Coordination and Governance: The case of Cooperatives versus IOFs

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'Perhaps the most important role of contracts is to coordinate the actions of independent decision makers.'

Bogetoft and Olesen 2002, p189

1 Introduction

Specialization is attractive according to the law of comparative advantages, but it also generates motivation and coordination problems due to the required exchange between specialized parties. The parties must be motivated to carry out their parts of the exchange, and the decisions and actions of the parties have to be coordinated to realize the gains of cooperation. A governance structure has to address these problems of conflicting as well as joint interests. Motivation problems can be addressed by designing incentives and assigning authority to reduce conflicts of interests and to provide the proper investment incentives, while coordination is required even if the parties involved have joint interests in order to focus on one course of action. The scientific literature has focused on analyzing the former, like in the agency literature (Fama and Jensen, 1983) and the property rights literature (Grossman and Hart, 1986). Coordination problems in a setting of joint interests have received limited attention during the last decades, but this is changing rapidly (for example, Alonso, et al., 2008; Dessein and Santos 2006).

As the opening citation indicates, in many production and supply chains, coordination is the primary concern, ensuring that production is optimized throughout the entire production chain and value is created through joint actions. For example, the harvesting of fruits and vegetables must be coordinated to avoid capacity problems like congestion as well as idleness at the factory. Coordination problems arise when there are (positive) externalities between different organizational units (Lazear and Gibbs, 2008). An example is double marginalization in a chain (Spengler, 1950). Vertical coordination entails aligning interdependent activities of various actors in a production chain. It requires complex information exchange, not only on supply and demand, but also on the quality requirements of retail customers and final consumers. The introduction of new products and improvement of logistic efficiency also require a coordinated effort of all actors in the value chain (Bijman et al, 2004).

The literature on agricultural cooperatives pays noticeable attention to the coordination problem over time. Coordination aims to harmonize the economic activities of different economic units. It is intended to "achieve necessary adjustments of functioning of the participants without any encroachments upon their individuality or their independence" (Emelianoff 1948). It is widely applied in both cooperatives and investor owned firms (IOFs). Shaffer (1987) argues that the patron-owned characteristics of a cooperative provide the potential for advantages in coordination for cooperatives since the coordination internalizes the vertical externality in a cooperative. However, he does not specify these advantages. Bogetoft and Olesen (2002) summarize ten rules of thumb in agricultural contract design and group them into three categories corresponding to the overall objectives of coordination, motivation, and minimization of transaction costs. Three rules relating to coordination are "coordinate production", "balance the pros and cons of decentralization" and "minimize the costs of risk and uncertainty". However, a relationship between governance structure and coordination is not outlined. Bijman et al. (2004) build on Thompson (1967)'s theory that associates three types of coordination mechanisms (standardization, plan, or mutual adjustment) to three types of interdependencies (pooled, sequential, or reciprocal), and apply it to various governance structures in the context of cooperatives. They establish that, if interdependencies shift from pooled to sequential to reciprocal, transactions will be governed in a more hierarchical way in order to economize on coordination costs. The reason is that more information has to be exchanged and more activities of various participants have to be aligned along the shift.

This article contributes to the literature by relating coordination mechanisms and governance structures. We examine the choice of coordination mechanism in the relationship between input supplier and the

processor of a certain good, and link it to the choice of governance structure, either a cooperative or an IOF. Two ingredients drive our results: externalities and uncertainty. First, a cooperative is a firm collectively owned by many independent farmers as input suppliers. Members own collectively a joint resource where they either further process or market their produce. They delegate certain rights to the cooperative. Subsequently, the cooperative enterprise concludes contracts with members, specifying for example delivery requirements. The vertical ties between the members and the processor therefore consist of a transaction element and an ownership element. An IOF processor is owned by outside investors and it has merely a transactional relationship with its input suppliers. The governance structure difference has an impact on the coordination problem. A cooperative takes into account the vertical externalities between member farms and the cooperative processor, whereas an IOF does not.[1]

Second, agricultural markets are subject to a wide range of risks and uncertainties. Information asymmetry is precisely what we expect to see in this market. There are production risks pertaining the farm operations. Farmers' ability to plant and yield, and the costs of production are difficult to predict, "due among other things, to varying weather conditions" (Nilsson 2001, p332). Price volatility is another important source of risk. Agricultural commodity prices are subject to sharp fluctuations over relatively short periods of time and between geographical dispersed markets, depending on both local and global supply and demand conditions. Moreover, the market is also characterized by information asymmetry among parties involved. The producers have, for instance, more information regarding production while the processors might be more knowledgeable about the market prices. We incorporate this latter uncertainty in the model and examine the implications for organizational structure choices.

Our study can also be seen as an extension of institutional market failure analysis. Williamson (1975) makes it clear that trust and goodwill among businessmen are essential, "A better understanding of market failure might also come from studying how good estimates and revelations must be to allow approximate planning rather than studying how to elicit the truth" (Flaherty 1981, p524).

We analyze the choice of coordination mechanism in the relationship between a producer and a processor governed by a cooperative or an IOF. Circumstances under which each governance structure is efficient are delineated. Section 2 characterizes the coordination problem. Section 3 sets up the model, followed by the equilibrium results in section 4. Section 5 concludes.

2 Coordination as a game of multiple equilibria

Classic definitions of management include often explicitly the coordination problem in characterizing the field. For example, Drucker (1946) states that 'Management science is the science of the coordination of activities and processes, decision making in organizations, and optimal use of scarce resources (human and financial capital, materials, equipment) in order to reach favorable outcomes (products and services, employment, profit) for the organization'. Organization theory (e.g. Thompson, 1967; Galbraith, 1977) deals also with the coordination either within the boundaries of one organization or among collaborators in a partnership. This article addresses issues regarding coordination from an economic perspective. A coordination problem can be conceptualized as a game with multiple equilibria (Milgrom and Roberts 1992). To illustrate, consider a situation with two growers and a processor. Suppose each grower produces 1 unit harvest and has to decide to deliver it to the processor either today

[1] Notice that the consolidation of ownership in cooperatives does not imply that the dominant coordination mechanism should be an authority relation. Conversely, an authority relation, in the sense of quantity instruction, can be used independently from the centralization of ownership and/or residual income rights, such as the relational contracts among separate firms (Grandori 1997).

or tomorrow. The processor can handle 1 unit harvest during one day. Coordination entails that one grower delivers today and the other tomorrow. There are 2 equilibria: grower 1 delivers today and grower 2 delivers tomorrow, and vice versa. Lack of coordination entails parties may be focusing on different equilibria, resulting in a coordination problem. For example, if grower 1 focuses on the equilibrium where grower 2 is delivering tomorrow, and grower 2 is focusing on the equilibrium where grower 1 is delivering tomorrow, then there is congestion at the processor today and idleness tomorrow.

Lazear and Gibbs (2008) distinguish two types of coordination problems. One is called synchronization problem which does not require parties involved to communicate to each other in order to coordinate. Examples are the synchronization of harvesting and processing of perishable products, the consistent overall product image, and uniform services provided by a firm at all of its retail locations. The other type is an integration problem. When there is specific knowledge rather than general knowledge in an organization that must be used to create firm value, and it is costly to communicate the knowledge to someone else, the integration problem arises. Should the decision making be centralized or decentralized is an example of such problem (Alonso, et al., 2008). Vertical or horizontal communication is needed to solve an integration problem. We look at the second type of coordination problems in the current article, more specifically, who and how to determine the efficient amount of production?

The solution to a coordination problem entails that the game with multiple equilibria is transformed into a game with one equilibrium. This can be done by changing the (number of) players, the choice possibilities, the payoffs, the information structure, or the rules of the game. One way of solving the synchronization problem and achieving consistency across employees and organizational units is to standardize practices and implement standard operating procedures. It entails that the number of choice possibilities for each player is reduced to one. There is of course a unique equilibrium in a game where each player has only one choice possibility. Milgrom and Roberts (1992) identify two solutions for an integration problem, namely, centralization and decentralization. Each solution has its advantages and disadvantages. "Either the dispersed information must be transmitted to a central computer or planner who is expected to solve the resource allocation problem or else a more decentralized system must be developed that involves less information transmission and, correspondingly, leaves at least some of the calculations and decisions about economic activity to those with whom the relevant information resides. The trick with the first option is to make timely decisions while keeping the costs of communication and computation from absorbing all the available resources low. The challenge of decentralization is to ensure that the separately made decisions yield a coherent, coordinated result" (p26).

Different organizational structures achieve coordination in an integration problem in different ways and with differing results. Weitzman (1974) makes this explicit by comparing the efficacy of instructions (centralization) versus price signals (decentralization). For a quantity control to work, one party specifies a quota, target, or command to produce a certain level of output, then the other party must obey without consideration of how costs will be met and how rewards will be distributed (Flaherty 1981). With price instruments, the rules specify explicitly or implicitly that profits are maximized at the given prices, taking into account the cost and revenue. A prominent example is US dairy marketing orders that establish minimum prices to be paid by the processors for milk purchased from producers. When there is no informational constraint, having the centre name prices while producers respond with quantities, or having the centre assign quantities while the producers reveal marginal costs does not make a difference. A more realistic issue of central control is to focus on the essential difference between quantities and prices as planning instruments when uncertainty is involved. Whether it is better to directly administer production under scrutiny, or to fix transfer prices and rely on self-interested profit maximization to achieve the same ends in decentralized fashion is contingent on the shape of the marginal cost and marginal revenue curves. Notice that the first solution establishes coordination by reducing the choice

possibilities to one, while the second solution entails changing the payoffs. Mintzberg (1980) defines organizational structure as the sum total of the ways in which it divides its labor into distinct tasks and then achieves coordination among them. He distinguishes five coordination mechanisms: mutual adjustment, direct supervision, outputs, skills, and the standardization of work processes. We focus on the two mechanisms suggested by Weitzman (1974) and add into the analysis the features of two governance structures. In Weitzman's framework, both mechanisms operate on the assumption that upstream units are obedient to downstream units. The coordination problem of concern is how to direct upstream actions with minimal loss when the downstream director has imperfect information about upstream costs. In the current article, the choice of coordination mechanisms is made by the party who owns and controls the processing stage, i.e. farmer in a cooperative and processor in an IOF.

3 Model

This section presents a non-cooperative game model regarding the relationship between governance structure and coordination. The decision makers, information structure, choices, sequence of decisions, and payoffs will be specified. There are two parties: an upstream farmer and a downstream processor. The farmer is representative of all farmers together. The information structure specifies the uncertainty regarding MR and MC. Ex ante the information regarding the optimal decision is hardly exactly available even to the persons involved. However, one party may have more information at disposal than the other due to his position in the production process. We assume the incompleteness of information resides with the farmer in a cooperative (the processor in an IOF), i.e. the cooperative farmer (IOF processor) is unsure about the precise marginal revenue (marginal cost) function. Particularly, an IOF processor may lack certain information regarding the marginal costs of its upstream supplier while a cooperative processor may incorrectly estimate the benefits of processing (Fleherty 1981).[2] There are four choices to be made. First, two governance structures are distinguished: a cooperative and an IOF. The identity of the party making the choice of coordination mechanism in the second stage of the game depends on the choice of governance structure. The farmer chooses the coordination device in a cooperative, while the processor makes this choice in an IOF. Second, in order to establish coordination between the upstream farmer and the processor, either the price or the quantity instrument may be adopted. That is, the cooperative can either specify an amount to be delivered or a price to its member farmer, while the IOF can either have a contract with the farmer fixing the quantity to supply or guarantee a price. Third, the farmer (processor) in a cooperative (an IOF) has to decide how much to produce (process) based on his information regarding MC (MR) and the guess of the MR (MC). Finally, the actual level of MR and MC has to be determined. The artificial player Nature chooses the level of the marginal costs to be either Low (MC_L) or High (MC_H), each with probability .5, and the level of the marginal revenues to be either Bottom (MR_B) or Top (MR_T), each with probability .5. The game consists of four stages. The choice of governance structure (cooperative or IOF) is made in the first stage. A coordination mechanism (price coordination or quantity coordination) is then chosen by the farmer (the processor) in a cooperative (an IOF) in the second stage of the game. Subsequently the cooperative member make a guess regarding the MR of the processor, or the IOF processor makes a guess on the MC of the upstream farmer. In the fourth stage Nature reveals the real MR and MC. The payoff differences between cooperative and IOF are due to their different objective functions. A cooperative takes into account not only the downstream surplus but also the upstream surplus while an IOF processor is merely concerned with the downstream surplus. Namely, a cooperative processor internalizes how its decisions affect the farmers, whereas an IOF processor does not. To delineate the implications of this distinction for the choice of coordination mechanism and the efficiency of a governance structure, we will specify the payoffs of the upstream farmer and the downstream processor.

[2] Posing the problem this way implicitly entails assuming that the cost of communication between the parties is high enough to warrant consideration of these coordination mechanisms.

Consider first a situation of a cooperative where the actual marginal revenue is MR_B and the farmer has a belief either MR_B or MR_T (figure 1). Notice that by definition a cooperative acquires the entire surplus generated in the transaction whereas the processor earns nothing. It entails that the payoff of the processor is always zero in a cooperative regardless of the choice of coordination mechanism and the belief of a farmer regarding the MR. If the farmer possesses an exact account of the MR, the upstream payoff is A+B regardless the choice of coordination mechanism. The price instrument will specify P_E, and an output level Q_E will be chosen. The quantity instrument will specify Q_E.

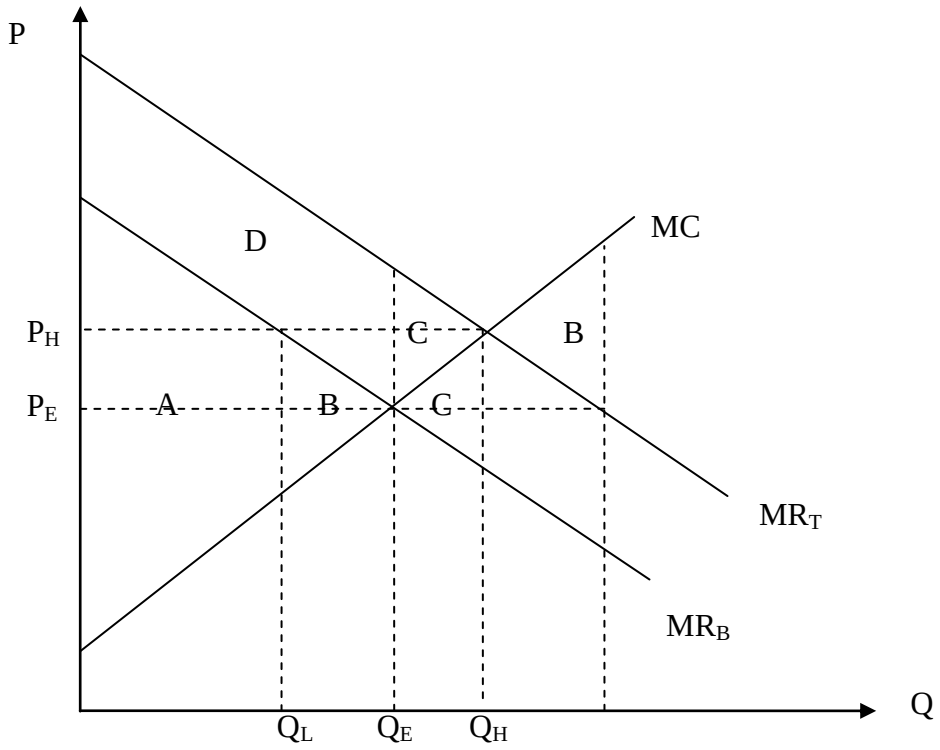

Figure 1: A cooperative

When the farmer overestimates MR, the size of the surplus depends on the choice of coordination mechanism. The price instrument determines a transfer price P_H. The processor faces a MC equal to P_H and the intersection of P_H and MR_B determines that the processor procures an amount Q_L. The surplus is therefore A. Similarly, the quantity mechanism determines a quantity Q_H and the surplus is A+B-C. The payoffs when the actual MR is MR_T and the farmer has a belief either MR_B or MR_T can be calculated in the same manner.[3] Figure 2 depicts the extensive form when the governance structure cooperative is chosen in the first stage. The farmer chooses first the coordination mechanism and then his belief regarding MR. Subsequently, Nature determines the true level of MR. Finally, the first number presents the payoff of the farmer, while the number below is the payoff of the processor. The payoff of the processor is always 0 in a cooperative because the farmer receives the entire surplus. The surplus received by the farmer in the various circumstances is retrieved from figure 1.

[3] We limit the presentation of the extensive form in figure 1 to reflect the uncertainty regarding MR when a cooperative prevails. The two levels of MC would only result in presenting figure 1 twice. One figure would have MC_L and the surfaces A_L, B_L, C_L and D_L, while the other figure would have MC_H and the surfaces A_H, B_H, C_H and D_H. This is the reason why MC, rather than MC_L and MC_H, is presented in figure 1.

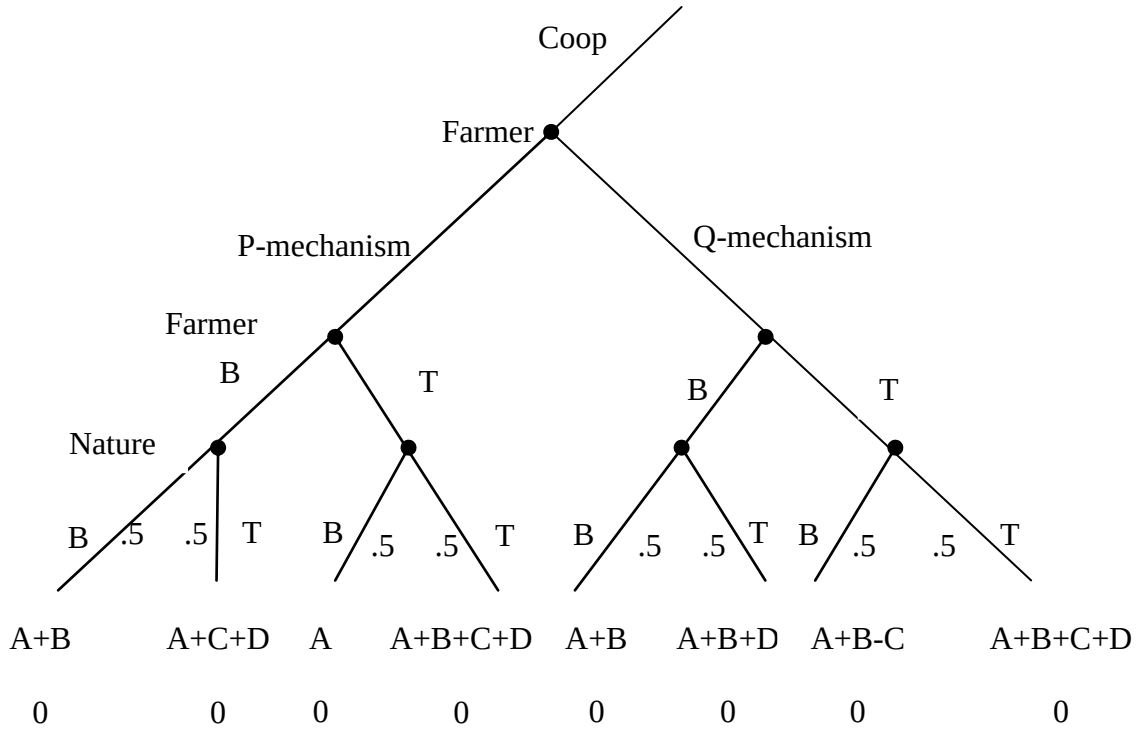

Figure 2: The extensive form of the game when the cooperative prevails

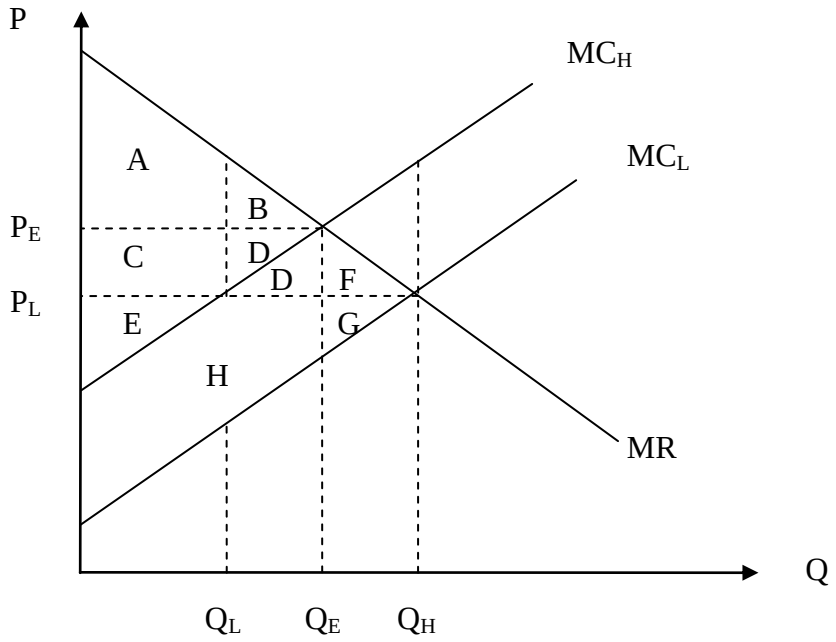

Figure 3: An IOF

Consider next a situation where MC_H is the actual MC and the IOF processor's belief is either MC_L or MC_H. If the belief is consistent with the real MC, then the payoffs of the farmer and the processor are C+D+E and A+B (figure 3), respectively, regardless the choice of coordination mechanism. The price mechanism determines the transfer price P_E, while the quantity mechanism determines the efficient quantity Q_E. If the processor underestimates MC, then the payoff of the farmer and the processor depend on the choice of coordination mechanism. If price instrument is chosen, the MR received by the farmer

is P_L, i.e. the transfer price is determined by the intersection of MR facing the processor and MC_L. An output level Q_L will be chosen. Thus the payoff of the farmer and the processor are E and A+C respectively. Similarly, if quantity instrument is chosen, the intersection of MR and MC_L determines that an output Q_H has to be delivered. The farmer earns E-D-2F-G, while the processor receives A+B+C+2D+F. The payoffs of both parties can be calculated in the same way when the actual marginal cost is MC_L and the IOF processor's belief is either MC_L or MC_H.

Figure 4 depicts the extensive form when the governance structure IOF is chosen in the first stage. The first number presents the payoff of the farmer, while the number below is the payoff of the processor. The payoffs in the various circumstances are retrieved from figure 3. The processor chooses first the coordination mechanism and then his belief regarding MC. Subsequently, Nature reveals the true MC.

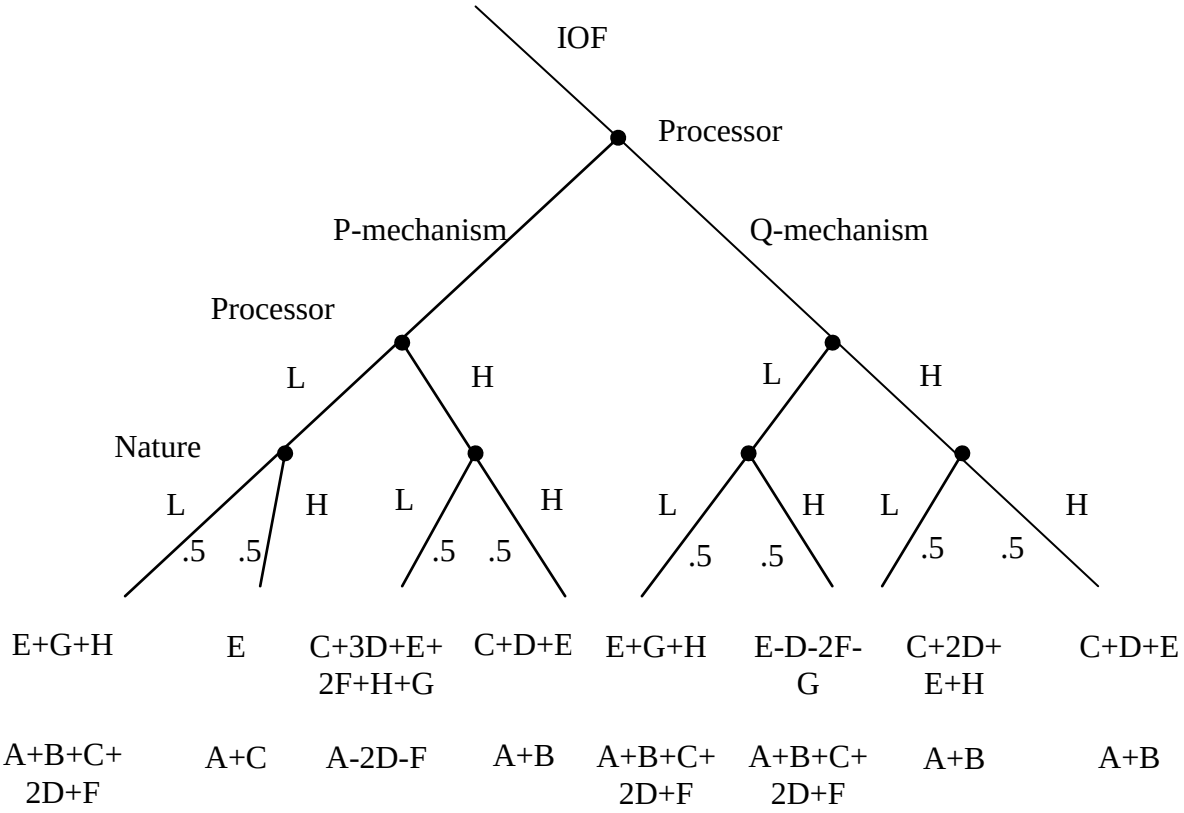

Figure 4: The extensive form of the game when the IOF prevails

4 Equilibrium

A cooperative takes into account not only the downstream surplus but also the upstream surplus, while an IOF processor is merely concerned with the downstream surplus. That is, a cooperative internalizes externalities, whereas an IOF does not. This entails that different coordination mechanisms may be employed in the two governance structures. This claim will be made specific by determining the subgame perfect equilibrium of the model with the method of backward induction. The choice of coordination mechanism in the second stage of the game is therefore addressed first, given the choice of governance structure. Subsequently, the choice of governance structure is addressed, anticipating the equilibrium choice of coordination mechanism in the next stage of the game. The choice of coordination mechanism in a cooperative is entirely guided by the size of the total surplus. We have therefore

Proposition 1: The choice of coordination mechanism in a cooperative is efficient.

This proposition is consistent with the findings of Flaherty (1981). If the relation between upstream and downstream unit is expected to endure for a long time and if it is expected to require much renegotiation at each point in time because a lot of uncertainties are involved, then financial integration may generate more joint profits. For a cooperative, the expected payoffs of making a guess of B or T are identical, given the choice of coordination mechanism. The expected payoff is (2A+B+C+D)/2 when the price mechanism is chosen, while it is (2A+2B+D)/2 when the quantity mechanism is adopted. Both mechanisms generate the same surplus when the guess turns out to be right, but the surplus differs when the guess is wrong. The deadweight loss is B in case of the price mechanism and C when the quantity mechanism is used. We have therefore that the total surplus generated by a cooperative with the price instrument is higher (lower) than the total surplus generated by a cooperative with the quantity instrument when C>B (C<B). It can be shown (Weitzman, 1974; Milgrom and Roberts, 1992) that C>B (C<B) corresponds with the slope of the MR being more (less) steep than the slope of the MC. Denote the slope of the MR as S^{MR} and the slope of the MC as S^{MC}. This result is summarized in proposition 2.

Proposition 2: A cooperative will choose the price (quantity) mechanism when $S^{MR} > S^{MC}$ ($S^{MR} < S^{MC}$).

This result indicates that a market mechanism like the price can be efficiently used in addition to hierarchy within a single firm, i.e. even if property rights over assets are not assigned to difference actors. There are situations where either price or quantity must be used to minimize losses in net joint profits.

It is obvious that the choice of coordination mechanism in an IOF is not always efficient because it is based only on the downstream payoff rather than total surplus. For example, payoff G (figure 3) is never taken into account by the processor. The extensive form in figure 4 reveals immediately that the quantity instrument performs better from the processor's point of view. The processor receives the same payoffs when the guess turns out to be right, but her payoff will be strictly lower with the price instrument when the guess is wrong because a larger share of the surplus goes to the upstream farmer. This result is formulated in proposition 3.

Proposition 3: An IOF will choose the quantity mechanism.

Figure 5 visualizes the insight of propositions 2 and 3. The choice of coordination mechanism by each governance structure is presented in terms of S^{MR} and S^{MC}, where j^i represents the choice of coordination mechanism j (Q or P) by governance structure i (C for cooperative or F for IOF).

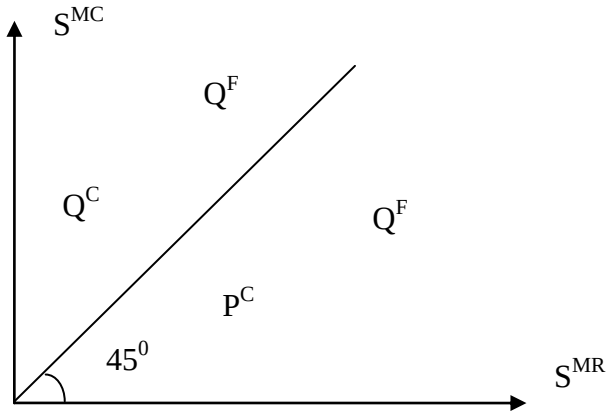

Figure 5: Choice of coordination mechanism

An IOF chooses a coordination mechanism based on the downstream surplus it acquires. Therefore the choice is not necessarily optimal in terms of total surplus. Yet an efficient coordination mechanism can be chosen if both the downstream surplus and the total surplus generated with a certain mechanism are higher than those with the other mechanism. We know already from proposition 3 that the downstream surplus associated with quantity control is higher than that associated with price control. So we investigate next if and when the total surplus associated with quantity control exceeds that associated with price control. The total surplus of an upstream farmer and an IOF processor can be represented by the area of 2A+B+2C+2D+2E+F+G+H when the price control is applied and by the area of 2A+2B+2C+3D+2E+H when the quantity control is used. It can be shown that the quantity control is more attractive than the price control when $S^{MR} > S^{MC}$. This result is stated in proposition 4.

Proposition 4: The choice of coordination mechanism in an IOF is efficient when $S^{MR} > S^{MC}$.

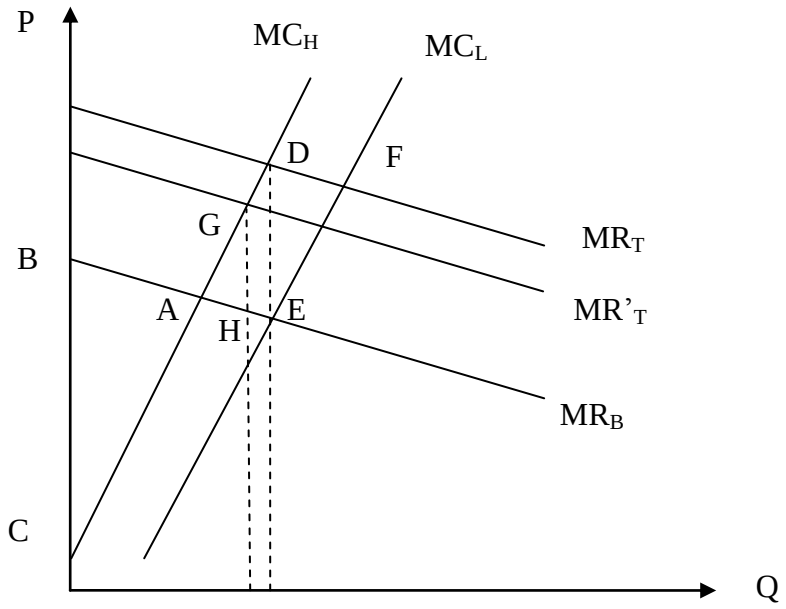

Figure 6: An illustration of total surplus generated in two governance structures

Having determined the efficient coordination mechanism choice for each governance structure, we identify next the efficient governance structure. It will depend on the choice of coordination mechanism and the extent to which MR or MC is over/under estimated. The argument is presented for the case where $S^{MR} < S^{MC}$ and MC_H and MR_B are the true MC and MR curves (figure 6). Denote the vertical distance between the actual and estimated MC as ΔC and that between the actual and estimated MR as ΔR. Notice that (line segment DE implies that) ΔC is taken to be equal to ΔR in figure 6. According to proposition 2, a cooperative will choose the quantity mechanism when $S^{MR} < S^{MC}$, and the total surplus can be represented by the area of ABC-ADE. According to proposition 3, an IOF will always choose the quantity control and the total surplus can also be represented by the area of ABC-ADE. That is, a cooperative and an IOF are equally efficient when $\Delta C = \Delta R$.

Suppose the cooperative's information about the MR is more accurate, i.e. $\Delta R < \Delta C$. It is represented in figure 6 by a downward shift of the estimate MR curve to MR'_T. The total surplus increases to ABC-AGH, making a cooperative uniquely efficient. Likewise, an IOF will become uniquely efficient if its information about the MC becomes more accurate, i.e. $\Delta R > \Delta C$. It can be shown in a similar manner

that when $S^{MR} > S^{MC}$, a cooperative is uniquely efficient if $\Delta R < (S^{MR} / S^{MC}) * \Delta C$ and an IOF is uniquely efficient if $\Delta R > (S^{MR} / S^{MC}) * \Delta C$[4]. This result is summarized in proposition 5.

Proposition 5: When $S^{MR} < S^{MC}$, a cooperative (an IOF) is uniquely efficient if $\Delta R < \Delta C$ ($\Delta R > \Delta C$); when $S^{MR} > S^{MC}$, a cooperative is uniquely efficient if $\Delta R < (S^{MR} / S^{MC}) * \Delta C$ and an IOF is uniquely efficient if $\Delta R > (S^{MR} / S^{MC}) * \Delta C$.

We have shown earlier that the choice of coordination mechanism in a cooperative is efficient (proposition 1), whereas it is not always in an IOF. However, a loss of surplus is associated with both coordination mechanisms. This is inevitable due to the lack of information. The cooperative lacks information regarding MR, whereas the IOF lacks information regarding the MC. An IOF may therefore be an efficient governance structure when its estimate of MC is more accurate compared to a cooperative's estimate of MR, despite its choice of coordination mechanism being inefficient.

5 Conclusions

The coordination mechanism choice in cooperative and IOF and the efficiency of the two governance structures is analyzed. Due to the "owner as user" characteristic, a cooperative internalizes the vertical externalities between upstream producers and the downstream processor, maximizing their joint profits, and will adopt therefore the efficient coordination mechanism. This contrasts with IOFs, where the coordination mode linking the upstream and downstream units is not always efficient. The slope of the MC and MR determines whether the price or quantity control is adopted. Each governance structure can be uniquely efficient, which depends on the importance of lacking information upstream or downstream. It is undoubtedly worthwhile to test the propositions. Even though a general prediction on governance structure or coordination mechanism requires examining all the activities performed by the constituent units and all the relevant conditions, we expect that a good prediction may be made by studying only the most important attributes. However, we leave careful testing for later, we proceed to list some extensions to the theory required to make it more useful and closer to the real practices.

There are various possibilities for future research regarding the relationship between coordination and governance structure. We indicate two. First, a simplifying assumption of our model is that there are physical communication constraints between the producers and the processors, which limits information transmission between the party that is best informed and the party with a natural disadvantage. An obvious way to enrich the model is to incorporate the informational flow. The cooperative 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), rendering better vertical information transmission in a cooperative than in an IOF. This suggests an additional advantage of coordination by cooperatives. One can go even further to examine the conditions under which the costly communication is worthwhile. Second, a cooperative is characterized by a processor (or wholesaler, or retailer) being owned by an upstream party (vertical relationship), where the upstream party consists of an association of many independent growers (horizontal relationship). This article has addressed coordination issues regarding the vertical relationship. Hart and Holmstrom (2010) address issues regarding governance and coordination between units that have a lateral relationship. Future efforts might be fruitfully devoted to investigating how the vertical alignment interacts with the horizontal coordination between the members.

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[4] The ratio of the two slopes shows up only when $S^{MR} > S^{MC}$ due to the fact that a cooperative and an IOF use different coordination mechanism while they both use quantity control when $S^{MR} < S^{MC}$.

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