies (Brown and Guo 2010; Fama and Jensen 1983; Miller-Millesen 2003) indicate that there is a notable difference between PCROs and other NP and FP entities. In fact, in all of the PCROs (except GRDC), the directors are assigned significant responsibilities in more-or-less every stage of decision-making. In other words, the directors are not just in charge of oversight, they are also involved in management decisions, this includes determining the

priorities, reviewing and ranking the proposals, making investment decisions and reflecting farmer feedback and research interests. This structure of control suggests that the PCROs primarily are classified as mutual and entrepreneurial and they are mostly located near the mutual end of the spectrum.

In return for the directors' efforts, they either receive nominal per diem payments, or they are not compensated at all. However, a director could receive three types of compensations by both being a farmer and exerting efforts in the PCROs: 1) The directors are agricultural sector beneficiaries and they gain from PCROs investments proportional to the size of their own business. 2) The interviewees expressed several times during the interviews that directors care about other farmers. In other words, it seems that altruism plays a key role in incentivizing directors to spend effort in PCROs. Given this observation and by following Besley and Ghatak (2005) one could assume directors could be mission-oriented agents, motivated to exert efforts in the PCROs because they care about a PCRO and its beneficiaries. 3) The interviews also support considering a director might benefit as a result of his/her involvement in the decision-making process of a PCRO by learning about new technologies and business opportunities. This knowledge is achieved in the course of making investment decisions implying that the board members gain additional utility by exerting extra efforts. In other words, the considerable involvement of the directors in PCROs suggests that they gain a marginal benefit by extra efforts that they exert in the PCROs. This extra benefit is expected to be greater than the marginal costs of their involvement.

In sum it was observed that the PCROs are a mix of mutual and entrepreneurial NP organizations while the weight of patrons in controlling these enterprises is notably higher than the managers. In addition, since the directors are the beneficiaries of PCROs, they use the products of these organizations on a regular basis and the net benefit of their involvement is greater than zero. However, it should be noted that the positive gain for the directors is not necessarily monetary as they might be motivated by other factors such as altruism.

In comparison with the directors, the managers of PCROs sampled did not have any farming activities. Therefore, it is safe to assume that the managers exert efforts primarily for financial incentives. However agricultural research typically has a very long gestation lag (Alston, James, and Pardey 2011). A comprehensive study of U.S. public agricultural research investments showed public agricultural research has measurable impacts 40 years after the investment was

made, and the peak impact occurs 25 years after the investment is made (Alston, James, and Pardey 2011). With these long timelines, rewarding manager performance based on research outcomes might not be practical. Therefore a contract incentivizing a manager where the observation of output is considerably noisy (which is the case in PCROs) could differ from what the private sector offers to executives (Fulton & Pohler, 2015; Glaeser & Shleifer, 2001; Roomkin & Weisbrod 1999).

In NP organizations, the compensation packages provided to the managers often include both base salary and bonus payments (Hallock, 2002). However, the managers of NP organizations receive considerably less total compensation in comparison with FP organizations (Hallock 2002; Handy and Katz 1998; Roomkin and Weisbrod 1999). The lower levels of payments to the managers of the NP organizations in comparison with FP enterprises is related to lack of non-distribution constraints and difficulties in measuring the performance of the management team (Preyra and Pink 2001)

In the private sector there are different types of incentives offered to a manager, including base salary, bonus payment, stock options and long-run performance incentives. In the case of bonuses, the companies in the private sector use one or more than one performance measures to reward their managers (Murphy 1999). The performance evaluation methods used in private enterprises include accounting performance measures (i.e. some measures of profit or income) and “non-financial” performance measures. The most frequently used non-financial performance measure is “individual performance,” measured according to pre-determined objectives and subjective evaluations of the manager’s individual performance (Murphy 1999).

Using a series of interviews with managers of fifteen cooperatives, Hueth and Marcoul (2009) show co-ops use different payment schemes for rewarding managers through the use of bonuses. The authors suggest the use of implicit contracts is common in co-ops. Also the authors hypothesize, as the directors in co-ops have a better understanding of the managers’ real efforts, they could at least partially reward the managers based on the direct observation of efforts. However, their interviews imply that this hypothesis can be rejected, as they observed the directors are not actively involved in the management decisions.

4. Theoretical Model

The model presented in this section is based on the following scenario: the objective function of the PCRO is to maximize the present expected value of the research investments, y , minus

investment costs, minus operating costs, which are invariant to the decision-making process and include fixed wage and bonus payments to the manager.

The model assumes the value of output from the decision-making function is as follows: the quality of the research decision, measured in terms of y , made by an agent i (M and B) is product of his knowledge level, k_i and effort, e_i . The quality of the research decision of the PCRO is an average of the quality of the research decision making of directors, $e_B k_B$, and the quality of the decisions making of the manager $e_M k_M$ weighted by the δ and $1 - \delta$ where $\delta \in [0,1]$.

$$y = \delta e_B k_B + (1 - \delta) e_M k_M \quad (1)$$

These choices of the PCRO are taken into account in two different scenarios. In the first scenario, we assume the PCRO's output is measureable and in the second scenario we assume because of the friction in measuring the PCRO's outcomes, the organization rewards the manager based on a measure of his input.

The PCRO makes the choices in a three-stages game. In the first stage, the PCRO chooses the weight of each agent, the board of directors and the manager, in the decision-making process. In the second stage, the PCRO decides about the components of the payment scheme. In the third stage, the manager and directors both as risk neutral agents, choose the amounts of effort that they are going to expend in the course of decision-making.

4.1. Rewarding the manager based on a measure of output.

The manager's reward, in terms of the bonus, could be based on the output of the organization (e.g. profit or in the case of PCROs additional yield for farmers or return on investments). Therefore, the stages of the game are as follows:

Stage 3:

In the third stage of the game, the manager and directors decide about the levels of efforts they are going to exert in the PCRO. As previously mentioned the PCRO's output is $y = \delta e_B k_B + (1 - \delta) e_M k_M$. However, following Alston et al. (2011) it is assumed that the outcome is not observable in the short-run. Therefore, the PCRO has to use a performance measure to evaluate the value generated by investments. This value is assessed by the performance measure of α_y . In this case, the setup presented in Baker, Gibbons, and Murphy (1994) is used to specify the implication of performance measure on the choice of agents' weights in the decision-making

process. It is assumed that α_y on average yields an unbiased measure of outcome ($E[\alpha_y] = 1$). However, there are some years in which α_y renders a higher (lower) measure of the output, implying that the payment to the manager is proportionally higher (lower) than the manager's contribution. In other words, measure of the performance has some variance indicated by σ_y^2 ($Var[\alpha_y] = \sigma_y^2$).

Therefore, in each year, the PCRO observes $\hat{y} = \alpha_y \cdot y$ and it pays the bonus of b per unit of \hat{y} . The manager also receives the fixed salary of F . Following Baker et al., (1994) it is assumed that the manager only knows there is a performance measure in the PCRO, however he can only realize the mechanism of α_y when he starts to work in the organization and not before accepting the contract. In this setting, although the manager is risk neutral he will have to be compensated for the uncertainty of the performance measure in terms of the fixed payment because of the incomplete information about the performance measure's mechanism.

The manager receives $F + b \hat{y}$ and incurs the cost of $1/2 c_M e_M^2$. Thus, the net utility of the manager because of exerting efforts in the PCRO is indicated in equation (2):

$$U_M = F + b \hat{y} - \left(\frac{1}{2} c_M e_M^2\right) \quad (2)$$

The manager maximizes (2) with respect to e_M that is: $\max_{e_M} U_M = F + b \hat{y} - \left(\frac{1}{2} c_M e_M^2\right)$

Consequently, the efforts exerted by the manager is shown in equation (3.3):

$$e_M^* = \frac{k_M}{c_M} [b \alpha_y (1 - \delta)] \quad (3)$$

Equation (3) denotes optimal effort of the manager is a positive function of his knowledge (k_M), bonus of b and weights of manager in the process of decision-making that is $(1 - \delta)$. It is also assumed that the manager's reservation wage is equal to \bar{w} , therefore, the lowest amount of expected F satisfying manager's participation's constraint is shown in equation (4) and this is the optimal base salary that PCRO pays to the manager.

$$E[F] = E \left[\bar{w} - b \hat{y} + \left(\frac{1}{2} c_M e_M^2\right) \right] \quad (4)$$

Taking the expected value from both side one can write equation (4) as follows $E[F] = \bar{w} - by + (k_M^2/2 c_M) b^2 (1 - \delta)^2 E[\alpha_y]^2$. Considering the assumptions that $E[\alpha_y] = 1$ and

$\text{Var}[\alpha_y] = \sigma_y^2$ gives $E[\alpha_y^2] = 1 + \sigma_y^2$ resulting in: $E[F] = \bar{w} - by + (k_M^2/(2 c_M))b^2(1 - \delta)^2(1 + \sigma_y^2)$. Therefore, although the manager is assumed to be risk-neutral, since he has quadratic cost function, as the friction of the organization's performance measure increases, the PCRO should offer the manager higher fixed payment to satisfy his participation constraint. Based on the PCRO's payment to the manager, the organization's expected profit is shown in equation (5):

$$E[\pi] = \delta e_B k_B + (1 - \delta)e_M k_M - \bar{w} - \left(\frac{1}{2} c_M E[e_M^2]\right) \quad (5)$$

The board members are the beneficiaries of the industry research and market development. Therefore, their utility is positively associated with the returns on the PCRO's investments. The interviews also support the supposition the board members' altruism and learning capacity positively affect their incentives.

$$U_B = (\rho + \theta (1 - \rho))\pi + g \cdot \rho \cdot \delta e_B k_B - \frac{1}{2} c_B e_B^2 \quad (6)$$

In equation (6) $\rho \in [0,1]$ is the share of the board member from the industry. So if a director is a farmer, ρ could be considered as the relative size of his/her farm to the industry. Following Besley and Ghatak (2005) it is assumed that directors could be mission-oriented agents and they are motivated to exert efforts in the PCROs by both pecuniary (ρ and $g \geq 0$) and non-pecuniary (θ) factors. Hence, a board member could also consider the factor of $\theta \in [0,1]$ as the degree by which he/she values the success of the rest of the industry members. It implies the higher values of θ correspond with higher efforts exerted by the directors. For instance, if $\theta = 1$ a director exerts efforts in the PCRO as if he or she owns the whole industry while if $\theta = 0$, the effort of the director will be only proportional to ρ .

Directors also gain from involvement in the PCROs' activities in the form of learning about new technologies, networking opportunities and so on. This gain is indicated by parameter $g \geq 0$ that is proportional to the directors' input and weight attached to it in the decision-making process and their share of industry (i.e. $g \cdot \rho \cdot \delta e_B k_B$). Finally, $1/2 c_B e_B^2$ is the cost of exerting efforts incurred by board of directors. The directors maximize (7) with respect to e_B that is:

$$\begin{aligned} \max_{e_B} U_B &= (\rho + \theta (1 - \rho))\pi + g \cdot \rho \cdot \delta \cdot e_B k_B - \frac{1}{2} c_B e_B^2 \\ e_B^* &= \frac{\delta k_B (g\rho + \rho + \theta(1-\rho))}{c_B} \end{aligned} \quad (7)$$

A board member's optimal effort illustrated in equation (7) is an increasing function of $\delta, g, \rho, \theta, k_B$ and decreasing function of his/her marginal cost of exerting efforts.

Stage 2:

In this stage of the game, PCROs determine the optimal bonus of b and F by maximizing its expected return:

$$\max_b E[\pi] = E \left[\delta e_B k_B + (1 - \delta) e_M k_M - \bar{w} - \left(\frac{1}{2} c_M e_M^2 \right) \right] \quad (8)$$

Substituting equations (3) and (7) into (8) we have:

$$\max_b E[\pi] = E \left[b \alpha_y \frac{k_M^2}{c_M} (1 - \delta)^2 + \frac{\delta^2 k_B^2 (g\rho + \rho + \theta(1 - \rho))}{c_B} - \bar{w} - \frac{1}{2} \left(b^2 \alpha_y^2 \frac{k_M^2}{c_M} (1 - \delta)^2 \right) \right].$$

that based on the expected values is:

$$\max_b E[\pi] = b \frac{k_M^2}{c_M} (1 - \delta)^2 + \frac{\delta^2 k_B^2 (g\rho + \rho + \theta(1 - \rho))}{c_B} - \bar{w} - \frac{1}{2} \left(b^2 (1 + \sigma_y^2) \frac{k_M^2}{c_M} (1 - \delta)^2 \right)$$

The first order condition of the PCRO's problem in the second stage of the game is:

$$\frac{\partial E[\pi]}{\partial b} = \frac{k_M^2}{c_M} (1 - \delta)^2 - b \left((1 + \sigma_y^2) \frac{k_M^2}{c_M} (1 - \delta)^2 \right) = 0$$

Solving for b , we get to the optimal outcome-based bonus paid to the manager shown in equation (9):

$$b^* = \frac{1}{1 + \sigma_y^2} \quad (9)$$

Equation (9) implies that, as the variance of the performance measure increases, the manager's payment decreases, weakening incentives for exerting efforts in the PCRO. Taking into account the nature of investments' return in agriculture R&D it is known that the outcomes of these types of investments are usually realized several years after the investments are made, suggesting that the use of any ex-ante performance measure could be accompanied with considerable variance. Therefore, one may discuss that the managers of PCROs will be less incentivized, when compared to other types of organizations, if they are rewarded based on the outcome of investments.

Also, the first-best effort level of the manager is $e_M^{**} = (1 - \delta)k_M/c_M$ where in presence of the noise in evaluation of the outcome (i.e. σ_y^2) the effort of the manager is $e_M^* = (1 - \delta)k_M/[c_M \cdot (1 + \sigma_y^2)]$. Therefore, the higher variance of output performance measures distracts the manager from expending e_M^{**} .

In addition, the performance measure of α_y does not measure the contribution of each agent in the investment decision made. Therefore, if the decisions are made by both the manager and the board of directors (i.e. $\delta \in (0,1)$). The manager could act as a free rider or lose his incentives if his contribution is not realized separately.

Stage 1:

In this stage, the PCRO determines the weight of each agent's input into the decision-making process. By substituting (9) into (8) we have:

$$\pi^*(\delta, \dots) = \frac{1}{2} \left(\frac{1}{1+\sigma^2} \right) \left(\frac{(1-\delta)^2 k_M^2}{c_M} \right) + \frac{\delta^2 k_B^2 (g\rho + \rho + \theta(1-\rho))}{c_B} - \bar{w} \quad (10)$$

Equation (10) implies that the return function of the PCRO is convex in δ . In other words, because the efforts of the agents are directly associated with their input weights (i.e. δ and $1 - \delta$), therefore, each agent is willing to have higher weight in the process and the PCROs' has to employ only one of the agents for making the investment decisions. Therefore, the ideal value of δ in this case is either equal to zero or one. In other words, the PCRO has to assign the decision-making authority only to one of the agents.

For instance, if $\delta^* = 1$, therefore the board will be in charge and $\pi^*(\delta = 1, \dots) = k_B^2 (g\rho + \rho + \theta(1-\rho)) / c_B - \bar{w}$ which in terms of the board's optimal input is equal to $e_B^* k_B - \bar{w}$. Similarly, if $\delta^* = 0$, the manager becomes the decision-making agent and $\pi^*(\delta = 0, \dots) = (1/(1+\sigma^2)) (k_M^2 / 2 c_M) - \bar{w}$ which is equal to $1/2 e_M^* k_M - \bar{w}$. Therefore, if $1/2 e_M^* k_M > e_B^* k_B$, the manager becomes in charge of the decision making, otherwise the PCRO assigns the job to the board of directors. In other words, if the relative quality of the research decision-making of the manager is defined as $e_M^* k_M / e_B^* k_B$, the board of directors will become the decision-making agent if its decision-making quality is two times more than that of the manager, otherwise the PCRO will delegate the decision-making to the manager and $\delta^* = 0$. One can also rewrite equation (10) as follows:

$$\pi = \frac{\left(\frac{1}{2}\right)(1-\delta)^2 M}{1+\sigma_y^2} + X.B.\delta^2 - \bar{w}$$

where $M = \frac{k_M^2}{c_M}$, $B = \frac{k_B^2}{c_B}$, $X = g\rho + \rho + \theta(1-\rho)$. Based on this new format, Figures 1 and 2 plot the expected return of the PCRO against the weight of the board in the decision-making process where in the first figure the $X = 1$ and in the second figure $X = 1/100$. In other words, in Figure

1 the directors are assumed to be highly altruistic while in the Figure 2 they only care about themselves. As it is indicated in Figure 1, where the board is notably altruistic, the PCRO prefers to assign the decision-making task to the manager if his knowledge level is higher than that of the board or if it is less costly for him to exert effort (i.e. $M = 3$). In other words, for lower values of M the PCRO's choice of δ is equal to one.

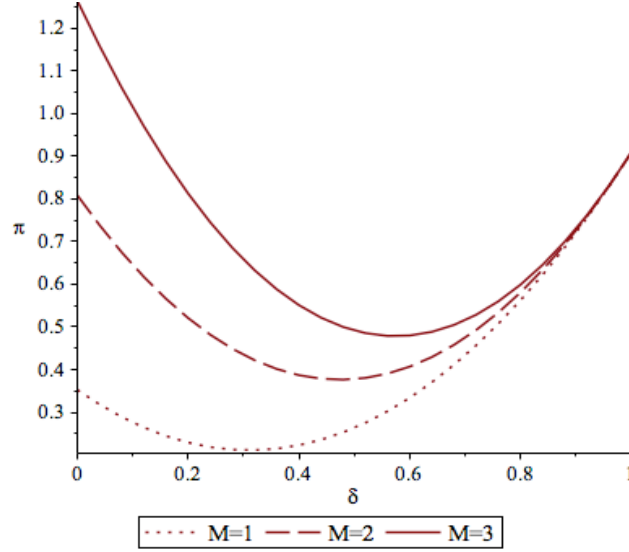


Figure 1. The choice of δ where $\bar{w} = 1/10$, $\sigma_y^2 = 1/10$, $X = 1$, $B = 1$

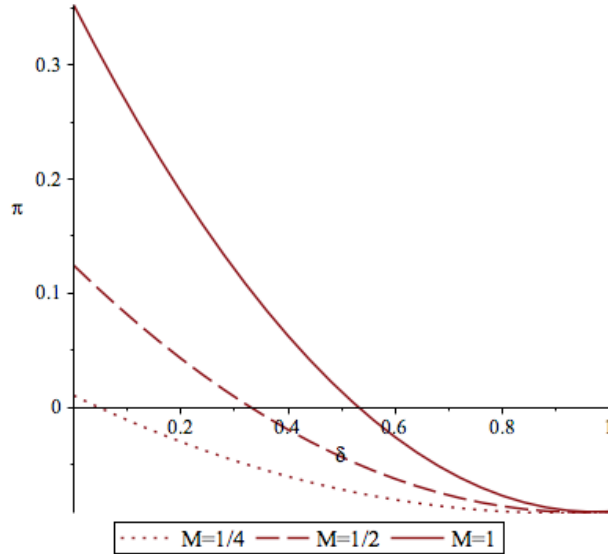


Figure 2. The choice of δ where $\bar{w} = 1/10$, $\sigma_y^2 = 1/10$, $X = 1/100$, $B = 1$

However, in Figure 2 we have $X = 1/100$ that is the board members primarily care about their share of industry. As it is shown in Figure 2, in the presence of self-interested board, even if the manager's input characteristics including knowledge or marginal costs are much lower than the that of the board (i.e. $M = 1/4$) the PCRO still prefers the manager over the board. In other words, altruism is the primary feature of the board that could stimulate the organization to use the board instead of the manager.

Given Haussmann's categorization of NP organizations one could discuss that if the manager rewards are based on the outcome of PCROs' investments, the PCROs' control status will be either mutual or entrepreneurial.

4.2. Rewarding the manager based on a measure of input.

A compensation plan encompassing reward based on a measure of input could be a more operative tool to incentivize the manager where there are noteworthy frictions in measuring the output (Sappington 1991). However, measuring the manager's contribution is contingent upon the presence of a third party evaluating his input. In the model this third party is the board of directors. In this setting, the board of directors is involved in the decision-making along with the manager and it also assesses the quality of decision-making of the manager, and the PCRO rewards him accordingly. In this scenario it is assumed the involvement of the board of directors in the decision-making process affects the performance measure of the manager's input through lessening the discrepancy of the performance measure.

Stage 3:

In this stage of the game the manager and the board adopt the levels of efforts they are going to exert in the PCRO. The PCRO's output (i.e. $y = \delta e_B k_B + (1 - \delta) e_M k_M$) is realized through the combination of the board and manager efforts, enhanced by their knowledge levels. The payment of the premium to the manager is conditional upon the measurement of the quality of his input into the decision-making (i.e. $e_M k_M$). Therefore, the presence of the board of directors in the process of decision-making improves the quality of the performance measure (i.e. it reduces the variance of the performance measure). Equation (11) denotes the net utility of the manager where he is rewarded based on the quality of his input.

$$U_M = F + \beta \alpha_e e_M k_M - \left(\frac{1}{2} c_M e_M^2 \right) \quad (11)$$

In equation (11), F is the base salary paid to the manager. In addition, the manager receives β per unit of input exerted. However, $e_M k_M$ is assessed by a performance measure (i.e. α_e) that on average yields an unbiased measure of $e_M k_M$. This performance measure encompasses some noises. However, the size of the variance is reduced by the presence of the board of directors in the course of the decision-making. In other words, $\alpha_e \sim (1, \sigma_e^2/\delta)$ implying that as the weight of the board of directors in the process of decision-making rises, α_e measures the $e_M k_M$ with more precision. However, if δ approaches zero, the use of this evaluation method will not be plausible.

Following Baker et al., (1994) I suppose the manager only knows there is a performance measure in the PCRO, however he does not know how α_e works before accepting the offer. The manager maximizes (11) with respect to e_M and consequently the effort that he is going to exert is shown in equation (12)

$$e_M^* = \beta \alpha_e \frac{k_M}{c_M} \quad (12)$$

Equation (12) denotes that optimal effort of the manager is a positive function of his knowledge (k_M), bonus of β , and the weight of the board in the decision made. Comparable to the previous case, the board of directors' optimal effort is:

$$e_B^* = \frac{\delta k_B (g\rho + \rho + \theta(1-\rho))}{c_B} \quad (13)$$

Stage 2:

In this stage of the game, the PCRO determines the optimal bonus β and the base salary of F by maximizing its expected yield:

$$\max_{\beta} E[\pi] = E \left[\delta e_B k_B + (1 - \delta) e_M k_M - \bar{w} - \left(\frac{1}{2} c_M e_M^2 \right) \right] \quad (14)$$

Substituting equations (12) and (13) into (14) the PCRO maximizes (15) with respect to β :

$$\max_{\beta} E[\pi] = \frac{(1-\delta) \beta \delta k_M^2}{c_M} + \frac{\delta^2 k_B^2 (g + \rho + \theta(1-\rho))}{c_B} - \frac{1}{2} \frac{\beta^2 \left(1 + \frac{\sigma_e^2}{\delta} \right) \delta^2 k_M^2}{c_M} - \bar{w} \quad (15)$$

The first order condition of PCRO's maximization problem in determination of β is: $\frac{\partial E[\pi]}{\partial \beta} =$

$$\frac{(1-\delta) \delta k_M^2}{c_M} - \frac{\beta \left(1 + \frac{\sigma_e^2}{\delta} \right) \delta^2 k_M^2}{c_M} = 0. \text{ Therefore, the optimal input-based bonus paid to the manager is:}$$

$$\beta^* = \frac{(1-\delta)\delta}{\delta + \sigma_e^2} \quad (16)$$

In this situation, the expected optimal effort of the manager is $E[e_M^*] = (1-\delta)\delta k_M / ((\sigma_e^2 + \delta)c_M)$. Comparing this level of effort with the first-best effort level that is $e_M^{**} = (1-\delta)k_M/c_M$ one can see that as σ_e^2 increases, the manager's effort diverts from first-best effort level.

Figure 3 plots the optimal bonus paid to the manager against the weight given to the board, in the process of decision-making. The optimal input-based bonus paid to the manager is the increasing function of the manager's weight in the process and decreasing function of σ_e^2 , however as the weight of the board of directors increases the negative impact of σ_e^2 on the size of the bonus will decline.

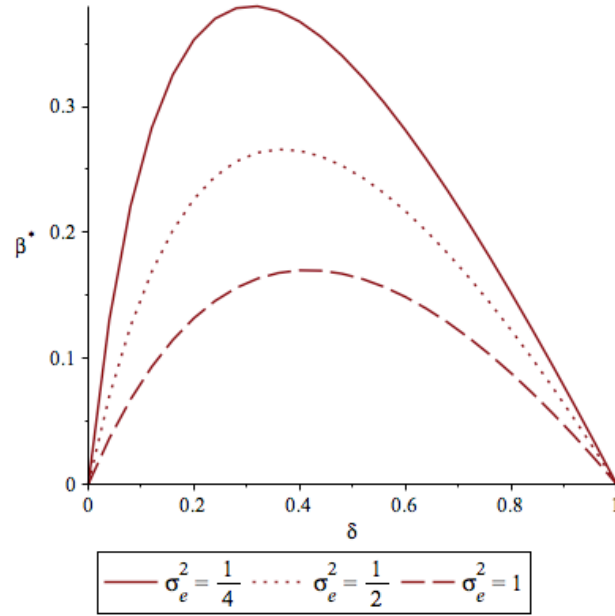


Figure 3. Optimal bonus paid to the manager based on the variance of input performance measure.

Stage 1:

In this stage, the PCRO determines the weight of each agent's input into the decision-making process. By substituting (16) into (15) we have:

$$\pi^*(.) = \left(\frac{(1-\delta)^2 \delta k_M^2}{c_M(\delta + \sigma_e^2)} \right) + \frac{\delta^2 k_B^2 (g\rho + \rho + \theta(1-\rho))}{c_B} - \bar{w} - \frac{1}{2} \left(\frac{(1-\delta)^2 \delta^2 \left(1 + \frac{\sigma_e^2}{\delta}\right) k_M^2}{c_M(\delta + \sigma_e^2)} \right) \quad (17)$$

This equation can be written in the form of equation (18)

$$\pi^*(.) = \frac{M}{2} \left(\frac{(1-\delta)^2 \delta}{(\delta + \sigma_\epsilon^2)} \right) + XB\delta^2 - \bar{w} \quad (18)$$

where in equation (18) $M = k_M^2/c_M$, $B = k_B^2/c_B$ and $X = g\rho + \rho + \theta(1 - \rho)$. To illustrate the choice of PCRO's optimal solution of δ (weight of the board of directors in the decision-making process) we use the of plot $\pi^*(.)$ against δ .

The choice of δ in the presence of highly altruistic board

Let's assume that the board of directors is highly altruistic or $\theta = 1$ so if the board does not learn anything in the process of decision-making, X will be equal to one. Figure 4 and 5 plot the expected return of the PCRO against the board's weight in the process of decision-making where $\bar{w} = 1/10$, $X = 1$ and $B = 1$. The only difference between these two figures is the value of σ_ϵ^2 , where in Figure 4 it is equal to $1/10$ and in Figure 5 it is equal to $1/5$. In this figure I am looking for the choice of δ where manager's characteristics of input ($M = k_M^2/c_M$) varies.

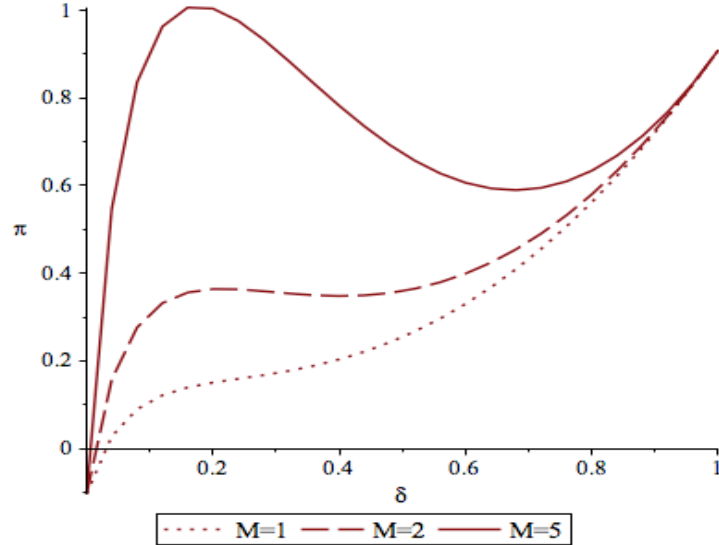


Figure 4. The choice of δ where $\bar{w} = 1/10$, $\sigma_y^2 = 1/10$, $X = 1$, $B = 1$

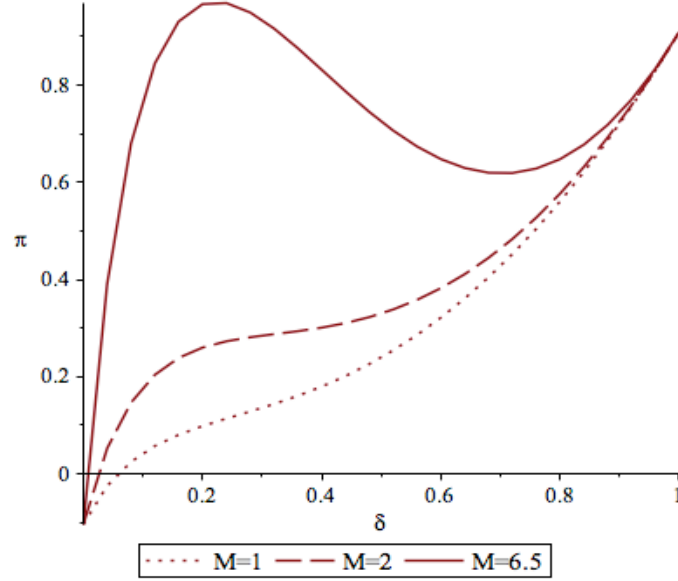


Figure 5. The choice of δ where $\bar{w} = 1/10$, $\sigma_y^2 = 1/5$, $X = 1$, $B = 1$

As it is indicated in Figure 4 and 5, in the presence of highly altruistic board, the PCRO uses both manager and the board if M is considerably higher than B . In addition, if σ_e^2 increases, as it is illustrated in Figure 5, the manager's input characteristics now should be even higher than in the case of figure 4 so the PCRO decides to share the decision-making task. In other words, the PCRO prefers to share the decision-making between the board of directors and manager if the manager's qualities are considerably higher than those of the board, otherwise the PCRO only use the board to make the investment decisions.

In the context of Hansmann's classification, the results in here suggest that if the board is vastly altruistic, the PCRO's governance structure will be a mix of mutual and entrepreneurial if the manager's quality of decision-making is higher than the directors. However, if this is not the case the PCRO will be classified just as a mutual entity.

The choice of δ in the presence of a self-centered board

Now a situation is considered in which the board only cares about itself and altruism does not play any role in board's incentives for exerting efforts in the process of decision-making.

In Figure 6 and 7 I take into account the case of selfish board in which $X = 1/100$. Similar to Figures 4 and 5 the choices of δ for two different values of σ_e^2 that are $1/10$ and $1/5$ are taken in to consideration respectively.

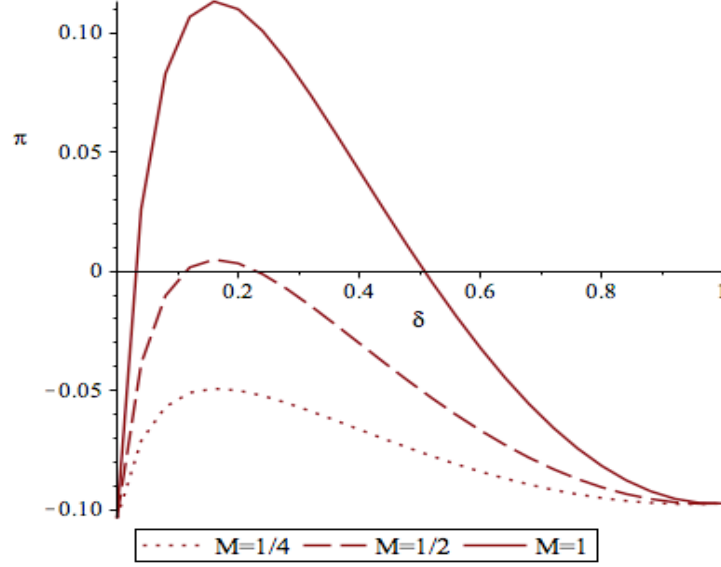


Figure 6. The choice of δ where $\bar{w} = 1/10$, $\sigma_e^2 = 1/10$, $X = 1/100$, $B = 1$

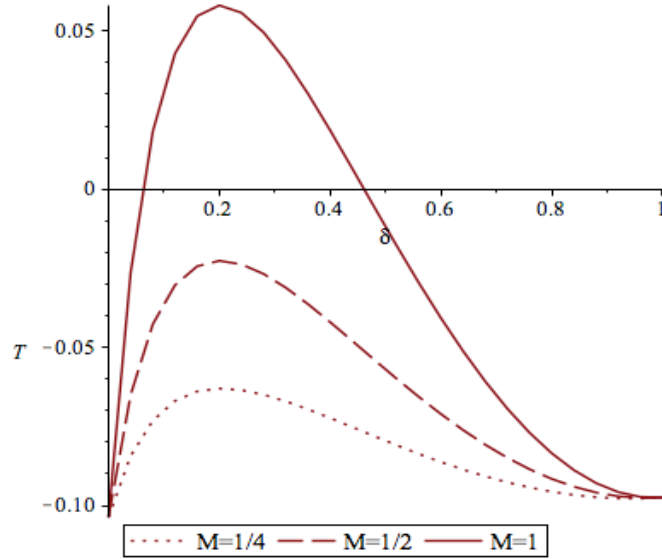


Figure 7. The choice of δ where $\bar{w} = 1/10$, $\sigma_e^2 = 1/10$, $X = 1/100$, $B = 1$

In Figures 6 and 7, if the board of directors does not much care about the rest of the industry, the PCRO is willing to share the decision-making between the board and the manager. In Figure 6, the PCRO shares the decision-making task even if M is half of B . However, in Figure 7, because σ_e^2 is two times larger than that of figure 6, the manager's input quality (including knowledge and cost of exerting efforts) should be close to that of the board. Therefore, in the presence of a non-altruistic board, the PCRO has to find a manager that is at least as good as the board.

To sum up we can now have an explanation about the conditions that may lead to the shared decision-making in PCROs. In other words, the results of the theoretical model developed have implications about why PCROs adopt a governance structure that is a mix of donative-mutual and donative-entrepreneurial. In fact, the analytical analyses in this paper suggest that factors incentivizing the controlling agents as well as the uncertainty embedded in the PCROs investment process may explain the mix status of PCROs.

Figure 8 summarizes the results of theoretical model in this paper and helps us to present two hypotheses that are as follows:

H1: PCROs that use shared decision-making may not have frictionless measures of either managerial input or PCRO's output.

H2: PCROs that use shared decision-making may either have highly altruistic directors perceiving the managers to be more knowledgeable than the board members or their directors are not altruistic.

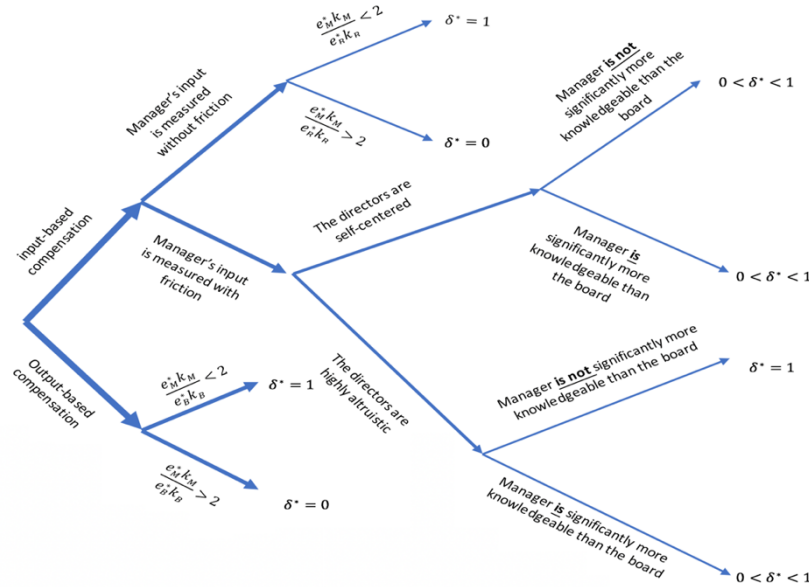


Figure 8. The theoretical models' implication for task assignment

5. Concluding remarks

Agency theory predicts the board of directors' involvement in the decision-making process of NP organizations is primarily limited to the oversight of managers' activities. However, in the course of conducting interviews with 14 PCROs it was observed the boards of directors are not only in charge of monitoring of decisions made by managers, they are also involved in many stages of decision-making process.

To examine the factors affecting the presence of board of directors in management decisions an analytical model was developed in which two agents can govern a PCRO whose objective is to maximize the return on investment in research and market promotion projects. The agents are the manager and the board of directors, where only the former is paid by the PCRO. Both agents combine their knowledge and efforts for making an investment decision. The PCRO faces two choices; 1) the weight that it has to assign to each agent in the decision-making process and 2) the payment scheme for the manager. Both of these decisions are made to maximize the returns on investments.

To consider the impact of different payment schemes on the choice of the task delegation, two cases were taken into account. In the cases of an output-based bonus, the results of the model suggested the PCRO decides to assign the task to either the almost perfectly incentivized manager or the board of directors, depending on their relative productivity. A separation of decision-making and oversight would exist in these cases over a range of plausible parameter values. In other words, the PCROs in this case will be either mutual or entrepreneurial organizations.

However, if the manager's input is the basis for his compensation, the PCRO has to use an evaluation method whose accuracy depends on the presence of a third party in the process of decision-making. In the model it is assumed the board of directors plays the role of the third party, where the weight of the board of directors' input in the decision-making process is positively associated with the accuracy of the manager's measure of input. In this situation, it is shown that the shared decision is more likely to be the norm if the board is not drastically altruistic. In addition, if the board is highly altruistic, the PCRO decides to share the decision-making if the manager has superior input quality (including knowledge or cost of exerting efforts) in comparison with the board. In these situations, the board of directors will generally also participate in order to incentivize managerial effort on one hand and help the PCRO to reach its objective on the other hand. In Hansmann's terminology, the results of the model implied that the the PCROs

could become a mix of mutual and entrepreneurial NP organizations based upon the factors incentivizing the controlling agents as well as the uncertainty embedded in the PCROs investment process. The first hypothesis states that; PCROs that use shared decision-making may not have frictionless measures of either managerial input or PCRO's output. The second hypothesis states that; PCROs that use shared decision-making may either have highly altruistic directors perceiving the managers to be more knowledgeable than the board members or their directors are not altruistic.

The PCROs are unique entities that do not separate between management and oversight. The current governance structure of PCROs seems to be inevitable for two reasons: 1) the outcomes of investments are not observable in the short-run and 2) the directors benefit from their involvements in the process of decision-making. Therefore, it seems that there is a rationale behind the choice of shared decision-making in these organizations. In fact, the unusual task assignment of PCROs helps these producer-led entities to accomplish their mission in provision of industry good. The high level involvement of directors representing VCs in the start-up companies could also be explained by the results of our theoretical model where we should that the higher the level of uncertainty, the more the involvement of directors in companies affairs will be.

The results of the study show that board members' altruism and knowledge levels are important contributions to the success of PCROs. This implies that resources spent on recruitment, training and retention will play long-term dividends for producers supporting the PCROs.

The results of the model are naturally limited by the assumptions imposed on the model. The model assumed the boards of directors do not impose any costs on the organization. It also assumed the directors do not extract any rent from the organization. Furthermore, it assumed that the presence of manager and board of directors in the decision-making process are independent of each other⁴. Further work could relax the above assumptions to explore the PCROs' choice of delegation between board of directors and manager in different situations.

Future studies could also explore the organizations in other industries that are in charge of producing industry goods. As a start it would be useful explore to what extent to similar

⁴ A possible, setup could be the use of Cobb-Douglass decision-making function. The results of the model for output-based compensation based on a Cobb-Douglass decision-making function is presented in the Appendix.

organizations exist in other industries and if they exist how do they make decisions. If they do not exist, is there scope to model their creation from the success in agriculture. Another interesting topic that could be taken into consideration in the future is study of entities in private and public sectors that do not tend to separate between oversight and management. In particular, the insights provided in this study could be used to find out whether the lack of separation in other organizations is related to the implications of this study, or not.

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Appendix

The choice of δ in the case of Cobb-Douglass decision-making function.

Stage 3: The return function of the PCRO is in Cobb-Douglass form as it is indicated in equation A.1 where I assume that manager and the board have the same knowledge levels and equal to 1.

$$\pi = (e_M)^{1-\delta}(e_B)^\delta - F - b\alpha_y((e_M)^{1-\delta}(e_B)^\delta) \quad A.1$$

The manager's net utility function is shown in equation A.2

$$U_M = F + b\alpha_y((e_M)^{1-\delta}(e_B)^\delta) - \frac{1}{2}c_M e_M^2 \quad A.2$$

The board's net utility function given the optimum fixed payment from the PCROs point of view is illustrated in equation A.3:

$$U_B = x \cdot ((e_M)^{1-\delta}(e_B)^\delta - \bar{w} - \frac{1}{2}c_M e_M^2) - \frac{1}{2}c_B e_B^2 \quad A.3$$

where $x = \rho + \theta$ representing altruism and personal gains of the board members

The manager and the board both maximize their utility with respect to their efforts (*i. e.* e_M and e_B). Consequently, the efforts exerted by the manager and boards are:

$$e_M^* = (1 - \delta) b \alpha_y \left(\frac{\delta x}{(1-\delta) b \alpha_y c_B} \frac{c_M}{c_B} \right)^{\frac{1}{2}\delta} \quad A.4$$

$$e_B^* = \left[\delta \frac{x}{c_B} \left(\left(\frac{\delta x}{(1-\delta) b \alpha_y c_B} \right)^{\frac{1}{2}\delta} \frac{1}{c_M} (1 - \delta) b \alpha_y \right)^{1-\delta} \right]^{\frac{1}{2-\delta}} \quad A.5$$

Stage 2:

In this stage the optimal bonus paid to the manager is determined. Therefore, the PCRO maximize its net return with respect to the bonus of b and I have:

$$b^* = \frac{2}{(2-\delta)(1+\sigma_y^2)} \quad A.6$$

Stage 1:

Given the optimal b^* shown in equation A.6 I now try to indicate the choice of δ considering the Figures A.1 and A.2 show the choice of δ where the arbitrary values of the model parameters are $\bar{w} = 1/10$, $\sigma_y^2 = 1/10$ and $c_B = 1$. However, in figure A.1 I assume the

board is highly altruistic ($x = 1$) while in figure A.2 it is assumed the board is primarily after its personal agenda ($x = 1/100$). In these two situations I indicate the choice of δ given the relative marginal cost of the manager to the board members.

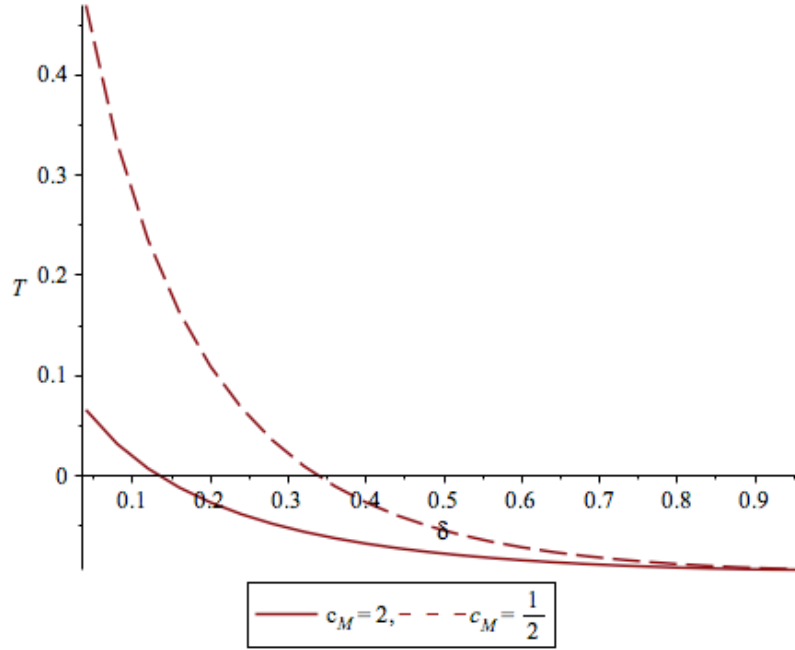


Figure. A.1. The choice of δ where $\bar{w} = 0.1, \sigma_y^2 = 0.1, x = 1, c_B = 1$

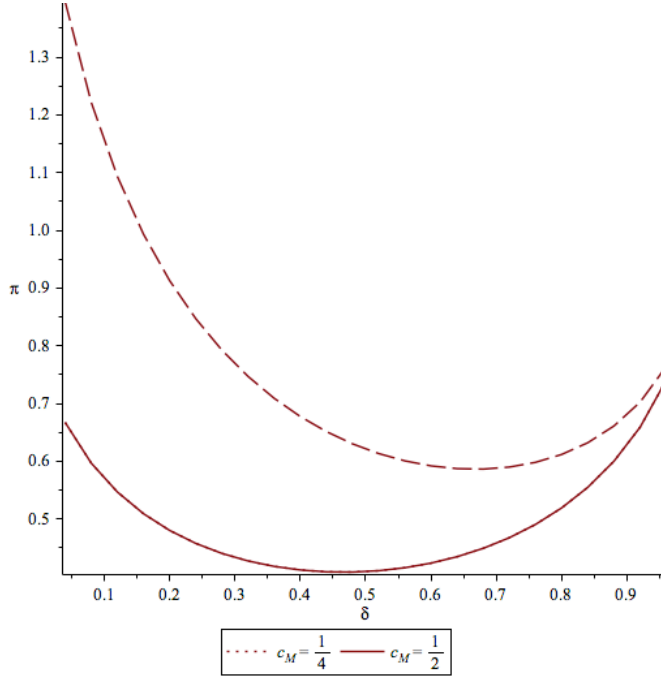


Figure. A.1. The choice of δ where $\bar{w} = 0.1, \sigma_y^2 = 0.1, x = 1, C_B = 1$

Thus as it is indicated in figure A.1, one can see that in the presence of a highly altruistic board, the board's share in the decision-making process approaches to zero if the manager's marginal cost of spending effort is notably lower than the board of directors' marginal cost (*i. e.* $\frac{c_B}{c_M} = 4$). However, in the case of $\frac{c_B}{c_M} = 2$ the PCROs still prefers to assign considerable part of the decision-making to the board.

Figure A.2 illustrates that if the board is primarily after personal gains, the manager will take over the decision-making assignment even if his marginal cost of exerting effort is significantly more than the board' marginal cost (*i. e.* $\frac{c_B}{c_M} = 2$). Therefore, one can see that even in the presence of a Cobb-Douglass decision-making function, the PCRO still prefers to delegate most of the decision-making assignment to one of the agents.

