409

XIAO PENG

Innovation, Member Sorting, and Evaluation of Agricultural Cooperatives

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ERIM

Innovation, Member Sorting, and Evaluation of Agricultural Cooperatives

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Innovatie, ledenbestand, en evaluatie van coöperaies

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My PhD journey is close to the end, yet another new journey has begun. Looking back at this journey, a lot of efforts and supports have been essential for my achievements.

To begin my PhD story, I have to start five years ago. After I obtained my master diploma in China, I had a strong feeling that it was not the end, something more was waiting for me to experience, to conquer. After some preparations, I was accepted by Erasmus as a PhD candidate. My PhD journey in the Netherlands started from then.

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My PhD journey is completed, yet another new journey is started, and I am ready to carry on.

Xiao Peng
2016

Table of Content

List of Figures v

List of Tables vii

Chapter 1 Introduction 1

1.1 Background knowledge 1

1.2 Research topics in cooperatives 4

1.3 Declaration of contribution 6

1.4 Outline of the thesis 6

Chapter 2 Communication and Innovation in Cooperatives 9

Abstract 9

2.1 Introduction 10

2.2 De Producent and Harvest House 14

2.3 Model 18

2.4 Equilibrium 20

2.4.1 Decentralized cooperative 20

2.4.2 Centralized cooperative 22

2.4.3 Comparative statics 24

2.5 De Producent versus Harvest House 30

2.6 Conclusion and future research 34

Chapter 3 Cooperatives and Investor-Owned Firms in a Member Sorting Model 37

Abstract 37

3.1 Introduction 38

3.2 Model 42

3.3 Equilibrium 44

3.3.1 Production choices 45

3.3.2 Governance structure choices 50

3.3.3 Enterprise choices 53
3.4 Profit maximizing IOF 54
3.4.1 Profit maximizing price policy of the IOF 55
3.4.2 Governance structure choices 60
3.4.3 Enterprise choices 62
3.5 Conclusion 62
Chapter 4 CEOs versus Members' Evaluation of Cooperative Performance — Evidence from China 65
Abstract 65
4.1 Introduction 66
4.2 Hypotheses 69
4.2.1 CEO versus Member Evaluation of Cooperatives 69
4.2.2 Financial and Social Performance of Cooperatives 72
4.3 Methodology 75
4.4 Analysis 77
4.5 Exploration of associated factor 80
4.6 Conclusions 87
Chapter 5 Summary and Conclusion 89
Summary 95
Samenvatting 97
References 99
Appendix 109
About the author 145

List of Figures

Figure 1.1: Outline of the thesis 7
Figure 2.1: Conceptual model 13
Figure 2.2: Communication in the cooperative 18
Figure 2.3: The three-stage game 19
Figure 2.4: Best-response functions 21
Figure 2.5: Comparison of HC and VC levels in the two governance structures 28
Figure 2.6: Comparison of production levels in the two cooperatives 29
Figure 2.7: Comparison of profit levels in the two cooperatives 30
Figure 2.8: De Producent and Harvest House in terms of *r, k, d, A* 32
Figure 2.9: De Producent versus Harvest House 33
Figure 3.1: Positioning of a farmer f and the enterprises in the market 42
Figure 3.2: The sequence of decisions 44
Figure 3.3: Production choices of the farmers in an IOF market structure 46
Figure 3.4: Production choices of the farmers in a mixed market structure 48
Figure 3.5: Coop market structure 49
Figure 3.6: The three market structures when $\beta = 0.5$ and $\delta = 1$ 50
Figure 3.7: The three market structures when $\beta = 0.905$ and $\delta = 1$ 51
Figure 3.8: The three market structures when $\beta = 1$ and $\delta = 1$ 52
Figure 3.9: Equilibrium governance structures in the market (β, δ) 53
Figure 3.10: Reaction functions around $(\beta_0^*, \beta_1^*) = \left(\frac{1}{2}, \frac{1}{2}\right)$ 57
Figure 3.11: IOF market structure 57
Figure 3.12: Mixed duopoly market structure 59
Figure 1: The three market structures when $\beta = 1.5$ and $\delta = 2$ 118
Figure 2: The three market structures when $\beta = 1.6$ and $\delta = 2$ 120
Figure 3: The three market structures when $\beta = 1.7$ and $\delta = 2$ 121
Figure 4: The three market structures when $\beta = 0.17$ and $\delta = 0.2$ 123
Figure 5: The three market structures when $\beta = 0.19$ and $\delta = 0.2$ 124

Figure 6: The three market structures when $\beta = 7$ and $\delta = 10$ 125
Figure 7: The three market structures when $\beta = 8$ and $\delta = 10$ 126
Figure 8: Mixed market and Coop market ($0 < \delta \leq 1$) 133
Figure 9: Farmers choices ($0 < \delta \leq 1$) 134
Figure 10: Mixed market and Coop market ($\delta = 1.5$) 134
Figure 11: Farmers choices ($\delta = 1.5$) 135
Figure 12: Mixed market and Coop market ($\delta = 3$) 136
Figure 13: Farmers choices ($\delta = 3$) 137
Figure 14: Mixed market and Coop market ($\delta = 15$) 137
Figure 15: Farmers choices ($\delta = 15$) 138

List of Tables

Table 2.1: De Producent versus Harvest House 17
Table 2.2: Equilibrium choices and payoffs in the decentralized/centralized cooperative 23
Table 2.3: Comparison of parameters between De Producent and Harvest House 31
Table 4.1: Measure of the dependent variables 77
Table 4.2: Correlation between reported performance and the archival performance . 77
Table 4.3: Descriptive statistics of performance Evaluation by CEOs and Members . 78
Table 4.4: Paired t-test regarding CEOs versus members evaluation of overall performance 79
Table 4.5: Paired t-test regarding CEOs versus members evaluation of member profitability 79
Table 4.6: Paired t-test regarding CEOs versus members evaluation of social influence 80
Table 4.7: Explanations and measures of independent variables 81
Table 4.8: Descriptive statistics 82
Table 4.9: Correlation matrix 84
Table 4.10: Factors which influence the evaluations 86
Table 1: Payoffs calculation steps in decentralized and centralized cooperatives (given HC and VC) 109
Table 2: Payoffs calculation steps in decentralized and centralized cooperatives (given HC) 110
Table 3: Payoffs calculation steps in decentralized and centralized cooperatives 112
Table 4: The associated factors regarding the evaluation of social influence by the CEOs 139
Table 5: The associated factors regarding the evaluation of social influence by the CEOs (with robustness check) 139

Table 6: The associated factors regarding the difference evaluation of social influence 140
Table 7: The associated factors regarding the difference evaluation of social influence (with robustness check) 140
Table 8: The associated factors regarding the difference evaluation of overall performance 141
Table 9: The associated factors regarding the difference evaluation of overall performance (with robustness check) 141
Table 10: VIF test with the evaluation of the social influence by the CEOs as the dependent variable 142
Table 11: VIF test with the difference of social influence evaluation as the dependent variable 142
Table 12: VIF test with the difference of overall evaluation as the dependent variable 142

Chapter 1

Introduction

This chapter provides an overall introduction to the thesis, including the relevant background knowledge of cooperatives (1.1), the introduction to the topics and concepts in cooperatives (1.2), the declaration of contribution (1.3), and the outline of this thesis (1.4).

1.1 Background knowledge

Cooperatives have always been an important governance structure. Dating back to early civilizations in Egypt and China around 1,500-1,300 BC, agricultural products were already exchanged and sold in cooperatives in Babylonia (Groeneveld, 2015). Recently, the 2015 World Co-operative Monitor shows that the top 300 cooperatives covers 25 countries, and generate total turnover of USD $2,360.05bn ("International Co-operative Alliance," 2015). A cooperative is characterized as a member-owned, member-used and member-controlled enterprise (Nilsson, Pyykkönen, Ollila, Bäckman, & Kauriinoja, 2012). Generally there are two main definitions about the cooperative. The first definition focuses on the enterprise: "an enterprise collectively owned by many

independent suppliers/buyers" (Hendrikse & Feng, 2013, p511). This firm view suggests that a cooperative is itself a business enterprise and an economic entity (Helmberger & Hoos, 1962, p290; Robotka, 1947, p103). The second definition focuses on the members: "an association of many independent parties (horizontal relationship) who jointly own an upstream/downstream party (vertical relationship)" (Hendrikse & Feng, 2013, p502). These two definitions have in common that two parts of a supply chain are present in a cooperative. It entails that "several stages in the production process are brought under one entrepreneurial control" (Phillips, 1953, p79). Therefore, a successful cooperative is seen as two worlds working together in one organization (Bijman, Hendrikse, & Van Oijen, 2013).

From the organizational structure point of view, a cooperative consists of two organizational layers: a society of members and an enterprise which is jointly owned by the members (Helmberger & Hoos, 1962). Similarly, "the double nature" of cooperatives elaborated by Georg (1955, p16), who argued that every cooperative represents simultaneously: 1) an association of all cooperative members in the sense of sociology and social psychology, i.e., a social group, and 2) a joint enterprise, owned and operated by the same members of the group (Valentinov, 2005). As the agricultural cooperative is growing, the director board is authorized by all the members to represent all the member interests. Moreover, due to most agricultural cooperative members are farmers without specialized financial or marketing knowledge, outside experts are hired to bring additional management expertise for managing and operating the enterprise. As the result of these changes, the organizational structure is also changed: a board of directors is democratically chosen by the members to represent and serve member interests. It governs the activities and chooses investments; there is a professional management team hired to carry out the operational management of the joined cooperative enterprise. In large cooperatives, the agency[1] relationship between board and manager team is changing. The professional management increasingly plays a more

[1] Agency theory (Shleifer & Vishny, 1997) captures prominently the advantages of delegating decision-making by having a principal assigning a task, or multiple tasks, to an agent.

important role, not only by making most strategic and operational decisions, pushing the board into a supervisory role (Bijman et al., 2013), but also interacting more regularly with the society of the members.

Owners of a cooperative can be providers of capital, suppliers, demanders, workers, government, or others (Hansmann, 2009). In this dissertation, we study the suppliers as owners of the cooperative, i.e. a marketing cooperative. The cooperative's main function is processing the products from the suppliers and selling them to customers. For example, a milk cooperative is collectively owned by many independent farmers. Marketing cooperatives have several advantages: bargaining power, knowledge of the market, effectiveness in innovation, competitive yardstick effect, horizontal and vertical coordination, adaptation advantages, etc. (e.g. Liang & Hendrikse, 2016, Deng, 2015, Feng, 2011).

A comparative institutional approach is adopted in this dissertation. It compares the behavior of two prominent governance structures in agribusiness: Cooperative (Coop) and investor-owned firm (IOF). Behavior is expected to differ because members of a cooperative have a transaction relationship and ownership relationship with the (cooperative) enterprise, whereas shareholders of an IOF have only an ownership relationship with the (investor-owned) enterprise (Barton, 1989; Bijman et al., 2013; Hansmann, 2009). Therefore the transaction relationship within the organization is expected to differ between a Coop and an IOF. IOFs and Coops have their own (dis)advantages. Cook (1995) formulates five problems of cooperatives: free rider problem (members tend to use the resources of a Coop for their individual benefits); horizon problem (when a member's residual claim on the net income generated by an asset is shorter than the productive life of that asset); portfolio problem (members adjust their cooperative asset portfolios to match their personal risk preferences); control problem (the different interests between the membership and their board of directors (principal) and management (agent) in a Coop); influence costs problem (members attempt to influence the decision of the cooperative when organizational decisions affect the distribution of benefits among members).

However, a Coop has also several benefits compared to an IOF. One advantage of a Coop is the elimination of the (double monopoly) markup, i.e. 'service at cost' (Hendrikse & Feng, 2013). It entails a transfer price equal to marginal cost between the member farmer and the cooperative, while a transaction price consisting of the marginal cost and a markup arises when there is a market relationship, i.e. a farmer and an IOF. Hess, Lind, & Liang (2013) provide evidence that the transaction costs increase when pig farmers deal with IOFs rather than with Coops. Furthermore, coordination and pooling in Coops increase the stability of the payment to members (Dunn, Ingalsbe, & Armstrong, 1979; Liang & Hendrikse, 2016). Lastly, Spear (2004) summarized some social advantages of Coop. A Coop has fewer contract/agency problems compare to an IOF, because the members have strong incentives to monitor and control the management. Moreover, members may get additional social benefits just from trading within their own organization. Some of the social benefits of Coop are trust in the Coop, participation in the democratic process, and a strong territorial network. Hirschman (1970) also states that a Coop can offer benefits in terms of access to services and "voice" or influence in the production chain.

1.2 Research topics in cooperatives

This section presents an introduction to the topics of the dissertation: innovation, member sorting, and the evaluation of cooperatives.

The first research topic is communication and innovation in cooperatives. Cooperatives differ in their intensity of horizontal and vertical communication, their innovation policies, and their centralization of decision-making power. We aim to establish relationships between these communication, innovation, and decision-making aspects of cooperatives, and to identify the circumstances when a particular configuration adds most value. Horizontal communication (HC) is characterized as exchange of information between farmers in the society of members. It is associated with process innovation. Vertical communication (VC) is the exchange of information between a member and the CEO of the cooperative enterprise. It is associated with product

innovation. Horizontal and vertical communication are analyzed in a decentralized and centralized cooperative. The CEO decides regarding the deliveries of the member and the level of vertical communication in the centralized cooperative, while these decisions are taken by the members in the decentralized cooperative. We establish that the decentralized cooperative is efficient at an intermediate level of the VC cost coefficient and when the HC cost coefficient is above a certain level, while the centralized cooperative is efficient in the other cases.

The second research topic addresses how heterogeneous farmers in terms of location and quality sort themselves across processor enterprises. The processor enterprise can be either a cooperative (Coop) or an investor-owned firm (IOF). The Coop pays a uniform price to all farmers to maximize members' revenue and retains no profits, whereas the IOF differentiates payments based on quality and maximizes profits. The governance structure of each enterprise in a duopoly market is determined by majority voting. A three-stage game is developed to address the sorting of farmers, the choice of governance structure at the processor enterprise, and the production choices of the farmers. In equilibrium a farmer tends to choose the enterprise most close to him/her, and a farmer with a high quality product tends to choose an IOF. We establish that the Coop (mixed, IOF) market is the equilibrium market structure when the payment for quality by the IOF is low (intermediate, high).

The last research topic is the evaluation of cooperative performance. The management and the society of members in cooperatives may have different evaluations. Understanding these evaluations can help CEOs to formulate strategies that best serve the membership and keep the cooperatives successful. Therefore, we investigate whether there are differences between CEO's and members' evaluations regarding cooperative performance, and what are the differences. A survey of Chinese agricultural cooperatives in Zhejiang Province (240 CEOs and 543 members) was conducted. Cooperative performance is measured by three indicators: member profitability, social influence in the local community, and overall performance (Franken & Cook, 2015). The results show that both CEOs and members agree that their cooperatives are

successful. However, members have higher scores than CEOs regarding member profitability and overall performance, while CEOs have a higher evaluation regarding social influence. The results also show that the number of general meetings and CEOs' age decrease the difference of evaluations. Male CEOs are more likely to evaluate more positive than female CEOs. Moreover female CEOs and members tend to have more similar evaluations.

1.3 Declaration of contribution

In this section, I declare my contribution to the different chapters of this thesis and also acknowledge the contribution of other parties.

This thesis is written by the author independently. Some inputs and feedbacks of the promoter and coauthors are implemented in different chapters. Introduction (Chapter 1) and conclusion (Chapter 5) of the thesis are written by the author with the implementation of the promoter's feedback. Three papers in this thesis (Chapter 2, Chapter 3 and Chapter 4) are written independently by the author and with the implementation of the feedbacks from coauthors. The data used in chapter 4 is collected through Zhejiang University China.

1.4 Outline of the thesis

The thesis is comprised of five chapters. The structure of the thesis is presented in Figure 1.1. In **Chapter 2** we highlight communication and innovation in cooperatives. A member sorting model is investigated in **Chapter 3**. In **Chapter 4**, we examine the CEO's versus members' evaluation of coops. Finally, we summarize the main findings from the research in **Chapter 5**.

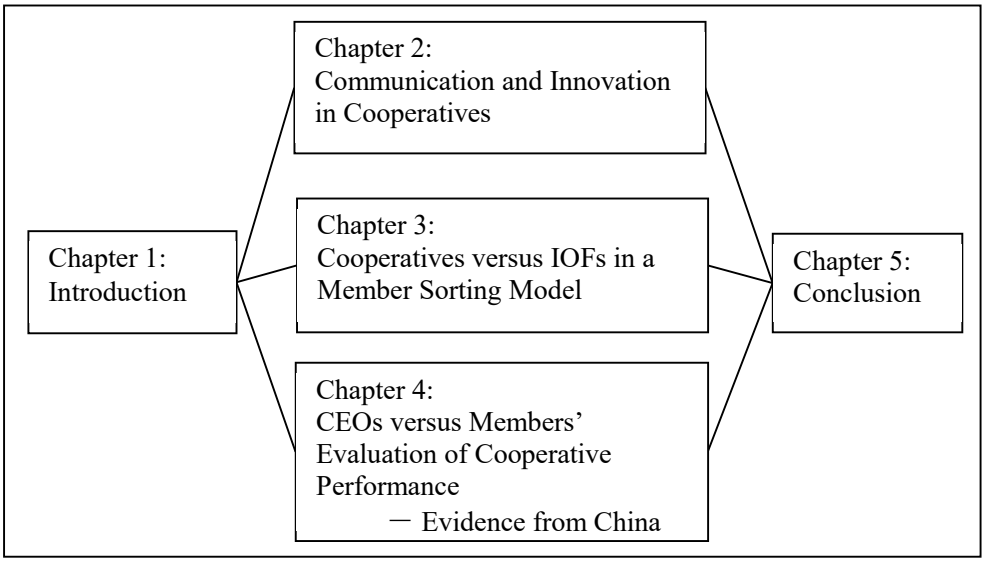

Figure 1.1: Outline of the thesis

Chapter 2

Communication and Innovation in Cooperatives[2]

Abstract

Cooperatives differ in their intensity of horizontal and vertical communication, their innovation policies, and their centralization of decision-making power. We aim to establish relationships between these communication, innovation, and decision-making aspects of cooperatives, and to identify the circumstances when a particular configuration adds most value. Horizontal and vertical communication are analyzed in a decentralized and centralized cooperative. Horizontal communication (HC) is characterized as exchange of information between farmers in the society of members. It is associated with process innovation. Vertical communication (VC) is the exchange of information between a member and the CEO of the cooperative enterprise. It is associated with product innovation. The CEO decides regarding the deliveries of the member and the level of vertical communication in the centralized cooperative, while these decisions are taken by the members in the decentralized cooperative. We establish

[2] A version of this chapter was accepted by Journal of the Knowledge Economy.

that the decentralized cooperative is efficient at an intermediate level of the VC cost coefficient and when the HC cost coefficient is above a certain level, while the centralized cooperative is efficient in the other cases.

Keywords: Agricultural cooperatives, communication, innovation, decentralization

2.1 Introduction

The organizational communication literature establishes that communication is one crucial element of organizational governance (Christensen & Cornelissen, 2011; Jablin & Putnam, 2001). White (1997) states that organizations can themselves be regarded as communication structures. Organizations cannot exist without communication, i.e., they come into existence in the interaction that takes place between organizational members and as a result of the communication between them. The wholeness of an organization shows a consistent and coherent image of what the organization is. Communication brings every part of the organization to the same level of understanding, and therefore allows the organization to achieve consistency and coherence (Schultz, Tannenbaum, & Lauterborn, 1994).

This paper analyses communication in cooperatives. A cooperative is an enterprise collectively owned by a society of members having a transaction relationship with it (Helmberger & Hoos, 1962; Hendrikse & Feng, 2013; Robotka, 1947). The cooperative's main function is to process the products from its members and then sell them to the customers. However, members are themselves business enterprises and economic units. An agricultural cooperative is therefore an enterprise collectively owned (vertical relationship) by an association of many independent upstream agricultural producer enterprises (horizontal relationship). Communication is essential to keep the cooperative working in the members' interests. Members who lack understanding of its practices are likely to have a negative attitude towards their cooperative, and this may cause poor performance (Goodman, 1994). Not only the

communication among the members themselves, but also the communication between the members and the cooperative management is important (Cechin, Bijman, Pascucci, & Omta, 2013).

Cremer, Garicano, & Prat (2007) and Garicano & Wu (2012) provide an organizational economics explanation of communication within an organization. They distinguish HC and VC. HC is defined as peer-to-peer communication among specialists with common codes, or overlapping knowledge, to share information in order to solve problems efficiently, which cannot be done by a single specialist with limited knowledge. VC is defined as communication between the peers and an external higher up "translators". Only when the knowledge is beyond the field of the specialists and costly to codify, does VC become necessary to facilitate the matching between problems and solutions. Patrucco (2008) also mentioned that the technical communication between the internal investments in R&D and the technologies provided by an external party is a crucial strategy for increasing returns in the production of knowledge.

These two types of communication have an impact on different types of innovation. HC is defined as the information exchange between farmers about their production methods. Farmers communicate with each other to share their production knowledge. This may decrease their own (marginal) production costs at the upstream stage of production. From the innovation perspective, this belongs to individual (small scale) innovation (Braguinsky & Rose, 2009; Pelz, Munson, & Jenstrom, 1978). We therefore associate HC with process innovation. VC is the communication between the member farmers (with superior production knowledge) and the CEO (with superior marketing experience in order to improve product quality). When the cooperative takes more responsibilities for the product than simply product sale, product innovation is gradually taken over by the CEO. Product innovation activities include quality control and development of new varieties in order to increase the price and demand in the market at the final stage of production. From the innovation perspective, this belongs to group (big scale) innovation (Pelz et al., 1978). We associate therefore VC with product innovation. Specifically, the farmers and the CEO exchange information about the development of

the product. On the one hand, the CEO organizes the research regarding the product from the customer perspective and sets up a research unit to develop the new production method. He is important in deciding what the farmers produce and then shares the technological knowledge with the farmers. On the other hand, the farmers provide feedback from the field, and collaborate with the CEO regarding product development. To summarize, the concept of HC and VC in this paper relates to two perspectives: 1) HC and VC reflect the horizontal relationship and vertical relationship in a cooperative organization; 2) HC and VC contribute to different types of innovation.

Observing the history of agricultural cooperatives, many governance structures have been adopted in this organization. Bijman, Hendrikse and Oijen (2013) discuss the governance structure in cooperatives regarding the allocation of decision right between the board of directors (representing the members) and the professional management. Chaddad and Iliopoulos (2013) also address the delegation of formal and real authority to non-patron, professional managers as a key to improving the efficiency of collective decision-making in cooperatives. In this paper, we study communication in two structures: decentralized and centralized cooperatives. We define (de)centralization in terms of the allocation of decision rights regarding innovation and production. Farmers decide regarding their own product innovation and production in a decentralized structure, while the farmers authorize the CEO to make product innovation and production decisions for the cooperative in a centralized structure.

Alonso, Dessein and Matouschek (2008) compare centralized and decentralized coordination when managers communicate strategically. They distinguish HC as communication between the division managers and VC as communication between the division managers and the headquarter. Moreover, HC emerges when coordination is decentralized, while VC emerges when coordination is centralized. The result shows that a higher need for coordination can improve HC in a decentralized structure but goes at the expense of centralization benefits. Specifically, under decentralization, an increase in the need for coordination makes the managers more willing to listen to each other to avoid costly coordination failures. In contrast, under centralization, when coordination

becomes more important, the headquarter increasingly ignores the division managers' information about their own divisions. This induces each manager to exaggerate his case more, which, in turn, leads to less information being exchanged. Unlike Alonso et al. (2008), we propose HC and VC exist in both structures, and we compared the level of HC and VC in the two structures. Moreover, we relate HC and VC to process and product innovation.

We examine how HC and VC contribute to process and product innovation, and how it differs between decentralized and centralized cooperatives. The role of VC is to increase final product demand by product innovation, while HC leads to upstream process innovation by decreasing production cost. The conceptual model linking the variables is presented in Figure 2.1. It is in line with the framework presented by (Williamson, 2000) in the sense that short run decisions are embedded in long run decisions. However, we provide more details by highlighting and positioning the role of communication. Two questions are addressed. First, how do the communication and production decisions differ between the two governance structures? Second, what determines the efficient governance structure? In order to answer these questions, we develop a three-stage non-cooperative model with two farmers and a CEO. In the first stage, the efficient governance structure is determined; in the second stage, the HC and VC levels are decided; in the last stage the production level is determined.

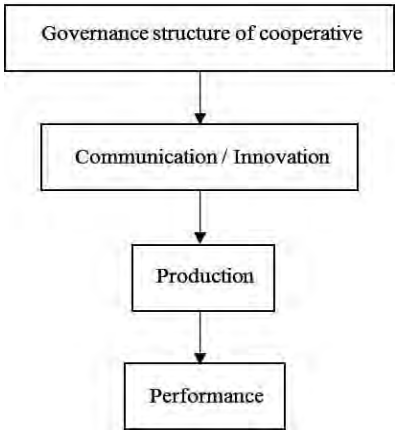

Figure 2.1: Conceptual model

The paper is organized as follows. Section 2 presents two cases of cooperatives to illustrate the relevance of different communication structures. Section 3 presents the model regarding HC and VC. Section 4 derives the equilibrium production and communication levels, and determines the efficient governance structure. Section 5 relates the two cases to the model. Finally, conclusions are formulated in section 6.

2.2 De Producent and Harvest House

We present a description of two cooperatives to illustrate the relevance of different types of innovation, communication, and the relationship with decision-making.[3]

De Producent

De Producent is a cheese cooperative. The turnover of De Producent was around 11 million euros in 2013. De Producent consists of 40 large members and 10 small, none-active members. The membership is therefore homogeneous. They are individual farmers located in a radius of 100km around Gouda. The dairy farmers produce their own cheese, while the storage/processing of the cheese and the transportation of the cheeses to wholesalers and retailers are done by the cooperative.

The decision structure of this cooperative can be characterized as centralized. The current general manager is not a farmer member. Instead, he is a professional manager with years of experience in the agricultural industry. Substantial decision power is delegated to the general manager, including the day-to-day operational decisions and the decision of whether to increase the cheese delivery of a member in the next year. He formulates a proposal regarding the retained earnings percentage, which is to be approved in the General Assembly meeting. The members are obligated to deliver 100% of their cheese to the cooperative. This bylaw has been in place since the birth of the cooperative. However, the general manager mentioned that “I am not a policeman”. If

[3] We visited cooperative De Producent on April 28, 2014 and talked with Director Jacco Bot. We visited cooperative Harvest House on January 23, 2015 and talked with General Director Jelte van Kammen and Financial Director Fons van der Vleuten.

outside delivery is detected, the management will just talk to the member and no financial punishment is imposed.

The cooperative pays substantial attention to product innovation. The cheese quality is independently checked by two fulltime employees based on three criteria: shape, taste, and consistency. The quality is also monitored. Each farm is checked approximately 2 full days a year by the two employees, and quality improvement advice is provided by a quality enhancement program. Via these measures, the cooperative helps members to improve the production process at the farm. Next to the quality innovation, a research team is organized for developing new products with new flavors. Usually, the cooperative will select two members to trial the production of a new product. After that, it spreads the production technology to all members.

There is a lot of communication between the general manager and the members, i.e., VC is intense. The cooperative sends a “weekly quality form” to every farmer. According to the general manager, “the cooperative is transparent about everything and farmers can check everything”. The general manager spends 50% of his time in communicating with the members, largely via phone calls and farm visits. The members do not like to use internet. The members trust the general manager/cooperative and share information with the cooperative. One important reason is that developing specialty cheeses has become financially very attractive, and therefore product innovation has gained in importance. The 40 active members know each other, but there is not much communication and information exchange between them. In fact, most of the farms grew to big enterprises in the past 10~15 years. Some of them have annual revenue of more than one million Euros. The growing size has limited communication between the farmers. Moreover, the CEO observes competition between members because everyone wants to deliver more cheese to the cooperative. It is known from the literature that the larger the number of participants in one project, the more direct the competition among them, and it leads to less information exchange concerning "precompetitive" data (Prosser, 1995).

Harvest House

Harvest House specializes in vegetables. It has 826 hectares under cultivation, and a turnover of 530 million euros in 2013. The membership consists of four product groups, and in total 67 growers. First, there are 52 paprika growers, including 5 large growers. Second, there are 11 tomato growers, including 5 large growers. Finally, there are 2 cucumber growers and 2 eggplant growers. The membership is therefore heterogeneous, within and between product groups.

The decision structure of this cooperative can be characterized as decentralized. A lot of decision power is not granted to the CEO by the farmers. The different product groups organize their own logistics and packaging centers. There is competition between these centers because they are allowed to choose between these centers. For instance, if one of the packaging companies within the cooperative is able to offer a lower price, other growers are free to choose its services. In this way, the packaging seems to be efficient (Bulow & Klemperer, 1996). Growers decide the quantity to be delivered, and the cooperative is obliged to sell them. The management is responsible for the quality control in the cooperative, but it does not command farmers about how to resolve a given quality problem. For example, the management may communicate to the grower that his product lacks certain taste characteristics, or may suffer from early perishability, but will leave it up to the grower to find a solution. The growers may of course consult with each other regarding such problems or raise an issue in the product committee. The reason for such allocation of control is the growers' better knowledge about the growing process and technology. Additionally, members are open to other growers' advice and continuously learn from each other.

Two product groups are set up for product related matters. When there is a problem regarding a product, the cooperative doesn't take the responsibility to resolve it. The members discuss with each other in order to find a solution themselves. It generates high commitment and trust in the coop community. It contributes to improving the products. Therefore, members take the innovation decisions regarding production processes and

product development. For example, some growers are involved in the product project Agriport A7. Agriport A7 is the site of a development project for large-scale greenhouse and open-field crop cultivation. The large-scale production of fresh vegetables, processing, and logistics have been clustered at Agriport A7, and it is considered the most modern agro-park in the world. Additionally, Harvest House focuses largely on sustainability, which is market-driven.

The coop provides many communication channels. Formally, the General Assembly meeting is organized two times a year. Once a month there is a product meeting, product groups attend the meeting and discuss price and quality and product competition issues. A newsletter is delivered to every member once a week, to report the weekly activities. Informally, the CEO visits every member once in a while. Besides, a digital platform is being built for better interaction within the coop. From the CEO's observation, HC is intensive and very much valued. Members themselves communicate a lot due to that they actively join the organizational activities and make most of the decisions. VC is relatively low because less information exchange is needed between the cooperative and the members.

Table 2.1 summarizes the differences between the two cooperatives.

Table 2.1: De Producent versus Harvest House

Attributes \ Case	**De Producent**	**Harvest House**
Product	Cheese	Vegetables
Turnover 2013	€11 million	€530 million
#Members	50	67
Member heterogeneity	Low	High
Governance structure	Centralized	Decentralized
Innovation support	High	Low
HC level	Low	High
VC level	High	Low

2.3 Model

Consider a cooperative in a monopolistic market. The cooperative consists of a CEO and two farmer members. Figure 2.2 shows the channels of communication in a cooperative. In the decentralized cooperative, farmer 1 chooses to communicate (h_1) with farmer 2 to improve his knowledge regarding his production process, i.e. process innovation. It results in reducing his production cost. The same decision has to be made by farmer 2 (h_2). The HC decisions h_1 and h_2 are made simultaneously. Meanwhile, farmers 1 and 2 have to choose the intensity of communication with the CEO (v_1 and v_2) to obtain knowledge regarding product innovation. Product innovation will increase the price of the products in the market. In the centralized cooperative, farmers 1 and 2 choose the intensity of the communication between each other to enable process innovation, while the CEO determines the product development by deciding the VC levels (v_1, v_2) for the cooperative.

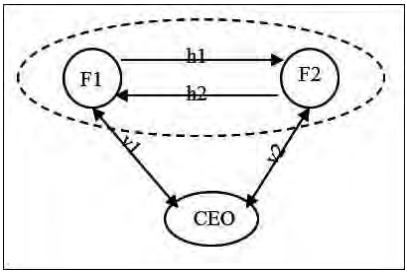

Figure 2.2: Communication in the cooperative

A three-stage game is developed to study HC and VC, innovation, and decision-making in a centralized and a decentralize cooperative. In the first stage, the governance structure decentralized (D) or centralized (C) cooperative is determined. In the second stage, the HC and VC decisions are determined simultaneously. Define h_i (v_i) as the level of HC (VC) regarding farmer i, where $i = 1, 2$. Define $\overline{h}$ ($\overline{v}$) as the average level of horizontal (vertical) communication. The HC decisions are taken by the farmers in both cooperatives, while farmers decide VC in the decentralized cooperative and the CEO is determining VC in the centralized cooperative. In the third stage, the farmers

choose their own level of production independently and simultaneously in the decentralized structure (q_1, q_2), while the CEO decides the production level q_1 and q_2 in the centralized structure. Figure 2.3 depicts the sequence of decisions.

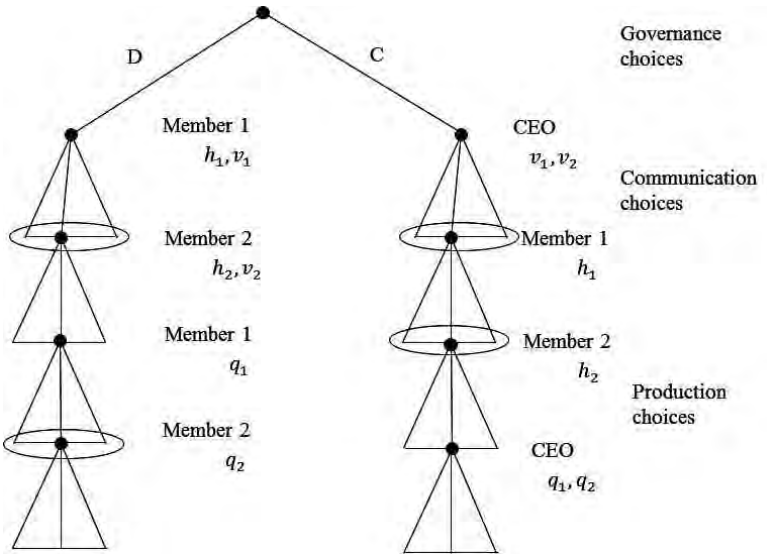

Figure 2.3: The three-stage game

The market demand function is inspired by the seminal product differentiation model of Mussa & Rosen (1978), which is summarized by Mérel, Saitone, & Sexton (2009). It is defined as $p = (\overline{v} + d) - Q$, where d (> 0) is the basic demand parameter and Q (> 0) is the quantity demanded. When v_1 (v_2) increases, more product innovation is created, and the consumers are willing to pay more for the new product.

Define the cost of VC as $V_i = \frac{1}{2} k v_i^2$, where $i = 1, 2$ and k is the VC cost coefficient $(k > 0)$. The second derivative of the cost of VC is $V_i'' = k$, i.e. the marginal cost of VC is increasing. V_i'' can be interpreted as the discretion of the farmer regarding the choice and execution of activities between the farm and the cooperative enterprise, like upgrading deliveries, facilitating transportation, and dealing with intermediate product peculiarities. A high value of k shows that additional VC is accompanied by a large increase in costs. An example is a bureaucratic organization (Milgrom & Roberts, 1992,

p122). In general, k will be smaller as the size of the membership is smaller, or when member homogeneity is higher.

The production cost of farmer i is $C_i = c_i q_i$. The farmers talk to each other in order to improve their production process. It decreases their (marginal) production cost. HC is therefore to be interpreted as process innovation by decreasing the members' marginal production cost to $c_i = A - h_i$ (Falvey, Poyago-Theotoky, & Teerasuwannajak, 2013), where A is a base cost (i.e., the production cost when there is no process innovation). It is assumed that process innovation cannot decrease the marginal production cost to zero, i.e. $0 < h_i < A$. Define the HC cost function for the farmer i as $H_i = \frac{1}{2} r h_i^2$, where r is the HC cost coefficient ($r > 0$). The payoff of farmer i is therefore $\pi_i = (\overline{v} + d - Q)q_i - c_i q_i - \frac{1}{2} r h_i^2 - \frac{1}{2} k v_i^2$.

2.4 Equilibrium

The concept of subgame perfect equilibrium is used to solve the game. We start therefore with determining the equilibrium production levels and communication levels in the decentralized cooperative (2.4.1) and the centralized cooperative (2.4.2). The mathematical details are presented in the appendix. Comparative statics results are formulated in section 2.4.3.

2.4.1 Decentralized cooperative

Production levels

In the final stage, each farmer determines his optimal production level by maximizing his own payoff. The first-order condition results in the best response functions

$q_1{}^*(q_2) = \frac{1}{2}(d - A + \overline{v} + h_1) - \frac{1}{2} q_2$

and

$q_2{}^*(q_1) = \frac{1}{2}(d - A + \overline{v} + h_2) - \frac{1}{2} q_1$.

The quantity competition between the enterprises is reflected in the negative slope of the reaction functions. Notice that the reaction function of farmer 1 (2) shifts outward as a function of v_1, v_2, h_1 (h_2).

The intersection of the reaction functions determines the Nash equilibrium production levels:

$q_1^* = \frac{1}{3}(d - A + \overline{v} + 2h_1 - h_2)$

and

$q_2^* = \frac{1}{3}(d - A + \overline{v} + 2h_2 - h_1)$.

The best-response functions of farmer 1 and farmer 2 and the equilibrium production levels are presented in Figure 2.4. Notice that q_1^* (q_2^*) is positively related to v_1, v_2, h_1 (h_2), and negatively related to h_2 (h_1).

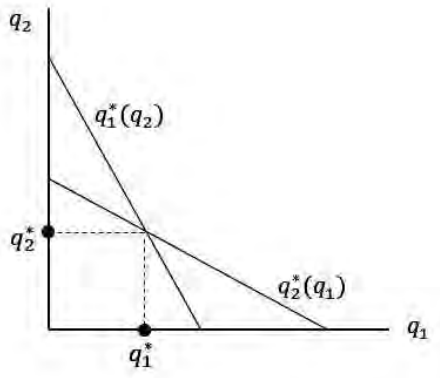

Figure 2.4: Best-response functions

Communication levels

The communication levels are determined in the second stage of the game.

Substituting q_1^*, q_2^* into π_1^* and π_2^*, and maximizing π_1^* and π_2^* with respect to the communication variables h_1, h_2, v_1 and v_2 results in four first-order conditions. The equilibrium levels of communication are

$h_1^*(k, r|D) = h_2^*(k, r|D) = \frac{4(d-A)}{r(9-1/k)-4}$

and

$v_1^*(k,r|D) = v_2^*(k,r|D) = \frac{(d-A)}{k(9-4/r)-1}$.

Substituting h_1^*, h_2^*, v_1^*, v_2^* into q_1^* and q_2^*, we obtain the Nash equilibrium production levels

$q_1^*(k,r|D) = q_2^*(k,r|D) = \frac{3(d-A)}{9-4/r-1/k}$.

Substituting the above results into the payoffs, we obtain the total payoff of the decentralized cooperative

$\pi^*(k,r|D) = \pi_1^* + \pi_2^* = \frac{(d-A)^2(18-16/r-1/k)}{(9-4/r-1/k)^2}$.

2.4.2 Centralized cooperative

The VC level is determined by the CEO and the cost is shared equally by the farmers, while the HC level is determined by each farmer and the cost is paid by each farmer. The CEO chooses the production levels q_1 and q_2 in order to maximize the payoff of the cooperative.

Production levels

The payoff of the cooperative can be written as

$\pi = \pi_1 + \pi_2 = (\overline{v} + d - Q)(q_1 + q_2) - c_1 q_1 - c_2 q_2 - \frac{1}{2} r h_1^2 - \frac{1}{2} r h_2^2 - \frac{1}{2} k (v_1 + v_2)^2$.

The payoffs of the farmers are

$\pi_1 = (\overline{v} + d - Q) q_1 - c_1 q_1 - \frac{1}{2} r h_1^2 - \frac{1}{4} k (v_1 + v_2)^2$,

$\pi_2 = (\overline{v} + d - Q) q_2 - c_2 q_2 - \frac{1}{2} r h_2^2 - \frac{1}{4} k (v_1 + v_2)^2$.

The first-order condition results in the best response functions

$q_1{}^*(q_2) = \frac{1}{2}(d - A + \overline{v} + h_1) - q_2$

and

$q_2{}^*(q_1) = \frac{1}{2}(d - A + \overline{v} + h_2) - q_1$.

Focusing on the symmetric equilibrium outcomes results in

$q_1{}^* = q_2{}^* = \frac{1}{4}\left(d - A + \overline{v} + \overline{h}\right)$.

Communication levels

Substituting $q_1{}^*$ and $q_2{}^*$ into π, π_1, π_2, farmers maximize their own payoffs with respect to h_1, h_2, while the CEO maximizes the total payoff with respect to v ($v = v_1 + v_2$). We get from the three first order conditions the equilibrium

$h_1^*(k, r|C) = h_2^*(k, r|C) = \frac{2(d-A)}{r(8-1/k)-2}$

and

$v^*(k, r|C) = \frac{2(d-A)}{k(8-2/r)-1}$.

Substituting the results back into q_1^* and q_2^*, we obtain the equilibrium centralized production level

$q_1{}^*(k, r|C) = q_2{}^*(k, r|C) = \frac{2(d-A)}{8-2/r-1/k}$.

Lastly, substitution of the above results in the total payoff of the centralized cooperative results in

$\pi^*(k, r|C) = \frac{2(d-A)^2}{8-2/r-1/k}$.

To summarize the equilibrium choices and payoffs, we list HC, VC, production and profit as functions of r and k in the (de)centralized structure in Table 2.2.

Table 2.2: Equilibrium choices and payoffs in the decentralized/centralized cooperative

Cooperative	**Decentralized structure**	**Centralized structure**
Production	$\frac{6(d-A)}{9-4/r-1/k}$	$\frac{4(d-A)}{8-2/r-1/k}$
HC	$\frac{8(d-A)}{r(9-1/k)-4}$	$\frac{4(d-A)}{r(8-1/k)-2}$
VC	$\frac{2(d-A)}{k(9-4/r)-1}$	$\frac{2(d-A)}{k(8-2/r)-1}$
Profit	$\frac{(d-A)^2(18-16/r-1/k)}{(9-4/r-1/k)^2}$	$\frac{2(d-A)^2}{8-2/r-1/k}$

In order to have meaningful result (by having positive values for all variables), assume that $d > A > 0$ and the parameters k, r satisfy $\begin{cases} \frac{1}{8} < k \leq \frac{1}{7}, r > \frac{2k}{8k-1} \\ \frac{1}{7} < k \leq \frac{1}{6}, r > \frac{4k}{9k-1} \\ k > \frac{1}{6}, r > \frac{16k}{18k-1} \end{cases}$.[4]

2.4.3 Comparative statics

This section formulates results regarding the level of production, HC, VC, and profit in the decentralized and centralized cooperatives. We start with formulating a result regarding the level of production and profit in the decentralized and centralized cooperative, given the HC and VC levels. First, the production level in the decentralized cooperative is $\frac{2}{3}(d - A + \overline{v} + \overline{h})$, and it is higher than the production level $\frac{1}{2}(d - A + \overline{v} + \overline{h})$ in the centralized cooperative.[5] This aligns with the overproduction problem of the decentralized cooperative (Albæk & Schultz, 1998). When farmers are making production decisions, they tend to produce more to achieve a higher payoff for themselves, ignoring the negative externalities for the entire membership. Proposition 1 states this result.

Proposition 1: *The production level is higher in the decentralized cooperative than in the centralized cooperative, given the levels of communication.*

The difference between the joint profit of the centralized cooperative and the decentralized cooperative is $\frac{1}{36}\left(d - A + \overline{v} + \overline{h}\right)^2 - k\overline{v}^2$, given the HC and VC levels. Therefore, given the communication levels, the centralized cooperative has a higher profit than the decentralized cooperative when k is small. The benefit of the centralized

[4] Given that $d - A > 0, r > 0, k > 0$, let both the denominators and the numerators be positive, we achieve $\begin{cases} \frac{1}{8} < k \leq \frac{1}{7}, r > \frac{2k}{8k-1} \\ \frac{1}{7} < k \leq \frac{1}{6}, r > \frac{4k}{9k-1} \\ k > \frac{1}{6}, r > \frac{16k}{18k-1} \end{cases}$.

[5] The proofs of the propositions are presented in the appendix.

cooperative is the internalization of the negative production externalities of individual profit maximization in the decentralized cooperative. However, when k is above a certain level, the centralized cooperative will have a lower profit than the decentralized cooperative due to the increasing marginal cost of VC. The reason is that the CEO is doing all the VC in the centralized cooperative and carries all the cost, while each farmer carries his own VC cost in the decentralized cooperative. The result is formulated in proposition 2.

Proposition 2: *The profit level is higher in the centralized cooperative than in the decentralized cooperative when k is small, given the levels of communication.*

The understanding of the results is facilitated by first addressing the relationship between VC and production. This is done by taking the HC equal to 0 in both cooperatives. We present the equilibrium VC, production, and profit levels in the proposition 3 – 5.

The difference between the level of VC in the centralized and decentralized cooperative is determined by the trade-off in the decentralized cooperative between the (unattractive) free riding due to the positive quality enhancement externality of the VC choices by the members and the (attractive) decentralized payments of the costs of VC by the members preventing to a certain extent the increasing marginal cost of VC. However, the first order conditions result in $VC_D = \frac{2(d-A)}{9k-1}$ and $VC_C = \frac{2(d-A)}{8k-1}$, i.e. the level of VC is always higher in the centralized cooperative than in the centralized cooperative for all possible values of the VC cost coefficient k. This result is presented in proposition 3. The dominance of the free riding effect in determining the level of VC is due to the specification of the cost function of VC. [6]

[6] A straightforward way to illustrate this is to introduce a capacity constraint for individuals regarding the level of VC. For example, the level of VC in the centralized cooperative is lower than in the decentralized cooperative when the cost function is $V_i = \frac{1}{2}kv_i^2$ when $k < \frac{3(d-A)}{2(9k-1)}$ and $V_i = \infty$ otherwise.

Proposition 3 presents the result regarding the level of VC.

Proposition 3: *The VC level is higher in the centralized cooperative than in the decentralized cooperative, given the level of HC.*

Proposition 1 states that the decentralized cooperative produces more than the centralized cooperative, given the levels of communication. However, this result may be reversed when the choice of VC is endogenized. We have established that the production level is positively related to the average VC level ($Q_D = \frac{2}{3}(d - A + \overline{v_D}), Q_C = \frac{1}{2}(d - A + \overline{v_C})$). An investment in VC creates therefore a positive quality enhancement externality. Lower level of VC due to the free riding in the decentralized cooperative leads to a lower price is paid by consumers for a unit of the product, and this reduces the incentive to overproduce. When the CEO in the centralized cooperative is not overburdened, i.e. *k* is sufficiently low, then the centralized cooperative produces more than the decentralized cooperative. This is reflected in the equilibrium output levels $Q_D = \frac{6(d-A)}{9-1/k}$ and $Q_C = \frac{4(d-A)}{8-1/k}$. Specifically, the centralized cooperative produces more when $k < \frac{1}{6}$. Proposition 4 summarizes this result.

Proposition 4: *The production level is higher (lower) in the decentralized cooperative than in the centralized cooperative when* $k > (<) \frac{1}{6}$*, given the level of HC.*

The profit is higher in the decentralized cooperative than in the centralized cooperative, i.e. $\frac{(d-A)^2(18-1/k)}{(9-1/k)^2} > \frac{2(d-A)^2}{8-1/k}$, when $k \in (\frac{5-\sqrt{7}}{18}, \frac{5+\sqrt{7}}{18})$. The level of profit of the two governance structures is determined by a number of factors. The centralized cooperative has two advantages. First, it internalizes the negative production externalities of decentralized production decisions by the members (proposition 1). Second, the higher level of VC in the centralized cooperative than in the decentralized cooperative (proposition 3) results in higher price per unit sold. However, a higher level of VC is expensive for the centralized cooperative due to the increasing marginal cost of VC

(proposition 2). The high cost of VC dominates the two advantages when $\frac{5-\sqrt{7}}{18} < k < \frac{5+\sqrt{7}}{18}$, i.e. the decentralized cooperative has higher profits when *k* is at an intermediate level. Finally, the overproduction and the underinvestment in VC in the decentralized cooperative dominate the higher cost of VC in the centralized cooperative when $k > \frac{5+\sqrt{7}}{18}$. The reason is that the equilibrium level of VC is inversely related to k, and therefore the total costs of VC are decreasing when k is increasing. Therefore the centralized cooperative has the highest profits when k is sufficiently high. The result is formulated in proposition 5.

Proposition 5: *The profit level is higher (lower) in the decentralized cooperative than in the centralized cooperative when* $k \in (\frac{5-\sqrt{7}}{18}, \frac{5+\sqrt{7}}{18})$ *(otherwise), given the level of HC.*

Next we address both HC and VC. The next two propositions formulate results regarding the equilibrium communication levels in the second stage of the game, anticipating the production level decisions in the final stage of the game.

The centralized and decentralized cooperative are identical regarding HC in the sense that each member chooses its level of HC and pays for the costs. It involves an indirect negative externality because a higher level of HC reduces the cost of production, and therefore will result in a higher output level, but the costs of the resulting decrease in the price paid by the consumers is carried also by the other member. This results in too much production, and is the (indirect) negative externality in the choice of production due to the choice of horizontal communication. This effect is qualitatively the same for both cooperatives. However, the level of HC differs between the two cooperatives because the VC and production choices differ between the two cooperatives. Figure 2.5 presents the comparison between the two cooperatives regarding their equilibrium communication choices (proof see appendix).

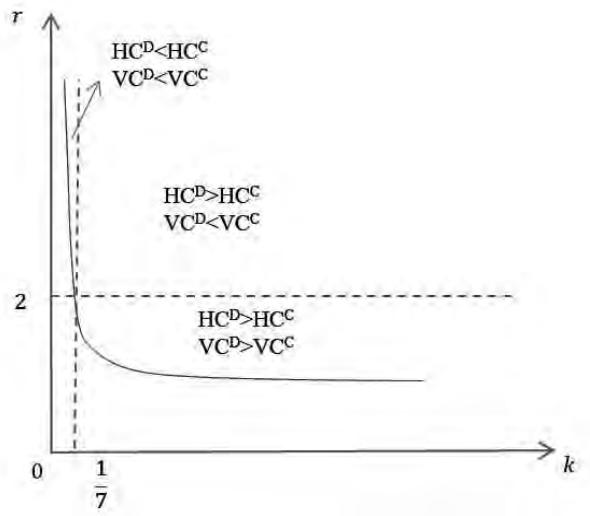

Figure 2.5: Comparison of HC and VC levels in the two governance structures

Next we compare the equilibrium production level in the two cooperatives. Similar to proposition 4, both VC and HC counter the overproduction effect. We have shown that the production level is positively related to both the HC and VC level ($Q_D = \frac{2}{3}\left(d - A + \overline{v_D} + \overline{h_D}\right), Q_C = \frac{1}{2}(d - A + \overline{v_C} + \overline{h_C})$). When k increases, more VC free riding problems occur in the decentralized cooperative, and it reduces the production. Moreover, when r increases, the indirect negative HC externality is weakened, less process innovation occurs in both cooperatives, and it reduces the overproduction. Therefore the production level decreases in both cooperatives. The centralized cooperative produces more than the decentralized cooperative when $\frac{6(d-A)}{9-4/r-1/k} < \frac{4(d-A)}{8-2/r-1/k}$, i.e. $k < \frac{2r}{15r-2}$. The result regarding the production level is formulated in proposition 6.

Proposition 6: *The equilibrium production level is higher (lower) in the decentralized than in the centralized cooperative when* $k > (<) \frac{2r}{15r-2}$.

Figure 2.6 presents proposition 6.

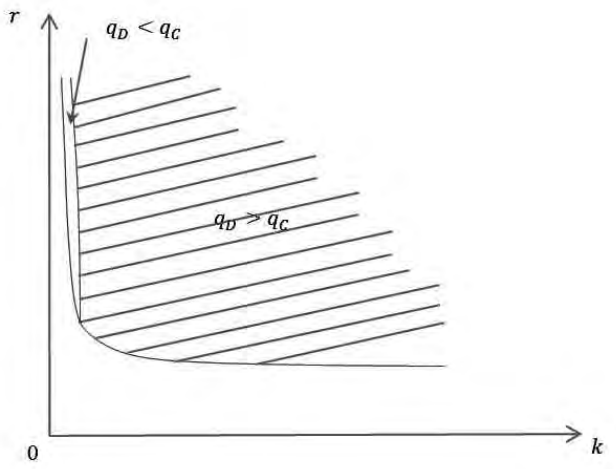

Figure 2.6: Comparison of production levels in the two cooperatives

The efficient governance structure is defined as the governance structure creating the highest value, while taking into account the communication and production level choices in the second and third stage of the game. When $k \leq \frac{5r+1-\sqrt{7r^2-10r+1)}}{20+18r}$, and r satisfies $r \in [(5+3\sqrt{2})/7, \infty)$, the profit is higher in the centralized cooperative due to its two advantages: it internalizes the negative production externalities, it generates a higher VC level and results in a higher price per unit sold. When $\frac{5r+1-\sqrt{7r^2-10r+1)}}{20+18r} < k < \frac{5r+1+\sqrt{7r^2-10r+1)}}{20+18r}$, and r satisfies $r \in [(5+3\sqrt{2})/7, \infty)$, the decentralized cooperative has a higher profit level due to the high equilibrium VC level and costs in the centralized cooperative. When $k > \frac{5r+1+\sqrt{7r^2-10r+1)}}{20+18r}$, and r satisfies $r \in [(5+3\sqrt{2})/7, \infty)$, the decentralized cooperative starts suffering from its overproduction and the underinvestment of the VC, and the loss of surplus is larger than the costly communication in the centralized cooperative. This makes the centralized cooperative efficient again. However, when $r < (5+3\sqrt{2})/7$ and regardless of *k*, the profit level is always lower in the decentralized cooperative than the centralized cooperative. This is due to that when *r* is small, the VC level is lower in the centralized cooperative, and therefore the costly VC in the centralized cooperative becomes insignificant. The

advantage of the internalization of the negative production externalities dominates. The result regarding the efficient governance structure for all possible values of the communication cost parameters is formulated in proposition 7.

Proposition 7: *The profit level is higher (lower) in the decentralized cooperative than the centralized cooperative when* $r \in [(5+3\sqrt{2})/7, \infty)$ *and* $k \in \left(\frac{5r+1-\sqrt{7r^2-10r+1})}{20+18r}, \frac{5r+1+\sqrt{7r^2-10r+1})}{20+18r}\right)$ *(otherwise).*

We present proposition 9 in Figure 2.7.

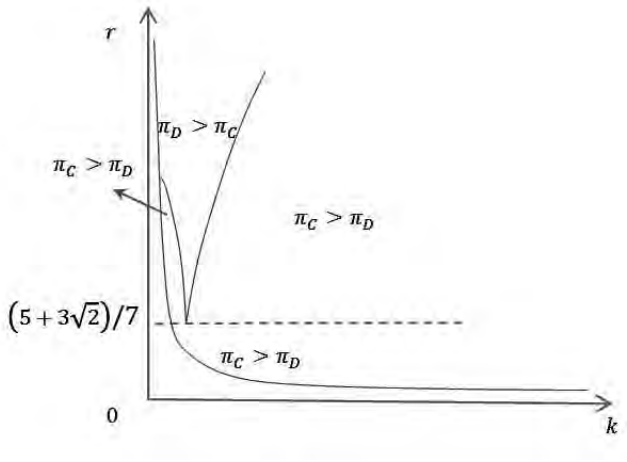

Figure 2.7: Comparison of profit levels in the two cooperatives

2.5 De Producent versus Harvest House

This section presents the two cooperatives in terms of the parameters of the model. With the description of the two cooperatives, we formulate the following assumptions of the four parameters in our model. First, the communication cost coefficients r and k are higher in Harvest House than in De Producent. This due to the different compositions of the membership of the two cooperatives. There is only one product in De Producent, while there are four products in Harvest House. Additionally, product groups in Harvest House have large and small growers, while the farmers owning De Producent have

similar sizes. Therefore member heterogeneity is higher in Harvest House than in De Producent. This makes it relatively more difficult to communicate both horizontally and vertically in Harvest House than in De Producent. However, Harvest House has separated the tomato group and paprika group in its governance structure to facilitate the HC. This lowers the parameter *r* to the level of De Producent. Moreover, the demand and the fixed production cost have to be considered as well since they are different in different cooperatives. Due to product differentiation, the price of cheese (De Producent) is relatively higher than that of vegetables (Harvest House), and the fixed production cost of cheese (De Producent) is relatively higher than that of vegetables (Harvest House). Table 2.3 summarizes these observations regarding the parameters of these two cooperatives, where H represents Harvest House and P represents De Producent.

Table 2.3: Comparison of parameters between De Producent and Harvest House

Member heterogeneity determines:	r	$r_H > r_P$
	k	$k_H > k_P$
Product feature determines:	d	$d_H < d_P$
	A	$A_H < A_P$

Figure 2.8 presents the two cooperatives in terms of the (relative) values of the four parameters of the model, taking into account the assumption $d > A > 0$ and $\begin{cases} \frac{1}{3} < k \leq \frac{3}{7}, \frac{k}{4k-1} < r < 1 \\ \frac{3}{7} < k < 1, \frac{4k}{9k-1} < r < 1 \end{cases}$.

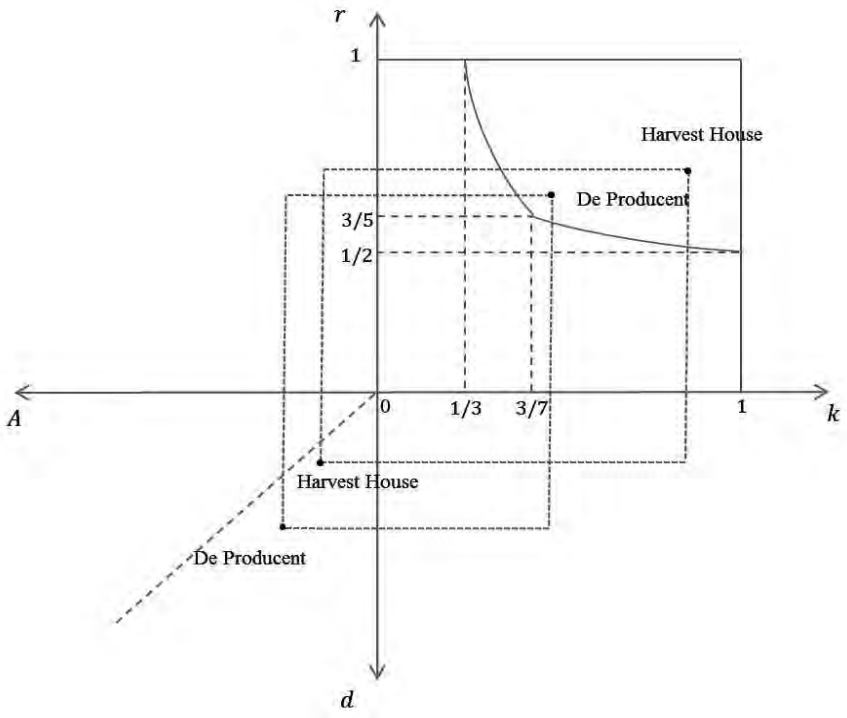

Figure 2.8: De Producent and Harvest House in terms of *r, k, d, A*

In order to compare De Producent and Harvest House, we combine Figure 2.7 and Figure 2.8 to illustrate proposition 7. Due to *d-A* is constant, Figure 2.9 is depicted with *r* on the vertical axis and *k* on the horizontal axis. From Figure 2.9 the parameters of the two cooperatives align with the finding of proposition 7. When *r* is lower and *k* is in small, the centralized cooperative is efficient, i.e. De Producent. When *r* is higher and *k* is in the middle range, the decentralized cooperative is efficient, i.e. Harvest House.

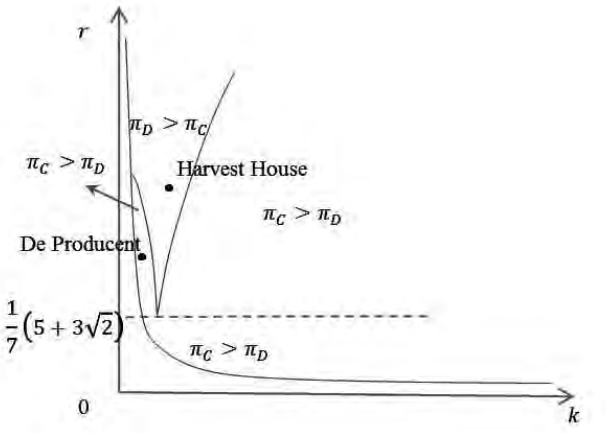

Figure 2.9: De Producent versus Harvest House

The different communication levels and governance structures of these two cooperatives may also be due to the nature of the product and the innovation strategies. Specifically, the vegetable cooperative has various ways of processing/packaging. Therefore HC is more important for improving the process innovation, and a decentralized structure is adopted to facilitate this. The cheese cooperative has identical packaging, but various flavors are developed. Therefore VC and product innovation are more important for a cheese cooperative, and a centralized structure is adopted to apply this strategy.

In other cooperatives, the situation may differ. However we claim that the general conclusion is applicable: 1) if process innovation is important for the cooperative, a decentralized governance structure should be adopted to secure the HC in order to create process innovation; 2) if the product innovation is the focus of a cooperative's strategy, a centralized governance structure should be adopted to implement intensive VC, in order to secure product innovation. In addition, the communication cost has to be considered. Member heterogeneity and distance of the members are examples that influence the communication cost. Our results show that when communication costs are small or large (intermediate), the centralized (decentralized) cooperative is efficient.

2.6 Conclusion and future research

In this paper, the relationship between communication, innovation, and (de)centralization in cooperatives is investigated. HC and VC associate with different types of innovation. HC is related to process innovation, while VC is related to product innovation. The intensity of the two types of communication depends on the costs of the two types of innovation. A decentralized cooperative is characterized by the members taking individually the vertical communication and production decisions, while these decisions are made by the CEO of the cooperative enterprise in a centralized cooperative. Horizontal communication decisions are made by members individually in both cooperatives. The decentralized cooperative has a tendency to overproduce due to the negative production externalities and to generate insufficient VC due to the positive externalities in the provision of product quality. An advantage of the decentralized cooperative is that the costs of VC are carried by the various members, as opposed to the centralized cooperative in which all VC are generated by the CEO. We find that when both communication cost coefficients are small and large, the centralized cooperative dominates, when both communication cost coefficients are in an intermediate range, the decentralized cooperative dominates.

There are various possibilities for future research. First, the current model provides a start to model the choice of communication policy of supplier owned enterprises. In practice, a much richer menu of communication devices is used and developed to address a variety of issues. For example, an important theme in cooperatives is the development of membership policies to foster involvement, commitment, and trust between the farmers and the cooperative enterprise. These membership policies involve several means to stimulate HC as well as VC. Another example is social capital in cooperatives (Deng, 2015). Second, VC in our model is a beneficial activity. It is related to product innovation, and increases therefore the product market price. However, other types of VC are present in cooperatives. Farmers communicate extensively with the general manager about the transactions between the farm and the cooperative enterprise,

and the strategy of the cooperative, due to their large financial involvement in the cooperative. Cook (1995) identifies five general problem sets in cooperatives: free-rider problem, horizon problem, portfolio problem, control problem, and the influence costs problem. At least two of these five problem sets, i.e. the control problem and the influence costs problem, involve VC. However, the nature of VC in these problem sets seems to be quite different, and requires therefore different modelling. Third, research regarding the governance of cooperatives is usually highlighting the differential incentives of various board models (Bijman et al., 2013). Such research addresses the relationship between a board representing the members and the professional management of the cooperative enterprise. However, the relationship between the professional management and the many individual members in terms of management may be more important in the creation of value, and is challenging and complex (Cook, 1994). Research regarding the governance of cooperatives will therefore benefit from putting more emphasis on the managerial importance of developing and implementing communication policies by distinguishing various types of communication and recognizing their differential impacts. Finally, we stated at the beginning of section 2 that the information about the two cooperatives are descriptions. These descriptions are valuable because they signal important phenomena in cooperatives. However, it will be informative and important to have future research using a rigorous case study methodology in the collection of data.

Chapter 3

Cooperatives and Investor-Owned Firms in a Member Sorting Model

Abstract

This article addresses how heterogeneous farmers in terms of location and quality sort themselves across processor enterprises and determine the governance structures of their enterprises by majority voting in a duopoly market. The processor enterprise can be either a cooperative (Coop) or an investor-owned firm (IOF). The Coop pays a uniform price to all farmers to maximize members' revenue and retains no profits, whereas the IOF differentiates payments based on quality and maximizes profits. A three-stage game is developed to address the sorting of farmers, the choice of governance structure at the processor enterprise, and the production choices of the farmers. In equilibrium, a farmer tends to choose the enterprise most close to him/her, and a farmer with a high quality product tends to choose an IOF. We establish that the Coop (mixed, IOF) market is the equilibrium market structure when the payment for quality by the IOF is low (intermediate, high).

Keywords: Cooperatives, investor-owned firms, farmer heterogeneity, sorting, majority voting

‘To our knowledge, there is no analysis in which both consumers and producers are differentiated. ’

Fulton & Giannakas (2013, p64)

‘If the membership expands, the composition of the *future* electorate changes. When today’s members vote for expansion, they have to take into account the impact on tomorrow’s vote. This is difficult territory. … We leave such tantalizing issues to future research.’

Hart & Moore (1996, p67)

3.1 Introduction

“For Farmers” is an animal feed enterprise. Its origins date back to 1896 when the cooperative Welbegrepen Eigenbelang was formed in the eastern part of the Netherlands. In a process of mergers (between cooperatives) and acquisitions, a large cooperative emerged with production facilities in the Netherlands, Belgium, Germany and the United Kingdom, 2,370 employees, and a turnover of 2.2 billion euros in 2015. In 2016, the 6300 members of For farmers voted almost unanimously to change the governance structure of For farmers from a Coop to an IOF (Kosterman, 2016). This article will address how many independent farmers sort themselves across enterprises and choose the governance structure of the enterprise by majority voting.

Governance structures are distinguished by ownership rights, decision rights, and income rights (Baker, Gibbons, & Murphy, 2008). A Coop is defined as user-owned, user-controlled, and user-benefitted (Dunn, 1988), i.e. a Coop is an enterprise collectively owned by many independent upstream or downstream farmers. Collective ownership requires a collective decision-making procedure. Democratic decision-making with a majority rule is the most well-known procedure and adopted by most Coops. The impact of this procedure is analyzed on the sorting of farmers across

processor enterprises, their anticipation of the choice of the majority voting outcome, and their production decisions. We follow Hart & Moore (1996) in adopting the one-member-one-vote voting rule. If at least half of the farmers at a processor enterprise vote for the Coop (IOF), then a Coop (IOF) governance structure is adopted for this enterprise.

Fulton & Giannakas (2013) argue that member heterogeneity becomes gradually more important for organizations generally, and for Coops in particular. Membership heterogeneity can be measured by variables such as geographic dispersion, the number of different commodities produced or inputs purchased by the members, the variance in members' age, the variance in members' educational levels, the differences between members in farm size, the percentage of non-farm income, or the differences between members in terms of business objectives (Iliopoulos & Cook, 1999). Member heterogeneity reflects therefore various benefits of members in different ways, and it affects the members' decisions such as coop's membership choice, R&D support, and the efforts to achieve product quality. We highlight that Coops and IOFs differ in their price policies regarding heterogeneous farmers.

Two income rights of a Coop are pooling and the zero-profit constraint. Cook, Iliopoulos, & Chaddad (2004) observe that pooling of revenues, which is a form of uniform price, is a common and traditional price scheme in Coops. For example, Emanuelsson & Lindholm (2000) mentioned that uniform delivered pricing is prevalent in the Swedish cooperative banking sector. Sometimes the government enforces pooling schemes to enable price supports and open access to resources like fisheries (Weitzman, 1974), and average cost pricing is used to allocate surpluses or deficits (Sexton, 1986).[7] The zero-profit feature captures that the revenues of the Coop are returned to members and that the Coop has therefore zero-profits, or balances its budget (Fulton & Giannakas, 2013; Helmberger & Hoos, 1962). We use the uniform price as the price policy of a Coop. It

[7] Non-uniform pricing schemes are developed when there is a heterogeneous membership to strengthen fairness and efficiency in agricultural cooperatives. However, it is likely to have distributional consequences (Fulton & Vercammen, 1995). Sexton (1986) observes that a non-uniform pricing mechanism is difficult to implement because it requires substantial information about members.

implies that the Coop does not differentiate payments to farmers based on quality. This is done by paying an average price to every farmer/member. The IOF is an enterprise which pays farmers based on their product quality and/or quantity. The IOF may decide to differentiate prices based on product quality. The Coop and IOF deal therefore in a different way with member heterogeneity. We analyze how this difference in the price policy has an impact on the choice of processor of the farmers, the choice of governance structure at each processor, and the production decisions of the farmers, i.e. the interaction between ownership rights (i.e. majority voting by members), and income rights (i.e. the price policy at the processor enterprise) are addressed.

Horizontal and vertical product differentiation models are surveyed by Mérel, et al. (2009). Horizontal product differentiation captures that consumers differ in their preferences regarding products. The classic model is formulated by Hotelling (1929). In his model enterprises position their products by a choice of location. A consumer closer to the location of an enterprise likes the product of this enterprise more. For example, Fulton & Giannakas (2001) and Giannakas & Fulton (2005) analyze the impact of member heterogeneity on innovation, where the level of commitment towards a consumer Coops is modelled along the lines of a horizontal product differentiation model. Producer heterogeneity in terms of location is analyzed with the Hotelling model by Sexton (1990).

Consumers agree unanimously about the ranking of producers in vertical product differentiation models, i.e. all consumers prefer high quality above low quality. Vertical product differentiation models are mostly adapted from Mussa & Rosen (1978). For example, Hoffmann (2005) investigates how ownership affects quality endogenously in a duopoly market with price competition under various cost structures. Pennerstorfer & Weiss (2012) investigate the incentive to produce high quality in a mixed duopoly. They claim that the Coop is characterized by decentralized decision-making which gives rise to overproduction and free riding. Therefore the Coop never produces high quality goods compared to the IOF. Liang & Hendrikse (2016) examine farmers' outlet and production choices in a vertically differentiated mixed duopoly market. A similar

finding is that the farmers with low quality products deliver to the cooperative, whereas farmers with high quality products deliver to the IOF. Moreover they find that the cooperative has a competitive yardstick effect.

Coops and IOFs coexist in most agricultural markets (Fulton & Giannakas, 2001; Hendrikse, 1998). Various explanations have been formulated for their coexistence, such as supply assurance (Carlton 1979a and 1979b), differences in the risk attitudes of both consumers and producers (Hendrikse and Peters, 1989), a pro-competitive yardstick effect of Coops on its rival IOF's pricing behavior (Sexton, 1990), screening differences in the decision-making processes of Coops and IOFs (Hendrikse, 1998), and contractual externalities in contract formation (Hendrikse, 2007).

Both consumer and producer differentiation are not yet investigated in one model (Fulton & Giannakas 2013, p64). This article develops a model where both types of heterogeneity are present. Producers differ in location and quality, while consumer heterogeneity is reflected as vertical product differentiation. The interactions between sorting of heterogeneous farmers, majority voting at enterprises, and production are analyzed in a three stage model. Each farmer chooses an enterprise in the first stage. In the second stage farmers choose collectively the governance structure of their enterprise by majority voting. In the last stage, the farmer decides to produce or not. Novel features of our model are therefore that both consumers and producers are differentiated (Fulton & Giannakas, 2013), and that producers anticipate that the prospect of the governance structure, and therefore the price policy of the enterprise, will be determined by majority voting and has an impact on the composition of the electorate and therefore the outcome (Hart & Moore, 1996, p67). In equilibrium a farmer tends to choose the enterprise most close to him/her, and a farmer with a high quality product tends to choose an IOF. The market consists of 2 (1, 0) Coops and 0 (1, 2) IOFs when the payment for quality by the IOF is low (intermediate, high).

The paper is organized as follows. Section 2 presents the model. Section 3 formulates the Nash equilibrium choices of the farmers. Section 4 considers a specific choice of

price policy by the IOF. Finally, section 5 formulates the conclusions and future research directions.

3.2 Model

In this section we present the model of a three-stage non-cooperative game. Farmers are heterogeneous in two uncorrelated dimensions: distance d and quality v (Shelef & Nguyen-Chyung, 2015). A farmer is characterized by (d, v). Farmers are uniformly distributed over the unit square $[0,1] \times [0,1]$. Define enterprise *e* as being located at (*e, 0*), $e \in \{0,1\}$. Farmer $f \equiv (d, v)$ represents therefore a farmer with quality level v located at a distance d $(1-d)$ from enterprise 0 (1). Figure 3.1 shows the positioning of farmer f and the two enterprises in the unit square.

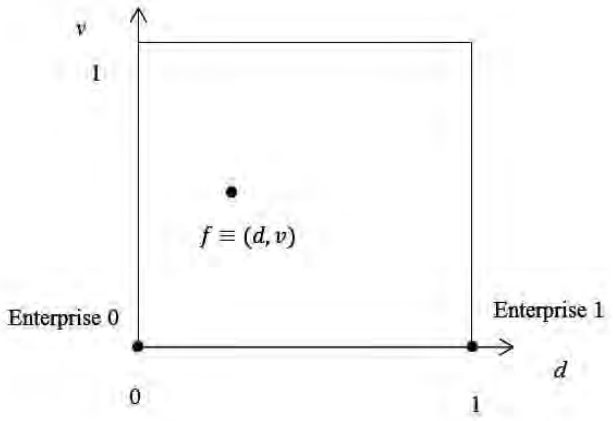

Figure 3.1: Positioning of a farmer f and the enterprises in the market

Let $e_f \in \{0,1\}$ be the choice of enterprise *e* by farmer *f*. Define $E_0 \equiv \{f | e_f = 0\} (E_1 \equiv \{f | e_f = 1\})$ as the set of the farmers who choose enterprise 0 (1), and the set of all farmers as $E \equiv E_0 \cup E_1$. Denote $g_f \in \{I, C\}$ as the governance structure choice of farmer f, where I reflects governance structure IOF and C reflects governance structure Coop. Define $E_{eC} = \{f | e_f = e, g_f = C\}$ as the set of farmers choosing governance structure Coop at enterprise *e*. Similarly, define $E_{eI} = \{f | e_f = e, g_f = I\}$ as the set of

farmers choosing governance structure IOF at enterprise *e*. The governance structure of enterprise *e* is defined as g_e and determined by majority voting of the farmers, i.e. $g_e = \begin{cases} C, when\ \frac{|E_{ec}|}{|E_{el}|} > 1 \\ I, otherwise \end{cases}$.

Let the market price be $Y(v) = \delta v$, where $\delta > 0$ is the exogenous market taste parameter regarding the product (Mussa & Rosen, 1978). Assume that the processing cost of enterprise *e* is 0. Define $p_{eI}(v) = \beta_e v$, with $0 < \beta_e \leq \delta$, as the price paid by enterprise *e* with governance structure IOF to a farmer who delivers one unit of product with quality v, i.e. the farmer's payment is incrementally affected by his delivered product quality. Define p_{eC} as the uniform price paid to the members by enterprise *e* with governance structure Coop. Define the uniform price as the average price paid to the producing members, i.e. the total revenue divided by the total number of the members who produce. It is equal to $p_{eC} = \iint \delta v p(f|E_e)\, dddv$, where $p(f|E_e)$ is the density function of the farmers in enterprise *e*.

Assume that the travel cost per unit of distance is 1. Therefore, the distance cost of a farmer *f* who delivers to enterprise *e* is $c_{fe} = |d - e|$. Assume the production cost of a farmer is 0. Define q_f as the amount of production by farmer *f*. Assume that a farmer produces either one unit of a product, or nothing, i.e. $q_f \in \{0,1\}$. The payoff of farmer *f* is therefore defined as

$$\pi_e = \begin{cases} \beta_e v q_f - c_{fe}, & when\ g_e = I \\ p_{eC} q_f - c_{fe}, & when\ g_e = C \end{cases}.$$

In the first stage of the game, farmers choose independently and simultaneously to deliver their products either to enterprise 0 or to enterprise 1. In the second stage, the governance structure of each enterprise g_e, i.e. IOF or Coop, is determined by majority voting. The choice of governance structure determines the price policy, i.e. a uniform price in the Coop and a price proportional to quality in the IOF. In the third stage, farmers

choose q_f, i.e. to produce and deliver one unit or nothing. The sequence of decisions in the game is depicted in Figure 3.2.

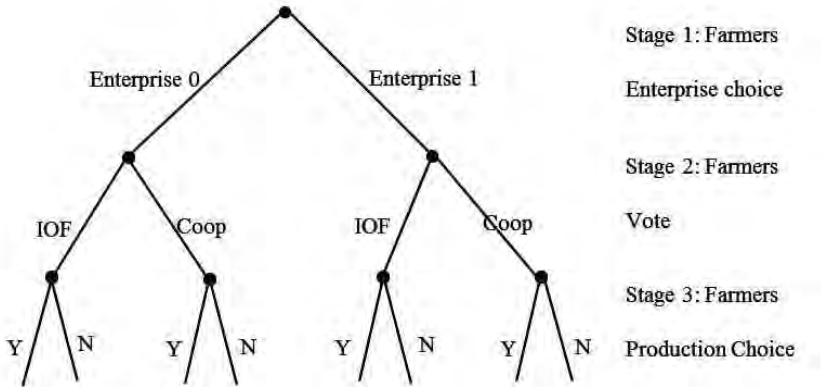

Figure 3.2: The sequence of decisions

3.3 Equilibrium

The game is solved by backward induction. It entails three steps. First, it is determined for each farmer whether it is attractive to produce one unit or nothing, given a choice of enterprise of each farmers in the first stage, i.e. a composition of the sets E_0 and E_1, and given a choice of governance structure of the enterprises 0 and 1 in the second stage, i.e. a choice of g_e. Next the choice of governance structure at the two enterprises is determined in the second stage, given a choice of enterprise of each farmer in the first stage, and anticipating the payoff maximizing production choices of the farmers in the third stage of the game. Finally, the payoff maximizing choice of enterprise is determined for each farmer, anticipating the majority vote of governance structure at the two enterprises in the second stage of the game, and the payoff maximizing production choices of all farmers in the third stage of the game.

The solution method of backward induction entails that an infinite number of enterprise choice possibilities of the farmers have to be considered when the payoff maximizing choices in the second and third stage of the game are determined. We deal with this issue by on the one hand exploiting the fact that many choices are not equilibrium outcomes

and on the other hand considering only one of the two mixed markets.[8] In section 3.3.1 we determine the production decisions. In section 3.3.2 the governance structure choices are determined. In section 3.3.3, the enterprise choices of the farmers are determined.

3.3.1 Production choices

The production decisions have to be determined for all possible choices of enterprise of all farmers and all possible choices of governance structure at the two enterprises. Three settings $G = I, M, C$ are distinguished regarding the governance structure choices in the second stage. First, $G = I$, the IOF market: the two enterprises choose the IOF governance structure ($g_e = I$). Second, $G = M$, the mixed market: enterprise 0 chooses the Coop ($g_0 = C$) and enterprise 1 chooses the IOF ($g_1 = I$). Lastly, $G = C$, the Coop market: the two enterprises choose the Coop governance structure ($g_e = C$). The farmers being indifferent between the two enterprises are identified, and it implies the strict preference of all other farmers regarding the choice of enterprise. Evaluating these enterprise choices will characterize the equilibrium choices in the first and second stage of the game.

IOF market

Suppose that both enterprises have adopted the IOF. The quality level v_{eg}^* at which farmers are indifferent between producing and not producing at location e with governance structure g is determined by $p_{eg} - c_{fe} = 0$. A farmer at enterprise e produces one unit when $p_{eg} - c_{fe} \geq 0$, while a farmer produces nothing when $p_{eg} -$

[8] Many choices do not have to be considered by realizing that a farmer will not join a specific enterprise when another farmer with the same quality level but closer to this enterprise does not join this enterprise. This feature will be used to determine the location d^* at which farmer (d, v) is indifferent regarding the choice of enterprise. Similarly, a farmer will not deliver to a specific enterprise when another farmer with the same distance to this enterprise but lower quality level, choses to produce nothing. This feature will be used to determine the quality level v^* of a farmer (d, v) at which this farmer is indifferent regarding production. Only the mixed market consisting of enterprise 0 with governance structure Coop and enterprise 1 with governance structure IOF is addressed. The other mixed market is not considered because the analysis is symmetric and it would introduce only certain coordination problems which are not core to the topic of this article.

$c_{fe} < 0$. The indifferent quality level in an IOF market is determined by $\beta_0 v - d = 0$ ($\beta_1 v - (1-d) = 0$). This results in $v_{0I}^* = \frac{d}{\beta_0}$ ($v_{1I}^* = \frac{1-d}{\beta_1}$).

We also determine the location of the farmers being indifferent between the two enterprises. The indifferent farmer location is determined by $p_{0g} - c_{f0} = p_{1g} - c_{f1} \Leftrightarrow d_G^* = \frac{p_{0g} - p_{1g} + 1}{2}$.The location of these farmers is therefore characterized by $d_I^* = \frac{(\beta_0 - \beta_1)v + 1}{2}$ in an IOF market structure. Therefore, each farmer satisfying both $p_{0I}(v) - c_{f0} \geq 0 \Leftrightarrow d \leq \beta_0 v$ and $d \leq \frac{(\beta_0 - \beta_1)v + 1}{2}$ delivers one unit of product to the IOF at location 0. It is shown in the shaded area $[v_{0I}^*, 1] \times [0, d_I^*]$ in Figure 3.3. Similarly, the farmers in the shaded area $[v_{1I}^*, 1] \times [d_I^*, 1]$ deliver to IOF 1.

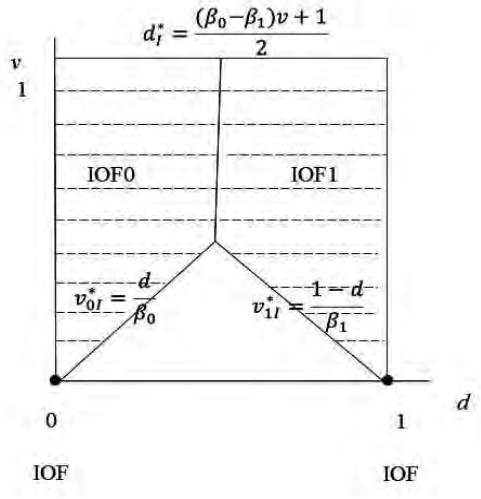

Figure 3.3: Production choices of the farmers in an IOF market structure

Mixed duopoly market

Suppose that enterprise 0 adopts the Coop and enterprise 1 adopts the IOF. The farmers being indifferent between producing and not producing at the Coop at location 0 are determined by $p_{0C} - c_{f0} = 0 \Leftrightarrow p_{0C}^* = d$, i.e. the farmers located to the left of $d = p_{0C}^*$ produce and deliver the products, while the farmers located to the right of $d = p_{0C}^*$ do

not produce. The farmers being indifferent between producing and not producing at the IOF at location 1 is determined by $p_{1I} - c_{f1} = 0 \Leftrightarrow \beta_1 v - (1-d) = 0 \Leftrightarrow v_{1I}^* = \frac{1-d}{\beta_1}$. Moreover, the location of the farmers being indifferent between the two enterprises is $d_M{}^* = \frac{p_{0C} - \beta_1 v + 1}{2}$ in a mixed duopoly market.[9]

For the distance dimension, farmers located to the right of the downward sloping line $d_M^* = \frac{p_{0C} - \beta_1 v + 1}{2}$ are not delivering to the Coop 0 because the (distance) costs are too high and the payment for quality is below what IOF 1 is offering. Similarly, farmers located to the left of the line $d_M^* = \frac{p_{0C} - \beta_1 v + 1}{2}$ are not delivering to the IOF 1 because the (distance) costs are too high. For the quality dimension, the farmers located below the downward sloping line $v_{1I}^* = \frac{1-d}{\beta_1}$ are not delivering to IOF 1 because the payment for the (low) quality is not sufficient to cover the distance cost.

The price paid by Coop 0 is an average price satisfying the zero-profit constraint. It equals to the total revenue divided by the total number of the members who produce. Three ranges of the payment parameter β_1 (small, medium, and large) are distinguished. Consider first case β_1 is small. Take $\beta_1 = 0.5\delta$ and $\delta = 1$. $p_{0C}^* = \frac{\int_0^{min(1, \frac{p_{0C}+1}{\beta_1})} \int_0^{min(p_{0C}, d_{M,1}^*)} \delta v \; dd \; dv}{\int_0^{min(1, \frac{p_{0C}+1}{\beta_1})} \int_0^{min(p_{0C}, d_{M,1}^*)} dd \; dv} = \frac{\delta}{2} = \frac{1}{2}$. Consider next case β_1 is intermediate. Take $\beta_1 = 0.905\delta$ and $\delta = 1$. This results in $p_{0C}^* = 0.468$. Suppose β_1 is large. Take $\beta_1 = \delta = 1$. This results in $p_{0C}^* = 0.455$. Figure 3.4 presents these three cases.

[9] The indifferent farmer location is determined by $p_{0C} - c_{f0} = p_{1I} - c_{f1} \Leftrightarrow p_{0C} - d = \beta_1 v - (1-d) \Leftrightarrow d_M^* = \frac{p_{0C} - \beta_1 v + 1}{2}$.

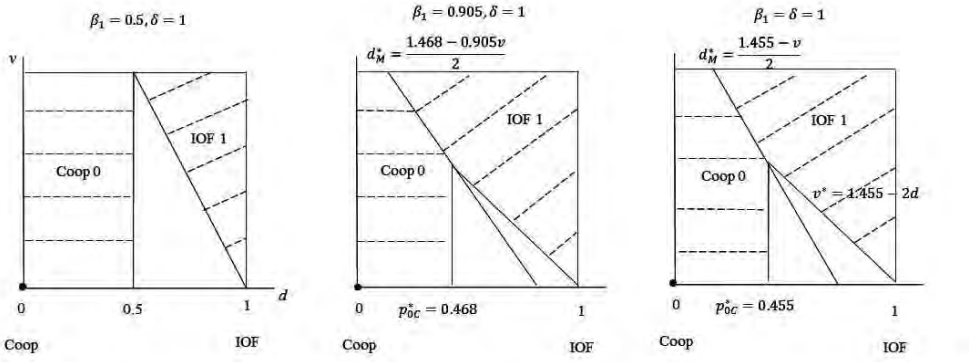

Figure 3.4: Production choices of the farmers in a mixed market structure

Notice that the numerical example indicates that the price paid by the Coop decreases when the payment by the IOF increases. This is due to more high quality farmers switching from the Coop to the IOF when the payment by the IOF increases. Notice also that the composition of producing and non-producing farmers changes when the payment by the IOF changes. If the payment by the IOF increases, then some farmers with relatively low quality and located close to the IOF will switch from not-producing to producing. There are also some farmers switching from producing to not-producing when the payment by the IOF increases. Some farmers delivering to the Coop will stop producing because the price paid by the Coop decreases due to some high quality farmers switching from the Coop to the IOF. Farmers located relatively far away from the Coop will not be able to cover the distance costs anymore, and prefer therefore to produce nothing.

Coop market

Suppose that both enterprises adopt the Coop. The farmers being indifferent between producing and not producing in the Coop market are determined by $p_{eg}(v) - c_{fe} = 0$. This results in $p_{0C}^* = d$ and $p_{1C}^* = 1 - d$.

Next, we determine the farmer's location $d_C^* = \frac{p_{0C} - p_{1C} + 1}{2}$ at which farmers are indifferent between the two enterprises in a Coop market structure. The indifferent

farmer location is determined by $p_{0C} - d = p_{1C} - (1 - d) \Leftrightarrow d_C^* = \frac{p_{0C} - p_{1C} + 1}{2}$. Notice that d_C^* is independent of v. This is due to the assumption that the production cost of quality is 0. It entails that a farmer at d chooses Coop 0 or 1 independently of his product value v. We compute that $p_{0C}^* = \frac{\int_0^{min\left(p_{0C}, \frac{p_{0C} - p_{1C} + 1}{2}\right)} \int_0^1 \delta v \; dv \, dd}{\int_0^{min\left(p_{0C}, \frac{p_{0C} - p_{1C} + 1}{2}\right)} \int_0^1 1 \; dv \, dd} = \frac{\delta}{2}$, which is driven by the market price δv. Symmetrically, $p_{1C}^* = \frac{\delta}{2}$. The farmers who choose Coop 0 (1) earn $\frac{\delta}{2} - d$ ($\frac{\delta}{2} - 1 + d$).

The two coops cover the market and split it equally when $d_C^* = \frac{1}{2}$. Figure 3.5 illustrates the sorting of farmer in a Coop market structure. Notice that when $0 < \delta < 1$, $p_{0C}^* = p_{1C}^* < \frac{1}{2}$. It implies that some farmers choose to produce nothing due to the high distance cost. Therefore the production choices in a Coop market are: when $0 < \delta < 1$, farmers produce one unit of the product when $d < \frac{\delta}{2}$ and $d > \frac{\delta}{2} + \frac{1}{2}$, otherwise they produce nothing. When $\delta \geq 1$, all farmers produce. The results are formulated in Proposition 1.

Proposition 1: *In the Coop market, the two Coops split the market and pay the same. All farmers produce and deliver when* $\delta \geq 1$*, while only the farmers close to* $d = \frac{1}{2}$ *do not produce when* $\delta < 1$.

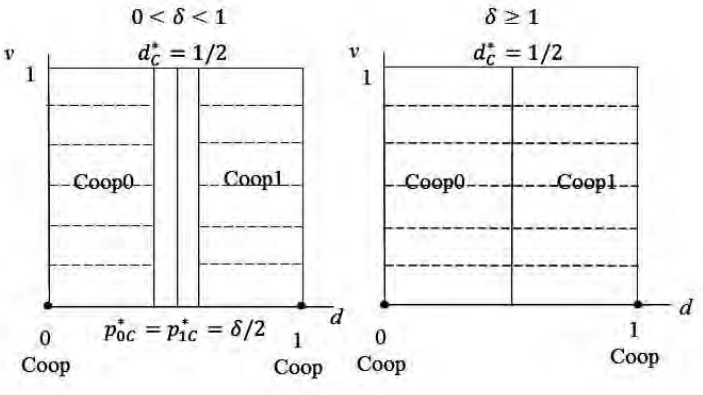

Figure 3.5: Coop market structure

3.3.2 Governance structure choices

The equilibrium governance structure choices are determined by majority voting of E_0 and E_1. We assume that the price policy of the IOFs in the IOF market are identical and define $\beta \equiv \beta_0 = \beta_1$. Three ranges of the price policy parameters β of the IOF are distinguished in order to determine the equilibrium governance structure choices. If β is small, then the Coop market is the equilibrium because the IOF is not able to attract enough farmers due to the low payment. Figure 3.6 presents the three market structures with $\beta = 0.5$ and $\delta = 1$.

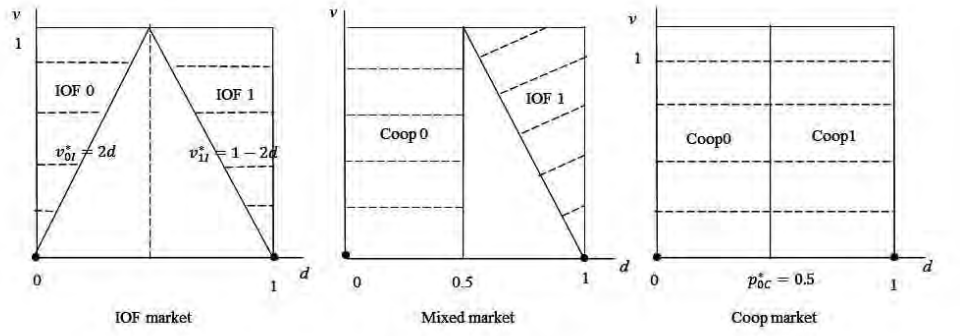

Figure 3.6: The three market structures when $\beta = 0.5$ and $\delta = 1$

First compare the IOF market with the mixed market. The farmers E_0 earn $0.5v - d$ in an IOF, while they earn $0.5 - d$ in a Coop. The farmers E_0 earn more in an IOF only if $0.5v - d > 0.5 - d \Leftrightarrow v > 1$. This implies that all the farmers E_0 prefer a Coop governance structure due to the average payment being higher than the differentiated payment β. Therefore the mixed market dominates the IOF market. It follows immediate with the same reasoning that the Coop market dominates the mixed market. The conclusion is therefore that the Coop market is the equilibrium. This result holds also when $\beta < 0.5$.

Consider now intermediate values of β. Figure 3.7 presents the three market structures when $\beta = 0.905$ and $\delta = 1$. First we compare the IOF market with the mixed market. The farmers E_0 earn $0.905v - d$ in an IOF, while they earn $0.468 - d$ in a Coop. The

farmers E_0 are indifferent when $0.905v - d = 0.468 - d \Leftrightarrow v^* \approx 0.517$. Therefore, the farmers E_0 in the area $v < v^* = 0.517$, $p < p_{0C}^* = 0.468$ prefer a Coop governance structure, while the farmers E_0 in the area $v > v^* = 0.517$, $v > v_0^* = \frac{d}{0.905}$ prefer an IOF governance structure. The former $(0.517 \times 0.468 = 0.242)$ dominates the latter $((1 - 0.517) \times 0.5 - \varepsilon = 0.241 - \varepsilon)$. Therefore the mixed market dominates the IOF market. We then compare the Coop market and the IOF market. The farmers E_1 in an IOF earn $0.905v - (1 - d)$, while the farmers E_1 in a Coop earn $0.5 - (1 - d)$. The farmers E_1 are indifferent when $0.905v - (1 - d) = 0.5 - (1 - d) \Leftrightarrow v^* \approx 0.552$. Therefore the farmers in the area $d > d_M^*$ and $v > v^* = 0.552$ choose an IOF $(0.448 \times 0.5 + 0.032 \times 0.413 + \frac{1}{2} \times 0.187 \times 0.413 + \varepsilon = 0.276 + \varepsilon)$ and they outnumber the farmers in the area $d > \frac{1}{2}$ and $v < v^* = 0.552$ who prefer a Coop $(0.552 \times 0.5 = 0.276)$. The mixed market dominates also the Coop market, and is therefore the equilibrium.

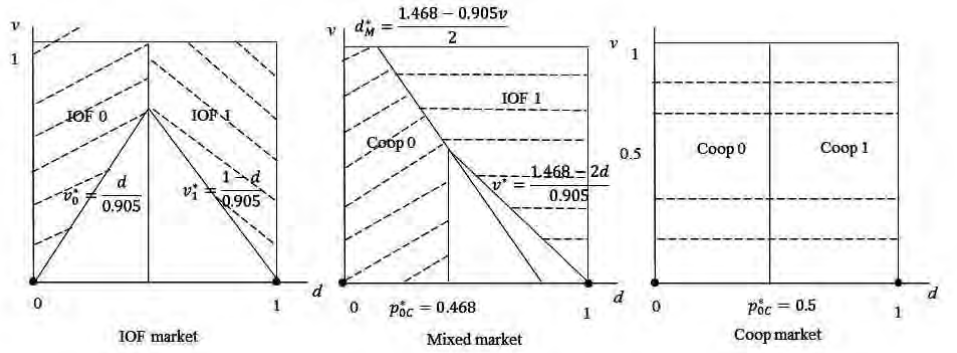

Figure 3.7: The three market structures when $\beta = 0.905$ and $\delta = 1$

Figure 3.8 presents the three market structures when $\beta = 1$ and $\delta = 1$. First we compare the Coop market with the mixed market. The farmers E_0 earn $v - d$ in an IOF, while they earn $0.455 - d$ in a Coop. The farmers E_0 are indifferent when $v - d = 0.455 - d \Leftrightarrow v^* \approx 0.455$. Therefore the farmers in the area $v < v^* = 0.455$ and $d < p_{0C}^* = 0.455$ prefer a Coop governance structure, but the farmers in the area $v >$

v^* and $d < \frac{1}{2}$ prefer an IOF governance structure and outnumber them. Therefore the IOF market dominates the mixed market. Compare then the Coop market with the IOF market. The farmers E_0 are indifferent when $v - d = 0.5 - d \Leftrightarrow v^* = 0.5$. For both enterprises, the farmers at $v > \frac{1}{2}$ prefer an IOF due to the high quality payment, and the farmers at $v < \frac{1}{2}$ prefer a Coop. Therefore, the IOF market is the equilibrium market structure when $\beta = 1$. When δ is 2, the Coop market is the equilibrium market structure when $0 < \beta < 1.6$. The mixed market is the equilibrium market structure when β is around 1.6. The IOF market is the equilibrium market structure when $1.7 < \beta \leq 2$. Furthermore, we test when δ is very small and very large. We find that Coop (IOF) market is the equilibrium when β is small (large).

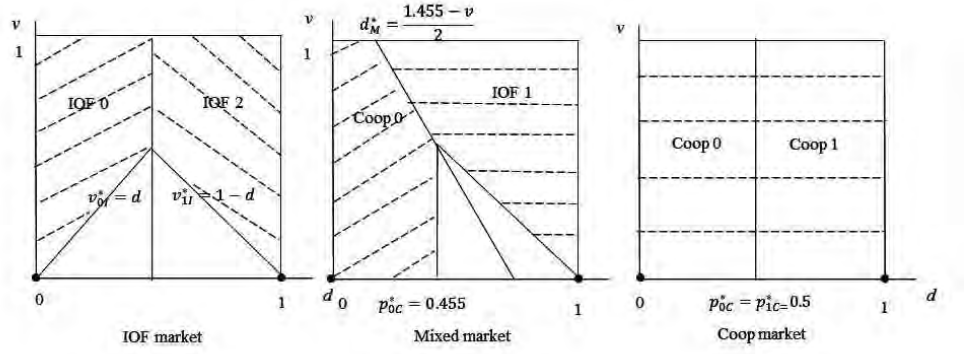

Figure 3.8: The three market structures when $\beta = 1$ and $\delta = 1$

We conclude that when β is small, i.e. the IOF does not pay a high price, the IOF is not attractive. More farmers prefer the Coop, and p_{eC}^* is therefore high. A Coop market is the equilibrium. When β is large, i.e. the IOF pays a high price, more farmers choose the IOF. The IOF market is the equilibrium. When δ and β are intermediate, both governance structures attract farmers. Specifically, the IOF attracts more high value farmers while the Coop attracts more low value farmers. The mixed market is the equilibrium. Additionally, when δ is small (i.e. $\delta < 1$), some farmers do not produce and deliver because they are far away from both enterprises. There is no interaction/competition between the IOF and the Coop, and the mixed market therefore

does not emerge. When δ is very large (e.g. $\delta = 10$), the IOF attracts most farmers. The mixed market does not emerge. The results are summarized in Proposition 2 and Proposition 3, and depicted in Figure 3.9. The numerical examples are shown in the appendix.

Proposition 2: *The Coop (IOF) market is the equilibrium market structure when β is small (large).*

Proposition 3: *If δ is at an intermediate level, then there exist intermediate values of β such that the mixed market is the equilibrium market structure.*

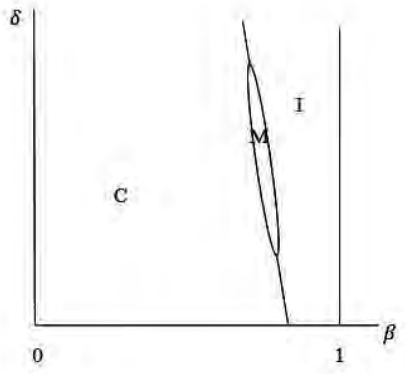

Figure 3.9: Equilibrium governance structures in the market (β, δ)

3.3.3 Enterprise choices

The equilibrium enterprise choices of the farmers have to be determined in the first stage of the game. The definitions of d_G^* and v_{eg}^* characterize the equilibrium enterprise choices. Take $\delta = 1$. When β is large, the IOF market is the equilibrium. The farmers at $d_I^* < (>) \frac{1}{2}$ choose enterprise 0 (1). When $\beta = 0.905$, the governance structure of enterprise 0 (1) is Coop (IOF). The farmers at the left (right) of $d_M^* = \frac{1.468 - 0.905v}{2}$ choose enterprise 0 (1). When β is small, the Coop market is the equilibrium, and the farmers at $d < (>) \frac{1}{2}$ choose enterprise 0 (1).

3.4 Profit maximizing IOF

The IOF is characterized as an enterprise which pays a farmer β for each unit of quality delivered, and therefore the IOF earns $1-\beta$ for each unit delivered to it. The payment policy β of the IOF is an exogenous parameter in the model. This raises the question how to endogenize β. A natural way to incorporate the choice of β in the game is the second stage, i.e. a choice of governance structure entails a process of determining the choice of beta. This can be done in various ways.

Our model highlights the importance of individual farmers in the supply chain. This is reflected in the first stage of the game by each farmer choosing the enterprise where the harvest will be delivered, in the second stage by the choice of governance structure of the enterprise by majority voting of the farmers, and the production decision by farmers in the third stage of the game. One way to endogenize β is to assume that the payment policy β in an IOF is chosen in a profit maximizing way by an outside entrepreneur. It entails that the entrepreneur pays β for each unit of quality delivered. The remainder $1-\beta$ is earned by the entrepreneur, and therefore farmers do not capture all value generated by their productive efforts. This matches with the observation that many markets are characterized by the coexistence of Coops and IOFs characterized by outside entrepreneurs (Fulton & Giannakas, 2001; Hendrikse, 1998, 2007; Liang & Hendrikse, 2016).

We will present in this section the implications of characterizing the IOF as a profit-maximizing entrepreneur regarding the choice of β. The implicit assumption is that there are prohibitive costs of dealing with member heterogeneity in a Coop. The analysis is involved because endogenizing β implies also endogenizing the sets E_0 and E_1, and therefore endogenizing the outcome of the majority voting by choosing the majority at each enterprise (Hart & Moore, 1996, p67).

The game with the profit maximizing IOF is again solved by backward induction. The production decisions in the final stage of the game are identical to the ones specified in

section 3.3.1 because the profit maximizing price policy of the IOF is a specific value of the price policy of the IOF. In the second stage the farmers anticipate that the choice for the IOF implies that they will face a payment for quality which is determined by the IOF in order to maximize its profit. The payoff maximizing price policy of the IOF has therefore to be determined. This is done in section 3.4.1. Section 3.4.2 is dedicated to the governance structure choices, and section 3.4.3 to the enterprise choices of the farmers.

3.4.1 Profit maximizing price policy of the IOF

IOF market

An IOF is assumed to maximize its profit, and therefore β_0 and β_1 have to be chosen in a payoff maximizing way. The payoff of the IOF at location 0 is

$$\pi_{0I} = \int_0^1 \int_0^{\min\left(\beta_0 v, \frac{(\beta_0-\beta_1)v+1}{2}\right)} (Y(v) - p_{0I}(v))dddv$$

$$= \int_0^{\frac{1}{\beta_0+\beta_1}} \int_0^{\beta_0 v} (\delta - \beta_0)vdddv + \int_{\frac{1}{\beta_0+\beta_1}}^1 \int_0^{\frac{(\beta_0-\beta_1)v+1}{2}} (\delta - \beta_0)vdddv.$$

Symmetrically, the payoff of the IOF at location 1 is

$$\pi_{1I} = \int_0^1 \int_{\max\left(1-\beta_1 v, \frac{(\beta_0-\beta_1)v+1}{2}\right)}^1 (Y(v) - p_{1I}(v))dddv$$

$$= \int_0^{\frac{1}{\beta_0+\beta_1}} \int_{1-\beta_1 v}^1 (\delta - \beta_1)vdddv + \int_{\frac{1}{\beta_0+\beta_1}}^1 \int_{\frac{(\beta_0-\beta_1)v+1}{2}}^1 (\delta - \beta_1)vdddv.$$

The payoff maximizing price policy of enterprise *e* as a function of the price policy parameter of the other enterprise is called the reaction function of enterprise *e*. The reaction function of enterprise *e* is determined by maximizing π_{eI} with respect to β_e, given the price policy of the other enterprise. The first order condition is a fourth degree polynomial. The mathematical software package Maple shows that there are real as well as complex roots to the first order condition. We proceed by determining the equilibrium price policies and the slopes of the reaction functions for specific parameter values. The Nash Equilibrium price policies are determined by the intersection of the two reaction

functions: $\beta_0^* = \beta_1^*$. When $\delta = 1$, an equilibrium payment policy for each IOF is $\beta_0^* = \beta_1^* = \frac{1}{2}$. This result is formulated in Proposition 4.

Proposition 4: *In the IOF market, the two IOFs split the market equally and pay the same.*

The nature of the payment policy competition between the two IOFs is reflected by the slope of the reaction functions. A competitive variable with a negative (positive) slope of the reaction function is called a strategic substitute (complement) (Fudenberg & Tirole, 1984). The slopes of the reaction functions are negative at $(\beta_0^*, \beta_1^*) = \left(\frac{1}{2}, \frac{1}{2}\right)$, and they are presented in Figure 3.10. The calculation $\frac{d\beta_0^*}{d\beta_1} = \frac{d\beta_1^*}{d\beta_0} = -\frac{3}{11} < 0$ is presented in the appendix. The explanation of this result is as follows. When IOF 0 increases the price parameter β_0, a larger part of the farmer deliveries are taken by IOF 0. This implies that the residual supply left for IOF 1 decreases. Moreover, the average quality of the remaining farmers at IOF 1 decreases as well because only high quality farmers are leaving. They are leaving IOF 1 because they are producing/delivering and are indifferent between the two enterprises before the price increase. Therefore the remaining farmers delivering to IOF 1 will have a lower quality on average. The profit-maximizing response of IOF 1 is to decrease β_1. Proposition 5 formulates this result, while the proof is presented in the appendix.

Proposition 5: *In an IOF market, the IOF payment parameters β_0 and β_1 are strategic substitutes.*

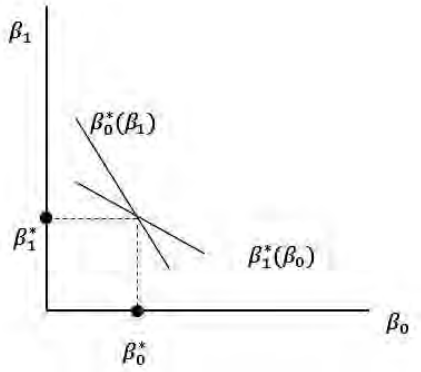

Figure 3.10: Reaction functions around $(\beta_0^*, \beta_1^*) = \left(\frac{1}{2}, \frac{1}{2}\right)$

The production choices of the farmers in an IOF market structure are characterized by the separating line $v_{0I}^* = \frac{d}{\beta_e^*}$ ($v_{1I}^* = \frac{1-d}{\beta_e^*}$) (e.g., when $\delta = 1$, $v_{0I}^* = 2d$ ($v_{1I}^* = 2(1-d)$).[10] When a farmer's quality is larger than v_{0I}^* (v_{1I}^*), he/she produces one unit of the product. Otherwise he/she produces nothing. Figure 3.11 presents the choice of enterprise and the quantity decision of each farmer in an IOF market structure.

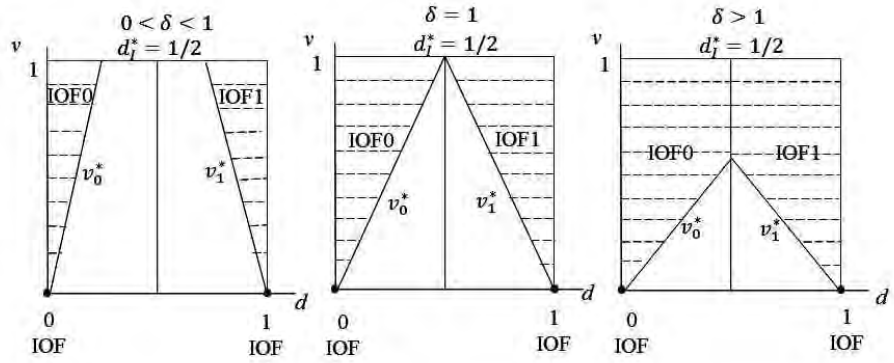

Figure 3.11: IOF market structure

Notice that the payoff maximizing β_e of IOF e increases with the final product market price (δ). For example, IOFs maximize their profit whith $\beta_{0(1)}^* \approx 0.36$ when $\delta = \frac{1}{2}$,

[10] When δ increases, the slope of $v_{eI}^*(d)$ declines. It entails that when IOFs pay more to farmers, more farmers produce.

$\beta^*_{0(1)} = \frac{1}{2}$ when $\delta = 1$, $\beta^*_{0(1)} \approx 0.87$ when $\delta = 2$, $\beta^*_{0(1)} \approx 1.59$ when $\delta = 3$, and $\beta^*_{0(1)} \approx 2.53$ when $\delta = 4$. It entails that when the market price is higher, IOFs will pay a higher price to farmers due to the competition between them. This result regarding the IOF market is formulated in Proposition 6.

Proposition 6: $\beta^*_{0(1)}$ *increases and more farmers deliver when the final product market price increases.*

Mixed duopoly market

The price paid by Coop 0 is an average price satisfying the zero-profit constraint. It is equal to the total revenue divided by the total number of the members who produce. Two ranges of the market taste parameter δ are distinguished in order to specify the price.

When $\delta \leq 1$, $p^*_{0C} = \beta^*_1 = \frac{\delta}{2}$.[11]

When $\delta > 1$,

$$p^*_{0C} = \frac{\int_0^{\min(1,\frac{p_{0C}+1}{\beta_1})} \int_0^{min(p_{0C},d^*_M,1)} \delta v \; dd \; dv}{\int_0^{\min(1,\frac{p_{0C}+1}{\beta_1})} \int_0^{min\left(p_{0C},d^*_M,1\right)} dd \; dv}.$$

The slope of d^*_M varies with different value of δ, and therefore the boundaries of the integrals changes correspondly. The detailed computation is shown in the appendix.

Meanwhile IOF 1 is maximizing its payoff by choosing β_1:

[11] Substitute $d = p_{0C}$ back to $d^*_M = \frac{p_{0C}-\beta_1 v+1}{2}$, we obtain $v = \frac{1-p_{0C}}{\beta_1}$. There is no interaction between Coop 0 and IOF 1 when $v = \frac{1-p_{0C}}{\beta_1} \geq 1$. In this case, $p^*_{0C} = \frac{\int_0^1 \int_0^{p_{0C}} \delta v \; dd \; dv}{\int_0^1 \int_0^{p_{0C}} dd \; dv} = \frac{\delta}{2}$. $\max_{\beta_1} \pi_{1I} = \max_{\beta_1} \left(\int_0^1 \int_{d^*_{1I}}^1 (\delta - \beta_1) v \; dd \; dv\right)$, which results in $\beta^*_1 = \frac{\delta}{2}$. Therefore, $\frac{1-p_{0C}}{\beta_1} \geq 1 \Leftrightarrow \frac{1-\frac{\delta}{2}}{\frac{\delta}{2}} = \frac{2-\delta}{\delta} \geq 1$ $\Leftrightarrow \delta \leq 1$.

$$\max_{\beta_1} \pi_{1I} = \max_{\beta_1} \left(\int_{\max(0,\frac{p_{0C}-1}{\beta_1})}^{1} \int_{max(1,d_M^*,d_{1I}^*)}^{1} (\delta - \beta_1) v \; dd \, dv \right).$$

When $\delta = 1.5$, solving the above two equations results in $p_{oC}^* \approx 0.71$ and $\beta_1^* \approx 0.6$. Similarly, we obtain $p_{oC}^* \approx 0.55$ and $\beta_1^* \approx 1.88$ when $\delta = 3$ and $p_{oC}^* = 4.42$ and $\beta_1^* = 7.63$ when $\delta = 15$. Figure 3.12 displays the equilibrium choices of farmers in a mixed duopoly market structure for various values of δ. d_M^* separates the farmers who choose Coop 0 or IOF 1.

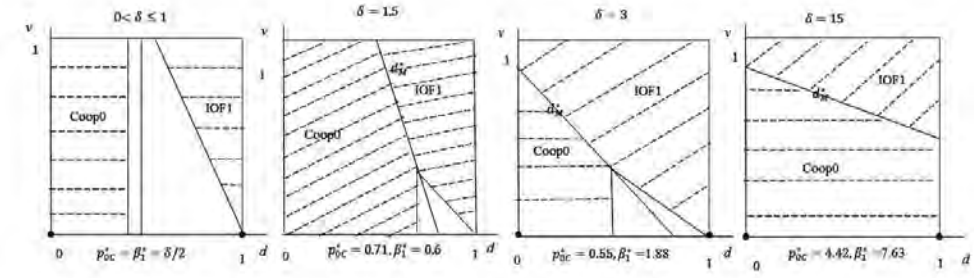

Figure 3.12: Mixed duopoly market structure

Notice that when δ is high (low), d_M^* is flatter (steeper). It entails that IOF 1 (Coop 0) attracts more high (low) quality farmers when δ is high. The results are formulated in Proposition 7 and Proposition 8.

Proposition 7: *There are high (low) value farmers at* $d < (>) 0.5$ *choosing IOF 1 (Coop 0) in the mixed market when* $\delta > 1$.

Proposition 8: *If* $\delta > 1$*, then IOF 1 (Coop 0) attracts more high (low) value farmers at* $d < (>) 0.5$ *when* δ *increases.*

Another observation is that when δ is high, all farmers produce. Coop 0 as well as IOF 1 are able to pay a sufficiently high price to the famers to cover the distance cost due to the market price is high. All high quality farmers, i.e. even the farmers located close to enterprise 0, go to IOF 1 because the policy of highly differentiated payments based on quality is sufficiently attractive to cover for the additional distance costs. Similarly, farmers with low quality and located close to enterprise 1 will choose to deliver to the

Coop at location 0. The average quality delivered at the Coop is sufficiently higher than the quality of such a farmer to cover for the additional distance cost of delivering to Coop 0. The result is formulated in Proposition 9.

Proposition 9: *All farmers produce when δ is sufficiently high.*

3.4.2 Governance structure choices

The equilibrium governance structure choices are determined in two steps. First, compare the Coop market with the mixed market, and determine the circumstances when the Coop market dominates the mixed market. Second, we compare the Coop market with the IOF market, and determine when the Coop market is the equilibrium.

First, compare the payoff of each farmer in the Coop market and the mixed duopoly market:

$$\pi_{f|CC} = \begin{cases} p_0 - d & ,0 \le d \le \frac{1}{2} \\ p_1 - (1-d), & \frac{1}{2} < d \le 1 \end{cases},$$

$$\pi_{f|CI} = \begin{cases} p_{0C} - d & ,0 < v \le v^* \\ \beta_1 v - (1-d), & v^* < v < 1 \end{cases}.$$

The Coop market dominates the mixed market. The IOF does not pay a sufficiently high price to attract enough farmers due to its profit maximizing price policy, given the choice of enterprise of the farmers. The choice of enterprise 1 by a farmer in the first stage of the game entails a powerful position for the outside investor when the IOF governance structure is adopted in the second stage of the game. A majority vote of the farmers in the set E_1 for the IOF (price policy) will put the outside investor in the attractive take-it-or-leave-it position when the profit maximizing price is determined in the second stage of the game. The majority of the farmers earns more in a Coop than in an IOF governance structure. This result is illustrated with four cases (δ is small ($0 < \delta \le 1$), intermediate ($\delta = 1.5$), large ($\delta = 3$), very large ($\delta = 15$)), and the numerical examples are presented in the appendix.

Second, compare the payoff of each farmer in the IOF market and the Coop market:

$$\pi_{f|II} = \begin{cases} \beta_0 v - d & ,0 \le d \le \frac{1}{2}, \\ \beta_1 v - (1-d), & \frac{1}{2} < d \le 1 \end{cases}$$

$$\pi_{f|CC} = \begin{cases} p_0 - d & ,0 \le d \le \frac{1}{2} \\ p_1 - (1-d), & \frac{1}{2} < d \le 1 \end{cases}.$$

When $0 \le d \le \frac{1}{2}$, $\begin{cases} \pi_{f|II} = \beta_0 v - d \\ \pi_{f|CC} = p_0 - d = \frac{\delta}{2} - d \end{cases}$. When $0 < v \le \frac{1}{2}, \pi_{f|II}(= \beta_0 v - d) < \pi_{f|CC}(= \frac{\delta}{2} - d)$, i.e. farmers choose Coop when their quality is lower and equal to 1/2. When $\frac{1}{2} < v \le 1, \pi_{f|II}(= \beta_0 v - d) > \pi_{f|CC}\left(= \frac{\delta}{2} - d\right)$, i.e. farmers choose IOF when their quality is higher than 1/2. Similarly, when $0 \le d \le \frac{1}{2}$, low (high) value farmers choose Coop (IOF). High value farmers like to be paid based on their delivered products' quality, while the low value farmers like the average payment by the Coop.

The number of farmers who like the IOF is always less than the number of the farmers who favor the Coop. This explains that the middle value farmers at $v = \frac{1}{2}$ choose Coop ($\frac{\beta_0}{2} - d < \frac{\delta}{2} - d$). Finally, majority voting determines the governance structures. The Coop market is the equilibrium outcome. The result is formulated in Proposition 10.

Proposition 10: *If the IOF adopts a profit maximizing price policy, then the Coop market is the equilibrium governance structure of the market for all parameters values.*

This specification of the model results in a Coop market equilibrium. The Coop price policy is more attractive than the price policy of a payoff maximizing IOF. The first reason is that the profit maximizing feature leads to a low payment to the farmers. The second reason is that the sequence of decisions influences the price decision by the IOF. The sequence of decisions is that the farmers choose the enterprise before the

governance structure is determined, i.e. an IOF determines its price after the IOF governance structure is chosen.

3.4.3 Enterprise choices

From section 3.4.1 and 3.4.2, we find the Coop market tends to be the Nash equilibrium. Therefore, the location choices are: farmers at $d < (>) \frac{1}{2}$ choose enterprise 0 (1) and farmers at $d < (>) \frac{\delta}{2}$ produce and deliver.

3.5 Conclusion

This paper contributes to the study of Coops and IOFs in several ways. First, we have formulated a model with consumer and producer heterogeneity. Consumer heterogeneity is reflected by vertical product differentiation, while producer heterogeneity is captured in terms of the farmers' location and quality. The result shows that the farmers choose the enterprises and the governance structures based on two dimensions: distance and quality. The farmers tend to choose the enterprise most close to them, and the high value farmers tend to choose an IOF. Second, the choice of governance structures by majority voting is analyzed in a duopoly market with sorting by members. When the IOF price is low, the Coop market is the equilibrium. When the IOF price is in a middle range, the mixed market is the equilibrium. When the IOF price is high, the IOF market is the equilibrium. Additionally, when the IOF adopts a profit maximizing price policy, the Coop market is always the equilibrium.

There are several possibilities for future research. First, the information regarding quality may differ between the governance structures. Members of a cooperative are more likely to make information about the level of quality of their products available due to their ownership of the downstream enterprise than farmers delivering to an IOF. This may have an impact on the price policy. Second, quality is exogenous in our model.

A topic for future research is to endogenize the quality decision by farmers, and to determine how these decisions are influenced by the governance structure and price policy (Shaked & Sutton, 1982). Third, one of the characteristics of the Coop in our model is the pooled price policy. Pooling is important in many cooperatives, but nowadays there are also many cooperatives paying for quality to a certain extent. This will make the cooperative more attractive for high quality farmers. One way to generalize the characterization of the Coop is to assume that β is chosen by majority voting in a farmer payoff maximizing way and obeying the zero-profit constraint at the level of the enterprise. The characterization of the Coop in section 3.3 is then a specific case, i.e. the Coop is an enterprise with β equal to zero and a balanced budget. However, members choosing the payment policy β is not without difficulties. There is a substantial literature regarding Coops arguing that they may experience difficulties dealing with member/farmer heterogeneity (Hansmann, 2009). More generally, it raises questions about the nature of the enterprise (Coase, 1937; Grossman & Hart, 1986; Williamson, 2000). The impact of a quality differentiated price policy of the cooperative on the equilibrium composition of the market is a topic for future research. Fourth, the model shows that the mixed or IOF market will not be an equilibrium outcome when the price policy of the IOF is chosen in a payoff maximizing way. However, these markets are equilibrium phenomena for certain parameter values when a different price policy is adopted by the IOF. Such a price policy may emerge when a different sequence of stages of the game is adopted. Alternatively, the mechanisms to commit to a different price policy is also a topic for future research (Vickers, 1985).

Chapter 4

CEOs versus Members' Evaluation of Cooperative Performance

— Evidence from China

Abstract

The management and the society of members in cooperatives may have different evaluations of their cooperatives. Understanding these evaluations can help CEOs to formulate strategies that best serve the membership and keep the cooperatives successful. We analyze the differences between CEOs and members' evaluations regarding cooperative performance. A survey of Chinese agricultural cooperatives (240 CEOs and 543 members) was conducted. Cooperative performance is measured by three indicators: member profitability, social influence in the local community, and overall performance (Franken & Cook, 2015). The results show that both CEOs and members agree that their cooperatives are successful. However, members have higher scores than CEOs regarding member profitability and overall performance, while CEOs have a higher evaluation regarding social influence. The results also show that the number of general

meetings and CEOs' age decrease the difference of social influence evaluation. Male CEOs are more likely to evaluate more positive than female CEOs. Moreover, female CEOs and members tend to have more similar evaluations.

Keywords: Cooperatives, performance, evaluation, CEOs, members.

4.1 Introduction

Developments in markets, digitalization, genetics, and robotics bring challenges for cooperatives. The cooperative may respond with expanding the size of operations and adopt various hybrid organizational forms (Chaddad & Cook, 2004; Hind, 1999). An important aspect in the response of modern cooperatives to these developments is the separation between management and the society of members (Bijman et al., 2013). In this separation, decision rights have been shifted to the professional management in order to be more responsive to market competition and/or to reduce the costs of collective decision-making. This may create increasingly autonomous management and reduce the influence of members in the decision-making process and outcome (Bager, 1996; Bhuyan, 2007; Bijman et al., 2013; Harte, 1997).

Cooperatives are special because the members not only own the cooperative, but also patronize it. Members have therefore an ownership as well as a transaction relationship with the cooperative. This feature is expected to have an impact on how the cooperative is evaluated by the members as well as the manager(s) (Feng & Hendrikse, 2012; Liang & Hendrikse, 2013). Members will evaluate the performance of a cooperative not only in terms of the financial results of the cooperative enterprise, but also in terms of the membership services delivered to them. Members expect better prices, an assured market, and also reliable services from the cooperative. Membership services have to be valuable for the farm enterprise and for the overall well-being of the member (Nilsson & Hendrikse, 2011). This dual role of a cooperative member makes management of a cooperative difficult.

A sustainable and successful cooperative requires a stable membership and high member commitment (Fulton & Adamowicz, 1993; Österberg & Nilsson, 2009). This includes members' willingness to patronize the cooperative processor, invest in risky equity, and participate in the governance of the cooperative (Österberg & Nilsson, 2009). Arcas-Lario, Martín-Ugedo, & Mínguez-Vera (2014) find that high member satisfaction increases the members' intention to continue their membership. However, the separation between the management and the members may result in dissatisfied members. The theoretical literature has associated a number of behaviors with unsatisfied members. First, unsatisfied members are not willing to participate in the governance of the cooperative (Birchall & Simmons, 2004). Second, unsatisfied members do not trust the long-run perspective of the cooperative and thus will be reluctant to invest (Nilsson et al., 2012). Finally, unsatisfied members may even exit and cause the dissolution of the cooperative (Bijman & Hendrikse, 2003; Cotterill, 2001; Hakelius, Karantininis, & Feng, 2013; Hendrikse, 2011; Sykuta & Cook, 2001).

Members' evaluation of their cooperative is an important indicator regarding their commitment. A positive evaluation of the cooperative makes it more likely that members stay with their cooperative than when the evaluation is low (Hernandez-Espallardo, Arcas-Lario, & Marcos-Matas, 2013), whereas a low evaluation of the cooperative, dissatisfaction and negative attitudes can decrease members' commitment. There are several empirical studies addressing members' evaluation of their cooperatives. Cobia & Navarro (1972) show that the members they surveyed generally had a favorable attitude towards farmer cooperatives in general. More specifically, the favorable attitude of the members towards their own cooperatives is positively related to the cooperative's financial performance as well as the length of time and level of their patronages. Other research reaches similar conclusions. The survey of Misra, Carley, & Fletcher (1993) on the dairy farmers located in 12 southern states of the US reveals that the degree of satisfaction of cooperative members towards their cooperatives is 1.167 on a scale from 0 to 2, slightly higher than neutral. They also confirm that a better price, lower costs, good field service, and the assurance of a market for milk is positively

related with members' satisfaction. Gray & Kraenzle (1998) find a positive attitude between the members of a North Central milk marketing cooperative. About 87 percent of the members are satisfied or very satisfied with their cooperative overall, and 73 percent of the members are satisfied or very satisfied with their management. Nearly 74 percent of the members are satisfied with "dairy farming as a way of life". However, only 36 percent of members are satisfied with the income from their cooperative business. Morfi et al. (2015) investigate the motivations of farmers' loyalty towards their cooperatives. Four factors turn out to be positively related to farmers' loyalty: cooperative ideology, assured market, business orientation, and trust.

These empirical studies examine only members' evaluation of the cooperatives. This makes it hard to determine whether the perception of the CEOs aligns with that of the members. Understanding how CEOs differ from members regarding their evaluations, in which way, and what causes the differences, brings insights that are valuable about how CEOs can best serve the members. This paper provides evidence that the evaluation of the cooperative performance differs between the CEOs and members in Chinese cooperatives. In Chinese cooperatives, there is also a separation between the management and the members. They differ from cooperatives in the Western world by a heterogeneous membership in terms of core and common members (Liang & Hendrikse, 2013). Core members refer to entrepreneurial farmers who initiated a cooperative or are in charge of the management and product marketing. Among them, the CEOs are elected and they are the most important core members. Common members are farmers who buy a small amount of capital shares or pay an entry fee to join a cooperative. Therefore there is a difference in terms of the tasks performed. Liang & Hendrikse (2013, p27) characterize the difference as "a member CEO has multiple roles: a member or supplier of the cooperative, a member of the management, a member of the board of directors, and/or a member of the board of supervisors of the cooperative, while other members are mainly producers, inputs suppliers, and residual claimants of the cooperative". The multiple roles of a CEO are likely to result in a different evaluation regarding the performance of the cooperative compared to the members.

Cooperative performance is measured by three indicators: member profitability, social influence in the local community, and overall performance (Franken & Cook, 2015). The results show that both CEOs and members agree that their cooperatives are successful. However, members have higher scores than CEOs regarding member profitability and overall performance, while CEOs have a higher evaluation regarding social influence. The heterogeneity of CEOs and members causes the different evaluations. This includes the divergence of interest, different knowledge, and self-perception bias. Moreover, the associated factors which may have an impact on the evaluations are explored. The results show that the number of general meetings and CEOs' age decrease the difference between the social influence evaluations of the CEOs and the members. Male CEOs are more likely to evaluate more positive than female CEOs. Moreover, female CEOs and members tend to have more similar evaluations.

The paper is organized as follows. Section 4.2 formulates the motivation for the hypotheses. Section 4.3 introduces the methodology of this study. Section 4.4 presents the analyses and results. Section 4.5 provides the exploratory tests regarding the associated factors. Finally, section 4.6 presents the conclusions.

4.2 Hypotheses

This section formulates the motivation for the hypotheses regarding overall performance (4.2.1) and financial and social performance (4.2.2).

4.2.1 CEO versus Member Evaluation of Cooperatives

The evaluation by members and the CEO of a cooperative are influenced by the different incentives faced by them and their different cognitive representations of the cooperative. Many authors argue that there is a divergence of interests between the membership and the management, and this leads to the control problem of cooperatives (Cook, 1995; Hendrikse & Feng, 2013; Vitaliano, 1983). The control problem is due to the separation of formal and real authority. It gives cooperative managers discretion to operate, and

therefore the possibility to pursue their own interest. Moreover, it is unlikely that the incentives of the CEO can be perfectly aligned with the interests of the members by incentive contracts due to the measurement limitations and difficulties in cooperatives (Hueth, Ligon, Wolf, & Wu, 1999; Feng & Hendrikse, 2012). As such, the different interests between the membership and the management cause different opinions of cooperatives' performance.

Differences in the evaluation of cooperative performance may also be due to different cognitive representations. Individuals employ simplified mental representations of their information environment. These representations have been referred to as implicit theories, cognitive maps, assumptions, schemata, and belief structures (Walsh, 1988). Dearborn and Simon (1958) claim that there is a bias of management in problem identification due to systematic information-processing failures. Walsh and Fahey (1986) extended the study by examining managers' belief structures.[12] A manager's belief structure not only reduces the information-processing demand but also restricts the capabilities of the manager to process the information (Bower, Black, & Turner., 1979). This has an impact on a manager's belief structure (Snyder & Uranowitz, 1978). Biek, Wood, & Chaiken (1996) state that the working knowledge and experience of managers have two effects on evaluations. One is a defensive bias of evaluation. In this case, the knowledgeable person uses his strength and others' weaknesses to evaluate a favourable outcome towards himself. The other one is objectiveness of evaluation. In this case the knowledgeable person is critical regarding all the relevant information and tends to give an objective evaluation. John & Robins (1994) investigate accuracy and bias in self-perceptions of performance in a managerial group-discussion task. They find that people are less accurate when judging themselves than when judging their peers.

In Chinese cooperative, CEOs who are core members operate the cooperatives and make

[12] "The simplified mental representations individuals employ to give their information environments form and meaning have been variously called implicit theories, cognitive maps, assumptions, schemata, and belief structures." (Walsh, 1988, p873) The terminology "belief structure" is used in Walsh's research.

a lot of decisions, while common members hardly participate in decision-making. This leads to different behavior between core and common members (Liang & Hendrikse, 2013). Core members may hide the true profits of cooperatives from common members and reap the profits (Ma & Meng, 2008). This observation aligns with the incentive difference between management and members in the literature. Moreover, the CEOs are elected because of their superior knowledge and experience. Their different cognitive representation causes different perceptions compared to the members. Hypothesis 1 summarizes these observations by stating that there is a difference between the CEOs and members' evaluation regarding the overall performance of Chinese cooperatives.

Hypothesis 1: *The CEOs' evaluation of the overall cooperative performance differs from the members' evaluation.*

The overall performance of an organization is described in different ways in the literature. Meyer, Paunonen, Gellatly, Goffin, & Jackson (1989) use overall performance of the unit managers as one construct to test the relationship between organizational commitment and job performance. They ask district managers to rate their unit managers on overall performance with a five-point rating scale. The results show that commitment correlates strongly with job performance. Wang, Chou, & Jiang (2005) use team effectiveness and team efficiency with a five-point Likert scale to measure overall team performance. They find that there is a positive relationship between team cohesiveness and overall team performance. Watson, Kumar, & Michaelsen (1993) take the overall performance of group tasks to analyze cultural diversity's impact on the interaction between process and performance. Evaluators were asked to express their performance evaluations with a five-point scale. The results show that at the early stage of the experiment, the homogeneous groups scored significantly higher than the diverse groups on overall performance. By week 17, cultural diversity leads to no significant difference in overall performance. In this paper, we first take the evaluation of overall performance as an indicator for the general opinion, by both CEOs and members, of the cooperative performance.

4.2.2 Financial and Social Performance of Cooperatives

Soboh, Lansink, Giesen, & van Dijk (2009) review the literature regarding the performance of agricultural marketing cooperatives. They argue that theory distinguishes member benefits and firm profitability, and assume multiple objectives. However the empirical research failed to address the cooperatives' objectives as represented by the theoretical literature, i.e. in practice only firm profitability is used to address the performance of cooperatives. The authors suggest that "a meaningful empirical evaluation of the cooperative's performance should address the dual objective nature of the organization". Franken & Cook (2015) advance the description of cooperative performance from a solely financial perspective to multiple dimensions. They delineate the overall performance of a cooperative into financial performance and social performance. Factor analysis supports the claim that the overall performance is reflected not only by financial performance but also by patron services. In this paper, we examine the evaluations of the cooperative performance with the perspective developed by Franken & Cook (2015).

We distinguish two components in the evaluation of the performance of a cooperative: financial and social performance. First, cooperatives are formed to advance members' financial interests. Karantininis & Zago (2001, p.1266) claim that the members of cooperatives focus mainly on the price that the processing firms pay for their products. Maximizing patronage returns is the members' main goal rather than maximizing the profits of the cooperative enterprise (Chaddad, 2001; Franken & Cook, 2015; Liebrand, 2007). The capacity of the cooperative to enhance members' financial well-being depends on the cooperative's financial performance. Therefore, whether members are satisfied with their cooperative is directly linked to the cooperative's ability to increase members' incomes. However, the different understanding between the CEOs and the members generates different evaluations regarding the cooperative's financial performance. Specifically, due to the CEOs' superior marketing and management background, they are able to include more and different information in the evaluation of

the financial performance than the members (Biek et al., 1996). The members are less informed due to a lack of knowledge. Moreover, CEOs in Chinese cooperatives are high performers, i.e. they are elected to be the CEOs because they are leaders of the community. The CEOs therefore expect a higher return from the cooperatives compare to small members. However, the pooling payment feature of the cooperatives does not favor CEOs' expectations regarding the financial return. Small members benefit more than the CEOs from the pooling payment scheme. Consequently, compared to the members, the CEOS have a lower evaluation of the financial performance. These observations are summarized in Hypothesis 2.

Hypothesis 2: *CEOs' evaluation of the cooperative's financial performance is lower than the members' evaluation.*

Soboh et al. (2009) review the financial performance measurement of cooperatives. Member profitability is one measure used frequently by the literature (Barton, 2004; Hardesty & Salgia, 2004; Harris & Fulton, 1996; Mckee, 2007; Notta & Vlachvei, 2007). In this paper we use also member profitability to measure the financial performance of cooperatives.

Second, cooperatives often have social objectives to promote cooperation, rural development, and community services. Fulton & Adamowicz (1993) argue that the cooperative patronage at the Alberta Wheat Pool is influenced not only by the dividend payments but also by the availability of agro-services. Ideological, cultural and political preferences are also relevant to explain differences in farmers' participation in cooperatives (Fulton, 1999; Karantininis, 2007). Although nowadays some social elements of cooperatives are becoming less important than the financial functions of cooperatives (Fulton, 1995; Karantininis & Zago, 2001), members' evaluation of their cooperative's social activities and the contribution to public goods may still play a role in some farmers' decisions (Fulton, 1999). Gray and Kraenzle (1998) indicate that the beliefs in collective actions and member identification with the cooperative continue to be relevant and important for members' decisions in participating in the governance of

cooperatives in the US. If a cooperative could no longer satisfy the members' social needs, it may lead to a lower evaluation of the cooperative by the members. This in turn makes the members identify less with the cooperative and thus negatively influence their participation in collective actions. The CEOs in Chinese cooperatives have not only large individual firms, but also a substantial network and a high social status (Liang & Hendrikse, 2013). Their contribution regarding the social aspect of cooperatives is recognized better by themselves because their belief structures leads to a defensive attitude bias regarding social performance, i.e. the CEOs use their knowledge and experience to evaluate an outcome according to their beliefs (Biek et al., 1996). Moreover, a high self-perception bias leads to a less accurate evaluation when the CEOs judge themselves rather than that they are judged by others (John & Robins, 1994). Finally, the social aspect is more difficult to be evaluated by the CEO than the members. Members enjoy the cooperatives' social services most, and therefore they are more sensitive to the social aspects than the CEOs. When the CEOs evaluate the cooperative's social performance as satisfactory, members may disagree. (Nilsson & Hendrikse, 2011) present a case of a Swedish agricultural cooperative. Although a cost cutting program improves the payment to the members, it cuts some of the connections between the members and the cooperative which are highly valued by the members. The members are therefore not satisfied. Therefore we hypothesize that the members have lower evaluations regarding their cooperative's social performance compared to the CEO.

Hypothesis 3: *CEOs' evaluation of the cooperative's social performance is higher than the members' evaluation.*

Soboh et al. (2009) mention that there are non-financial benefits of cooperatives: "participating in a democratic organization, contributing on the local community's development, strengthening the social bonds among members". In this paper, we use social influence in the local community to measure the social performance of cooperatives.

4.3 Methodology

This section presents the methodological aspect of the study in terms of the sample, the data extraction method, the data aggregation, and the variables and measurements.

Sample

Development of cooperatives in China varies between regions. Cooperatives in the eastern part of China are more developed than those in western China (Han & Zhang, 2012). In this paper, we collect the data from three provinces, i.e. Zhejiang, Sichuan, and Heilongjiang. They are located in the southeastern, southwestern, and northeastern part of China respectively. These provinces vary in terms of natural resources, economic development, and agricultural production. Zhejiang specializes in high value-added products such as vegetables and fruits. Sichuan is one of the largest provinces in livestock husbandry. Heilongjiang is famous for grain production. All three provinces have relatively high levels of cooperative development among all the provinces in China. Zhejiang is leading the development of cooperatives in China. Sichuan is one of the places where farmer cooperatives emerged initially. Heilongjiang has the best developed grain cooperatives.

Two to five cooperatives from each county of the three provinces were selected randomly from the list of cooperatives provided by the agricultural departments of the three provinces. Moreover, more than three members of a cooperative were interviewed in order to enhance the representativeness of the performance evaluation by the members. In each cooperative, we chose more than three members randomly to evaluate their cooperative. 266 cooperatives were examined: 114 from Sichuan, 78 from Heilongjiang, and 74 from Zhejiang. In these cooperatives, 562 members and 266 CEOs were interviewed. Finally, 543 members and 240 CEOs responded the survey. [13]

[13] Data is accessible upon request to the authors.

Data extraction method

Data is collected regarding personal demographic information and performance evaluations of members and CEOs of cooperatives in China. Field work was carried out in the summer of 2011 by selected students from Zhejiang University. The students collected the data when they were back home during the summer holiday. Before their interview work they had training to be objective regarding the data collection. The interviewers are outsiders, i.e. not part of either the cooperatives or the research group. An important reason is to avoid the social desirability bias. In addition, professors of Zhejiang University collected some of the CEO data via the cooperative training meetings. All the questionnaires were filled in by the interviewers in order to raise the quality of the data. Moreover, at the end of the questionnaire, the respondents have to sign an agreement: "The respondent guarantees that: I follow all the required procedure to fill in all the questions in this questionnaire, the information is all fact. If it is found false, all questionnaires filled by me will be treated invalid, and I will pay the corresponding loss." Multiple pre-tests were conducted in Lishui and some other cities of Zhejiang province, in April and June, 2011, in order to revise questionnaires to be clear and easy to the respondents.

Data aggregation

From the responses of the 543 members and 240 CEOs, we cleaned the data in the following way. We first removed the observations with no response on all the evaluation questions. Data remains regarding 496 members and 212 CEOs. Then we sorted the data with the same cooperative name. As it is mentioned earlier, more than three members of a cooperative were interviewed to enhance the representativeness of the performance evaluation by the members. We therefore removed the data of cooperatives with less than three observations regarding members from the analysis. 118 cooperatives remained. Lastly, we averaged the members' data to obtain one average value of a cooperative. Finally, an aggregated dataset with 111 cooperatives remained. In this dataset, each cooperative has a response of the CEO and an average value of the

response of three or more members.

Measurement

The variables member profitability, social influence in the local community, and overall performance are used in the survey. They are measured by the Likert scale, ranging from 1 (very bad) to 7 (very good) (See Table 4.1).

Table 4.1: Measure of the dependent variables

	Variables	**Measurements**
Cooperative Performance	Member profitability	Likert scale: 1 (very bad) to 7 (very good)
	Social influence	Likert scale: 1 (very bad) to 7 (very good)
	Overall performance	Likert scale: 1 (very bad) to 7 (very good)

To avoid social desirability effects, we test for the correlation between reported performance and the archival performance. We use surplus data of cooperatives as the archival performance, and this indicates the financial performance. Table 4.2 shows that the member profitability is positively correlated with the surplus year 2010, and the overall performance is positively correlated with the surplus year 2010. This implies that the survey data regarding financial performance and overall performance correspond with the objective data regarding cooperative surplus. Social performance is itself a subjective measure, and we do not have objective data as archival performance to compare.

Table 4.2: Correlation between reported performance and the archival performance

	1	2	3
1 Member profitability			
2 Overall performance	0.54*		
	(0)		
3 Surplus 2010	0.19*	0.16	
	(0.07)	(0.1)	

Note: p value in parentheses; * $p<0.1$.

4.4 Analysis

This section starts with the descriptive statistics regarding the cooperative performance evaluations by CEOs and members. Next the hypotheses are tested.

The evaluations of the CEOs and members are presented in Table 4.3. The results show that the mean evaluation of both CEOs and members regarding their cooperatives are quite high (mean > 4). The CEOs and the members are similar in their evaluations that cooperatives are successful in member profitability, social influence and overall performance, i.e. the mean value is higher 4 on the Linkert scale. However, there are differences between CEOs and members. Social influence receives the highest score, followed by overall performance. Member profitability displays the lowest score. Members evaluate their profitability and overall performance of cooperatives better than CEOs do, whereas CEOs have a higher evaluation of cooperatives' social influence.

Table 4.3: Descriptive statistics of performance Evaluation by CEOs and Members

Variables	Identity	Mean	Std. Dev.	Min	Max
Member profitability	CEOs	4.88	1.36	1	7
	Members	5.26	1.05	1.50	7
Social influence	CEOs	6.19	0.96	3	7
	Members	5.94	0.80	3.50	7
Overall performance	CEOs	5.63	0.90	3	7
	Members	5.83	0.71	4	7

We examine whether the evaluation of the cooperative performance evaluation is significantly different between CEOs and members by a paired t-test. The results regarding the variances of the three aspects of the evaluation of CEOs and members on a sample of 111 observations are presented in tables 4-6. The test results show that the difference in the evaluations of the CEOs and members regarding all three performance aspects is statistically significant.

Results of the paired t-test regarding the overall evaluation of performance between CEOs and members are illustrated in Table 4.4. CEOs score the overall performance of their cooperatives with 5.63 ± 0.90, while the members score it with 5.83 ± 0.71. The group means are significantly different as the p-value in the Pr(|T| > |t|) row (under Ha: diff != 0, i.e. difference is not equal to 0) is less than 0.05 (i.e., p = 0.02). A statistically significant decrease of .20 (95% CI, -.37 to -.03, t(110) = -2.34, $p < 0.05$) is found. Hence, CEOs' evaluation of the cooperative's overall performance is significantly lower than that of members. Hypothesis 1 is therefore supported.

Table 4.4: Paired t-test regarding CEOs versus members evaluation of overall performance

Variable	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Overallperformance_CEO	5.63	.09	.90	5.46	5.80
Overallperformance_member	5.83	.07	.71	5.70	5.96
Overallperformance_difference	-.20	.09	.90	-.37	-.03

mean(diff) = mean(Overallperformance_CEO –Overallperformance_member) t = -2.34
Ho: mean(diff) = 0 degrees of freedom = 110
Ha: mean(diff) < 0 Ha: mean(diff) != 0 Ha: mean(diff) > 0
Pr(T < t) =0.01 Pr(|T| > |t|) = 0.02 Pr(T > t) = 0.99

Results of the paired t-test regarding the difference in member profitability evaluation between CEOs and members are illustrated in

Table 4.5. CEOs score the member profitability of their cooperatives with 4.88 ± 1.36, while the members score it with 5.26 ± 1.04. The difference between these two scores is significant, i.e. Pr(|T| > |t|) = 0.001. Specifically, a statistically significant decrease of .38 (95% CI, -.60 to -.16, t(110) = -3.40, p < .05) is found. Hence, the CEOs' evaluation of the cooperative's member profitability is significantly lower than that of members. Hypothesis 2 therefore is supported.

Table 4.5: Paired t-test regarding CEOs versus members evaluation of member profitability

Variable	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Memberprofitability_CEO	4.88	.13	1.36	4.63	5.14
Memberprofitability_member	5.26	.10	1.05	5.07	5.46
Memberprofitability_difference	-.38	.11	1.18	-.60	-.16

mean(diff) = mean(Memberprofitability_CEO–Memberprofitability_member) t = -3.40
Ho: mean(diff) = 0 degrees of freedom = 110
Ha: mean(diff) < 0 Ha: mean(diff) != 0 Ha: mean(diff) > 0
Pr(T < t) = 0.0005 Pr(|T| > |t|) = 0.0010 Pr(T > t) = 0.9995

Results of the paired t-test regarding the difference in social influence evaluation between the CEOs and the members are displayed in Table 4.6. CEOs score the social influence of their cooperatives with 6.19 ± 0.96, while the members score it with 5.94 ± 0.80. The difference between these two scores is significant, i.e. Pr(|T| > |t|) = 0.01. Moreover, a statistically significant increase of .25 (95% CI, .06 to .44, t(110) = 2.57, p < .05) is found. Hence, CEOs' evaluation of the cooperative's social influence is significantly higher than that of members. Hypothesis 3 is therefore supported.

Table 4.6: Paired t-test regarding CEOs versus members evaluation of social influence

Variable	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Socialinfluence_CEO	6.19	.09	.96	6.01	6.37
Socialinfluence_member	5.94	.084	.80	5.791	6.09
Socialinfluence_difference	.25	.10	1.03	.057	.44

mean(diff) = mean(Socialinfluence_CEO –Socialinfluence_member) t = 2.57
Ho: mean(diff) = 0 degrees of freedom = 110
Ha: mean(diff) < 0 Ha: mean(diff) != 0 Ha: mean(diff) > 0
Pr(T < t) = 0.9942 Pr(|T| > |t|) = 0.0116 Pr(T > t) = 0.0058

4.5 Exploration of associated factors

Besides the analysis of the difference between the CEOs and the members' evaluation regarding cooperative performance, we also explore the associated factors that may influence the CEOs' evaluation, the members' evaluation and the difference between CEOs' and members' evaluation. Arcas-Lario et al., (2014) find that more information, more control, and more trust lead to higher satisfaction of cooperatives. Karami & Rezaei-Moghaddam, (2005) model the determinants of the cooperative performance in Iran. The results show that the "government support factor", which indicates the amount of loan, aid, and the value of machinery provided by the government, has a positive impact on the cooperative performance. In this section, we explore the first step of the associated factors that may influence the evaluations with the collected data.

Variables and Measurement

We test the impacts of two categories of factors associated with the performance evaluation of CEOs and members. The first category refers to the governance of cooperatives. Specifically, we test regarding the number of general meetings and the ways of profit distribution. The second category of factors is personal information regarding the CEOs and members. It consists of gender, age, education, and working experience. We compare the average members' personal information with the CEOs' data, and then test their impact. Lastly, we consider several cooperative characteristics as control variables, including membership size, product type, and the cooperative's economic status. Measurements of each variable are displayed in Table 4.7.

Table 4.7: Explanations and measures of independent variables

	Variables	Measurements
Cooperative governance (independent variables)	The number of general meetings	Average times of general meeting per year
	Profit distribution	Based on capital shares=1; Based on both patronage and capital shares=2; Based on patronage=3; Equal distribution=4; Others=5
Personal information CEOs (independent variables)	Gender	Male=1; Female=2
	Age	
	Education	No education=1; Primary school=2; Junior high school=3; Senior high school=4; College or university=5
	Working experience	Having working experience other than farming=1; Otherwise=2
Personal information Average Members (independent variables)	Gender	Male=1; Female=2
	Age	
	Education	No education=1; Primary school=2; Junior high school=3; Senior high school=4; College or university=5
	Working experience	Having working experience other than farming=1; Otherwise=2
Control variables	Product type	Grain and oil=1; Vegetables=2; Fruit=3; Chicken=4; Pork=5
	Economic status	Best=1; Above average=2; Average=3; Blow average=4; Worst=5
	Membership size	Number of members

Descriptive Statistics

Table 4.8 shows the descriptive statistics of the investigated variables. The average size of the examined cooperatives is large (mean=483.41, min=6, max=21000). Besides that,

the data of the CEOs and the members show that the average age of the CEOs and members are similar. The gender of the CEOs is more towards male than the members. The average gender of members also shows that there are more male than female members. The education of the CEOs is higher than the education of the members. Finally, the working experience of the CEOs is more towards the option "Having working experience other than farming" than that of the members. The dependent variables regarding the evaluations are in the descriptive statistics. Additionally, we generate dependent variables regarding the difference of evaluations between the CEOs and the members by using CEOs' evaluation scores minus members' evaluation scores. Note that the difference of the evaluations have negative results in member profitability and overall performance. This corresponds with our findings in the previous section, i.e. members have a higher evaluation of member profitability and overall performance of cooperatives than CEOs, while the difference of the evaluations is positive regarding social influence. This implies that CEOs have a higher evaluation of cooperatives' social influence than the members. The descriptive statistics in Table 4.8 provide an overview of all the variables which will be investigated.

Table 4.8: Descriptive statistics

	Variable	Mean	Std. Dev.	Min	Max
1	The number of general meetings	2.18	1.38	1	7
2	Profit distribution	3.13	1.49	1	6
3	Gender of CEOs	1.05	0.21	1	2
4	Age of CEOs	48.15	8.31	28	69
5	Education of CEOs	3.86	0.83	1	5
6	Working experience of CEOs	1.18	0.59	1	6
7	Average Gender of members	1.15	0.21	1	2
8	Average Age of members	47.06	6.58	29.33	62.25
9	Average Education of members	3.19	0.52	2.2	4.67
10	Average Experience of members	1.40	0.33	1	3
11	Product type	2.76	1.40	1	6
12	Economic status	2.14	0.85	1	4
13	Membership size	438.41	1997.12	6	21000

14	Evaluation member profitability of CEOs	4.88	1.36	1	7
15	Evaluation social influence of CEOs	6.19	0.96	3	7
16	Evaluation overall performance of CEOs	5.63	0.90	3	7
17	Average Evaluation member profitability of members	5.26	1.05	1.5	7
18	Average Evaluation social influence of members	5.94	0.80	3.5	7
19	Average Evaluation overall performance of members	5.83	0.71	4	7
20	Difference evaluation member profitability	-0.38	1.18	-3.25	2.8
21	Difference evaluation social influence	0.25	1.03	-3	2.67
22	Difference evaluation overall performance	-0.2	0.9	-3	1.75

N=111. Variables 14 to 19 are the evaluations by the CEOs and the members. Variables 20 to 22 are the difference of evaluations between the CEOs and the members.

Table 4.9 shows the correlation of all the investigated variables. Note that there are some correlations between the dependent variables. This indicates that the total evaluation is related to the other evaluations. The difference in evaluations is also related to other evaluations. Jarque-Bera test is performed for the normality, and the results shows a normal distribution. We therefore conduct multiple regressions to test the relationship between the associated factors and the evaluations.

Table 4.9: Correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
1 Number of general meetings																					
2 Profit distribution	-0.18																				
3 Gender of CEOs	0.17	-0.02																			
4 Age of CEOs	0.11	-0.07	-0.08																		
5 Education of CEOs	-0.01	0.15	-0.09	-0.32																	
6 Working experience of CEOs	-0.05	-0.18	0.01	0.04	-0.01																
7 Average Gender of members	-0.03	-0.1	0.1	-0.01	-0.15	0.27															
8 Average Age of members	0.04	-0.1	-0.2	0.3	-0.1	0.04	-0.17														
9 Average Edu~ of members	0.03	0.05	0.19	0.07	0.15	0.1	0.06	-0.43													
10 Average Exp~ of members	0.04	0.03	-0.17	-0.01	0.03	0.09	-0.02	0.07	-0.27												
11 Product type	-0.04	0.06	0.07	0.04	-0.14	0.05	0.17	-0.13	0.07	-0.02											
12 Economic status	-0.18	0.01	0.03	-0.01	0.02	-0.13	-0.06	-0.24	0.05	0.11	0.2										
13 Membership size	-0.1	0.09	-0.02	0.11	0.14	0.12	0.04	0.1	0.01	0.15	-0.1	-0.17									
14 Eva~ mem~ pro~ of CEOs	0.1	-0.01	-0.01	0.04	-0.1	-0.03	-0.03	0.12	-0.18	0.06	-0.02	0.04	0.14								
15 Eva~ soc~ inf~ of CEOs	-0.2	0.23	-0.22	0.03	0.13	0.08	0	0.22	-0.02	0.03	0.05	-0.18	0.1	0.37							
16 Eva~ ove~ per~ of CEOs	0.01	0.14	-0.2	0.12	0.08	0.02	-0.04	0.18	-0.01	0.08	-0.15	-0.18	0.15	0.54	0.69						
17 Ave~ Eva~ mem~ pro~ of members	0.09	-0.07	0.08	0.14	-0.2	0.04	0.13	-0.16	-0.02	0.04	-0.01	0.19	0.12	0.54	0.1	0.32					
18 Ave~ Eva~ soc~ inf~ of members	0.13	0.02	0.01	0.19	-0.09	0.04	-0.1	-0.1	0.08	0	-0.05	0.04	0.1	0.31	0.33	0.45	0.56				
19 Ave~ Eva~ ove~ per~ of members	0.13	0.14	0.1	0.16	-0.19	0.01	0	-0.06	0.07	-0.03	0.12	0.02	0.12	0.4	0.24	0.4	0.63	0.78			
20 Diff~ Eva~ mem~ pro	0.04	0.04	-0.09	-0.08	0.06	-0.07	-0.15	0.28	-0.18	0.04	-0.02	-0.12	0.05	0.67	0.34	0.34	-0.26	-0.13	-0.1		
21 Diff~ Eva~ soc~ inf	-0.29	0.2	-0.21	-0.12	0.19	0.05	0.76	0.28	-0.09	0.02	0.09	-0.17	0.01	0.1	0.68	0.29	-0.34	-0.47	-0.38	0.42	
22 Diff~ Eva~ ove~ per	-0.1	0.03	-0.28	0	0.23	0.02	-0.04	0.23	-0.06	0.1	-0.25	-0.2	0.06	0.23	0.5	0.69	-0.18	-0.16	-0.39	0.42	0.6

* $p < .05$

Analysis and result

We test the relationship between various cooperative governance variables, CEOs' and members' personal information variables, and the CEOs' and members' evaluations. Additionally, we use the difference of the evaluations between the CEOs and the members as the dependent variable, the difference of personal information between the CEOs and the members as the independent variable. For example, the difference of education is defined as the CEOs' education minus the average members' education. In this way, we test the relationship between the difference of personal information and the difference of the evaluations.

The tests show that the number of general meetings is negatively related to the difference of evaluations regarding social influence. This implies that the difference of evaluations regarding social influence decreases when there are more general meetings. We find that the difference in age has a negative impact on the difference of evaluations regarding social influence. This implies that if CEOs are older than the members, the difference of the evaluations regarding social influence is smaller. It can be explained by young CEOs tending to be more over-confidence compared to old CEOs (Richeson & Shelton, 2006). The old CEOs therefore have a lower self-perception bias compared to the young CEOs, and evaluate social influence more similar to the members'. Gender is negatively related to the social evaluation of CEOs. Moreover, the difference in gender is negatively related to the difference of evaluations. This implies that male CEOs' evaluations are higher than female CEOs', and female CEOs' evaluations are more similar to the members' evaluations. An explanation is that there is a confidence level difference between men and women. Men tend to be more confident and evaluate too positively regarding their performance (Beyer, 1990; Sarsons & Xu, 2015). The female CEOs are therefore less likely to have a self-perception bias compared to the male CEOs, and they evaluate more similar to the members. We do not find significant results to show that there are factors in the dataset that influence the members' evaluations. This implies that in this current model, cooperative governance variables and members'

personal information variables do not significantly influence members' evaluations. The relationship between the associated factors and the evaluations is presented Table 4.10. The robustness check of the regression models is in the appendix.

Table 4.10: Factors which influence the evaluations

	Evaluation social influence of CEOs	**Difference evaluation social influence**	**Difference evaluation overall performance**
Number of general meetings	-0.1	-0.17*	-0.03
	(-1.19)	(-2.14)	(-0.36)
Profit distribution	0.13	0.09	0
	(1.80)	(1.21)	(0.07)
Gender of CEOs	-1.39*		
	(-2.36)		
Age of CEOs	0		
	(0.33)		
Education of CEOs	0.2		
	(1.20)		
Working Experience of CEOs	0.09		
	(0.53)		
Difference in gender		-0.94*	-0.93**
		(-2.42)	(-2.66)
Difference in age		-0.03*	-0
		(-2.23)	(-0.24)
Difference in education		0.16	0.16
		(1.32)	(1.46)
Difference in experience		-0.12	-0.15
		(-0.77)	(-1.01)
Product type	0.1	0.16*	-0.12
	(1.28)	(2.20)	(-1.72)
Economic status	-0.22	-0.18	-0.1
	(-1.73)	(-1.37)	(-0.88)
Membership size	0	0	0
	(0.42)	(1.64)	(1.37)
Constant	6.69***	-0.02	-0.02
	(5.52)	(-0.03)	(-0.04)

Note: t statistics in parentheses; * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

Several tests are performed to check the validity of the regression models. The variance inflation factor test for multicollinearity shows that the VIF scores for all regression models are smaller than 5. There is no multicollinearity. Moreover, the Breusch Pagan test is performed to test for heteroscedasticity. The test does not reject the null hypothesis. Therefore, there is no heteroscedasticity problem in the regression models. The results of these two tests are presented in the appendix.

4.6 Conclusions

This study provides evidence of Chinese cooperatives regarding the different evaluations between CEOs and members. Hypotheses regarding the differences between CEOs' and members' evaluation of their cooperative performance are established and tested. Furthermore, various relevant factors are analyzed which may influence the evaluations. The results show that although both CEOs and members provide a high evaluation of their cooperatives' performance, their degree of satisfaction differs significantly. First, CEOs' evaluation is significantly different from the members' evaluation of overall performance, and the difference is negative. Second, CEOs' evaluation is lower than the members' evaluation regarding financial performance of their cooperatives. Lastly, CEO's evaluation is higher than the members' evaluation regarding social performance. A number of factors that are associated with the CEOs' evaluations, the members' evaluations, and the difference between them have been explored. Specifically, more general meetings decrease the difference of evaluations regarding the social performance of cooperatives. Male CEOs are more likely to evaluate more positive than female CEOs. Moreover, female CEOs and members tend to have more similar evaluations. Lastly, the evaluations between CEOs and members differ less when CEOs are older. The findings are in line with the literature.

A CEO has to have an accurate understanding of members' interests in order to operate the cooperative enterprise well. Therefore, knowledge of members' evaluation of cooperatives, as well as how members' evaluation differs from that of their own, can help cooperative CEOs to formulate strategies that best serve the membership and keep the cooperative successful. For example, if the cooperative recognizes that the CEO has higher expectations regarding financial performance rather than the social performance, social performance of the cooperative can be added and higher weighed as one task of the CEO's responsibilities, and as one measurement of CEO's performance. Moreover, the associated factors add to the knowledge on how the cooperative can reduce the different perceptions between CEOs and members.

This study has various limitations. First, the data is collected in Chinese cooperatives. A future study could have a sample from the Western world, to test if different cooperative structures lead to different results. Second, this study applies the measurements of the literature. However, confirmatory factor analysis is lacking. In a future study, a confirmatory factor analysis should be considered to avoid validity and reliability problems of the measurements. Third, omitted variables and common method bias are not tested in this study. A future study can test other variables and to examine if there is a bias in the current model. For example, social activities, social services can be examined and added to the social performance of cooperatives, to develop the measure of cooperatives' social performance. Lastly, the exploration of associated factors is only a start for finding the relevant influential factors that may have an impact on the evaluations. Future studies need to be designed to further investigate this issue

Chapter 5

Summary and Conclusion

This thesis has addressed communication and innovation, member sorting, and evaluations of cooperatives. The general introduction to cooperatives and the topics of this thesis are presented in chapter 1. In chapter 2, two types of innovation which are associated with two types of communication are investigated in different governance structures, and efficient governance structures are determined. A member sorting model is developed in chapter 3. The model investigates how farmers choose the processor enterprise and its governance structure, where farmers are characterized by both their location and the quality of their product. Lastly, we empirically investigate the CEOs' and the members' evaluation of Coops.

An overall introduction to the thesis, including the background, research objectives, and the outline of the thesis, is presented in **Chapter 1**. The cooperative is characterized and Coops and IOFs are compared. The transaction relationship distinguishes the Coop and the IOF. A cooperative has disadvantages and advantages compared to an IOF. Disadvantages of a Coop are the free rider problem, the horizon problem, the portfolio problem, the control problem, and the influence costs problem (Cook, 1995). Advantages of a Coop are the elimination of double marginalization, countervailing power, assurance of supply, stable payment, and social benefits. Lastly, the research topics and outline of the thesis are introduced.

Chapter 2 investigates the relationship between communication, innovation, and (de)centralization in cooperatives. Two types of communication are distinguished: horizontal and vertical. Horizontal communication (HC) is communication between the members, while vertical communication (VC) is communication between the members and the CEO. HC and VC are associated with different types of innovation. HC is related to process innovation, while VC is related to product innovation. We characterize a decentralized cooperative by members taking their own decisions regarding VC and production. In a centralized cooperative these decisions are made by the CEO of the cooperative enterprise. HC decisions are made by members individually in both cooperatives. The decentralized cooperative tends to overproduce due to the negative production externalities and it generates insufficient VC due to the positive product quality externalities. An advantage of the decentralized cooperative is that the costs of VC are carried by the various members, as opposed to the centralized cooperative in which all VC costs are generated by the CEO. The findings show that the centralized cooperative dominates when both communication cost coefficients are small and large, while the decentralized cooperative dominates when both communication cost coefficients are in an intermediate range.

In **Chapter 3** a sorting model is developed to analyze how farmers choose the processor enterprises and their governance structures. Farmers make decisions based on their location and product quality characteristics, and majority voting determines which governance structure the enterprise adopts. A three-stage game is developed. In the first stage each farmer chooses an enterprise. In the second stage the governance structure is determined by majority voting of the members. In the last stage, the farmer decides to produce or not. When the IOF price is low, the Coop market is the equilibrium. When the IOF price is in a middle range, the mixed market is the equilibrium. When the IOF price is high, the IOF market is the equilibrium. Additionally, when the IOF adopts a profit maximizing price policy, the Coop market is always the equilibrium.

We provide evidence from China for understanding the different evaluations between CEOs and members in **Chapter 4**. The results of a survey regarding Chinese cooperatives show that although both CEOs and members are satisfied with their cooperatives' performance, their evaluations differ significantly. Specifically, the CEOs' evaluation is lower than the members' evaluation regarding the overall performance and financial performance of their cooperatives. However, CEO's evaluation is higher than the members' evaluation regarding social performance. The analyses imply that CEOs focus more on the economic performance of the cooperative, while the members focus more on the social performance. A number of factors that are associated with the CEOs' evaluations, the members' evaluation, and the difference between them have been identified as well. Specifically, the number of general meetings and CEOs' age decrease the difference of evaluations. Male CEOs are more likely to evaluate more positive than female CEOs. Moreover female CEOs and members tend to have more similar evaluations.

This dissertation contributes to the literature and practice in several ways. In chapter 2, we associate HC and VC with process and product innovation and determine the efficient governance structures. In practice, this chapter provides advice for the choice of communication policy of supplier owned enterprises in different settings. HC (VC) is expected in a decentralized (centralized) cooperative. In chapter 3, we analyze both vertical and horizontal differentiation in a single model. This is novel in the literature. We also determine the circumstances when the Coop and IOF governance structures emerge. In practice, this chapter provides advice for the farmers for how to make decisions with considering both location (to the enterprise) and quality (of their products). When the market price is low, farmers choose the closest enterprise and a Coop governance structure is adopted. When the market price is high, besides that the farmers like to choose the closest enterprise, high (low) quality farmers vote for the IOF (Coop) governance. In chapter 4, the difference between the evaluations of the manager and the members is determined. This may be useful in formulating a cooperative's strategy. For example, if the cooperative recognizes that the CEO puts more weight on

financial performance than social performance, then social performance of the cooperative may have to receive more weight in the CEO's performance measure. Moreover, the associated factors add to the knowledge on how the cooperative can reduce the different perceptions between CEOs and members. For instance, more GA meetings can be organized to ensure that the members wishes are understood, and taken into account, by the CEOs.

There are various possibilities for future research. In chapter 2, a distinction is made between HC and VC, and these two types of communication are associated with different types of innovation. However, actual organizations use a rich menu of communication devices to address various issues. For example, both HC and VC are related to foster involvement, commitment, and trust between the farmers and the cooperative enterprise. Moreover, VC occurs also when farmers communicate extensively with the CEO about the transactions between the farm and the cooperative enterprise, and the strategy of the cooperative. Moreover, the control problem and the influence costs problem also involve VC (Cook, 1995). This may require different modelling. For instance, if involvement, commitment, and trust are considered in the model, both HC and VC have to add value regarding these aspects. A higher level of VC may lead to higher trust between the member and the CEO, and higher commitment of the CEO. If the control problem and the influence costs problem are considered together in the model, then a high level of VC may contribute to reducing the control problem, but it may increase the influence costs problem. In chapter 3, our model considers an average price policy for a Coop. However, Coops may adopt a differentiated price policy to create fairness between the members and to reflect product quality. Furthermore, quality is exogenous in our model (Sutton, 1991). Lastly, future research has to show how robust the two governance structures are in the competition with other governance structures. In chapter 4, a future study may use a sample from the Western world in order to account for different cooperative structures. Second, a confirmatory factor analysis can be performed in a future study to secure validity and reliability of the measurements. Third, there are possibilities to test other variables. For example, social activities and

social services can be examined and added to the social performance of cooperatives, to develop the measure of cooperatives' social performance. Lastly, a study of the associated factors regarding the evaluations of the cooperative, and the difference in CEOs' and members' evaluations, has to be designed and investigated in order to deepen the understanding of the associations.

Summary

An agriculture cooperative is an enterprise collectively owned by an association of many independent upstream agricultural farmers. This dissertation addresses various aspects of these cooperatives. In chapter 1, cooperatives are introduced. In chapter 2, two types of innovation are associated with two types of communication. They are analyzed in different governance structures, and the efficient governance structures are determined. A member sorting model is developed in chapter 3 to investigate which processor enterprise farmers choose and how the governance structure is determined. In chapter 4, CEOs' and the members' evaluations are empirically investigated in Chinese Coops. Finally, chapter 5 provides a summary and conclusion of this dissertation.

The major conclusions are as follows. Chapter 2 investigates the relationship between communication, innovation, and (de)centralization in cooperatives. Horizontal communication (HC) is associated with process innovation, while vertical communication (VC) is associated with product innovation. The CEO decides regarding the deliveries of the member and the level of vertical communication in the centralized cooperative, while these decisions are taken by the members in the decentralized cooperative. The findings show that a decentralized cooperative is efficient for an intermediate level of the VC cost coefficient and when the HC cost coefficient is above a certain level, while a centralized cooperative is efficient in the other cases. This is due to the centralized cooperative internalizing the negative production externalities and a higher VC level. Chapter 3 investigates how members sort themselves across enterprises and which governance structures are adopted. The Coop pays a uniform price to all farmers to maximize members' revenue and retains no profits, whereas investor-owned firm (IOF) differentiates payments based on quality. The market consists of 2 (1, 0) Coops and 0 (1, 2) IOFs when the payment for quality by the IOF is low (intermediate, high). In equilibrium a farmer tends to choose the enterprise most close to him/her, and a farmer with a high quality product tends to choose an IOF. In chapter 4, we provide

evidence from China for understanding the different evaluations between CEOs and members. The results of a survey show that both CEOs and members are satisfied with their cooperatives' performance. However, members have higher scores than CEOs regarding member profitability and overall performance, while CEOs have a higher evaluation regarding social influence. The results also show that the number of general meetings and CEOs' age decrease the difference in the evaluations. Male CEOs are more likely to evaluate more positive than female CEOs. Moreover female CEOs and members tend to have more similar evaluations.

Samenvatting

Een landbouw coöperatieve is een onderneming in het bezit van een vereniging van onafhankelijke agrarische landbouwers. Dit proefschrift analyseert verscheidene aspecten van deze coöperatie. Hoofdstuk 1 introduceert coöperaties en de onderwerpen in het proefschrift. In hoofdstuk 2 worden twee soorten innovatie in verband gebracht met twee soorten communicatie. Ze worden geanalyseerd in verschillende coöperatieve bestuursstructuren en de efficiënte bestuursstructuur wordt bepaald. In hoofdstuk 3 wordt een leden sortering model ontwikkeld om te onderzoeken welke onderneming boeren kiezen en hoe de bestuursstructuur wordt bepaald. In hoofdstuk 4 worden de evaluaties van de CEO's en de leden empirisch onderzocht in Chinese coöperaties. Hoofdstuk 5 vat de belangrijkste resultaten samen en formuleert conclusies.

De belangrijkste conclusies zijn als volgt. Hoofdstuk 2 onderzoekt de relatie tussen communicatie, innovatie, en (de)centralisatie in coöperaties. Horizontale communicatie (HC) is gelieerd aan procesinnovatie en verticale communicatie (VC) aan productinnovatie. De CEO beslist ten aanzien van de leveringen van de leden en het niveau van de verticale communicatie in de gecentraliseerde coöperatie, terwijl deze beslissingen worden genomen door de leden in de gedecentraliseerde coöperatie. De bevindingen tonen aan dat een gedecentraliseerde coöperatie efficiënt is voor een gemiddeld niveau van de VC, en wanneer de HC kosten boven een bepaald niveau zijn. Een gecentraliseerde coöperatie is efficiënt in de overige scenarios. Dit komt doordat de centrale coöperatie de negatieve externaliteiten in productie kan internaliseren en een hoger niveau van VC heeft. Hoofdstuk 3 onderzoekt hoe leden ondernemingen kiezen en hoe de bestuursstructuur binnen een onderneming wordt gekozen. De coöperatie wordt verondersteld een uniforme prijs te betalen en keert alle opbrengsten uit aan de leden, terwijl de NV onderscheidt maakt in zijn betalingen op basis van kwaliteit en uit is op maximalisatie van de eigen winst. De markt bestaat uit 2 (1, 0) coöperaties en 0 (1, 2) NVs wanneer de betaling voor kwaliteit door de NV laag (midden, hoog) is. In het

evenwicht kiest de boer de dichtstbijzijnde onderneming, en een boer met producten van hoge kwaliteit kiest de NV. In hoofdstuk 4 gebruiken we een enquête onder coöperaties in China om de verschillende evaluaties van de CEO en de leden te begrijpen. De resultaten tonen aan dat zowel CEO's en leden tevreden zijn over de prestaties van hun coöperaties. Echter, de leden hebben hogere scores dan CEO's met betrekking tot lid winstgevendheid en de algemene prestaties, terwijl de CEO's een hogere score hebben op het vlak van sociale invloed. De resultaten tonen ook aan dat meer algemene vergaderingen tot een verbetering van de evaluaties leidt, en dat meer algemene vergaderingen (mannelijke CEO's, oudere en meer ervaren leden) tot een daling (stijging, afname) van de evaluatieverschillen leiden.

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Appendix

Chapter 2

Payoffs in Decentralized/Centralized Cooperative (given HC and VC)

The mathematical steps to obtain the comparative statics in the centralized and centralized cooperatives given HC and VC are presented Table 1 below:

Table 1: Payoffs calculation steps in decentralized and centralized cooperatives (given HC and VC)

Decentralized cooperative	Centralized cooperative
$\pi_1 = (\overline{v} + d - q_1 - q_2)q_1 - (A - h_1)q_1 - \frac{1}{2}rh_1^2 - \frac{1}{2}kv_1^2$ $\pi_2 = (\overline{v} + d - q_1 - q_2)q_2 - (A - h_2)q_2 - \frac{1}{2}rh_2^2 - \frac{1}{2}kv_2^2$ $\pi = \pi_1 + \pi_2 = (\overline{v} + d - Q)Q - c_1q_1 - c_2q_2 - \frac{1}{2}rh_1^2 - \frac{1}{2}kv_1^2 - \frac{1}{2}rh_2^2 - \frac{1}{2}kv_2^2$	$\pi = (\overline{v} + d - q_1 - q_2)(q_1 + q_2) - c_1q_1 - c_2q_2 - \frac{1}{2}rh_1^2 - \frac{1}{2}rh_2^2 - \frac{1}{2}k(v_1 + v_2)^2$ $\pi_1 = (\overline{v} + d - q_1 - q_2)q_1 - (A - h_1)q_1 - \frac{1}{2}rh_1^2 - \frac{1}{4}k(v_1 + v_2)^2$ $\pi_2 = (\overline{v} + d - q_1 - q_2)q_2 - (A - h_2)q_2 - \frac{1}{2}rh_2^2 - \frac{1}{4}k(v_1 + v_2)^2$
First step: Maximize simultaneously π_1 regarding q_1 and π_2 regarding q_2, and solve for q_1 and q_2 results in the reaction functions $q_1^*(q_2) = \frac{1}{2}(d - A + \overline{v} + h_1) - \frac{1}{2}q_2$, $q_2^*(q_1) = \frac{1}{2}(d - A + \overline{v} + h_2) - \frac{1}{2}q_1$. The intersections of the reaction functions result in the equilibrium	First step: Maximize π regarding q_1 and q_2, and solve for q_1 and q_2 results in the reaction functions $q_1{}^*(q_2) = \frac{1}{2}(d - A + \overline{v} + h_1) - q_2$, $q_2{}^*(q_1) = \frac{1}{2}(d - A + \overline{v} + h_2) - q_1$. The symmetric solution to the interaction of the reaction functions results in the equilibrium

$q_1^*\|_D = \frac{1}{3}(d - A + \overline{v} + 2h_1 - h_2)$ $q_2^*\|_D = \frac{1}{3}(d - A + \overline{v} + 2h_2 - h_1)$. Therefore, $Q^*\|_D = \frac{2}{3}(d - A + \overline{v} + \overline{h})$.	$q_1^*\|_C = q_2^*\|_C = \frac{1}{4}\left(d - A + \overline{v} + \overline{h}\right)$. Therefore, $Q^*\|_C = \frac{1}{2}\left(d - A + \overline{v} + \overline{h}\right)$
Second step: Plug $q_1^*\|_D$, $q_2^*\|_D$ back into π. Due to symmetric computation, we take $h_1 = h_2 = \overline{h}, v_1 = v_2 = \overline{v}, q_1 = q_2 = \frac{Q}{2} = \frac{1}{3}(d - A + \overline{v} + \overline{h})$. $\pi\|_D = (\overline{v} + d - Q)Q - \left(A - \overline{h}\right)Q - r\overline{h}^2 - k\overline{v}^2 = \frac{2}{9}\left(d - A + \overline{v} + \overline{h}\right)^2 - r\overline{h}^2 - k\overline{v}^2$	Second step: Plug $q_1^*\|_C$, $q_2^*\|_C$ back into π. Due to symmetric computation, we take $h_1 = h_2 = \overline{h}, v_1 = v_2 = \overline{v}, q_1 = q_2 = \frac{Q}{2} = \frac{1}{4}(d - A + \overline{v} + \overline{h})$ $\pi\|_C = (\overline{v} + d - Q)Q - \left(A - \overline{h}\right)Q - r\overline{h}^2 - 2k\overline{v}^2 = \frac{1}{4}\left(d - A + \overline{v} + \overline{h}\right)^2 - r\overline{h}^2 - 2k\overline{v}^2$.

Payoffs in Decentralized/Centralized Cooperative (given HC)

Similarly, the mathematical steps to obtain the comparative statics in the centralized and centralized Cooperative without HC are presented in Table 2:

Table 2: Payoffs calculation steps in decentralized and centralized cooperatives (given HC)

Decentralized structure	Centralized structure
$\pi_1 = (\overline{v} + d - q_1 - q_2)q_1 - Aq_1 - \frac{1}{2}kv_1^2$ $\pi_2 = (\overline{v} + d - q_1 - q_2)q_2 - Aq_2 - \frac{1}{2}kv_2^2$ $\pi = \pi_1 + \pi_2 = (\overline{v} + d - Q)(q_1 + q_2) - Aq_1 - Aq_2 - \frac{1}{2}kv_1^2 - \frac{1}{2}kv_2^2$	$\pi = (\overline{v} + d - q_1 - q_2)(q_1 + q_2) - Aq_1 - Aq_2 - \frac{1}{2}k(v_1 + v_2)^2$ $\pi_1 = (\overline{v} + d - q_1 - q_2)q_1 - Aq_1 - \frac{1}{4}k(v_1 + v_2)^2$ $\pi_2 = (\overline{v} + d - q_1 - q_2)q_2 - Aq_2 - \frac{1}{4}k(v_1 + v_2)^2$

First step: Maximize simultaneously π_1 regarding q_1 and π_2 regarding q_2, and solve for q_1 and q_2 results in the reaction functions $q_1^*(q_2) = \frac{1}{2}(d - A + \overline{v}) - \frac{1}{2}q_2,$ $q_2^*(q_1) = \frac{1}{2}(d - A + \overline{v}) - \frac{1}{2}q_1.$ The intersections of the reaction functions result in the equilibrium $q_1^*(v_1, v_2|_D) = \frac{1}{3}(d - A + \overline{v})$ $q_2^*(v_1, v_2|_D) = \frac{1}{3}(d - A + \overline{v}).$ Therefore, $Q(v_1, v_2|_D) = \frac{2}{3}(d - A + \overline{v_D})$.	First step: Maximize π regarding q_1 and q_2, and solve for q_1 and q_2 results in the reaction functions $q_1{}^*(q_2) = \frac{1}{2}(d - A + \overline{v}) - q_2,$ $q_2{}^*(q_1) = \frac{1}{2}(d - A + \overline{v}) - q_1.$ The symmetric solution to the intersection of the reaction functions results in the equilibrium $q_1^*(v_1, v_2|_C) = q_2^*(v_1, v_2|_C) = \frac{1}{4}(d - A + \overline{v}).$ Therefore, $Q(v_1, v_2|_C) = \frac{1}{2}(d - A + \overline{v_C})$.
Second step: Plug $q_1^*(v_1, v_2|_D)$, $q_2^*(, v_1, v_2|_D)$ back into π_1 and π_2. $\pi_1 = \left(\frac{1}{3}(d + 2A) + \frac{1}{6}(v_1 + v_2)\right)(\frac{1}{3}(d - A) + \frac{1}{6}(v_1 + v_2)) - A(\frac{1}{3}(d - A) + \frac{1}{6}(v_1 + v_2)) - \frac{1}{2}kv_1^2$ $\pi_2 = \left(\frac{1}{3}(d + 2A) + \frac{1}{6}(v_1 + v_2)\right)(\frac{1}{3}(d - A) + \frac{1}{6}(v_1 + v_2)) - A(\frac{1}{3}(d - A) + \frac{1}{6}(v_1 + v_2)) - \frac{1}{2}kv_2^2.$ Maximizing π_1 regarding v_1; maximizing π_2 regarding v_2, results in the first order conditions,	Second step: Plug $q_1^*(v_1, v_2|_C)$, $q_2^*(v_1, v_2|_C)$ back into π. $\pi = \left(\frac{1}{2}(d + A) + \frac{1}{4}(v_1 + v_2)\right)(\frac{1}{2}\left(d - A) + \frac{1}{4}(v_1 + v_2\right)) - A(\frac{1}{2}\left(d - A) + \frac{1}{4}(v_1 + v_2\right)) - \frac{1}{2}k(v_1 + v_2)^2.$ Maximizing π regarding v ($v = v_1 + v_2$), results $v^*(k|_C) = \frac{2(d-A)}{8k-1}.$ Therefore, $v_1^*(k|_C) = v_2^*(k|_C) = \frac{(d-A)}{8k-1}.$

$v_1^*(v_2\|_D) = \frac{2A-2d-v_2}{1-18k}$ $v_2^*(v_1\|_D) = \frac{2A-2d-v_1}{1-18k}$. Solve the four reaction functions: $v_1^*(k\|_D) = v_2^*(k\|_D) = \frac{(d-A)}{9k-1}$.	
Final step: Substitute $v_1^*(k\|_D)$ and $v_2^*(k\|_D)$ into q_1, q_2, $Q^*(k\|_D) = {q_1}^*(k\|_D) + {q_2}^*(k\|_D) = \frac{6(d-A)k}{9k-1}$ and $\pi^*(k\|_D) = \frac{(d-A)^2k(18k-1)}{(9k-1)^2}$.	Final step: Substitute $v_1^*(k\|_C)$ and $v_2^*(k\|_C)$ into q_1, q_2, $Q^*(k\|_C) = {q_1}^*(k\|_C) + {q_2}^*(k\|_C) = \frac{4k(d-A)}{8k-1}$ and $\pi^*(k\|_C) = \frac{2(d-A)^2k}{8k-1}$.

Payoffs in Decentralized/Centralized Cooperative

The mathematical steps to obtain the comparative statics in the centralized and centralized Cooperative, are presented in Table 3:

Table 3: Payoffs calculation steps in decentralized and centralized cooperatives

Decentralized structure	Centralized structure
$\pi_1 = (\overline{v} + d - q_1 - q_2)q_1 - (A - h_1)q_1 - \frac{1}{2}rh_1^2 - \frac{1}{2}kv_1^2$ $\pi_2 = (\overline{v} + d - q_1 - q_2)q_2 - (A - h_2)q_2 - \frac{1}{2}rh_2^2 - \frac{1}{2}kv_2^2$ $\pi = \pi_1 + \pi_2 = (\overline{v} + d - Q)(q_1 + q_2) - c_1q_1 - c_2q_2 - \frac{1}{2}rh_1^2 - \frac{1}{2}kv_1^2 - \frac{1}{2}rh_2^2 - \frac{1}{2}kv_2^2$	$\pi = (\overline{v} + d - q_1 - q_2)(q_1 + q_2) - c_1q_1 - c_2q_2 - \frac{1}{2}rh_1^2 - \frac{1}{2}rh_2^2 - \frac{1}{2}k(v_1 + v_2)^2$ $\pi_1 = (\overline{v} + d - q_1 - q_2)q_1 - (A - h_1)q_1 - \frac{1}{2}rh_1^2 - \frac{1}{4}k(v_1 + v_2)^2$ $\pi_2 = (\overline{v} + d - q_1 - q_2)q_2 - (A - h_2)q_2 - \frac{1}{2}rh_2^2 - \frac{1}{4}k(v_1 + v_2)^2$
First step: Maximize simultaneously π_1 regarding q_1 and π_2 regarding q_2, and	First step: Maximize π regarding q_1 and q_2, and solve for q_1 and q_2 results in the

solve for q_1 and q_2 results in the reaction functions $q_1^*(q_2) = \frac{1}{2}(d - A + \overline{v} + h_1) - \frac{1}{2}q_2,$ $q_2^*(q_1) = \frac{1}{2}(d - A + \overline{v} + h_2) - \frac{1}{2}q_1.$ The intersections of the reaction functions result in the equilibrium $q_1^*(h_1, h_2, v_1, v_2|_D) = \frac{1}{3}(d - A + \overline{v} + 2h_1 - h_2)$ $q_2^*(h_1, h_2, v_1, v_2|_D) = \frac{1}{3}(d - A + \overline{v} + 2h_2 - h_1).$ Therefore, $Q(h_1, h_2, v_1, v_2|_D) = \frac{2}{3}(d - A + \overline{v} + \overline{h}).$	reaction functions $q_1{}^*(q_2) = \frac{1}{2}(d - A + \overline{v} + h_1) - q_2,$ $q_2{}^*(q_1) = \frac{1}{2}(d - A + \overline{v} + h_2) - q_1.$ The symmetric solution to the interaction of the reaction functions results in the equilibrium $q_1^*(h_1, h_2, v_1, v_2|_C) =$ $q_2^*(h_1, h_2, v_1, v_2|_C) = \frac{1}{4}\left(d - A + \overline{v} + \overline{h}\right).$ Therefore, $Q(h_1, h_2, v_1, v_2|_C) = \frac{1}{2}\left(d - A + \overline{v} + \overline{h}\right).$
Second step: Plug $q_1^*(h_1, h_2, v_1, v_2|_D)$, $q_2^*(h_1, h_2, v_1, v_2|_D)$ back into π_1 and π_2. $\pi_1 = \left(\frac{1}{3}(d + 2A) + \frac{1}{6}(v_1 + v_2 - 2h_1 - 2h_2)\right)(\frac{1}{3}\left(d - A) + \frac{1}{6}(4h_1 - 2h_2 + v_1 + v_2\right)) - (A - h_1)(\frac{1}{3}\left(d - A) + \frac{1}{6}(4h_1 - 2h_2 + v_1 + v_2\right)) - \frac{1}{2}(rh_1^2 + kv_1^2)$ $\pi_2 = \left(\frac{1}{3}(d + 2A) + \frac{1}{6}(v_1 + v_2 - 2h_1 - 2h_2)\right)(\frac{1}{3}\left(d - A) + \frac{1}{6}(4h_2 - 2h_1 + v_1 + v_2\right)) - (A - h_2)(\frac{1}{3}\left(d - A) + \frac{1}{6}(4h_2 -	Second step: Plug $q_1^*(h_1, h_2, v_1, v_2|_C)$, $q_2^*(h_1, h_2, v_1, v_2|_C)$ back into π. $\pi = \left(\frac{1}{2}(d + A) + \frac{1}{4}(v_1 + v_2 - h_1 - h_2)\right)(\frac{1}{2}\left(d - A) + \frac{1}{4}(h_1 + h_2 + v_1 + v_2\right)) - \left(A - \frac{1}{2}(h_1 + h_2)\right)(\frac{1}{2}\left(d - A) + \frac{1}{4}(h_1 + h_2 + v_1 + v_2\right)) - \frac{1}{2}(rh_1^2 + rh_2^2 + k(v_1 + v_2)^2).$ Maximizing π_1 regarding h_1, maximizing π_2 regarding h_2, maximizing π regarding v ($v = v_1 + v_2$), results in the first order conditions, $h_1^*(h_2, v|_C) = \frac{4A - 4d - h_2 - 2v_1 - 2v_2}{3 - 16r}$

$2h_1+v_1+v_2\big)) - \frac{1}{2}(rh_2^2 + kv_2^2)$. Maximizing π_1 regarding h_1, v_1; maximizing π_2 regarding h_2, v_2, results in the first order conditions, $h_1^*(h_2, v_1, v_2\|_D) = \frac{2(2A-2d+2h_2-v_1-v_2)}{8-9r}$ $v_1^*(v_2, h_1, h_2\|_D) = \frac{2A-2d-v_2-4h_1+2h_2}{1-18k}$ $h_2^*(h_1, v_1, v_2\|_D) = \frac{2(2A-2d+2h_1-v_1-v_2)}{8-9r}$ $v_2^*(v_1, h_1, h_2\|_D) = \frac{2A-2d-v_1-4h_2+2h_1}{1-18k}$. Solve the four reaction functions: $h_1^*(k, r\|_D) = h_2^*(k, r\|_D) = \frac{4(d-A)k}{9kr-4k-r}$ $v_1^*(k, r\|_D) = v_2^*(k, r\|_D) = \frac{(d-A)r}{9kr-4k-r}$.	$h_2^*(h_1, v\|_C) = \frac{2A-2d-h_1-v_1-v_2}{1-8r}$ $v^*(h_1, h_2\|_C) = \frac{2A-2d-h_1-h_2}{1-8r}$. Solve the three reaction functions: $h_1^*(k, r\|_C) = h_2^*(k, r\|_C) = \frac{2(d-A)k}{8kr-2k-r}$ $v^*(k, r\|_C) = \frac{2(d-A)r}{8kr-2k-r}$. Therefore, $v_1^*(k, r\|_C) = v_2^*(k, r\|_C) = \frac{(d-A)r}{8kr-2k-r}$.
Final step: Substitute $h_1^*(k, r\|_D)$, $h_2^*(k, r\|_D)$, $v_1^*(k, r\|_D)$ and $v_2^*(k, r\|_D)$ into q_1, q_2, $q_1{}^*(k, r\|_D) = q_2{}^*(k, r\|_D) = \frac{3(d-A)kr}{9kr-4k-r}$ and $\pi^*(k, r\|_D) = \frac{(d-A)^2kr(18kr-16k-r)}{(9kr-4k-r)^2}$.	Final step: Substitute $h_1^*(k, r\|_C)$, $h_2^*(k, r\|_C)$, $v_1^*(k, r\|_C)$ and $v_2^*(k, r\|_C)$ into q_1, q_2, $Q^*(k, r\|_C) = q_1{}^*(k, r\|_C) +$ $q_2{}^*(k, r\|_C) = \frac{4(d-A)kr}{8kr-2k-r}$ and $\pi^*(k, r\|_C) = \frac{2(d-A)^2kr}{8kr-2k-r}$.

Proof Proposition 1:

From Table 1 we obtain that given HC and VC, $Q_D = \frac{2}{3}\left(d - A + \overline{v} + \overline{h}\right)$ and $Q_C = \frac{1}{2}\left(d - A + \overline{v} + \overline{h}\right)$. We can see that always $Q_D > Q_C$.

Proof Proposition 2:

From Table 1 we obtain that given HC and VC, $\pi_D = \frac{2}{9}\left(d - A + \overline{v} + \overline{h}\right)^2 - r\overline{h}^2 - k\overline{v}^2$ and $\pi_C = \frac{1}{4}\left(d - A + \overline{v} + \overline{h}\right)^2 - r\overline{h}^2 - 2k\overline{v}^2$. The difference between the joint profit of the centralized cooperative and the decentralized cooperative is $\frac{1}{36}\left(\mathrm{d} - \mathrm{A} + \overline{v} + \overline{h}\right)^2 - k\overline{v}^2 > 0$ when VC is 0.

Proof Proposition 3:

From Table 2 we obtain that without HC, $V_D = \frac{2(d-A)}{9-1/k}$ and $V_C = \frac{2(d-A)}{8-1/k}$. Therefore the VC level is always higher in the centralized cooperative for all possible values of *k*.

Proof Proposition 4:

From Table 2 we obtain that without HC, $Q_D = \frac{6(d-A)}{9-1/k}$ and $Q_C = \frac{4(d-A)}{8-1/k}$. The production level is higher in the decentralized cooperative than the centralized cooperative when $\frac{6(d-A)}{9-1/k} > \frac{4(d-A)}{8-1/k} \Leftrightarrow 3\left(8 - \frac{1}{k}\right) > 2\left(9 - \frac{1}{k}\right) \Leftrightarrow 21 - \frac{3}{k} > 18 - \frac{2}{k} \Leftrightarrow 6 > \frac{1}{k} \Leftrightarrow k > \frac{1}{6}$. Therefore the production level is higher in the decentralized cooperative than in the centralized cooperative when *k>1/6*.

Proof Proposition 5:

From Table 2 we obtain that without HC, $\pi_D = \frac{(d-A)^2(18-1/k)}{(9-1/k)^2}$ and $\pi_C = \frac{2(d-A)^2}{8-1/k}$. The profit level is higher in the decentralized cooperative than in the centralized cooperative when $\frac{(d-A)^2(18-1/k)}{(9-1/k)^2} > \frac{2(d-A)^2}{8-1/k} \Leftrightarrow \left(18 - \frac{1}{k}\right)\left(8 - \frac{1}{k}\right) > 2\left(9 - \frac{1}{k}\right)^2 \Leftrightarrow 144k^2 - 26k + 1 > 162k^2 - 36k + 2 \Leftrightarrow 18k^2 - 10k + 1 < 0$. The roots of the equation $18k^2 - 10k + 1 = 0$ are $k = \frac{5 \pm \sqrt{7}}{18}$. Therefore $\pi_D > \pi_C$ holds when $k \in (\frac{5-\sqrt{7}}{18}, \frac{5+\sqrt{7}}{18})$. To conclude, the profit level is higher (lower) in the decentralized cooperative than in the centralized

cooperative when k $\in (\frac{5-\sqrt{7}}{18}, \frac{5+\sqrt{7}}{18})$ (otherwise).

Proof regarding the equilibrium communication levels (Figure 4):

From Table 2.2 in chapter 2, we obtain that with both HC and VC, $HC_D = \frac{8(d-A)}{r(9-1/k)-4}$ and $HC_C = \frac{4(d-A)}{r(8-1/k)-2}$. The HC level in the decentralized cooperative is higher than in the centralized cooperative when $\frac{8(d-A)}{r(9-1/k)-4} > \frac{4(d-A)}{r(8-1/k)-2} \Leftrightarrow 2r\left(8-\frac{1}{k}\right)-4 > r\left(9-\frac{1}{k}\right)-4 \Leftrightarrow 16-\frac{2}{k} > 9-\frac{1}{k} \Leftrightarrow k > \frac{1}{7}$. Therefore when $k > (<)\frac{1}{7}$, the HC level is higher (lower) in the decentralized cooperative than in the centralized cooperative.

From Table 2.2 in chapter 2, we obtain that with both HC and VC, $VC_D = \frac{2(d-A)}{k(9-4/r)-1}$ and $VC_C = \frac{2(d-A)}{k(8-2/r)-1}$. The VC level is higher in the decentralized cooperative than in the centralized cooperative when $\frac{2(d-A)}{k(9-4/r)-1} < \frac{2(d-A)}{k(8-2/r)-1} \Leftrightarrow k\left(8-\frac{2}{r}\right)-1 < k\left(9-\frac{4}{r}\right)-1 \Leftrightarrow 8-\frac{2}{r} < 9-\frac{4}{r} \Leftrightarrow r > 2$. Therefore, when $r > (<)2$, the VC level is higher (lower) in the centralized structure than in the decentralized structure.

Proof Proposition 6:

From Table 2.2 in chapter 2, we obtain that with both HC and VC, $Q_D = \frac{6(d-A)}{9-4/r-1/k}$ and $Q_C = \frac{4(d-A)}{8-2/r-1/k}$. The production level is higher in the decentralized cooperative than in the centralized cooperative when $\frac{6(d-A)}{9-4/r-1/k} > \frac{4(d-A)}{8-2/r-1/k} \Leftrightarrow \frac{3}{9-4/r-1/k} > \frac{2}{8-2/r-1/k} \Leftrightarrow k > \frac{2r}{15r-2}$.

Proof Proposition 7:

From Table 2.2 in chapter 2, we obtain that with both the equilibrium HC and VC, $\pi_D =$

$\frac{(\mathrm{d}-\mathrm{A})^2(18-16/\mathrm{r}-1/\mathrm{k})}{(9-4/\mathrm{r}-1/\mathrm{k})^2}$ and $\pi_C = \frac{2(\mathrm{d}-\mathrm{A})^2}{(8-2/\mathrm{r}-1/\mathrm{k})}$. The profit level is higher in the decentralized cooperative than in the centralized cooperative when $\frac{(\mathrm{d}-\mathrm{A})^2(18-16/\mathrm{r}-1/\mathrm{k})}{(9-4/\mathrm{r}-1/\mathrm{k})^2} > \frac{2(\mathrm{d}-\mathrm{A})^2}{(8-2/\mathrm{r}-1/\mathrm{k})} \Leftrightarrow (18kr - 16kr)(8kr - 2k - r) > 2(9kr - 4k - r)^2 \Leftrightarrow \left(-\frac{20}{r} - 18\right)k^2 + \left(10 + \frac{2}{r}\right)k - 1 > 0 \Leftrightarrow \left(\frac{20}{r} + 18\right)k^2 - \left(10 + \frac{2}{r}\right)k + 1 < 0$. The roots of the equation $\left(\frac{20}{r} + 18\right)k^2 - \left(10 + \frac{2}{r}\right)k + 1 = 0$ are $k = \frac{5r+1\pm\sqrt{7r^2-10r+1)}}{20+18r}$ when $r \in \left(0, \frac{1}{7}\left(5 - 3\sqrt{2}\right)\right) or\ r \in [\frac{1}{7}\left(5 + 3\sqrt{2}\right), \infty)$. Due to the conditions of *k* and *r*; see footnote 3, r is larger than $\frac{1}{7}\left(5 - 3\sqrt{2}\right)$, hence $r \in \left(0, \frac{1}{7}\left(5 - 3\sqrt{2}\right)\right)$is eliminated. Therefore when $\frac{5r+1-\sqrt{7r^2-10r+1)}}{20+18r} < k < \frac{5r+1+\sqrt{7r^2-10r+1)}}{20+18r}$ and $r \in [\frac{1}{7}\left(5 + 3\sqrt{2}\right), \infty)$, the profit level is higher in the decentralized cooperative than in the centralized cooperative.

Chapter 3

Numerical examples illustrating Figure 3.9

When $\beta = 1.5$ and $\delta = 2$,

$$p_{0C}^* = \frac{\int_0^{\min(1,\frac{p_{0C}+1}{\beta_1})} \int_0^{min(p_{0C},d_M^*,1)} \delta v \; dd \; dv}{\int_0^{\min(1,\frac{p_{0C}+1}{\beta_1})} \int_0^{min\left(p_{0C},d_{M,}^*1\right)} dd \; dv} = \frac{\int_0^{\frac{1-p_{0C}}{1.5}} \int_0^{p_{0C}} 2v \; dd \; dv + \int_{\frac{1-p_{0C}}{1.5}}^1 \int_0^{\frac{p_{0C}-1.5v+1}{2}} 2v \; dd \; dv}{\int_0^{\frac{1-p_{0C}}{1.5}} \int_0^{p_{0C}} dd \; dv + \int_{\frac{1-p_{0C}}{1.5}}^1 \int_0^{\frac{p_{0C}-1.5v+1}{2}} dd \; dv}$$, it

results in $p_{0C}^* = 0.766$. The three market structures are presented in Figure 1.

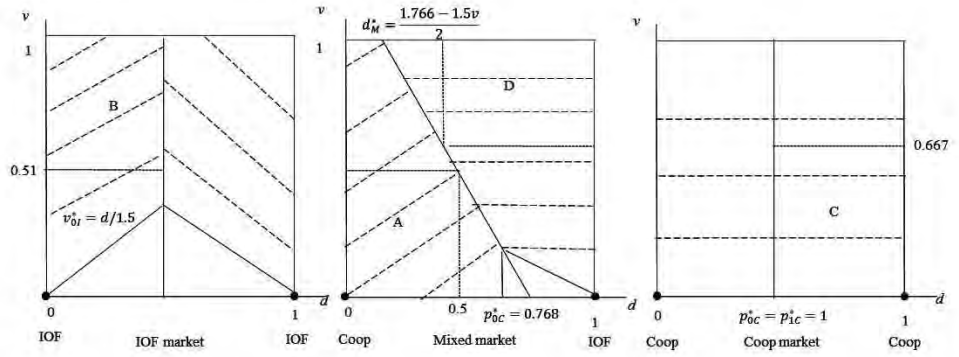

Figure 1: The three market structures when $\beta = 1.5$ and $\delta = 2$

We first compare the IOF market with the mixed market. The enterprise 1 is the IOF governance structure for both markets, while the enterprise 0 is either an IOF or a Coop. The payoff of the farmer of enterprise 0 in the IOF market structure is $\pi_{f0I} = 1.5v - d$, while the payoff of the farmer of enterprise 0 in the mixed market structure is $\pi_{f0C} = 0.766 - d$. Therefore the indifferent farmer regarding the payoff is $v^* = 0.51$, i.e. when $\pi_{f0I} = \pi_{f0C}$.

Farmers in $v < v^*$, $d < p_{0C}^*$, $d < d_M^*$ (i.e. area A in Figure 1) prefer the Coop governance structure. The area is $0.5 \times 0.51 + 0.5 \times (0.51 + 0.153) \times 0.268 = 0.344$. Farmers in $v > v^*$, $v > v_{0I}^*$ (i.e. area B in Figure 1) prefer the IOF governance

structure. The area is $0.5 \times (1 - 0.51) = 0.245$. A > B, therefore the mixed market dominates the IOF market.

Next compare the mixed market with the Coop market. The enterprise 0 is the Coop governance structure for both markets, while the enterprise 1 is either an IOF or a Coop. The payoff of the farmer in enterprise 1 in the mixed market structure is $\pi_{f1I} = 1.5v - (1 - d)$, while the payoff of the farmer of enterprise 1 in the Coop market structure is $\pi_{f1C} = 1 - (1 - d)$. Therefore the indifferent farmer regarding the payoff is $v^* = 0.667$ when $\pi_{f1I} = \pi_{f1C}$.

Farmers in $v < v^*$, $d < 0.5$ (i.e. area C in Figure 1) prefer the Coop governance structure. The area is $0.5 \times 0.667 = 0.333$. Farmers in $v > v^*$, $d > d_M^*$ (i.e. area D in Figure 1) prefer the IOF governance structure. The area is $(1 - 0.667) \times (1 - 0.383) + 0.5 \times (1 - 0.667) \times (0.383 - 0.133) = 0.247$. The Coop market dominates the mixed market because C > D.

Finally the Coop market is the equilibrium market when $\delta = 2$, $\beta = 1.5$. Similarly, the Coop market is the equilibrium when $\beta < 1.5$.

When $\beta = 1.6$ and $\delta = 2$,

$$p_{0C}^* = \frac{\int_0^{\min(1,\frac{p_{0C}+1}{\beta_1})} \int_0^{min(p_{0C},d_M^*,1)} \delta v \; dd \; dv}{\int_0^{\min(1,\frac{p_{0C}+1}{\beta_1})} \int_0^{min(p_{0C},d_M^*,1)} dd \; dv} = \frac{\int_0^{\frac{1-p_{0C}}{1.6}} \int_0^{p_{0C}} 2v \; dd \; dv + \int_{\frac{1-p_{0C}}{1.6}}^1 \int_0^{\frac{p_{0C}-1.6v+1}{2}} 2v \; dd \; dv}{\int_0^{\frac{1-p_{0C}}{1.6}} \int_0^{p_{0C}} dd \; dv + \int_{\frac{1-p_{0C}}{1.6}}^1 \int_0^{\frac{p_{0C}-1.6v+1}{2}} dd \; dv}$$

. It results in $p_{0C}^* = 0.728$. The three market structures are presented in Figure 2.

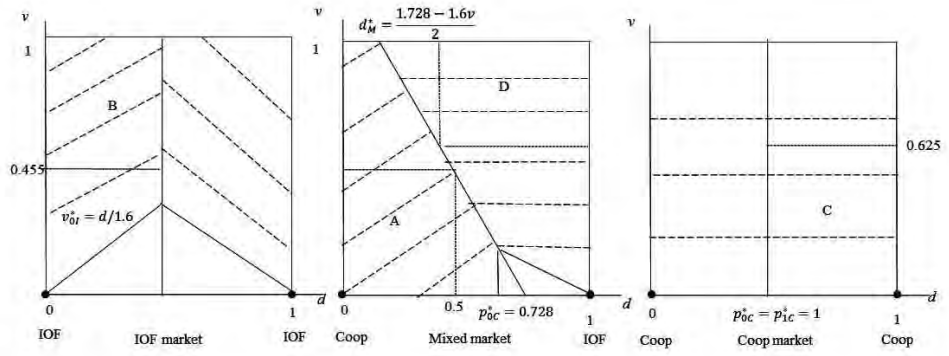

Figure 2: The three market structures when $\beta = 1.6$ and $\delta = 2$

We first compare the IOF market with the mixed market. Enterprise 1 is the IOF governance structure for both markets, while enterprise 0 is either an IOF or a Coop.

The payoff of the farmer of enterprise 0 in the IOF market structure is $\pi_{f0I} = 1.6v - d$, while the payoff of the farmer of enterprise 0 in the mixed market structure is $\pi_{f0C} = 0.728 - d$. Therefore the indifferent farmer is characterized by $v^* = 0.455$, i.e. when $\pi_{f0I} = \pi_{f0C}$.

Farmers in $v < v^*$, $d < p_{0C}^*$, $d < d_M^*$ (i.e. area A in Figure 2) prefer the Coop governance structure. The area is $0.5 \times 0.455 + 0.5 \times (0.17 + 0.455) \times (0.728 - 0.5) = 0.299$. While farmers in $v > v^*$, $v > v_{0I}^*$ (i.e. area B in Figure 2) prefer the IOF governance structure. The area is $0.5 \times (1 - 0.455) = 0.273$. A > B, therefore the mixed market dominates the IOF market.

We then compare the mixed market with the Coop market. Enterprise 0 is the Coop governance structure for both markets, while enterprise 1 is either an IOF or a Coop. The payoff of the farmer of enterprise 1 in the mixed market structure is $\pi_{f1I} = 1.6v - (1 - d)$, while the payoff of the farmer of enterprise 1 in the Coop market structure is $\pi_{f1C} = 1 - (1 - d)$. Therefore the indifferent farmer regarding is characterized by $v^* = 0.625$ when $\pi_{f1I} = \pi_{f1C}$.

Farmers in $v < v^*$, $d < 0.5$ (i.e. area C in Figure 2) prefer the Coop governance structure. The area is $0.5 \times 0.625 = 0.313$, while farmers in $v > v^*$, $d > d_M^*$ (i.e. area D in Figure 2) prefer the IOF governance structure. The area is $(1 - 0.625) \times (1 - 0.299) + 0.5 \times (1 - 0.625) \times (0.299 - 0.064) = 0.318$. D > C, therefore the mixed market dominates the Coop market. The conclusion is therefore that the mixed market is the equilibrium market when $\beta = 1.6$ and $\delta = 2$.

When $\beta = 1.7$ and $\delta = 2$,

$$p_{0C}^* = \frac{\int_0^{\min(1,\frac{p_{0C}+1}{\beta_1})} \int_0^{min(p_{0C},d_M^*,1)} \delta v \; dd \; dv}{\int_0^{\min(1,\frac{p_{0C}+1}{\beta_1})} \int_0^{min\left(p_{0C},d_{M,}^*1\right)} dd \; dv} = \frac{\int_0^{\frac{1-p_{0C}}{1.7}} \int_0^{p_{0C}} 2v \; dd \; dv + \int_{\frac{1-p_{0C}}{1.7}}^{\frac{1+p_{0C}}{1.7}} \int_0^{\frac{p_{0C}-1.7v+1}{2}} 2v \; dd \; dv}{\int_0^{\frac{1-p_{0C}}{1.7}} \int_0^{p_{0C}} dd \; dv + \int_{\frac{1-p_{0C}}{1.7}}^{\frac{1+p_{0C}}{1.7}} \int_0^{\frac{p_{0C}-1.7v+1}{2}} dd \; dv}.$$

It results in $p_{0C}^* = 0.679$. Figure 3 presents the three market structures.

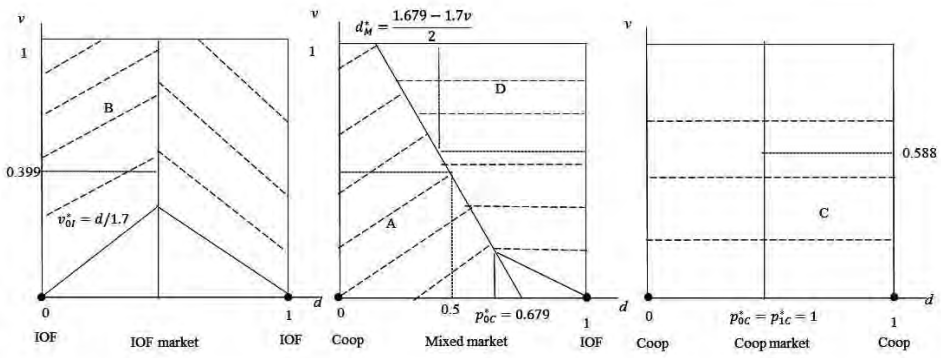

Figure 3: The three market structures when $\beta = 1.7$ and $\delta = 2$

We first compare the IOF market with the mixed market. Enterprise 1 is the IOF governance structure for both markets, while enterprise 0 is either an IOF or a Coop.

The payoff of the farmer in enterprise 0 in the IOF market structure is $\pi_{f0I} = 1.7v - d$, while the payoff of the farmer of enterprise 0 in the mixed market structure is $\pi_{f0C} = 0.679 - d$. Therefore the indifferent farmer is characterized by $v^* = 0.399$.

Farmers in $v < v^*$, $d < p_{0C}^*$, $d < d_M^*$ (i.e. area A in Figure 3) prefer the Coop governance structure. The area is $0.5 \times 0.399 + 0.5 \times (0.189 + 0.399) \times (0.179) = 0.252$. The farmers in $v > v^*$, $v > v_{0I}^*$ (i.e. area B in Figure 3)) prefer the IOF governance structure. The area is $0.5 \times (1 - 0.399) = 0.3$. B > A, therefore the IOF market dominates the mixed market.

Compare next the mixed market with the Coop market. Enterprise 0 is the Coop governance structure for both markets, while enterprise 1 is either an IOF or a Coop. The payoff of the farmer of enterprise 1 in the mixed market structure is $\pi_{f1I} = 1.7v - (1 - d)$, while the payoff of the farmer of enterprise 1 in the Coop market structure is $\pi_{f1C} = 1 - (1 - d)$. Therefore the indifferent farmer is characterized by $v^* = 0.588$.

Farmers in $v < v^*$, $d < 0.5$ (i.e. area C in Figure 3) prefer the Coop governance structure. The area is $0.5 \times 0.588 = 0.294$. While farmers in $v > v^*$, $d > d_M^*$ (i.e. area D in Figure 3) prefer the IOF governance structure. The area is $(1 - 0.588) \times (1 - 0.339) + 0.5 \times (1 - 0.588) \times (0.339) + \varepsilon = 0.342 + \varepsilon$. D > C, therefore the mixed market dominates the Coop market. The conclusion is therefore that the IOF market is the equilibrium market when $\delta = 2$, $\beta = 1.7$. Similarly, the IOF market is the equilibrium when $\beta > 1.7$.

To summarize, when $\delta = 2$, the Coop market is the equilibrium when $0 < \beta \leq 1.6$, the mixed market is the equilibrium when β is around 1.6, the IOF market is the equilibrium when $1.7 \leq \beta < 2$.

Next we investigate the equilibrium market structure when $\delta < 1$. Take $\beta = 0.17$ and $\delta = 0.2$. It follows immediately that $p_{0C}^* = \frac{1}{2}\delta = 0.1$. Figure 8 presents the three market structures.

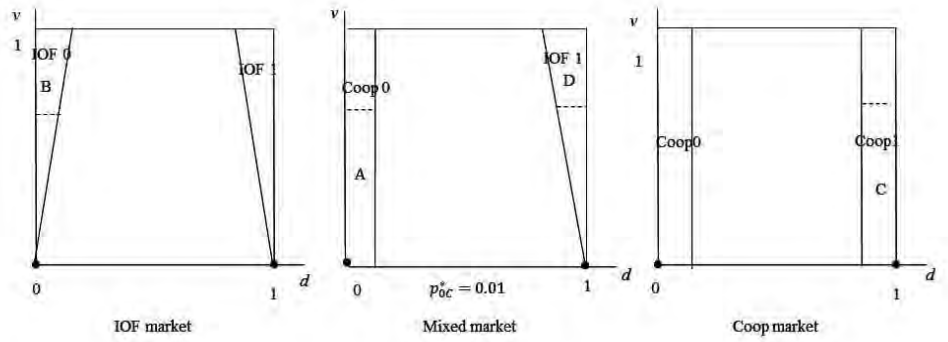

Figure 4: The three market structures when $\beta = 0.17$ and $\delta = 0.2$

We first compare the IOF market with the mixed market. The payoff of the farmer in enterprise 0 in the IOF market structure is $\pi_{f0I} = 0.17v - d$, while the payoff of the farmer in enterprise 0 in the mixed market structure is $\pi_{f0C} = 0.1 - d$. Therefore the indifferent farmer is characterized by $v^* = 0.588$.

Farmers in $v < v^*$, $d < p_{0C}^*$, $d < d_M^*$ (i.e. area A in Figure 4) prefer the Coop governance structure. The area is $0.588 \times 0.1 = 0.0588$, while farmers in $v > v^*$, $v > v_{0I}^*$ (i.e. area B in Figure 4) prefer the IOF governance structure. The area is $(0.1 + 0.17) \times (1 - 0.588) \times 0.5 = 0.0556$. A > B, therefore the mixed market dominates the IOF market.

Similarly, C > D, therefore the Coop market dominates the mixed market. The conclusion is therefore that the Coop market is the equilibrium market when $\delta = 0.2$, $\beta = 0.17$.

Consider next the case $\beta = 0.19$ and $\delta = 0.2$. It follows immediately that $p_{0C}^* = \frac{1}{2}\delta = 0.1$. Figure 5 presents the three market structures.

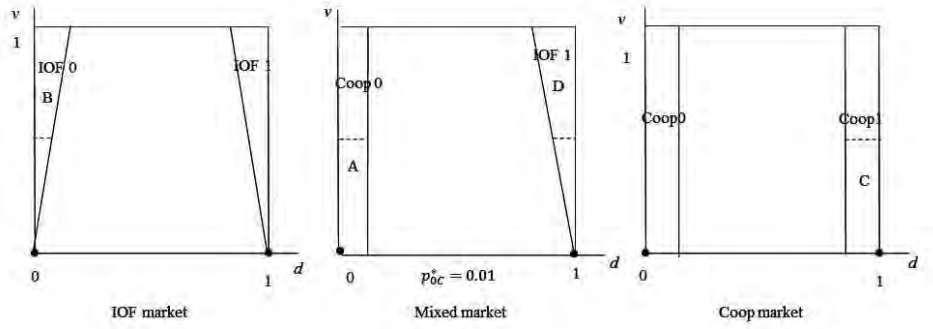

Figure 5: The three market structures when $\beta = 0.19$ and $\delta = 0.2$

We first compare the IOF market with the mixed market. The payoff of the farmer in enterprise 0 in the IOF market structure is $\pi_{f0I} = 0.19v - d$, while the payoff of the farmer in enterprise 0 in the mixed market structure is $\pi_{f0C} = 0.1 - d$. Therefore the indifferent farmer is characterized by $v^* = 0.5263$.

Farmers in $v < v^*$, $d < p_{0C}^*$, $d < d_M^*$ (i.e. area A in Figure 5) prefer the Coop governance structure. The area is $0.5263 \times 0.1 = 0.05263$, while farmers in $v > v^*$, $v > v_{0I}^*$ (i.e. area B in Figure 5) prefer the IOF governance structure. The area is $(0.1 + 0.19) \times (1 - 0.5263) \times 0.5 = 0.0687$. B > A, therefore the IOF market dominates the mixed market.

Similarly, D > C, therefore the mixed market dominates the Coop market. The conclusion is therefore that the IOF market is the equilibrium market when $\beta = 0.19$ and $\delta = 0.2$.

Notice that when $\delta = 0.2$, there is no interaction/competition between the IOF and the Coop, the mixed market never emerges. Similarly for all $\delta < 1$, the mixed market never emerges.

Consider next the case when δ is very large. Take $\beta = 7$ and $\delta = 10$. It can be determined that $p_{0C}^* = 0.41667$. Figure 6 presents the three market structures.

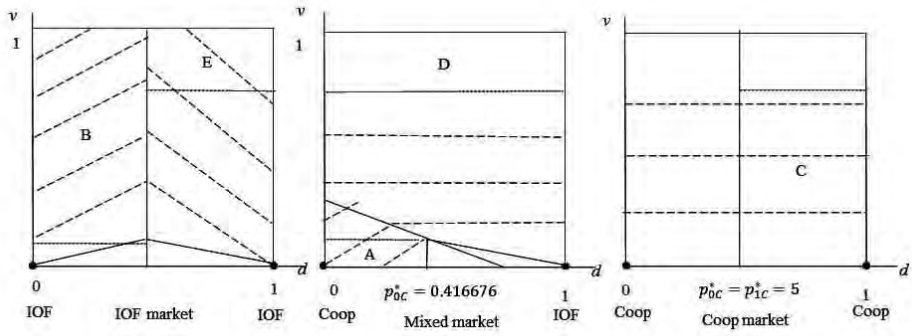

Figure 6: The three market structures when $\beta = 7$ and $\delta = 10$

We first compare the IOF market with the mixed market. The payoff of the farmer in enterprise 0 in the IOF market structure is $\pi_{f0I} = 7v - d$, while the payoff of the farmer in enterprise 0 in the mixed market structure is $\pi_{f0C} = 0.41667 - d$. Therefore the indifferent farmer is characterized by $v^* = 0.059$.

Farmers in $v < v^*$, $d < p_{0C}^*$, $d < d_M^*$ (i.e. area A in Figure 6) preferring the Coop governance structure are obviously less than farmers in $v > v^*$, $v > v_{0I}^*$ (i.e. area B in Figure 6) preferring the IOF governance structure. Therefore the IOF market dominates the mixed market.

We then compare the mixed market with the Coop market. The payoff of the farmer in enterprise 1 in the mixed market structure is $\pi_{f1I} = 7v - (1 - d)$, while the payoff of the farmer in enterprise 1 in the Coop market structure is $\pi_{f1C} = 5 - (1 - d)$. Therefore the indifferent farmer is characterized by $v^* = 0.714$.

Farmers in $v < v^*$, $d > 0.5$ (i.e. area C in Figure 6) prefer the Coop governance structure. The area is $0.714 \times 0.5 = 0.357$. Farmers in $v > v^*$, $d > 0.5$ (i.e. area D in Figure 6) prefer the IOF governance structure. The area is $(1 - 0.714) = 0.286$. C > D, i.e. more farmers close to enterprise 1 vote for a Coop governance structure. Therefore the Coop market dominates the mixed market.

Lastly we compare the IOF market with the Coop market. The payoff of the farmer in enterprise 1 in the IOF market structure is $\pi_{f1I} = 7v - (1 - d)$, while the payoff of the farmer of enterprise 1 in the Coop market structure is $\pi_{f1C} = 5 - (1 - d)$. Therefore the indifferent farmer is characterized by $v^* = 0.714$.

Farmers in $v < v^*$, $d > 0.5$ (i.e. area C in Figure 6) prefer the Coop governance structure. The area is 0.714×0.5. Farmers in $v > v^*$, $d > 0.5$ (i.e. area E in Figure 6) prefer the IOF governance structure. The area is $(1 - 0.714) \times 0.5$. C > E, i.e. more farmers close to enterprise 1 vote for a Coop governance structure. Similarly, the farmers close to enterprise 0 vote for a Coop governance structure as well. Therefore the Coop market dominates the IOF market.

The conclusion is therefore that the Coop market is the equilibrium market when $\beta = 7$ and $\delta = 10$. Similarly, the Coop market is the equilibrium when $\beta < 7$ and $\delta = 10$.

If $\beta = 8$ and $\delta = 10$, then $p_{0C}^* = 0.3846$. Figure 7 presents the three market structures.

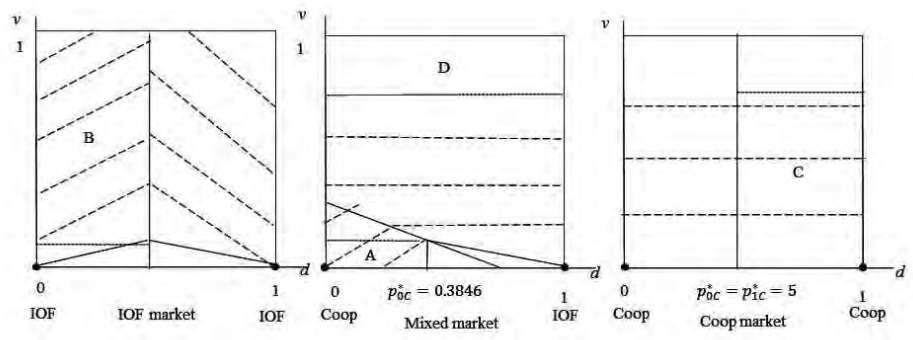

Figure 7: The three market structures when $\beta = 8$ and $\delta = 10$

We first compare the IOF market with the mixed market. The payoff of the farmer in enterprise 0 in the IOF market structure is $\pi_{f0I} = 8v - d$, while the payoff of the farmer in enterprise 0 in the mixed market structure is $\pi_{f0C} = 0.3846 - d$. Therefore the indifferent farmer is characterized by $v^* = 0.048$.

Farmers in $v < v^*$, $d < p_{0C}^*$, $d < d_M^*$ (i.e. area A in Figure 7) preferring the Coop governance structure are obviously less than the farmers in $v > v^*$, $v > v_{0I}^*$ (i.e. area B in Figure 7) preferring the IOF governance structure. Therefore the IOF market dominates the mixed market.

We then compare the mixed market with the Coop market. The payoff of the farmer in enterprise 1 in the mixed market structure is $\pi_{f1I} = 8v - (1 - d)$, while the payoff of the farmer in enterprise 1 in the Coop market structure is $\pi_{f1C} = 5 - (1 - d)$. Therefore the indifferent farmer is characterized by $v^* = 0.625$.

Farmers in $v < v^*$, $d > 0.5$ (i.e. area C in Figure 7) prefer the Coop governance structure. The area is $0.625 \times 0.5 = 0.312$. Farmers in $v > v^*$, $d > 0.5$ (i.e. area D in Figure 7) prefer the IOF governance structure. The area is $(1 - 0.625) = 0.375$. D > C, therefore the mixed market dominates the Coop market. The conclusion is therefore that the IOF market is the equilibrium market when $\beta = 8$ and $\delta = 10$. Similarly, the IOF market is the equilibrium when $\beta > 8$ and $\delta = 10$. Notice that when $\delta = 10$, the mixed market does not emerge.

Proof Proposition 5:

In an IOF market, the payoff of IOF 0 is

$$\pi_{0I} = \int_0^1 \int_0^{\min\left(\beta_0 v, \frac{(\beta_0 - \beta_1)v+1}{2}\right)} (Y(v) - p_{0I}(v)) d d d v$$

$$= \int_0^{\frac{1}{\beta_0+\beta_1}} \int_0^{\beta_0 v} (\delta - \beta_0) v d d d v + \int_{\frac{1}{\beta_0+\beta_1}}^1 \int_0^{\frac{(\beta_0-\beta_1)v+1}{2}} (\delta - \beta_0) v d d d v$$

$$= \frac{(\delta-\beta_0)\left(2\beta_0^3+2\beta_0^2\beta_1+3\beta_0^2+6\beta_0\beta_1-2\beta_0\beta_1^2-2\beta_1^3+3\beta_1^2-1\right)}{12(\beta_0+\beta_1)^2}.$$

We first take $\delta = 1$ for computational convenience. The reaction function β_0^* of IOF 0 is determined by the first order condition $\frac{d\pi_{0I}}{d\beta_0} = 0$. The first order condition entails that the payoff maximizing price parameter β_0^* is determined by the implicit function $f(\beta_0^*, \beta_1) = 0$, where

$$f(\beta_0^*, \beta_1) \equiv \frac{-4\beta_0^{*4} - \beta_0^{*3}(10\beta_1 + 1) - 3\beta_0^{*2}\beta_1(2\beta_1 + 1) + \beta_0^*(2\beta_1^3 - 3\beta_1^2 - 1) + 2\beta_1^4 - \beta_1^3 + \beta_1 + 2}{12(\beta_0^* + \beta_1)^3}.$$

Similarly, the payoff of IOF 1 is

$$\pi_{1I} = \int_0^1 \int_{\max\left(1-\beta_1 v, \frac{(\beta_0-\beta_1)v+1}{2}\right)}^1 (Y(v) - p_{1I}(v)) dddv$$

$$= \int_0^{\frac{1}{\beta_0+\beta_1}} \int_{1-\beta_1 v}^1 (\delta - \beta_1) v dddv + \int_{\frac{1}{\beta_0+\beta_1}}^1 \int_{\frac{(\beta_0-\beta_1)v+1}{2}}^1 (\delta - \beta_1) v dddv.$$

Take $\delta = 1$. The reaction function β_1^* of IOF 1 is determined the first order condition $\frac{d\pi_{1I}}{d\beta_1} = 0$. The first order condition entails that the payoff maximizing price parameter β_1^* is determined by the implicit function $g(\beta_0, \beta_1^*) = 0$, where

$$g(\beta_0, \beta_1^*) \equiv \frac{-4\beta_1^{*4} - \beta_1^{*3}(10\beta_0 + 1) - 3\beta_1^{*2}\beta_0(2\beta_0 + 1) + \beta_1^*(2\beta_0^3 - 3\beta_0^2 - 1) + 2\beta_0^4 - \beta_0^3 + \beta_0 + 2}{12(\beta_0 + \beta_1^*)^3}.$$

The Nash equilibrium in terms of the price parameters is determined by the intersection of the reaction functions β_0^* and β_1^*. Notice that one of the solutions is $\beta_0^* = \beta_1^* = \frac{1}{2}$.

We obtain the slope of the reaction function IOF 0 by taking the total derivative of $f(\beta_0^*, \beta_1) = 0$. The total derivative is $\frac{\partial f}{\partial \beta_0^*} d\beta_0^* + \frac{\partial f}{\partial \beta_1} d\beta_1 = 0$. It results in $\frac{d\beta_0^*}{d\beta_1} = \frac{\beta_0^4 + 4\beta_0^3\beta_1 + 6\beta_0^2\beta_1^2 + 2\beta_0 + 4\beta_0\beta_1^3 - 3 - \beta_1 + \beta_1^4}{2\beta_1^4 + 8\beta_0\beta_1^3 + 12\beta_0^2\beta_1^2 + 8\beta_0^3\beta_1 + 2\beta_1 + 3 - \beta_0 + 2\beta_0^4}$.

Substituting $\beta_0^* = \beta_1^* = \frac{1}{2}$ results in $\frac{d\beta_0^*}{d\beta_1} = -\frac{3}{11} < 0$. Therefore the reaction function β_0^* has a negative slope at $(\frac{1}{2}, \frac{1}{2})$. Symmetrically, the reaction function of IOF 1 has also a negative slope at $(\frac{1}{2}, \frac{1}{2})$.

A strategic substitute is a choice variable having a negatively sloping reaction function (Hendrikse, 2003, p314). This completes the proof of **Proposition 5**.

Numerical examples illustrating Proposition 6

We obtain from the proof of **Proposition 5** that the two IOFs pay the same $\beta_0^* = \beta_1^* = \frac{1}{2}$ when $\delta = 1$. The following shows the computational details of β_0^* and β_1^* for different values of δ.

When $\delta = \frac{1}{2}$, the payoff of IOF 0 is

$$\pi_{0I} = \int_0^1 \int_0^{\min\left(\beta_0 v, \frac{(\beta_0-\beta_1)v+1}{2}\right)} (Y(v) - p_{0I}(v)) dddv$$

$$= \int_0^{\frac{1}{\beta_0+\beta_1}} \int_0^{\beta_0 v} (\frac{1}{2} - \beta_0) v dddv + \int_{\frac{1}{\beta_0+\beta_1}}^1 \int_0^{\frac{(\beta_0-\beta_1)v+1}{2}} (\frac{1}{2} - \beta_0) v dddv$$

$$= \frac{(1-2\beta_0)\left(2\beta_0^3+2\beta_0^2\beta_1+3\beta_0^2+6\beta_0\beta_1-2\beta_0\beta_1^2-2\beta_1^3+3\beta_1^2-1\right)}{24(\beta_0+\beta_1)^2}.$$

Maximizing the payoff of IOF 0 regarding the payment parameter β_1 results in the first order condition:

$$\frac{d\pi_{0I}}{d\beta_0} = \frac{-4\beta_0^4-2\beta_0^3(5\beta_1+1)-6\beta_0^2\beta_1(\beta_1+1)+\beta_0\left(2\beta_1^3-6\beta_1^2-1\right)+2\beta_1^4-2\beta_1^3+\beta_1+1}{12(\beta_0+\beta_1)^3} = 0.$$

Similarly, the payoff of IOF 1 is

$$\pi_{1I} = \int_0^1 \int_{\max\left(1-\beta_1 v, \frac{(\beta_0-\beta_1)v+1}{2}\right)}^1 (Y(v) - p_{1I}(v)) dddv$$

$$= \frac{(-1+2\beta_1)\left(2\beta_0^3+2\beta_0^2\beta_1-3\beta_0^2-6\beta_0\beta_1-2\beta_0\beta_1^2-2\beta_1^3-3\beta_1^2+1\right)}{24(\beta_0+\beta_1)^2}.$$

Maximizing the payoff of IOF 1 regarding the payment parameter β_1 results in the first order condition:

$$\frac{d\pi_{1I}}{d\beta_1} = \frac{2\beta_0^4+2\beta_0^3(\beta_1-1)-6\beta_0^2\beta_1(\beta_1+1)-\beta_0\left(10\beta_1^3+6\beta_1^2-1\right)-4\beta_1^4-2\beta_1^3-\beta_1+1}{12(\beta_0+\beta_1)^3} = 0.$$

Solving the reaction functions results in $\beta_0^* = \beta_1^* \approx 0.36$.

When $\delta = 2$, the payoff of IOF 0 is

$$\pi_{0I} = \frac{(2-\beta_0)\left(2\beta_0^3+2\beta_0^2\beta_1+3\beta_0^2+6\beta_0\beta_1-2\beta_0\beta_1^2-2\beta_1^3+3\beta_1^2-1\right)}{12(\beta_0+\beta_1)^2}.$$

Maximizing the payoff of IOF 0 regarding the payment parameter β_1 results in the first order condition:

$$\frac{d\pi_{0I}}{d\beta_0} = \frac{-4\beta_0^4-\beta_0^3(10\beta_1-1)-3\beta_0^2\beta_1(2\beta_1-1)+\beta_0\left(2\beta_1^3-3\beta_1^2-1\right)+2\beta_1^4+\beta_1^3+\beta_1+4}{12(\beta_0+\beta_1)^3} = 0.$$

Similarly, the payoff of IOF 1 is

$$\pi_{1I} = \frac{(-2+\beta_1)\left(2\beta_0^3+2\beta_0^2\beta_1-3\beta_0^2-6\beta_0\beta_1-2\beta_0\beta_1^2-2\beta_1^3-3\beta_1^2+1\right)}{12(\beta_0+\beta_1)^2}.$$

Maximizing the payoff of IOF 1 regarding the payment parameter β_1 results in the first order condition:

$$\frac{d\pi_{1I}}{d\beta_1} = \frac{2\beta_0^4+\beta_0^3(2\beta_1+1)-3\beta_0^2\beta_1(2\beta_1-1)-\beta_0\left(10\beta_1^3-3\beta_1^2-1\right)-4\beta_1^4+\beta_1^3-\beta_1+4}{12(\beta_0+\beta_1)^3} = 0.$$

Solving the reaction functions results in $\beta_0^* = \beta_1^* \approx 0.87$.

Using the same method, we compute that $\beta_{0(1)} \approx 1.59$ when $\delta = 3$, and $\beta_{0(1)} \approx 2.53$ when $\delta = 4$.

Therefore, we conclude that $\beta_{0(1)}$ increases when δ increases.

Numerical examples illustrating Proposition 7-9

Consider a mixed market with $\delta = 1.5$. Coop 0 has an average price

$$p_{0C} = \frac{\int_0^1 \int_0^{min(p_{0C}, d_M^*)} \delta v \; dd\, dv}{\int_0^1 \int_0^{min(p_{0C}, d_M^*)} dd\, dv} = \frac{\int_0^{\frac{1-p_{0C}}{\beta_1}} \int_0^{p_{0C}} \delta v \; dd\, dv + \int_{\frac{1-p_{0C}}{\beta_1}}^1 \int_0^{\frac{p_{0C}-\beta_1 v+1}{2}} \delta v \; dd\, dv}{\int_0^{\frac{1-p_{0C}}{\beta_1}} \int_0^{p_{0C}} dd\, dv + \int_{\frac{1-p_{0C}}{\beta_1}}^1 \int_0^{\frac{p_{0C}-\beta_1 v+1}{2}} dd\, dv} =$$

$$-\frac{0.5(3p_{0C} - 3p_{0C}^2 + p_{0C}^3 - 2\beta_1^3 - 1 + 3p_{0C}\beta_1^2 + 3\beta_1^2)}{\beta_1(-2p_{0C} + p_{0C}^2 - 2p_{0C}\beta_1 + \beta_1^2 + 1 - 2\beta_1)}.$$

The payoff of IOF 1 is

$$\pi_{1I} = \int_0^1 \int_{max(d_M^*, d_{1I}^*)}^1 (\delta - \beta_1) v \; dd\, dv$$

$$= \int_0^{\frac{1-p_{0C}}{\beta_1}} \int_{1-\beta_1 v}^1 (\delta - \beta_1) v \; dd\, dv + \int_{\frac{1-p_{0C}}{\beta_1}}^1 \int_{\frac{p_{0C}-\beta_1 v+1}{2}}^1 (\delta - \beta_1) v \; dd\, dv =$$

$$\frac{(1.5-\beta_1)}{\beta_1^2}(0.33(1-p_{0C})^3 + 0.167(\beta_1^3 - (1-p_{0C})^3) + 0.25(1-p_{0C})(\beta_1^2 - (1-p_{0C})^2)).$$

IOF 1 maximizes its payoff by choosing β_1 such that it satisfies $\frac{d\,\pi_{1I}}{d\beta_1} = 0$.

Subsitution of p_{0C} in this first order condition results in $p_{oC}^* \approx 0.71$ and $\beta_1^* \approx 0.6$.

Similarly, we compute the equilibrium prices in the mixed duopoly when $\delta = 3$ and $\delta = 15$.

When $\delta = 3$,

$$p_{0C} = \frac{\int_0^{\frac{1+p_{0C}}{\beta_1}} \int_0^{min(p_{0C}, d_M^*)} \delta v \; dd\, dv}{\int_0^{\frac{1+p_{0C}}{\beta_1}} \int_0^{min(p_{0C}, d_M^*)} dd\, dv} = \frac{\int_0^{\frac{1-p_{0C}}{\beta_1}} \int_0^{p_{0C}} \delta v \; dd\, dv + \int_{\frac{1-p_{0C}}{\beta_1}}^{\frac{1+p_{0C}}{\beta_1}} \int_0^{\frac{p_{0C}-\beta_1 v+1}{2}} \delta v \; dd\, dv}{\int_0^{\frac{1-p_{0C}}{\beta_1}} \int_0^{p_{0C}} dd\, dv + \int_{\frac{1-p_{0C}}{\beta_1}}^{\frac{1+p_{0C}}{\beta_1}} \int_0^{\frac{p_{0C}-\beta_1 v+1}{2}} dd\, dv} =$$

$\frac{3+p_{0C}^2}{2\beta_1}$, i.e. $p_{0C} = \sqrt{\frac{3}{2\beta_1 - 1}}$.

$$\pi_{1I} = \int_0^1 \int_{max(d_{1I}^*, d_M^*, 1)}^1 (\delta - \beta_1) v \; dd\, dv = \int_0^{\frac{1-p_{0C}}{\beta_1}} \int_{1-\beta_1 v}^1 (\delta - \beta_1) v \; dd\, dv +$$

$$\int_{\frac{1-p_{0C}}{\beta_1}}^{\frac{1+p_{0C}}{\beta_1}} \int_{\frac{p_{0C}-\beta_1 v+1}{2}}^1 (\delta - \beta_1) v \; dd\, dv + \int_{\frac{1+p_{0C}}{\beta_1}}^1 \int_0^1 (\delta - \beta_1) v \; dd\, dv = \frac{(3-\beta_1)(3\beta_1^2 - 3p_{0C}^2 - 1)}{6\beta_1^2}.$$

Substituting p_{0C} in the first order condition $\frac{d\,\pi_{1I}}{d\beta_1} = \frac{6+18p_{0C}^2 - \beta_1 - 3p_{0C}^2\beta_1 - 3\beta_1^3}{6\beta_1^3} = 0$, results in $p_{0C}^* \approx 0.55$ and $\beta_1^* \approx 1.88$.

When $\delta = 15$,

$$p_{0C} = \frac{\int_0^{\frac{1+p_{0C}}{\beta_1}} \int_0^{min(1, d_M^*)} \delta v \; dd\, dv}{\int_0^{\frac{1+p_{0C}}{\beta_1}} \int_0^{min(1, d_M^*)} dd\, dv} = \frac{\int_0^{\frac{1-p_{0C}}{\beta_1}} \int_0^1 \delta v \; dd\, dv + \int_{\frac{1-p_{0C}}{\beta_1}}^{\frac{1+p_{0C}}{\beta_1}} \int_0^{\frac{p_{0C}-\beta_1 v+1}{2}} \delta v \; dd\, dv}{\int_0^{\frac{1-p_{0C}}{\beta_1}} \int_0^1 dd\, dv + \int_{\frac{1-p_{0C}}{\beta_1}}^{\frac{1+p_{0C}}{\beta_1}} \int_0^{\frac{p_{0C}-\beta_1 v+1}{2}} dd\, dv} =$$

$\frac{5\left(1+3p_{0C}^2\right)}{2\beta_1 p_{0C}}$, i.e. $p_{0C} = \sqrt{\frac{5}{2\beta_1 - 15}}$.

$$\pi_{1I} = \int_{\frac{1-p_{0C}}{\beta_1}}^1 \int_{max(d_M^*, 1)}^1 (\delta - \beta_1) v \; dd\, dv = \int_{\frac{1-p_{0C}}{\beta_1}}^{\frac{1+p_{0C}}{\beta_1}} \int_{\frac{p_{0C}-\beta_1 v+1}{2}}^1 (\delta - \beta_1) v \; dd\, dv +$$

$$\int_{\frac{1+p_{0C}}{\beta_1}}^1 \int_0^1 (\delta - \beta_1) v \; dd\, dv.$$

IOF 1 maximizes its payoff by choosing β_1 such that it satisfies $\frac{d\,\pi_{1I}}{d\beta_1} = 0$**.** This results in $-\frac{1}{6}\frac{\beta_1 + 3\beta_1 p_{0C}^2 - 30 - 90p_{0C}^2 + 3\beta_1^3}{\beta_1^3} = 0$.

Substituting p_{0C} in $-\frac{1}{6}\frac{\beta_1+3\beta_1 p_{0C}^2-30-90p_{0C}^2+3\beta_1^3}{\beta_1^3}=0$ results in the price policies $p_{oC}^*=$ 4.42 and $\beta_1^*=7.63$. Notice that $p_{oC}^*=4.42>1$, and the slope of $v^*=\frac{1-p_{0C}}{\beta_1}$ is lower than the slope of d_M^*. This implies that all farmers earn a positive payoff, and therefore produce and deliver (Proposition 9).

Substitute back the values of p_{oC}^* and β_1^* into the separating line $d_M^*=\frac{p_{0C}-\beta_1 v+1}{2}$. We find that the when δ increases, the line is flatter. It implies that when δ increases IOF 1 (Coop 0) attracts more high (low) value farmers (Proposition 7, Proposition 8).

Numerical examples illustrating Proposition 10

Compare the four cases for mixed market and Coop market (δ is small, intermediate, large, very large).

Case 1: $0<\delta\leq 1$. Figure 8 presents the mixed market and the Coop market.

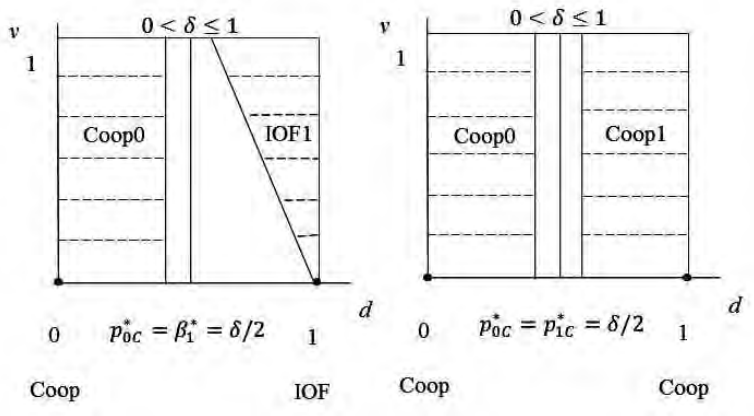

Figure 8: Mixed market and Coop market ($0<\delta\leq 1$)

The majority of the farmers located at the right side of d= ½ votes for Coop.

First, the farmers located below the line $v=\frac{1-d}{\beta_1^*}$ (i.e. $=\frac{2(1-d)}{\delta}$, see area a in Figure 9) vote Coop for enterprise 1, because they would gain nothing if it is an IOF. Second, the

farmers located above the line $v = \frac{1-d}{\beta_1^*}$ (see area b in Figure 9) also vote Coop for enterprise 1, because the payment for lower value farmers from a Coop ($p_C = \frac{\delta}{2}$) is higher than from an IOF ($p_I = \frac{\delta}{2}v$). To conclude, the mixed market dominates the Coop market when $\delta \leq 1$.

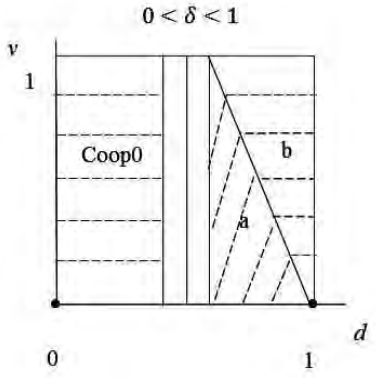

Figure 9: Farmers choices ($0 < \delta \leq 1$)

Case 2: δ is intermediate, e.g. $\delta = 1.5$. Figure 10 presents the mixed market and the Coop market.

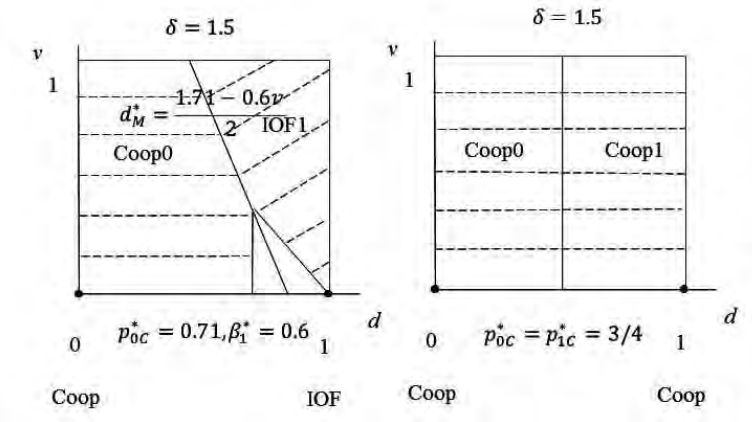

Figure 10: Mixed market and Coop market ($\delta = 1.5$)

The majority of the farmers located at the right side of d =1/2 votes Coop.

When $\delta = 1.5$, $\pi_{f|CI} = \begin{cases} 0.71 - d, \ 0 \le d \le \frac{1.71-0.6v}{2} \\ 0.6v - 1 + d, \ \frac{1.71-0.6v}{2} < d \le 1 \end{cases}$,

$\pi_{f|CC} = \begin{cases} \frac{3}{4} - d, \ 0 \le d \le \frac{1}{2} \\ d - \frac{1}{4}, \ \frac{1}{2} < d \le 1 \end{cases}$.

First, the farmers located at the right side of d_M^* (see area b in Figure 11) earn either $0.6v - 1 + d$ in an IOF or $d - \frac{1}{4}$ in an Coop. $0.6v - 1 + d - \left(d - \frac{1}{4}\right) = 0.6v - 0.75 < 0$. Therefore all the farmers located at the right side of d_M^* vote Coop. Second, the farmers located at $\frac{1}{2} < d < d_M^*$ (see area a in Figure 11) earn $0.71 - d$ in the mixed market, or $d - \frac{1}{4}$ in the Coop market. $0.71 - d - \left(d - \frac{1}{4}\right) = 0.96 - 2d < 0$. Therefore, the farmers located at the left side of d_M^* prefer the Coop market. To conclude, the Coop market dominates the mixed market when $\delta = 1.5$.

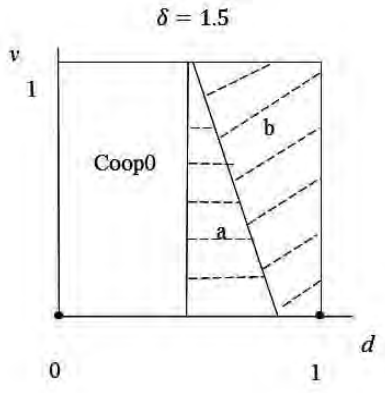

Figure 11: Farmers choices ($\delta = 1.5$)

Case 3: δ is high, e.g. $\delta = 3$. Figure 12 presents the mixed market and the Coop market.

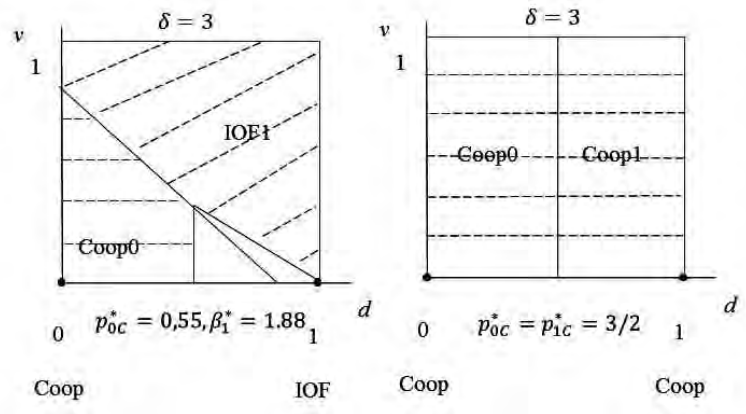

Figure 12: Mixed market and Coop market ($\delta = 3$)

When $\delta = 3$, $\pi_{f|CI} = \begin{cases} 0.55 - d, \ 0 \le d \le \frac{1.55-1.88v}{2} \\ 1.88v - 1 + d, \ \frac{1.55-1.88v}{2} < d \le 1 \end{cases}$,

$\pi_{f|CC} = \begin{cases} \frac{3}{2} - d, \ 0 \le d \le \frac{1}{2} \\ d + \frac{1}{2}, \ \frac{1}{2} < d \le 1 \end{cases}$.

First, the farmers located at the right side of $d = \frac{1}{2}$ (see area a in Figure 13) earn either $1.88v - 1 + d$ in an IOF or $d + \frac{1}{2}$ in a Coop. $1.88v - 1 + d - \left(d + \frac{1}{2}\right) = 1.88v - 1.5 > 0$ when $v > 0.8$. Otherwise the payoff in a Coop is higher. Therefore most of the farmers located at the right side of $\frac{1}{2}$ vote Coop. Second, the farmers located at the right side of d_M^* and the left side of $\frac{1}{2}$ (see area b in Figure 13) earn either $1.88v - 1 + d$ in a mixed market, or $\frac{3}{2} - d$ in the Coop market. $1.88v - 1 + d - \left(\frac{3}{2} - d\right) = 1.88v + 2d - 2.5 > 0$ when $v > 0.8$. Therefore the farmers located at area b prefer the Coop market. To conclude, the majority vote determines that the Coop market dominates the mixed market when $\delta = 3$.

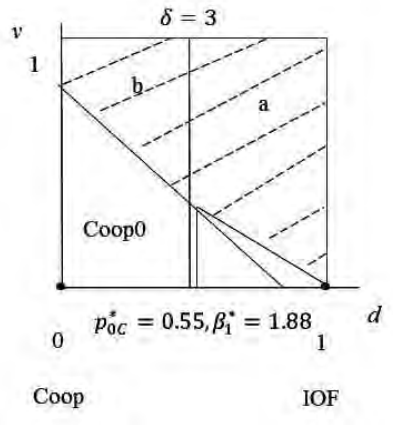

Figure 13: Farmers choices ($\delta = 3$)

Case 4: δ is very high, e.g. $\delta = 15$. Figure 14 presents the mixed market and the Coop market.

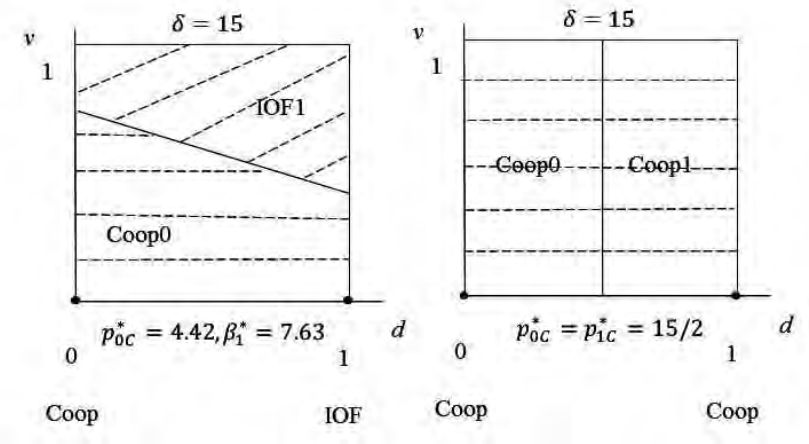

Figure 14: Mixed market and Coop market ($\delta = 15$)

When $\delta = 15$, $\pi_{f|CI} = \begin{cases} 4.42 - d, \ 0 \le d \le \frac{5.42 - 7.63v}{2} \\ 7.63v - 1 + d, \ \frac{5.42 - 7.63v}{2} < d \le 1 \end{cases}$,

$\pi_{f|CC} = \begin{cases} \frac{15}{2} - d, \ 0 \le d \le \frac{1}{2} \\ d + \frac{13}{2}, \ \frac{1}{2} < d \le 1 \end{cases}$.

First, the farmers located at the upper side of d_M^* and left side of $\frac{1}{2}$ (see area a in Figure 15) earn either $7.63v - 1 + d$ in a mixed market or $\frac{15}{2} - d$ in a Coop market. $7.63v - 1 + d - \left(\frac{15}{2} - d\right) = 7.63v + 2d - 8.5 > 0$ when $v > \frac{8.5-2d}{7.63}$ (i.e. when $v > \frac{p_{0C}^* - 2d}{\beta_1^*}$), the farmers choose IOF. Otherwise the payoff in a Coop is higher and the farmers choose Coop. Therefore most of the farmers located at the left side of $d = \frac{1}{2}$ vote Coop. Second, the farmers located at the right side of d_M^* and the right side of $d = \frac{1}{2}$ (see area b in Figure 15) earn either $7.63v - 1 + d$ in the mixed market, or $d + \frac{13}{2}$ in the Coop market. $7.63v - 1 + d - \left(d + \frac{13}{2}\right) = 7.63v - 7.5 > 0$ when $v > 0.98$. Therefore most of the farmers located at area b prefer the Coop market. To conclude, the majority vote determines that the Coop market dominates the mixed market when $\delta = 15$.

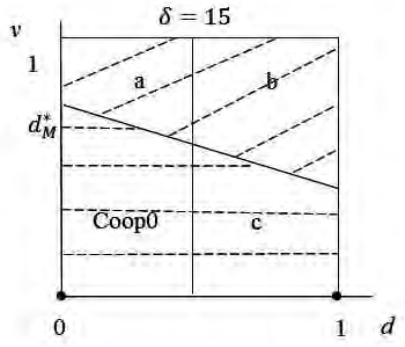

Figure 15: Farmers choices ($\delta = 15$)

Moreover, we determined that the line $v = \frac{p_{0C}^* - 2d}{\beta_1^*}$ is always higher than d_M^* for other large values of δ. This implies that there are not enough farmers voting for an IOF governance structure in enterprise 1 no matter how high the market price is. This completes the proof that the Coop market dominates the mixed market.

Chapter 4

Table 4-9 in this appendix show the relationships between the associated factors and the evaluations of the cooperative.

Table 4 shows the regression result of the associated factors regarding the evaluation of social influence by the CEOs. Table 5 introduces the robustness check. Comparing these two tables, the coefficients of each variable are the same, and the errors differ slightly. Therefore, this regression model is robust.

Table 4: The associated factors regarding the evaluation of social influence by the CEOs

The evaluation of social influence by the CEOs	**Coefficients (standard errors)**
The number of general meetings	-0.1 (0.08)
Profit distribution	0.13 (0.07)
Gender of CEOs	-1.39* (0.58)
Age of CEOs	0 (0.01)
Education of CEOs	0.15 (0.13)
Working Experience of CEOs	0.09 (0.17)
Product type	0.1 (0.07)
Economic status	-0.22 (0.13)
Membership size	0 (0)
Constant	6.69*** (1.21)

Note: N=91; * p<0.05, ** p<0.01, *** p<0.001; coefficients are reported; standard errors are in parentheses.

Table 5: The associated factors regarding the evaluation of social influence by the CEOs (with robustness check)

The evaluation of social influence by the CEOs	**Coefficients (robust errors)**
The number of general meetings	-0.1 (0.09)
Profit distribution	0.13 (0.07)
Gender of CEOs	-1.39* (0.42)
Age of CEOs	0 (0.02)
Education of CEOs	0.15 (0.13)
Working Experience of CEOs	0.09 (0.08)
Product type	0.1 (0.08)
Economic status	-0.22 (0.12)
Membership size	0 (0)
Constant	6.69*** (1.38)

Note: N=91; * p<0.05, ** p<0.01, *** p<0.001; coefficients are reported; robust errors are in parentheses.

Table 6 shows the regression result of the associated factors regarding the difference evaluation of social influence. Table 7 introduces the robustness check. Comparing these two tables, the coefficients of each variable are the same, and the errors differ slightly. Therefore, this regression model is robust.

Table 6: The associated factors regarding the difference evaluation of social influence

Difference evaluation social influence	**Coefficients (standard errors)**
The number of general meetings	-0.17* (0.08)
Profit distribution	0.09 (0.07)
Difference in gender	-0.94* (0.39)
Difference in age	-0.03* (0.01)
Difference in education	0.16 (0.12)
Difference in experience	-0.12 (0.16)
Product type	0.16* (0.07)
Economic status	-0.18 (0.13)
Membership size	0 (0)
Constant	-0.02 (0.49)

Note: N=91; * p<0.05, ** p<0.01, *** p<0.001; coefficients are reported; standard errors are in parentheses.

Table 7: The associated factors regarding the difference evaluation of social influence (with robustness check)

Difference evaluation social influence	**Coefficients (robust errors)**
The number of general meetings	-0.17* (0.1)
Profit distribution	0.09 (0.07)
Difference in gender	-0.94* (0.44)
Difference in age	-0.03* (0.01)
Difference in education	0.16 (0.13)
Difference in experience	-0.12 (0.10)
Product type	0.16* (0.08)
Economic status	-0.18 (0.14)
Membership size	0 (0)
Constant	-0.02 (0.52)

Note: N=91; * p<0.05, ** p<0.01, *** p<0.001; coefficients are reported; robust errors are in parentheses.

Table 8 shows the regression result of the associated factors regarding the difference evaluation of overall performance. Table 9 introduces the robustness check. Comparing these two tables, the coefficients of each variable are the same, and the errors differ slightly. Therefore, this regression model is robust.

Table 8: The associated factors regarding the difference evaluation of overall performance

Difference evaluation overall performance	**Coefficients (standard errors)**
The number of general meetings	-0.03 (0.07)
Profit distribution	0 (0.06)
Difference in gender	-0.93** (0.35)
Difference in age	-0 (0.01)
Difference in education	0.16 (0.11)
Difference in experience	-0.15 (0.15)
Product type	-0.12 (0.07)
Economic status	-0.1 (0.12)
Membership size	0 (0)
Constant	-0.02 (0.44)

Note: N=91; * p<0.05, ** p<0.01, *** p<0.001; coefficients are reported; standard errors are in parentheses.

Table 9: The associated factors regarding the difference evaluation of overall performance (with robustness check)

Difference evaluation overall performance	**Coefficients (robust errors)**
The number of general meetings	-0.03 (0.09)
Profit distribution	0 (0.06)
Difference in gender	-0.93** (0.36)
Difference in age	-0 (0.01)
Difference in education	0.16 (0.11)
Difference in experience	-0.15 (0.09)
Product type	-0.12 (0.06)
Economic status	-0.1 (0.11)
Membership size	0 (0)
Constant	-0.02 (0.46)

Note: N=91; * p<0.05, ** p<0.01, *** p<0.001; coefficients are reported; robust errors are in parentheses.

Multicollinearity diagnostics are performed by the variance inflation factor test. The results are presented in Table 10-12. VIF scores for all regression models are smaller than 5, it entails that there is no multicollinearity.

Table 10: VIF test with the evaluation of the social influence by the CEOs as the dependent variable

Variable	**VIF**
The number of general meetings	1.22
Profit distribution	1.17
Gender of CEOs	1.15
Age of CEOs	1.18
Education of CEOs	1.2
Working Experience of CEOs	1.13
Product type	1.17
Economic status	1.12
Membership size	1.15
Mean VIF	1.17

Table 11: VIF test with the difference of social influence evaluation as the dependent variable

Variable	**VIF**
The number of general meetings	1.22
Profit distribution	1.2
Difference in gender	1.12
Difference in age	1.28
Difference in education	1.33
Difference in experience	1.18
Product type	1.17
Economic status	1.16
Membership size	1.14
Mean VIF	1.2

Table 12: VIF test with the difference of overall evaluation as the dependent variable

Variable	**VIF**
The number of general meetings	1.22
Profit distribution	1.2
Difference in gender	1.12
Difference in age	1.28
Difference in education	1.33
Difference in experience	1.18
Product type	1.17
Economic status	1.16
Membership size	1.14
Mean VIF	1.2

Moreover, Breusch Pagan test is performed for heteroscedasticity. The test of Breusch Pagan with dependent variable evaluation social influence of CEOs results in p=0.52. There is no evidence to reject null hypothesis which is homoscedasticity. Similarly, with dependent variable difference evaluation social influence (overall performance), the test result is p=0.56 (0.48). There is no evidence to reject null hypothesis. Therefore, there is no heteroscedasticity problem in the regression models.

About the author

Xiao Peng was born on March 12, 1984 in Jiangsu, China. She obtained her Master of Science degree in Enterprise Management in 2011, at China University of Mining and Technology. In the same year, she joined the Rotterdam School of Management, Erasmus University, as a PhD candidate. Her research focuses on the internal and industrial organization of enterprises.

Xiao's work has been presented at various international conferences including "SICSS" Shanghai International Conference on Social Science, "PREBEM" Business Economics and Management Phd Conference, "EAWOP" European Association of Work and Organizational Psychology, Conference Producers Organizations in Agricultural Markets, eRNAC Modern Cooperatives, ICA 2015 Paris "Future of the Cooperative model: creativity, innovation and research", and the 146th EAAE Seminar "Technology transfer as a driver of innovative entrepreneurship in agriculture and the agri-food industry". Her paper "Communication and Innovation in Cooperatives" was accepted by Journal of the Knowledge Economy, and her other research is currently under review in management and economics journals.

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PhD-period:	September 9 2011 - September 9 2016
Promotor:	George Hendrikse

PhD training	
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Experimental Methods in Business Research	2011/12
Publishing Strategy	2011/12
Research Methodology & Measurement	2011/12
Topics in the Philosophy of Science	2011/12
ERIM/CentER Workshop on Information Management Research	2011/12
Academic writing in English for PhD students	2012/13
Boostcamp-"transferable skills"	2012/13
Managerial Economics	2013/14
Presentations in Conferences	
"SICSS" Shanghai China	August 2012
"PREBEM" Amsterdam the Netherlands	March 2013
"EAWOP" Muenster Germany	May 2013
Conference Producers Organizations in Agricultural Markets	September 2014
eRNAC Modern Cooperatives	February 2015
ICA 2015 Paris "Future of the Cooperative model: creativity, innovation and research"	May 2015
the 146th EAAE Seminar "Technology transfer as a driver of innovative entrepreneurship in agriculture and the agri-food industry"	July 2015
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Participate in course design, lectures, grading in master elective course "future of work"	2012/13
Supervise bachelor students in "Business Administration" thesis methodology course	2013/14

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Propositions

attached to the thesis

Innovation, Member Sorting, and Evaluation of Agricultural Cooperatives

Xiao Peng

Erasmus University Rotterdam

26 January 2017

1. A centralized cooperative internalizes the negative production externalities, and generates a higher vertical communication level than a decentralized cooperative.

   (this thesis)

2. Horizontal and vertical communication levels are determined by the nature of the product, the innovation strategies, and the governance structure.

   (this thesis)

3. Each farmer chooses an enterprise and its governance structure based on two dimensions: distance and quality. The farmers tend to choose the enterprise most close to them, and the high value farmers tend to choose an IOF.

   (this thesis)

4. The emergence of a Coop (mixed, IOF) duopoly market structure depends on the IOF's price policy. Coop (mixed, IOF) market is the equilibrium market structure when the payment for quality by the IOF is low (intermediate, high). Additionally, when the IOF adopts a profit maximizing price policy, the Coop market is always the equilibrium.

   (this thesis)

5. The management and the society of members in cooperatives have different evaluations of their cooperatives. Members have higher scores than CEOs regarding member profitability and overall performance, while CEOs have a higher evaluation regarding social influence.

   (this thesis)

6. Cooperation of individuals makes a bigger team, but not always a better team.

7. Progress is made by trial and failure; the failures are generally a hundred times more numerous than the successes; yet they are usually left unchronicled.

(William Ramsay)

8. Stubbornness creates great discovery as well as blindness of advices.

9. PhD: “Piled higher and deeper”.

(PhD comics)

10. Being able to use multi-perspective, multi-culture, multi-language skills provide ample opportunities for academic research.

11. It isn’t what you have, or who you are, or where you are, or what you are doing that makes you happy or unhappy. It is what you think about.

(Dale Carnegie)

Innovation, Member Sorting, and Evaluation of Agricultural Cooperatives

This dissertation aims to extend the current understanding of the agricultural cooperatives, and it is done by executing three studies regarding various aspects of the cooperatives. First study investigates the relationship between communication, innovation, and (de)centralization in cooperatives. This study claims that the communication between members is related to process innovation, while the communication between mangers and members is related to product innovation. The adopted (de)centralization depends on the two types of communication costs. Second, a sorting model is developed to examine how members sort themselves across enterprises and which governance structures are adopted.
A cooperative pays a uniform price to all farmers to maximize members' revenue and retains no profits, whereas investor-owned firm differentiates payments based on quality. The model shows that the farmers tend to choose the neighboring enterprise, and the farmers with high quality products tend to choose an investor-owned firm. Besides, higher the quality payment, more farmers are attracted by the investor-owned firm, and it has an impact on the market structure. Last, this dissertation provides evidence from China for a better understanding of the different evaluations between CEOs and members, therefore helps CEOs to best serve the membership of the cooperatives. The survey shows that members have higher scores than CEOs regarding member profitability and overall performance, while CEOs have a higher evaluation regarding social influence. Moreover, the associated factors that may influence the evaluations are explored.

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