"Institutions in Transition –

Challenges for New Modes of Governance"

IAMO Forum 2010, 16-18 June 2010 | Halle (Saale), Germany

Quality Provision and Governance Structure Variety: Pooling versus double markup

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Abstract: This paper examines how farmers producing differentiated quality products choose different governance structures in a non-cooperative game between farmers, enterprises, and consumers. A cooperative and an IOF (investor owned firm) coexist in equilibrium and low quality is delivered by the cooperative. The trade-off between pooling and the elimination of the double markup determines the attractiveness of cooperatives compared to IOFs.

Keywords: Quality, Cooperatives, Investor-Owned Firms.

JEL Classification: C72, L22, Q13

1 INTRODUCTION

Nowadays food quality and safety have become so important that suppliers have to attach more and more emphasis on it, as well as consumers' preferences. As the economy develops, consumer preferences are becoming more diversified. Given the great heterogeneity among consumers, there are opportunities for farmers to produce differentiated products. We know from previous research that the demand for variety and the willingness to pay for quality are fairly limited in poor countries (ANTLE 1999; SWINNEN et al. 2008; VANDEPLAS et al. 2009). In Vandeplas et al. (2009) model, they model the quality provision difference between a richer country and a poor country and find that the quality premium in a low income economy is lower than in a high income economy. Suppliers in a low income economy will choose to offer a higher share of low quality food products than in a high income economy. This observation makes the quality provision issue even more important and interesting in transition countries that are on the way to become developed, like China.

The product supply chain in China is diversified at present and undergoing transformation in both structure and management. It includes not only the traditional production-supply-marketing system constituting of small farm households, peddlers, processing enterprises, wholesalers and retailers, but also new retailers such as synthesized supermarkets and specialized fruit supermarkets. Helper (1991) indicates that buyer-supplier relationships are becoming more dependent on factors such as quality, delivery performance, flexibility in contract, and commitment to work together, as opposed to traditional relationships based on cost. The changing production methods, increased concentration in the supply chain, lower world prices and more open markets to international competition are threatening to small farmers (HAZELL et al. 2006).

The rising of supermarkets and sequential specialized distribution centers is a challenge to small farmers. They can hardly deal with the private standards of these modern transaction parties, nor can they have the counter' veiling power to gain reasonable value added shares. According to Hu and Reardon (2004), supermarkets are developing in China at a higher speed than any other developing countries. Hayek (1945) holds that "economic problems arise always and only in consequence of change". Institutional arrangements or governance structures are required to response to these emerging issues in supply chains. Due to the small farmer characteristics in China, cooperatives have become the main adopters of food quality standards (ZHOU and JIN 2009). In China and other countries, different governance structures are observed at the stages of production and marketing, ranging from spot market, contract farming, and farmer cooperative, to investor-owned firms. The co-existence of various governance structures raises the question why one governance structure is preferred to another, as well the comparisons between these governance structures.

Market and firm are recognized as two alternative mechanisms through which transactions occur (COASE 1937). But still, there are various forms of governance structures in between. Williamson (1979) introduces three types of governance structures, namely market, bilateral structure, and unified structure or vertical integration, which are more commonly recognized as market, hybrid, and hierarchy. Here the term governance traditionally has been defined very broadly as a "mode of organizing transactions" (WILLIAMSON and OUCHI 1981). Governance structure is defined as the allocation of

decision rights and income rights over relevant assets (HANSMANN 1996). In other words, governance structure specifies on the one hand who formally holds the decisions rights and on the other hand the way in which revenues and costs are distributed in terms of income rights. Here decision rights in the form of authority and responsibility address the question 'Who has authority or control (regarding the use of assets)?', while income rights address the question 'How are benefits and costs allocated?'. Just as the name implies, investor owned firms are firms hold by investors, while cooperatives are characterized by member use and member control.

We address various research questions:

1) Under the presence of both investor-owned firms and cooperatives, how farmers heterogeneous in product quality choose between alternative outlets?
2) What are the differences in payoffs of various participants of food supply chain when there are different market compositions?
3) And what is the special function of cooperatives in influencing payoffs of farmers as well as other market participants?

This article is organized as follows. Related papers are reviewed in section 2. Section 3 outlines the game between enterprises, farmers, and consumers. Each player of the game, choice and payoff of each player, sequence of the game, and information structure are specified. Section 4 is dedicated to an example. We extend the model by including government subsidy in section 5. In section 6, equilibrium of the game is determined and propositions are formulated. Finally we conclude with some possibilities for future research in section 7.

2 RELATED LITERATURE

Markup refers to the difference between its price and its marginal cost (CARLTON and PERLOFF 1990). In a supply chain comprised of farmers, investor-owned firms, and consumers, there are double markups. One occurs when an investor-owned firm purchases a product from a farmer, implying the procurement price being relatively higher than production cost of the product. The other markup is seen when a consumer buys the product with a sale price which is higher than the procurement price. This double markup provides an incentive for vertical integration. A cooperative reduces the markup between producers and processors to zero through pooling pricing or vertical integration.

Herbst and Prufer (2008) formulate a model regarding the comparison between quality provisions of nonprofits, cooperatives, and firms. They find that nonprofits provide highest, followed by cooperatives, and firms lowest levels of quality. Shareholders of firms exclusively maximize monetary profits since they don't consume the good themselves. Firms face the trade-off of the increase in revenues from higher prices versus higher cost in producing high quality products. Thus a too low quality is produced in firms. The non-profits, however, only care about utilities or surpluses of consumers from consuming the product, i.e. non-monetary profits. A maximum level of quality is chosen and any inefficiency from too high quality is neglected, which explains why non-profits are often perceived to operate inefficiently in resource allocation or utility and are

expensive. In cooperatives, members maximize the sum of the utilities from consuming the products and the monetary profits. In order to solve the trade-off between consuming utilities and profits, neither the maximum quality level of the nonprofits nor the profit-maximizing quality level of the firm are optimal for cooperatives. Consequently, a quality level between that of firms and non-profits is achieved. However, the free-rider problem leads cooperatives to include some members of relatively low quality, which implies that cooperatives provide inefficiently low quality.

Fulton and Sanderson (2002) think traditional cooperatives have disadvantage in meeting markets' demands for quality, due to several reasons. Firstly, revenue pooling generates adverse selection problem. Secondly, patronage-based financing leads to horizon problem and underinvestment in long-term strategies that can enhance objective or perceived product quality. Thirdly, providing a "home" for member production is problematic both with respect to product quality and the potential to glut niche market. Finally, difficulty in "marginal" members leads to revenue inefficiencies of each member.

In the similar sense, Tina and Richard (2009) argue that the pooling practice of cooperatives can counteract the tendency of competitive farmers to overproduce high-quality product relative to the amount that maximizing industry profits and pooling also insures risk-averse farmers against quality risk. Quality levels of the products are assumed to be exogenous and farmers are able to take activities ex ante to enhance the quality levels of products from low to high with certain costs. Since consumers attach value to high quality, farmers tend to produce high quality products to gain more revenue. They find that competitive farmers would supply an excessive amount of high quality product relative to the amount that maximizes industry profits. The presence of a marketing cooperative, however, benefits markets by attenuating the risks to individual farmers from stochastic production of quality levels and limiting farmers' incentives to transform low quality products to high quality products, by pooling revenues of the whole membership. Members of a cooperative receive a "pooled price" which is a quantity-weighted average of various-quality prices. Additionally, the degree of pooling, ranging from no pooling to complete pooling, matters a lot to the competitiveness of a cooperative. Complete pooling is actually problematic since farmers with high quality products anticipate a substantial transfer of revenues to farmers with low quality products. An optimal pooling degree is found in between, which is called partial pooling.

However, Yu (2009) concludes that farmers gain higher level prices when there is coexistence of a coop and a firm than in the two-firm case, after analyzing a model focusing on the quality provision and farmer inclusion of a cooperative under the assumption of a mixed oligopsonistic competition between a cooperative and an IOF. She highlights the advantage of the cooperative if the cooperative imposes a similar quality standard to that imposed by the IOF and the cooperative may drive the IOF out of the market. It also means that the IOF always wants to differentiate the quality standard, while the cooperative would like to choose the same standard as that of the IOF.

3 MODEL

This section develops a non-cooperative game with producers (farmers), product marketing enterprises, and consumers. It highlights the farmers' choice of product outlet.

It depends on the pricing policies of the enterprises and consumers' choice of where to buy. The five ingredients of the game, i.e. players, choices, payoffs, information structure, and sequence of the game, are specified in this section.

Players

Assume that there are two enterprises, three farmers, and three consumers. The two enterprises act as marketing organizations that buy products from farmers and sell to consumers.

Choices

An enterprise has one of two governance structures: an investor-owned firm (IOF) or an open-membership cooperative. It implies that there are three possible compositions of the market, i.e. an IOF and a cooperative, two IOFs, and two cooperatives. An open-membership cooperative entails that farmers can join and deliver products to the cooperative without limitation or any cost. The main distinction between an IOF and a cooperative lies in their pricing policy. An IOF is allowed to set differentiated prices towards farmers as well as consumers, whereas a cooperative adopts a uniform pricing policy. To be more specific, the IOF prices products discriminatorily, depending on the quality of products, whereas the cooperative prices products uniformly, regardless of the quality of products. Additionally, an IOF can reject farmers, whereas a cooperative can't.

Each farmer produces either one unit of a product or nothing. Products differ in quality. Farmer $1(2, 3)$ produces low (median, high) quality product. A farmer chooses to deliver the product to either enterprise 1 or enterprise 2 when a unit is produced. Let $q_j^{eg} = 1(0)$ when farmer j delivers (doesn't deliver) to enterprise e with governance structure g, where $j = 1, 2, 3$, $e = 1, 2$, $g = f, c$, and f (c) is an IOF (a cooperative).

Each consumer buys either one unit of the product or nothing. Consumer i chooses where to buy and which product to buy in order to gain highest surplus. Let $d_{ij}^{eg} = 1(0)$ when consumer i buys (does not buy) product j from enterprise e with governance structure g, where $i = 1, 2, 3$, $j = 1, 2, 3$, $e = 1, 2$ and $g = f, c$. Define $d_{ij}^{eg} = 0$ when $q_j^{eg} = 0$. Consumer i is supposed to prefer a higher quality product to a lower quality product if they generate identical surplus.

Payoffs

Enterprises earn the difference between the price paid by consumers and the price paid to farmers. Let p_{jb}^{eg} be the procurement price that enterprise e with governance structure g pays when buying (b) product j and p_{js}^{eg} be the sale price that enterprise e with governance structure g receives for selling (s) product j to a consumer. Define p_b^{1f} as $(p_{1b}^{1f}, p_{2b}^{1f}, p_{3b}^{1f})$ and p_s^{1f} as $(p_{1s}^{1f}, p_{2s}^{1f}, p_{3s}^{1f})$. The payoff of enterprise e with governance structure g is:

$$\Pi^{eg} = \sum_{i=1}^{3} \sum_{j=1}^{3} d_{ij}^{eg} p_{js}^{eg} - \sum_{j=1}^{3} q_j^{eg} p_{jb}^{eg}, \qquad (1)$$

where $\sum_{i=1}^{3}\sum_{j=1}^{3} d_{ij}^{eg} p_{js}^{eg}$ is the total revenue that enterprise e with governance structure g receives from consumers and $\sum_{j=1}^{3} q_j^{eg} p_{jb}^{eg}$ refers to what enterprise e with governance structure g pays to farmers.

A cooperative is conceptualized as a pooling device. It sells all the products at a uniform price and pays all farmers a uniform price. Define therefore $p_s^{ec} \equiv p_{js}^{ec}$ for $j = 1, 2, 3$ and $p_b^{ec} \equiv p_{jb}^{ec}$ for $j = 1, 2, 3$. A cooperative distributes its revenue equally among its producing members. It entails that a cooperative has zero profits. This zero profit condition implies that

$$p_b^{ec} = p_s^{ec} \sum_{i=1}^{3}\sum_{j=1}^{3} d_{ij}^{ec} / \sum_{j=1}^{3} q_j^{ec} , \tag{2}$$

i.e. farmers delivering to the cooperative share total revenue equally.

The revenue of farmer j is p_{jb}^{ef} (p_b^{ec}) when he delivers to an IOF (a cooperative) and nothing if he doesn't produce. Assume that members of a cooperative shoulder production costs individually. The production costs of farmer j are c_j ($j = 1, 2, 3$), where c_j is increasing in j. Production costs are 0 when the farmer does not produce. The payoff of farmer j is therefore

$$F_j = \sum_e \sum_g q_j^{eg} \left(p_{jb}^{eg} - c_j \right). \tag{3}$$

Define R_{ij} is the reservation price of consumer i for product j. Consumers attach value to quality, i.e. $R_{i1} < R_{i2} < R_{i3}$ for $i = 1, 2, 3$. Assume that consumers are distinguished by different reservation prices for the same quality product, i.e. $R_{1j} < R_{2j} < R_{3j}$, where $j = 1, 2, 3$. The payoff of consumer i is

$$D_i = \sum_e \sum_g \sum_{j=1}^{3} d_{ij}^{eg} \left(R_{ij} - p_{js}^{eg} \right). \tag{4}$$

Information structure

Suppose there is perfect information throughout the supply chain regarding product quality, farmers' production cost, consumers' reservation price, enterprises' purchasing and selling price, and the choice of each player.

Sequence of decisions

The two enterprises choose simultaneously their governance structure, i.e. price policy, in the first stage of the game. There are three possible outcomes with respect to governance structure choice: a mixed market with an IOF and a cooperative, a pure IOF market, and a pure cooperative market. The two enterprises choose their pricing policies sequentially in the second stage of the game. If the market consists of two IOFs (cooperatives), then it is

assumed that IOF 1 (cooperative 1) moves first. If the market consists of an IOF and a cooperative, then both cases are considered.

In the second stage of the game, farmers choose first where to deliver and next their level of output. The three farmers act simultaneously. In the final stage, consumers decide where to buy, which product to buy, and whether to buy. Consumer 3 is supposed to act first, followed by consumer 2, and finally consumer 1.

4 AN EXAMPLE

An example is presented to illustrate the model. The method of backward induction will be used to solve the model in order to maintain time consistency. It entails that consumer choices are determined, given the choices of the farmers and the pricing policy of the enterprises. Subsequently, the production decisions of the farmers are considered, anticipating the choices of the consumers and given their outlet choices and the pricing policy of the enterprises. Next, the outlet choices of the farmers are determined, anticipating their production decisions and the choices of the consumers, given the pricing policy of the enterprises. Finally, governance structures are determined, anticipating the choices the subsequent choices. The section is organized around the various possible outcomes of the first stage of game. There are three possible outcomes: a mixed market comprised of an IOF and a cooperative (4.1), a pure market comprised of two IOFs (4.2), and a pure market comprised of two cooperative (4.3). The equilibrium choices in the first stage of the game are presented in 4.4. Finally, some observations are formulated (4.5).

Let reservation prices of consumers for different products be as listed in Table 1.

Table 1: Reservation prices of consumers

	Product 1	**Product 2**	**Product 3**
Consumer 1	$R_{11}=1$	$R_{12}=2$	$R_{13}=3$
Consumer 2	$R_{21}=1$	$R_{22}=3$	$R_{23}=5$
Consumer 3	$R_{31}=1$	$R_{32}=4$	$R_{33}=7$

Production costs of three farmers are assumed to be 0, 1, and 2 respectively, i.e. $c_1=0$, $c_2=1$, and $c_3=2$.

4.1 A mixed market consisting of an IOF and a cooperative.

For product j ($j=1,2,3$) delivered through the IOF, there are two markups. One markup arises when the IOF buys from farmer j. Farmer j delivering to the IOF earns the difference between the procurement price and the sales price. The other markup arises when the IOF sells product j to consumer i ($i=1,2,3$). Thus the IOF chooses two sets of prices, i.e. the procurement prices and the sale prices. This is known as double markup or double marginalization (SPENGLER, 1950). A cooperative has only one markup.

There is a single price which is called the pooling price. The cooperative charges consumers the same price for all the products and distributes the revenues entirely and equally among the producing members.

Consider first the case where the IOF decides first regarding its price policy. We determine first the pricing policy of the IOF when it is a monopolist in order to understand the competitive effect of a cooperative facing an IOF. The monopolist will maximize its payoff by buying inputs at the lowest prices, i.e. $p_b^{1f} = (\varepsilon, 1+\varepsilon, 2+\varepsilon)$, and selling the outputs at the highest possible prices, i.e. $p_s^{1f} = (1-\varepsilon, 3-\varepsilon, 6-\varepsilon)$. All farmers deliver to the IOF and all consumers buy. The payoff of the IOF is $7-6\varepsilon$, each farmer earns ε, and surpluses of three consumers are: $D_1 = \varepsilon$, $D_2 = \varepsilon$, $D_3 = 1+\varepsilon$.

This price policy of the IOF will not survive when it has to compete with a cooperative. If the IOF continues with this price policy when facing a cooperative, then the payoff maximizing reply of the cooperative is to choose $p_b^{2c} = 3-\varepsilon$ and $p_s^{2c} = 3/2-\varepsilon/2$. It establishes that both farmer 1 and farmer 2 deliver to the cooperative whereas farmer 3 sells to the IOF consumer 2 buys from the cooperative and consumer 3 buys from the IOF. The IOF will respond to this price policy of the cooperative by $p_b^{1f} = (\varepsilon, 3/2, 2+\varepsilon)$ and $p_s^{1f} = (1-\varepsilon, 3-\varepsilon, 6-\varepsilon)$. The cooperative will sequentially reacts by choosing $p_b^{2c} = 7-\varepsilon$ and $p_s^{2c} = 7/3-\varepsilon/3$ since all three farmers will deliver to the cooperative whereas only consumer 3 buys rather than consumer 1 or consumer 2. By inference, the IOF replies with $p_b^{1f} = (\varepsilon, 3/2, 7/3)$ and $p_s^{1f} = (1-\varepsilon, 3-\varepsilon, 6-\varepsilon)$. The rest of competition can be done in the same manner. The final results of pricing depend on who is the last mover, or who is the first mover.

Suppose that the IOF moves first. Then the pricing policies of the IOF and the cooperative respectively, as well as actions of farmers and consumers, are presented in Table 2. The effect of the presence of the cooperative as well as the pooling price policy is that all the farmers earn more, whereas the IOF have less profit in a mixed market where the IOF moves first, compared with those in an IOF monopolistic market (see payoffs of players in Table 3).

The IOF chooses higher procurement prices for product 2 and product 3 than in an IOF monopolistic market, being afraid that the cooperative choose a relative high pooling price to attract farmer 2 or farmer 2.

Table 2: Equilibrium exchange via the IOF and the cooperative when the IOF moves first

j	p_{jb}^{1f}	p_b^{2c}	q_j^{1f}	q_j^{2c}	p_{js}^{1f}	p_s^{2c}	d_{1j}^{1f}	d_{1j}^{2c}	d_{2j}^{1f}	d_{2j}^{2c}	d_{3j}^{1f}	d_{3j}^{2c}
1	ε	$1-\varepsilon$	0	1	$1-\varepsilon$	$1-\varepsilon$	0	1	0	0	0	0
2	$3/2$	$1-\varepsilon$	1	0	$3-\varepsilon$	$1-\varepsilon$	0	0	1	0	0	0
3	$7/3$	$1-\varepsilon$	1	0	$6-\varepsilon$	$1-\varepsilon$	0	0	0	0	1	0

Table 3: Payoffs when the IOF moves first in IOF-Coop mixed market

	Payoff of each player	*Total Surplus*
Enterprises	$\Pi^{1f} = 31/6 - 2\varepsilon$, $\Pi^{2c} = 0$	$\Pi^{1f} = 31/6 - 2\varepsilon$
Farmers	$F_1 = 1-\varepsilon$, $F_2 = 1/2$, $F_3 = 1/3$.	$TF = 11/6 - \varepsilon$
Consumers	$D_1 = \varepsilon$, $D_2 = \varepsilon$, $D_3 = 1+\varepsilon$	$TD = 1+3\varepsilon$
Total surplus		$TS = 8$

If the cooperative moves first, the pricing policies of the cooperative and the IOF respectively, as well as actions of farmers and consumers, will be as shown in Table 4. The effect of the presence of the cooperative as well as the pooling price policy is that only farmer 1 better off, whereas the IOF have less profit in a mixed market where the cooperative moves first, compared with those in an IOF monopolistic market (see Table 5).

The cooperative chooses a relative low purchasing price $1-\varepsilon$. Because if the cooperative chooses a higher pooling price, for example $3-\varepsilon$ or $7-\varepsilon$, it can be expected that the IOF will always choose a price a little higher for a certain product than that of the pooling price chosen by the cooperative, to prevent as many farmers as possible from delivering to the cooperative, which will lead to the cooperative's being driven out of the market since no farmer will deliver to the cooperative.

Table 4: Equilibrium exchange via the IOF and the cooperative when the cooperative moves first

j	p_{jb}^{1f}	p_b^{2c}	q_j^{1f}	q_j^{2c}	p_{js}^{1f}	p_s^{2c}	d_{1j}^{1f}	d_{1j}^{2c}	d_{2j}^{1f}	d_{2j}^{2c}	d_{3j}^{1f}	d_{3j}^{2c}
1	ε	$1-\varepsilon$	0	1	$1-\varepsilon$	$1-\varepsilon$	0	1	0	0	0	0
2	$1+\varepsilon$	$1-\varepsilon$	1	0	$3-\varepsilon$	$1-\varepsilon$	0	0	1	0	0	0
3	$2+\varepsilon$	$1-\varepsilon$	1	0	$6-\varepsilon$	$1-\varepsilon$	0	0	0	0	1	0

Table 5: Payoffs when the coop moves first in IOF-Coop mixed market

	Payoffs of each player	*Total Surplus*
Enterprises	$\Pi^{1f} = 6-4\varepsilon$, $\Pi^{2c} = 0$	$\Pi^{1f} = 6-4\varepsilon$
Farmers	$F_1 = 1-\varepsilon$, $F_2 = \varepsilon$, $F_3 = \varepsilon$.	$TF = 1+\varepsilon$
Consumers	$D_1 = \varepsilon$, $D_2 = \varepsilon$, $D_3 = 1+\varepsilon$	$TD = 1+3\varepsilon$
Total surplus		$TS = 8$

The cooperative chooses a low price $1-\varepsilon$ because a higher price may cause either cross-subsidization or excessive supply to the cooperative. Cross-subsidization occurs when

one party benefits from the value generated by another party without paying for it. Farmer 1 will be cross-subsidized when the cooperative attracts farmer 2 or farmer 3 by a high price. Then farmer 2 and/or farmer 3 will hesitate to deliver to the cooperative and may turn to the IOF. In addition, no consumer would like to buy product 1 from the cooperative if the price is higher than the reservation price. Thus products of the cooperative are excessively produced.

Farmers stay insistent in where to deliver regardless which enterprise is the first mover in pricing. There is neither any change in consumers' decision or payoffs. The only difference of competition results between the case if the IOF moves first and the case if the cooperative moves first lies in the payoff of farmer 2, farmer 3, and the IOF. Farmer 2 and farmer 3 catch some additional revenue from the IOF if the IOF moves first. Either farmer 2 or farmer 3 hardly gain any revenue if the cooperative moves first, since the cooperative choose such a low price that both farmer 2 and farmer 3 have no choice but deliver to the IOF. Thus the IOF only pay farmers marginal production cost. But if the IOF moves first, it has to take into account the possibility that the cooperative chooses a price that is so high to attract farmer 2 and/or farmer 3. Thus a higher procurement price is chosen to prevent the cooperative from choosing a higher price and to prevent farmer 2 from delivering to the cooperative as well.

Summarizing, the equilibrium results are that farmer 1 delivers to the cooperative whereas both farmer 2 and farmer 3 deliver to the IOF, since the IOF always attract farmers by raising prices slightly above that of the cooperative as long as it is below the reservation prices of the consumers. The cooperative chooses a relatively low price to prevent too many deliveries. The price chosen by the cooperative is too low for farmers 2 and farmer 3 to join the cooperative. Consumer 1 buys product 1 from the cooperative, while consumer 2 buys product 2 and consumer 3 buys product 3, both from the IOF.

4.2 A pure IOF market.

Recall the assumption that IOF 1 moves first when there are two IOFs. Prices that the IOFs charge consumers are $p_{1s}^{1f} = p_{1s}^{2f} = 1-\varepsilon$, $p_{2s}^{1f} = p_{2s}^{2f} = 3-\varepsilon$, and $p_{3s}^{1f} = p_{3s}^{2f} = 6-\varepsilon$. There is severe price competition between the two IOFs to attract farmers. The follower would always choose a price that is a little bit higher than the price chosen by the first mover. Thus either firm can make sufficient positive profit. Purchasing prices of the two IOFs are finally $p_{1b}^{1f} = p_{1b}^{2f} = 1-2\varepsilon$, $p_{2b}^{1f} = p_{2b}^{2f} = 3-2\varepsilon$, and $p_{3b}^{1f} = p_{3b}^{2f} = 6-2\varepsilon$. There's no pure strategy equilibrium, but only mixed strategy equilibrium. Farmers are indifferent in choosing product outlet; neither do consumers have any preference in choosing from where to buy. Equilibrium exchanges are shown in table 6. Payoffs of players and total and sub-total surpluses are described in Table 7.

Table 6: Equilibrium exchange via the IOFs in duopolistic IOF market

j	p_{jb}^{1f}	p_{jb}^{2f}	q_j^{1f}	q_j^{2f}	p_{js}^{1f}	p_{js}^{2f}	d_{1j}^{1f}	d_{1j}^{2f}	d_{2j}^{1f}	d_{2j}^{2f}	d_{3j}^{1f}	d_{3j}^{2f}
1	ε	ε	1/2	1/2	$1-\varepsilon$	$1-\varepsilon$	1/2	1/2	0	0	0	0
2	$1+\varepsilon$	$1+\varepsilon$	1/2	1/2	$3-\varepsilon$	$3-\varepsilon$	0	0	1/2	1/2	0	0
3	$2+\varepsilon$	$2+\varepsilon$	1/2	1/2	$6-\varepsilon$	$6-\varepsilon$	0	0	0	0	1/2	1/2

Table 7. Payoffs in duopolistic IOF market

	Payoffs of each player	***Total Surplus***
Enterprises	$\Pi^{1f} = 3\varepsilon/2$, $\Pi^{2f} = 3\varepsilon/2$	
Farmers	$F_1 = 1-2\varepsilon$, $F_2 = 3-2\varepsilon$, $F_3 = 6-2\varepsilon$	$TF = 7-6\varepsilon$
Consumers	$D_1 = \varepsilon$, $D_2 = \varepsilon$, $D_3 = 1+\varepsilon$	$TD = 1+3\varepsilon$
Total surplus		$TS = 8$

It seems that farmers have sufficient surplus in a pure IOF market, which is contradict with the real situation where farmers are well-known for their weak position and small transaction power. If an IOF hardly has any profit, it tends to retire from the market. Finally one IOF will drive the other out of the market and there will be a monopolistic market. Results of pricing are: $p_{1s}^f = 1-\varepsilon$, $p_{2s}^f = 3-\varepsilon$, $p_{3s}^f = 6-\varepsilon$ and $p_{1b}^f = \varepsilon$, $p_{2b}^f = 1+\varepsilon$, $p_{3b}^f = 2+\varepsilon$. Pricing policies of the IOF, as well as actions of farmers and consumers, are presented in Table 8.

Farmers gain a little bit in an IOF monopoly market which is emphasized by a lot of researchers. Almost all revenues are held by the IOF (see Table 9).

Table 8: Equilibrium exchange via the IOF in IOF monopolistic market

j	q_j^{1f}	p_{jb}^{1f}	p_{js}^{1f}	d_{1j}^{1f}	d_{2j}^{1f}	d_{3j}^{1f}
1	1	ε	$1-\varepsilon$	1	0	0
2	1	$1+\varepsilon$	$3-\varepsilon$	0	1	0
3	1	$2+\varepsilon$	$6-\varepsilon$	0	0	1

Table 9: Payoffs in an IOF monopolistic market

	Payoffs of each player	*Total Surplus*
Enterprise	$\Pi^f = 7 - 6\varepsilon$	
Farmers	$F_1 = \varepsilon,\ F_2 = \varepsilon, F_3 = \varepsilon$	$TF = 3\varepsilon$
Consumers	$D_1 = \varepsilon,\ D_2 = \varepsilon,\ D_3 = 1 + \varepsilon$	$TD = 1 + 3\varepsilon$
Total surplus		$TS = 8$

4.3 A pure cooperative market.

If farmer 3 decides first where to deliver, both farmer 2 and farmer 1 would like to deliver to the same cooperative as farmer 3 does, which makes payoff of farmer 3 smaller than zero. Thus farmer 3 would not produce at all. Sequentially, farmer 1 would always deliver to the same cooperative as farmer 2 does. Neither consumer 1 nor consumer 2 buys anything. And consumer 3 buys product 2. In other word, resources are not efficiently distributed and there is over-producing problem as well. The competition result of two cooperatives is $p_s^{1c} = p_s^{2c} = 3 - \varepsilon$. The actions of various players are presented in Table 10 and payoffs in Table 11.

Table 10: Equilibrium exchange via Coops while farmer 3 moves first in pure cooperative market

j	p_{jb}^{1c}	p_{jb}^{2c}	q_j^{1c}	q_j^{2c}	p_{js}^{1c}	p_{js}^{2c}	d_{1j}^{1c}	d_{1j}^{2c}	d_{2j}^{1c}	d_{2j}^{2c}	d_{3j}^{1c}	d_{3j}^{2c}
1	$3/2 - \varepsilon/2$	$3/2 - \varepsilon/2$	1/2	1/2	$3 - \varepsilon$	$3 - \varepsilon$	0	0	0	0	0	0
2	$3/2 - \varepsilon/2$	$3/2 - \varepsilon/2$	1/2	1/2	$3 - \varepsilon$	$3 - \varepsilon$	0	0	0	0	0	0
3	$3/2 - \varepsilon/2$	$3/2 - \varepsilon/2$	0	0	$3 - \varepsilon$	$3 - \varepsilon$	0	0	0	0	1/2	1/2

Table 11: Payoffs when farmer 3 moves first in pure cooperative market

	Payoffs of each player	*Surplus*
Enterprises	$\Pi^{1c} = 0,\ \Pi^{2c} = 0$	
Farmers	$F_1 = 3/2 - \varepsilon/2,\ F_2 = 1/2 - \varepsilon/2,\ F_3 = 0.$	$TF = 2 - \varepsilon$
Consumers	$D_1 = 0,\ D_2 = 0,\ D_3 = 4 + \varepsilon$	$TD = 4 + \varepsilon$
Total surplus		$TS = 6$

If farmer 1 decides, there would be different results. The competition result of two cooperatives is $p_s^{1c} = p_s^{2c} = 3 - \varepsilon$. As followers, farmer 2 and farmer 3 would like to deliver to the otherwise cooperative than where farmer 1 delivers, i.e. both farmer 2 and farmer 3 deliver to cooperative 2 if farmer 1 delivers to cooperative 1, whereas farmer 2

and farmer 3 deliver to cooperative 1 if farmer 1 delivers to cooperative 2. Farmer 1 would finally decide not to produce since his product is not able to be sold. Therefore either farmer 2 or farmer 3 has any preference in choosing which cooperative to deliver to. Consumer 1 buys nothing, consumer 2 buys product 2, and consumer 3 buys product 3. Transactions via coop 1 and coop 2 are presented in table 12 respectively. Payoffs are displayed in Table 13.

Table 12: Equilibrium exchange via Coops while farmer 1 moves first in pure cooperative market

j	p_{jb}^{1c}	p_{jb}^{2c}	q_j^{1c}	q_j^{2c}	p_{js}^{1c}	p_{js}^{2c}	d_{1j}^{1c}	d_{1j}^{2c}	d_{2j}^{1c}	d_{2j}^{2c}	d_{3j}^{1c}	d_{3j}^{2c}
1	$3/2-\varepsilon/2$	$3/2-\varepsilon/2$	0	0	$3-\varepsilon$	$3-\varepsilon$	0	0	0	0	0	0
2	$3/2-\varepsilon/2$	$3/2-\varepsilon/2$	1/2	1/2	$3-\varepsilon$	$3-\varepsilon$	0	0	1/2	1/2	0	0
3	$3/2-\varepsilon/2$	$3/2-\varepsilon/2$	1/2	1/2	$3-\varepsilon$	$3-\varepsilon$	0	0	0	0	1/2	1/2

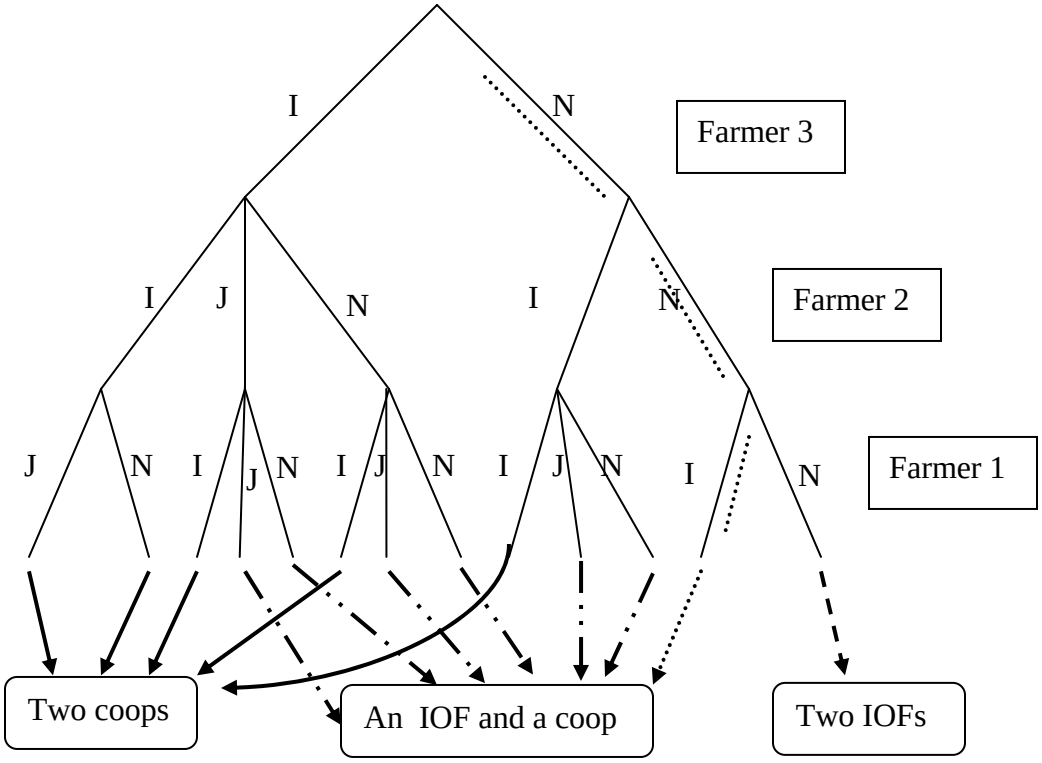
Table 13. Payoffs when farmer 1 moves first in pure coop market

	Payoffs of each player	***Surplus***
Enterprises	$\Pi^{1c}=0$, $\Pi^{2c}=0$	
Farmers	$F_1=0$, $F_2=2-\varepsilon$, $F_3=1-\varepsilon$.	$TF=3-2\varepsilon$
Consumers	$D_1=0$, $D_2=\varepsilon$, $D_3=4+\varepsilon$	$TD=4+2\varepsilon$
Total surplus		$TS=7$

4.4 Governance structure choice and equilibrium

Each farmer decides to deliver to an IOF, initiate a cooperative, or join an existing cooperative, in order to gain maximized revenue. Governance structure composition of the market is determined by farmers' outlet choice. Take for example that farmer 3 decides first. The strategy tree of governance structure choice is described in Figure 1. Farmer 3 chooses to initiate a cooperative or not. If yes, then farmer 2 decides to initiate a second cooperative, to join the cooperative, or to deliver to an IOF. If not, then farmer 2 decides to initiate a cooperative or not. In the same sense, farmer 1 decides to initiate a new cooperative if there is no cooperative or only one cooperative in the market, to join the cooperative if there is at least one cooperative, or to deliver to an IOF. According to the competition result of the example raised in the former parts, sub-game perfect equilibrium is described by the dot line, i.e. there are an IOF and a cooperative.

Figure 1: Strategy tree of governance structure choice



	IOF moves first	Coop moves first
Two coops	$\Pi^{1c}=0$ $\Pi^{2c}=0$ $F_3=0$ $F_2=1/2-\varepsilon$ $F_1=3/2-\varepsilon$ $D_3=4+\varepsilon$ $D_2=0$ $D_1=0$	
An IOF and a coop	$\Pi^{1f}=31/6-2\varepsilon$ $\Pi^{2c}=0$ $F_3=1/3$ $F_2=1/2$ $F_1=1-\varepsilon$ $D_3=1+\varepsilon$ $D_2=\varepsilon$ $D_1=\varepsilon$	$\Pi^{1f}=6-4\varepsilon$ $\Pi^{2c}=0$ $F_3=\varepsilon$ $F_2=\varepsilon$ $F_1=1-\varepsilon$ $D_3=1+\varepsilon$ $D_2=\varepsilon$ $D_1=\varepsilon$
Two IOFs		$\Pi^{f}=7-6\varepsilon$ $F_3=\varepsilon$ $F_2=\varepsilon$ $F_1=\varepsilon$ $D_3=1+\varepsilon$ $D_2=\varepsilon$ $D_1=\varepsilon$

4.5 Some observations

Results of competition are collected in Table 14. In each cell of the table, payoffs are listed social surplus. Payoff of cooperatives is excluded since it is always zero.

Table 14: Collected payoffs of all the four cases

	IOF	**Coop**
IOF (First mover)	$\Pi^{f} = 7 - 6\varepsilon$ $TF = 3\varepsilon$ $TD = 1 + 3\varepsilon$ $TS = 8$	$\Pi^{1f} = 11/2 - 3\varepsilon$ $TF = 3/2$ $TD = 1 + 3\varepsilon$ $TS = 8$
Coop (First mover)	$\Pi^{1f} = 6 - 4\varepsilon$ $TF = 1 + \varepsilon$ $TD = 1 + 3\varepsilon$ $TS = 8$	$TF = 2 - \varepsilon$ $TD = 4 + \varepsilon$ $TS = 6$

Some observations are drawn out from results of the competition.

(1) In a pure market comprised of two IOFs, there is severe price competition and finally either both IOFs can make sufficient profit or one IOF is driven out of the market by the other.

(2) A pure coop market is not efficient in social welfare when there are heterogeneous farmers producing differentiated products. The uniform pricing policy of cooperatives prevents realization of welfare maximization due to that it is not able to price products discriminatorily according to values of products. Besides, there are both free-rider problem and excessive produce problem in a cooperative pure market.

(3) In an IOF-coop mixed market, the presence of a cooperative mitigates market competition to a certain extend compared with that of a pure IOF market and the IOF is better off as, which is referred to as “yardstick effect”.

(4) In an IOF-coop mixed market, only farmers producing the lowest level quality tend to deliver to the cooperative. Farmers with higher quality products however prefer delivering to the IOF over to the cooperative since their revenue would be distributed together with those who produce the lowest level quality if they join cooperatives.

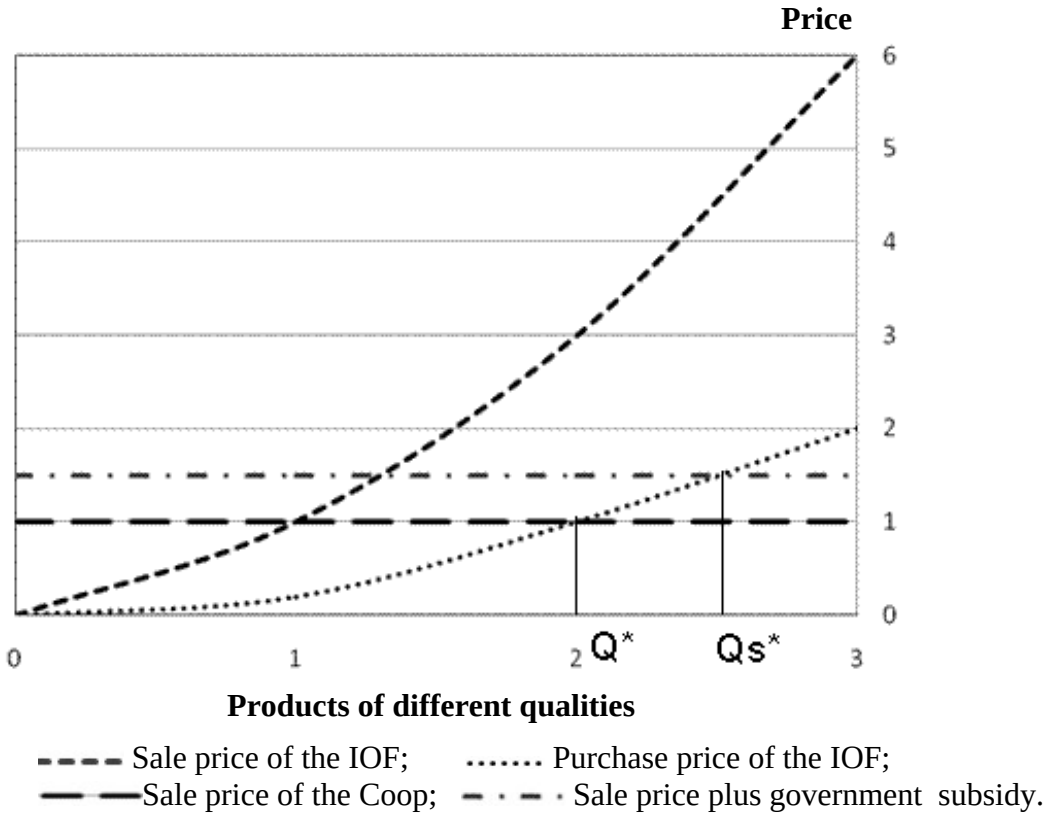
(5) Farmers gain more when the IOF moves first in an IOF-Coop mixed market than when the Coop moves first.

5 EXTENDED MODEL WITH GOVERNMENT SUBSIDY

Hereby we extend our model by adding external subsidy to the revenue of farmers joining a cooperative. External subsidy is mainly referred to subsidies from government. Cooperatives are usually subsidized according to the size of membership. Define each farmer who delivers product to the cooperative gets a distributed subsidy s from government. No farmer receives any subsidy when there is pure IOF market, whereas all farmers have subsidy when there is pure cooperative market, which will not have any influence on farmers’ choices of outlet in these two cases. Thus we only focus on the

scenario when there is an IOF-coop mixed market. Then revenue of farmer j is $F_j = q_j^{1f}\left(p_{jb}^{1f} - c_j\right) + q_j^{2c}\left(p_b^{2c} + s - c_j\right)$. With subsidy s, farmers providing higher quality than $Qs*$ are prone to deliver to the IOF (Figure 2). Although it is possible that the IOF will be driven out of the market if government subsidy is sufficient high (the dashed horizontal line in Figure 2), it will not happen. Since a pure cooperative market is not efficient from point of social welfare which has been proven in the previous part, government will not choose so high a subsidy level as to drive the IOF out.

Figure 2: Farmers' outlet choice when there is government subsidy



6 EQUILIBRIUM

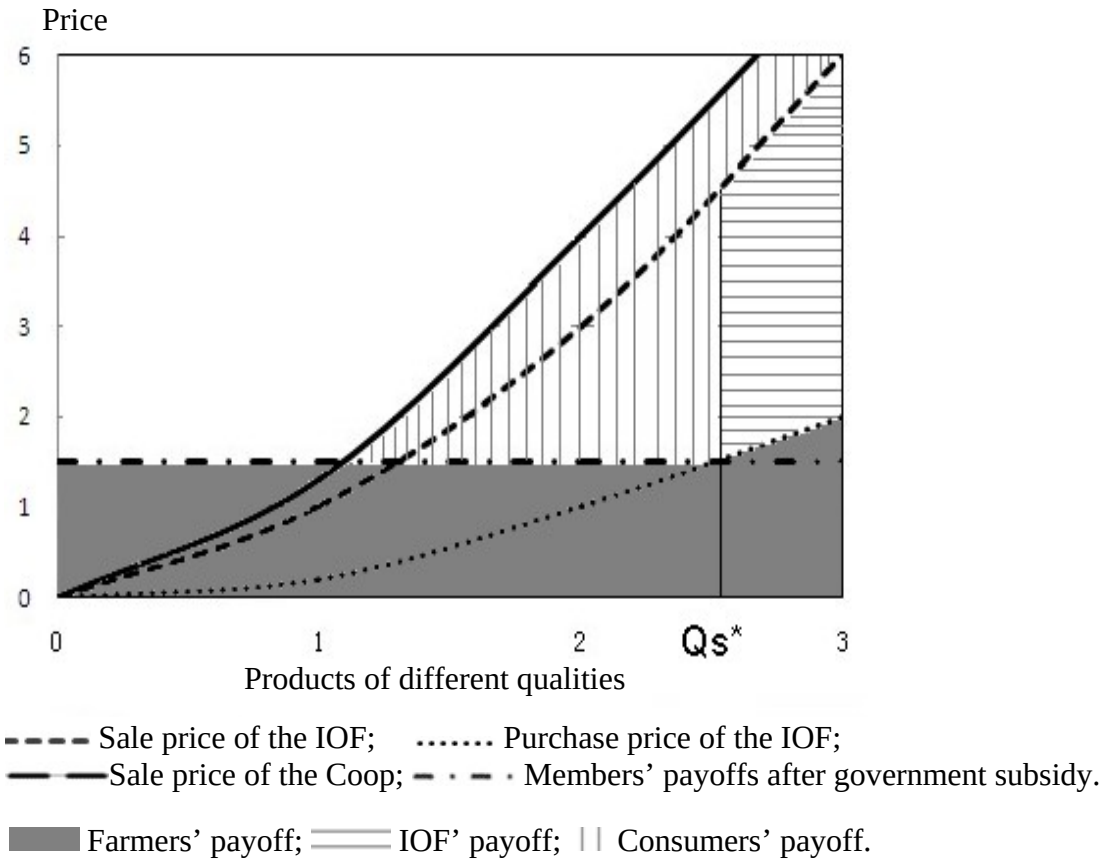
This section determines the sub-game equilibrium of the model (6.1) and formulates some propositions (6.2).

6.1 Equilibrium

Neither pure IOF market nor pure cooperative market is an equilibrium solution. In a pure IOF market, either one IOF drives the other out of the market or some farmers organize together to form a cooperative to enhance their revenue. A pure cooperative market is obviously inefficient in social welfare in that products are excessively produced and resources are not efficiently distributed.

Finally we get that there will be co-existence of both an IOF and a cooperatives in the food supply chain. Choices of farmers and consumers, pricing functions of the IOF and the cooperatives, and Surpluses are described in Figure 3. Farmers with higher product quality levels than Q_s^* will deliver to the IOF, while farmers with product quality levels lower than Q_s^* will deliver to the cooperative.

Figure 3: Choices and surpluses of food chain players



6.2 Propositions

Proposition 1. *Farmers producing low quality product tend to deliver to cooperatives whereas farmers producing high quality product would like to deliver to IOFs.*

The pooling function of a cooperative prevents farmers with high quality products from joining the cooperative because it under-value high quality products by pooling all the products with alternative qualities.

Proposition 2. *The presence of cooperatives in food market has a "yardstick effect" and farmers are better off compared with alternative market comprised of only IOFs.*

"Competitive yardstick effect" refers to the fact that the presence of cooperative forces investor-owned firms to offer higher procurement prices for farmers' products (SEXTON 1990; MILFORD 2004; NOVKOVIC 2008), which entails that IOFs prices products of

farmers higher in market where there is cooperatives than otherwise. The "yardstick effect" is proven by the competition results of our model, i.e. not only farmers delivering to the cooperative earn more in coop-IOF mixed market than in pure IOF market, but also farmers delivering to the IOF obtain higher prices under the existence of cooperatives.

Proposition 3. *The pooling function of cooperatives on the one hand can bring inefficiency to social welfare due to free-rider problem and on the other hand relieve market competition to a certain extent, compared with totally double markup economy.*

The uniform pricing policy can lead to value distortion of products in pricing because it prices products delivered to a cooperative with the same prices. Products of higher quality or higher value than the uniform price will be under-priced and free-rider problem tends to arise as well.

The presence of cooperatives in the market helps IOFs to escape from severe price competition due to that a cooperative prices only once for all the products which means an IOF can easily hold some market niche that the cooperative can not reach such as high quality product. When there is a two-IOF market, however, they compete equally for all market niches.

Proposition 4. *Cooperatives tend to have a bigger market share in areas where there are more subsidies for cooperatives.*

Governments of various levels (state level, provincial, city level, and town level) help to found cooperatives and subsidize cooperatives directly with goal to better off small farmers in China. This subsidy varies as districts. There are usually more subsidies in developed provinces where governments are rich, such as Zhejiang province who leads the way in the development of cooperatives. The additional subsidy promotes foundation of cooperatives and abstracts farmers with product prices in area $p_b^{2c} < p_{jb}^{1f} < p_b^{2c} + s$ to transfer from delivering to the IOF to joining the cooperative.

7 FURTHER RESEARCHES

There are some possibilities for further researches by relaxing some assumptions where our model is based. One is that cooperatives are supposed to have total pooling strategy on pricing and income distribution. It is implied that total or excessive pooling can bring inefficiency due to free-rider problem and/or ineffective resource distribution problem. What is the optimal pooling for cooperatives when farmers' surplus is considered and when social welfare is considered? The other is that if results of equilibrium will be different with relaxation of open-membership assumption, seeing restricted membership policy practically in a lot of cooperative.

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