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GATE Groupe d'Analyse et de Théorie Économique Lyon-St Étienne

93, chemin des Mouilles 69130 Ecully – France

Tel. +33 (0)4 72 86 60 60

Fax +33 (0)4 72 86 60 90

6, rue Basse des Rives 42023 Saint-Etienne cedex 02 – France

Tel. +33 (0)4 77 42 19 60

Fax. +33 (0)4 77 42 19 50

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Agricultural marketing cooperatives with direct selling: A cooperative non cooperative game*

Maxime Agbo^{†1}, Damien Rousselière^{‡2,3}, and Julien Salanié^{§4,5}

¹*African School of Economics, Abomey-Calavi, Benin*

²*AGROCAMPUS OUEST, Departement of Economics, Management and Society, Angers, France*

³*UMR GRANEM, Angers, France*

⁴*Université de Lyon, Lyon, F-69007, France ; CNRS, GATE Lyon Saint-Étienne, Écully, F-69130, France*

⁵*Université Jean Monnet, Saint-Étienne, F-42000, France*

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Abstract

We build a theoretical model to study a market structure of a marketing cooperative with direct selling, in which many farmers are members of an agricultural marketing cooperative. They can sell their production either to the cooperative or on an oligopolistic local market. We show that the decision to sell to the cooperative induces an anti-competitive effect on the direct selling market. The cooperative facilitates collusion on the local market by making farmers softer competitors on that market. Conversely, direct selling may create a "healthy emulation" among farmers, leading to more production benefiting the cooperative.

Keywords: marketing cooperative, direct selling, local market, competition.

JEL Classifications: D43; L11; Q13.

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[†]Corresponding author, Email: magbo@africanschoolofeconomics.com

[‡]Email: damien.rousseliere@agrocampus-ouest.fr

[§]Email: julien.salanie@univ-st-etienne.fr

1 Introduction

An agricultural marketing cooperative is an association of farmers who voluntarily cooperate to pool their production for sale. That pooled production is marketed and distributed through the cooperative which is owned and controlled by the farmers themselves. Around the world, farmers are increasingly encouraged to join marketing cooperatives, and cooperatives hold a significant market share in agricultural product distribution from farms to final consumers (Deller *et al.*, 2009). For example, according to a publication by the International Labour Office, more than 50% of global agricultural output is marketed through cooperatives in Finland, Italy, and the Netherlands (Tchami, 2007). In 2002, agricultural cooperatives accounted for 27% of U.S. total farm marketing expenditure (USDA, 2004). Marketing cooperatives comprise about 53% of all cooperatives and product distribution represents 64% of the net business volume of cooperatives in the U.S. (USDA, 2011). The rationale is that marketing cooperatives allow small farmers to get better or secure price by overcoming the "powerful" oligopsonist Investor-owned firms (IOFs) (Sexton, 1990; Bontems & Fulton, 2009). With marketing cooperatives, farmers have a much better position for price negotiation (Ladd, 1974; Cakir & Balagtas, 2012) and can have access to markets that they cannot access individually (Camanzi *et al.*, 2011). Cooperatives also enable farmers to face uncertainty about agricultural market prices (Jang & Klein, 2011).

However, some of producers prefer to sell a part (or all) of their production directly to end consumers (Brown & Miller, 2008; Timmons & Wang, 2010; Uematsu & Mishra, 2011; Low & Vogel, 2011; Fischer & Qaim, 2012). As reported by Timmons & Wang (2010), direct food sales from farmers to consumers in the U.S. increased by 59% from 1997 to 2007. In 2007, more than 21% of french producers were involved in direct selling.¹ Unlike cooperatives, and depending on the market conditions, with direct selling the farmer has control over sales prices and therefore obtain greater market power. This enables farmers to increase their profit margin (Uematsu & Mishra, 2011).²

In practice, many farmers combine direct selling and marketing through cooperatives. They sell part of their production to the cooperative and the rest is sold directly to the consumers. For example in France, 19.5% of apple producers, who are members of a cooperative, sell via the cooperative and at the same time directly on local markets. For pear producers however, this proportion falls to 15%.³ The combination of direct selling with marketing cooperative gives rise to a particular market structure. The farmers are playing a game in which they simultaneously cooperate and compete

¹Source: Census of Agriculture, French Department of Agriculture, 2007.

²According to Jang & Klein (2011), small farmers often sell their products directly to consumers for a greater price than wholesale.

³Source: Authors calculations based on the Orchard Survey, French Department of Agriculture, 2007.

against each other.

The purpose of this paper is to study that market structure generated by the sale of goods simultaneously through cooperatives and directly to consumers. Indeed, the framework of a marketing cooperative coupled with direct selling describes a specific environment and market structure. In many situations, farmers sell directly to consumers on local markets avoiding transaction costs (Timmons & Wang, 2010). On the local market, farmers make decisions independently which may lead to competition between them. Another point to consider is that the local market generally differs from the market where the cooperative operates.⁴ Therefore, for farmers, the market is composed of two parts. The first one is the market on which the marketing cooperative sells the volume of production proposed by farmers. On this market, farmers sell collectively and cooperatively. The second one is the direct selling local market where farmers are in oligopoly. The main goal of this paper is to analyze behaviors in this specific market structure where farmers are on the one hand in cooperation and in oligopolistic competition on the other. We study the interdependence between the two distribution channels.⁵

We build a model in which a marketing cooperative is owned by many farmers who produce a homogeneous good. They have the possibility to sell their production either to the cooperative or on a local market. The cooperative sells farmers' goods on a large competitive market where the price can not be bargained. In addition to the marketing cooperative, farmers have access to a local market where they can sell directly to consumers. We assume that the large competitive market and the local market are separated, and the local market is oligopolistic. The marketing cooperative does not control farmers' production decisions, but decides the price at which it buys the goods from the farmers. In turn, farmers decide on the production quantity and how to share this production between the local market and the cooperative.

Our analysis stresses two important results. First, we find that, under certain conditions, farmers sell the same quantity on the local market, even though they do not produce the same amount of product. Farmers behave as if they collude on the quantities destined for the local market, limiting competition, in order to get a higher price for their goods. Compared to the standard oligopolistic structure, the presence of the marketing cooperative allows farmers to reduce the amount of product sold on the local market, hence reducing competition on that market. Thus, the marketing cooperative

⁴For example in some developing countries, the quantity of cocoa, coffee, cotton, pineapple, among others marketed through cooperatives are exported. The rest of the production is sold directly by farmers to local processors, final consumers, etc.

⁵In previous literature, economists mostly focused on the case where the two possibilities are marketing cooperatives and IOFs. In that literature, marketing cooperatives compete against IOFs (Sexton, 1990; Tennbakk, 1995; Giannakas & Fulton, 2005). But in our case, the challenge for the cooperative is its own members.

plays an important role in protecting the small farmers of the local market. The collusive effect of the cooperative is due to the combination of two facts that characterize cooperatives. First, beside the local market, the cooperative is considered by farmers as another market opportunity for which they are price takers. The cooperative provides them with a secure fixed price contrary to the local market where they are price makers. Therefore, in order to get better price on the local market they reduce the local offer and sell the excess to the cooperative. Second, by proposing unique price to all the farmers and maximizing a profit that is uniformly shared, the cooperative attaches the same importance to the farmers, even though they are heterogeneous regarding their cost structures. Because farmers are equal on their most secured market (with no limited demand), this affects their behavior on the local market. Their standardized status inside the cooperative makes them use a standardized market power on the local market. In other words, through the unique price and the uniform profit sharing, the cooperative game played inside the cooperative has an effect on the non cooperative game played on the local market. If the cooperative behaves as an Investor-owned-firm by fixing for each farmer the price at his marginal cost the farmers would not sell the same quantity on the local market.

Second, we also find that, compared with a situation in which farmers do not have direct selling opportunity, farmers deliver more to the cooperative if the maximal possible price on local market is lower (but not too low) than the price on the large competitive market. Since direct selling is operated on oligopolistic market, it brings more competitive structure to the model. In other words, direct selling through the oligopolistic market creates a "healthy emulation", and incites farmers to produce more. The cooperative takes advantage from this production increase by causing collusion on the local market. Hence, direct selling is not necessarily harmful for cooperatives. This could help alleviate the concern of some cooperatives' managers who consider direct selling as a serious threat for their activities. In a context where membership and loyalty are threatened (USDA, 2002; Bond, 2006; Bijman & Verhees, 2011; Mujawamariya *et al.*, 2013), cooperatives increasingly question the pertinence of allowing their members to sell directly to consumers. Specifically, marketing cooperatives fear that they may not be able to sustain the stock required for their activity if members are engaged in direct selling. To avoid collapse, some cooperatives prevent their members from selling through other channels than the cooperative, or settle (with members) contracts which guarantee a minimum volume of delivery. For instance in France, all of the milk production from dairy cooperatives' members must go through the cooperative, while in the U.S. tobacco marketing cooperatives allow farmers to draw up contracts to distribute their production through other channels.⁶ So, our paper is a way to revisit the

⁶We can also mention the example of New Generation Cooperatives (Cook & Chaddad, 2004;

appropriateness of this cooperatives' managers concern.

This work also lies in the stream of literature about the multi-market oligopoly *à la* Bulow *et al.* (1985), where the shocks borne by a firm in one market can affect its competitors' strategies in a second oligopoly market. In our setup, if the price on the large competitive market increases, the cooperative increases the price it proposes to the farmer who delivers to it. That change in opportunities on the cooperative side makes the farmer increase his delivery amount and decrease his sales on the local market. This places him at a strategic disadvantage relative to the other local market competitors who, then, reoptimize.⁷ Our paper has also a similarity with that of Kawasaki *et al.* (2014) who considered a multimarket Cournot model where firms are engaged in research and development (R&D) investments. A multimarket firm operates on all the markets. The authors show that new entry on one of the markets by a competitor can enhance the total R&D expenditures of the multimarket firm. In our case, we find that the existence of the oligopoly local market may induce the farmer (who sells to the cooperative) to increase his production and his delivery to the cooperative. In other words, under some conditions, more there are actors on the local market more the farmers can sell to the cooperative.⁸

The rest of the paper is organized as follows. We present the model in Sections 2. Sections 3 and 4 analyze the interdependence between direct selling performance and marketing cooperative. In Section 5, we discuss the specific case where the marketing cooperative and farmers are operating on the same market. We conclude in Section 6.

2 The Model

In this section, we present our model which is the hybrid case of the marketing cooperative with direct selling. But before presenting the model, we introduce two benchmark models, which are the two extreme cases of *full marketing cooperative* where the farmers have to deliver their whole production to the cooperative, and of *full direct selling* where farmers are not members of a cooperative and sell their products themselves on a local market. These two benchmark models are used to study how the marketing cooperative with direct selling affects agents' behavior. We also derive the quantity produced by the farmers for each benchmark.

Holland & King, 2004).

⁷We thank an anonymous referee for drawing our attention to this explanation.

⁸Sorenson (2007) used another framework to show how multimarket facilitates collusion when there are reciprocal differences between firms. See Weisman (2003), Agarwal & Barua (2004), and Billand *et al.* (2010) for other works related to the issue of multimarket oligopoly.

2.1 Marketing cooperative with no direct selling: full marketing cooperative

Consider an agricultural marketing cooperative owned by $N \geq 2$ farmers. The farmers produce a homogeneous product and sell it to the cooperative at a unit price p_c . Farmer i decides and produces the good in quantity of q_i at a total cost of $C_i(q_i) = A_i q_i^2$, where A_i is a positive constant.⁹ In turn the cooperative sells the product on a large competitive market at a unit price P .¹⁰ Here, we abstract from any processing and distribution costs borne by the cooperative. We assume that the product delivered by farmers is sold by the cooperative without being processed (example of fruits and vegetable, eggs, . . . , as in Tennbakk (1995)). We also assume that the cooperative takes the price P as given, but decides on the price p_c to buy the product from the farmers.¹¹ We consider the cooperative does not price discriminate and proposes the same unit price to all members.¹² Therefore, the profit of the cooperative is

$$\pi_c = (P - p_c) \sum_{j=1}^N q_j \quad (1)$$

As owner of the cooperative, each farmer receives a percentage $b_c \leq \frac{1}{N}$ of the profit made by the cooperative (Karantininis & Zago, 2001).¹³ So, the total profit of the

⁹In other words, the cooperative's managers do not have control over farmers' output, as in Karantininis & Zago (2001), Albaek & Schultz (1998).

¹⁰Here, we implicitly assume that each farmer is non negligible inside the cooperative as he makes decision by taking into account the fact that his production affects the cooperative's profit. Therefore, for small farmers we need to consider relatively small cooperatives. We also consider the cooperative has access to a distant large competitive market. However, assuming that a small cooperative has access to a distant competitive market may seem controversial and deserves close attention. A way for a small cooperative to sell on a distant market is by means of federation or network of cooperatives. Examples are the Irish Dairy Board (Briscoe & Ward, 2006) and the inter-cooperation in the state of Panama (Ritossa & Bulgacov, 2009). Small cooperatives could also settle agreement with private firms (Vargas-Cetina, 2011) or lean on Non Governmental Organizations (Rampedi & Olivier, 2008) to export their products. Some other empirical works have also reported examples of french small cooperatives which export their commodities by themselves (Magrini *et al.*, 2013).

¹¹For models in which cooperatives are price-takers in their selling market, see Karantininis & Zago (2001), Albaek & Schultz (1997), Sexton (1990).

¹²In our case of homogeneous product, there is no reason to consider a price discriminating cooperative. For papers considering unique price for all farmers, see for example Albaek & Schultz (1997), Royer & Matthey (1999), Giannakas & Fulton (2005). However, a cooperative can price discriminate farmers if there are heterogenous products of different qualities (Hendrikse & Bijman, 2002; Pascucci *et al.*, 2012).

¹³Here, we assume that the farmers receive an equal part of the cooperative's profit, as done in Tennbakk (1995). We could consider that the profit is shared proportionally to the quantity delivered by the farmer. Specifically, farmer i receives a part $q_i / \sum q_j$ (like investment sharing in cooperatives, as in Albaek & Schultz (1997)). Therefore, the profit of farmer i is $u_i = p_c q_i - A_i q_i^2 + \mu \pi_c (q_i / \sum q_j) = p_c q_i - A_i q_i^2 + \mu (P - p_c) q_i$, where $0 < \mu < 1$ is the part of the profit the cooperative decides to share out. However, as it is easy to check, considering proportionally profit sharing would not change our results. We do a short discussion in footnote 15. See also Fatas *et al.* (2010) for other view on benefits sharing in cooperatives.

producer i is

$$u_i = p_c q_i - A_i q_i^2 + b_c \pi_c \quad (2)$$

The game is as follows. Given the market price P , the cooperative chooses the price p_c that maximizes its profit π_c . Each farmer i , leaning on p_c , choose the quantity q_i to produce and to sell to the cooperative, by maximizing his profit u_i .

Unlike an investor-owned firm (IOF), the cooperative's profit maximizing is also beneficial for the members, as a part of the profit is returned to them. Moreover, profit maximization by the cooperative does not necessarily consist of paying farmers a low price for goods. In order to encourage delivering, the cooperative has to decide on a reasonable price p_c . In other words, the problem of the cooperative is to choose a price p_c that insures its supplying, while maximizing the cooperation return to farmers. This consideration is similar to the seminal work by Helmberger & Hoos (1962).

The first-order condition of the farmer i yields

$$q_i = \frac{b_c P + (1 - b_c) p_c}{2A_i} \quad (3)$$

Using (3) the cooperative's problem becomes¹⁴

$$\max_{p_c} (P - p_c) (b_c P + (1 - b_c) p_c) \sum_{j=1}^N \frac{1}{2A_j} \quad (4)$$

Solving the problem in (4) gives the optimal price and quantity

$$\hat{p}_c = \frac{(1 - 2b_c)P}{2(1 - b_c)} \quad \text{and} \quad \hat{q}_i = \frac{P}{4A_i} \quad (5)$$

One could remark that the farmers' decision does not depend on b_c , the part of the profit received as owners. Actually, when making their production and delivering decision, the farmers are more interested in the price they will be paid, as this price relies on the large competitive price P . On the other hand, this result is also a consequence of the traditional agricultural cooperatives' characteristics, which is what makes them different from investor-owned firms (IOFs). There is a trade-off between the price p_c paid by the cooperative and the profit share b_c . Deriving the equilibrium price p_c in (5) yields $\frac{\partial \hat{p}_c}{\partial b_c} \leq 0$. Farmers are owners, controllers, and beneficiaries of the cooperative (Bijman

¹⁴We consider that the cooperative maximizes its profit as considered in Hoffmann (2005), Lopez & Spreen (1985), Royer & Matthey (1999), Hovelaque *et al.* (2009). Boyle (2004) found empirical evidences that cooperatives behave as if they are profit maximizers. However, some authors considered a members-welfare-maximizing cooperative (Giannakas & Fulton, 2005; Tennbakk, 1995; Sexton, 1986). Actually, as mentioned by Tennbakk (1995), there is no consensus regarding what cooperatives maximize. See Soboh *et al.* (2009) for more complete review on the objective functions of cooperatives.

et al., 2013). If for instance b_c decreases because of an increase of reserves, farmers (as beneficiaries) will benefit from that increase of reserves, even though they bear a loss as owners. If b_c decreases for other reasons, as controllers the members can increase p_c to compensate. In other words, the cooperative adjusts the price p_c to b_c . So, only market conditions and their production efficiency matter to farmers. Therefore, in order to succeed in preserving membership, agricultural cooperatives either need to reinforce their market power or help farmers improve their production efficiency. Another result worth mentioning is that, unlike Albaek & Schultz (1998), the individual production does not depend on the number of farmers. This is because the cooperative does not have market power and operates on a competitive market.

2.2 Direct selling without marketing cooperative: full direct selling

Consider N farmers ($N \geq 2$) producing a homogeneous agricultural good that they sell to final consumers on a local market.¹⁵ We assume that the local market is an oligopolistic one, where the consumers demand for the agricultural good is characterized by the inverse-demand function $P^o = \alpha - \beta Q^o$, Q^o being the total production of all the farmers. Farmer i chooses the quantity q_i^o to produce by maximizing his profit defined as

$$V_i^o = \left(\alpha - \beta \sum_{j=1}^N q_j^o \right) q_i^o - A_i (q_i^o)^2, \quad (6)$$

where $A_i (q_i^o)^2$ is the production cost of i . The oligopoly production of farmer i is given as

$$q_i^o = \frac{\alpha}{(\beta + 2A_i) \left(1 + \beta \sum_{j=1}^N \frac{1}{\beta + 2A_j} \right)}. \quad (7)$$

2.3 Marketing cooperative with direct selling: the hybrid case

Here, we still consider a marketing cooperative of N farmers. But in addition to their cooperative, the farmers can sell by themselves a part of their production directly on a local market (as in Jang & Klein (2011) among others). Each farmer i has to decide on the quantity q_i^c to sell to the cooperative, and the quantity q_i^l to sell on the local

¹⁵The definition of "local" is an ongoing debate in the literature (Hand & Martinez, 2010). In this paper, the market is local when farmers and consumers have access with negligible transaction costs (mostly transportation cost).

market.¹⁶ We assume that the local market is common for the N farmers, and is an oligopolistic market with Cournot competition. The demand function on the local market is

$$P^D = \alpha - \beta \sum_{j=1}^N q_j^l \quad (8)$$

where P^D is the price on the local market and $\alpha, \beta > 0$ are parameters. The cooperative buys the product from the farmers at the unit price P_c and sells it on a large competitive market (non local market) at a unit price P . We assume that the competitive market where the cooperative sells and the local market are separated.¹⁷ The profit of the cooperative is then

$$\Pi_c = (P - P_c) \sum_{j=1}^N q_j^c \quad (9)$$

As owner of the cooperative, each farmer earns a proportion b_c of the profit made by the cooperative.¹⁸ The total profit of the farmer i is¹⁹

$$V_i = P_c q_i^c - A_i (q_i^c + q_i^l)^2 + b_c \Pi_c + P^D q_i^l \quad (10)$$

¹⁶Albaek & Schultz (1997) argued that, in many cooperatives (particularly Danish cooperatives), the farmers decide individually on the amount of production to deliver to the cooperative. Also, Giannakas & Fulton (2005) pointed out the prevalence of open-membership cooperatives, and, according to (Petraglia & Rogers, 1999), open-membership implies the cooperative will serve as quantity-taker with respect to members' output.

¹⁷Implicitly, we consider that farmers will not decide to sell directly (i.e not through cooperative) on the non local market. This paradigm is realistic because of transaction costs. For farmers, selling on the non local market would create higher transaction costs than selling on the local market. Since one of the attributes of cooperatives is transaction costs reducing (Holloway *et al.*, 2000; Roy & Thorat, 2008; Markelova *et al.*, 2009; Fischer & Qaim, 2012), and farmers cannot influence the price P , it is reasonable to consider that they will prefer using the cooperative than selling directly on the non local market. We discuss in Section 5 the case where both the cooperative and the farmers operate on the local market.

¹⁸We could consider that the profit of the cooperative is shared accordingly to the quantity delivered by the farmer, and farmer i receives a share $q_i^c / \sum q_j^c$ of the profit. In that case, farmer i 's profit is $P_c q_i^c - A_i (q_i^c + q_i^l)^2 + b(P - P_c) q_i^c + P^D q_i^l$, where $0 < b < 1$ is the part of the profit the cooperative decides to share out. As we said before, proportionally profit distribution does not change our results. Indeed, even if the profit is proportionally shared, an increase of the quantity delivered by a given farmer is also profitable for the other farmers. So, proportionally profit sharing does not completely solve the free rider problem, and might not incite farmers to deliver more. This drawback of the proportionally profit sharing is highlighted by Ortmann & King (2007), regarding new members and existing members of the cooperative. On the other hand, the organizational structure of many cooperatives is changing, and the benefits sharing rules are becoming more hybrid and complex (Deller *et al.*, 2009; Bijman *et al.*, 2013).

¹⁹Our way to formalize the farmer's objective matches well with Bontems & Fulton (2009), among others papers. In Bontems & Fulton (2009), page 323, we can read: "*The farmers who own the cooperative, are interested in maximizing the returns from each of their own operations plus their share of the profits generated by the cooperative*".

The game consists in two steps. At the first step the cooperative chooses the price P_c that maximizes its profits Π_c . At the second step, basing on P_c , farmer j ($j = 1, \dots, N$) chooses the quantities q_j^c and q_j^l that maximize V_j .

2.4 Remark

Even though we consider the cooperative maximizes its profits, our results cannot be generalized to investor-owned-firms (IOFs). In other words, we cannot insure that our model remains valid beyond cooperation and direct selling environment. Indeed, IOFs will behave like a monopsonist and will decide on and control over the quantity to purchase from the farmers. Since farmers are price-takers, the IOF will pay them according to their supply, i.e, aggregated marginal cost (Karantininis & Zago, 2001). In contrast, the cooperative pays according to the conditions on the competitive market on which it sells the products delivered. If these conditions get better, the cooperative will pay more. This is not necessary true for the IOF who may still pay the same price, even if the price increases in the large competitive market. In this paper, unlike IOFs, the cooperative is considered as an association for which farmers are owners and controllers, so that farmers' production decision coincides with (or is close to) the cooperative's decision. An illustration of how our results are affected is provided in Section 3.2 where an introduction of capacity constraint changes some of our results.

3 The effect of the cooperative on local market transactions

In this section, we study how quantities sold and profits made by farmers on the local market are affected by the fact that they are members of a cooperative through which they can sell part of their production on a large competitive market (different from the local market). But before that, let us analyze briefly the choice of a farmer at the second step of the game, given the price decided by the cooperative at the first step.

3.1 Decision of the farmers given the cooperative's price: the second step of the game

For any additional unit of production, a given farmer i will decide to sell it either to the cooperative or on the local market. The farmer will make the decision by comparing the marginal revenues of the two markets he has at disposal (cooperative and local market). In other words, the farmer sells on the market with the higher marginal revenue, if that

marginal revenue is greater than the marginal cost. Therefore, the aggregate marginal revenue (for the whole market composed of cooperative and local market) is equal to the maximum of the marginal revenue from selling to the cooperative and the marginal revenue from selling on the local market. The total production of the farmer is found where the aggregate marginal revenue is equal to the marginal cost. This decision rule gives rise to three situations (cases): 1- the farmer i sells a positive quantity on each market ($q_i^l > 0$ and $q_i^c > 0$), 2- the farmer sells positive quantity on the local market and nothing to the cooperative ($q_i^l > 0$ and $q_i^c = 0$), or 3- the farmer sells positive quantity to the cooperative and nothing on local market ($q_i^l = 0$ and $q_i^c > 0$).

Case 1: the farmer sells a positive quantity on each market. Illustration is given in Figure 1.²⁰ It is the case where there is interior solution for the maximization of V_i given in (10). The first order conditions of farmer i are:

$$\text{For } q_i^c : \quad b_c P + (1 - b_c) P_c = 2A_i (q_i^c + q_i^l) \quad (11)$$

$$\text{For } q_i^l : \quad \alpha - \beta \sum_{j=1}^N q_j^l - \beta q_i^l = 2A_i (q_i^c + q_i^l) \quad (12)$$

The expression $b_c P + (1 - b_c) P_c$ is the marginal revenue of the farmer from selling to the cooperative R_{mi}^{coop} , and $\alpha - \beta \sum_{j=1}^N q_j^l - \beta q_i^l$ is the marginal revenue on the local market R_{mi}^{local} . The aggregate marginal revenue $R_{mi}^{aggregated}$ is displayed in Figure 1b. From (11) and (12) and as shown in Figure 1, the quantity sold on the local market is determined at the point where the curve of the marginal revenue from the cooperative meets the curve of the marginal revenue on the local market.

Case 2: the farmer sells positive quantity on the local market and nothing to the cooperative. Illustration is given in Figure 2. In this case the price proposed by the cooperative is not attracting for the farmer. Selling on the local market is highly beneficial. The aggregate marginal revenue meets the marginal cost curve at a point where the farmer produces only for the local market.

Case 3: the farmer sells positive quantity to the cooperative and nothing on the local market. Illustration is given in Figure 3. The marginal revenue from the cooperative is always higher than the local market marginal revenue. The aggregate marginal revenue curve is the curve of the marginal revenue from the cooperative. The farmer produces only for the cooperative.

²⁰We thank Murray Fulton for proposing us this nice way to illustrate the second step of the game.

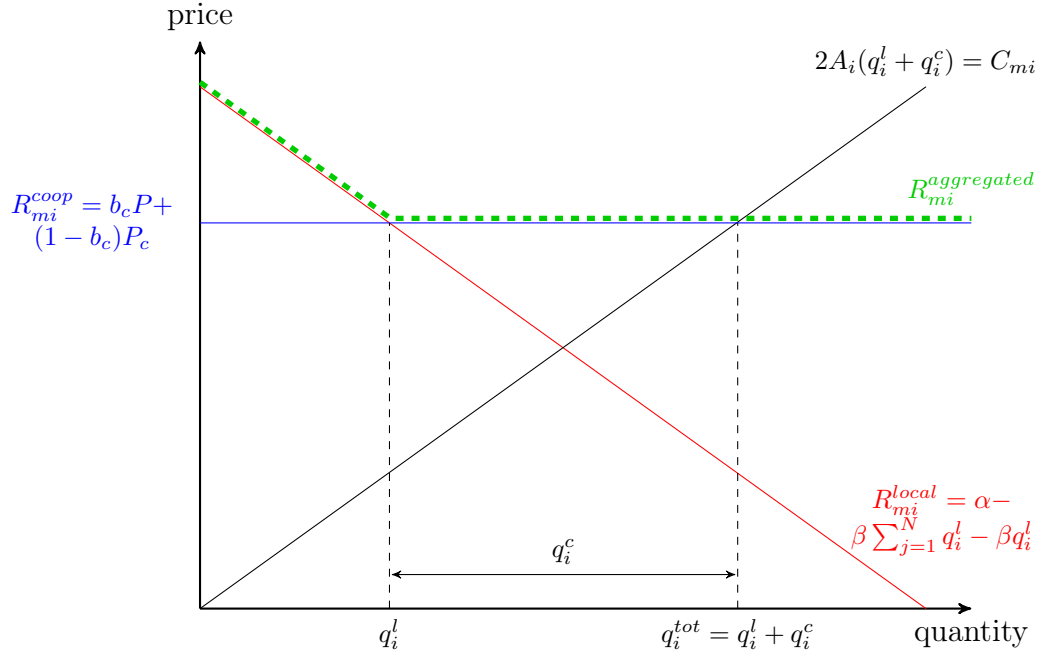


Figure 1: The farmer sells to the cooperative and on the local market (Case 1)

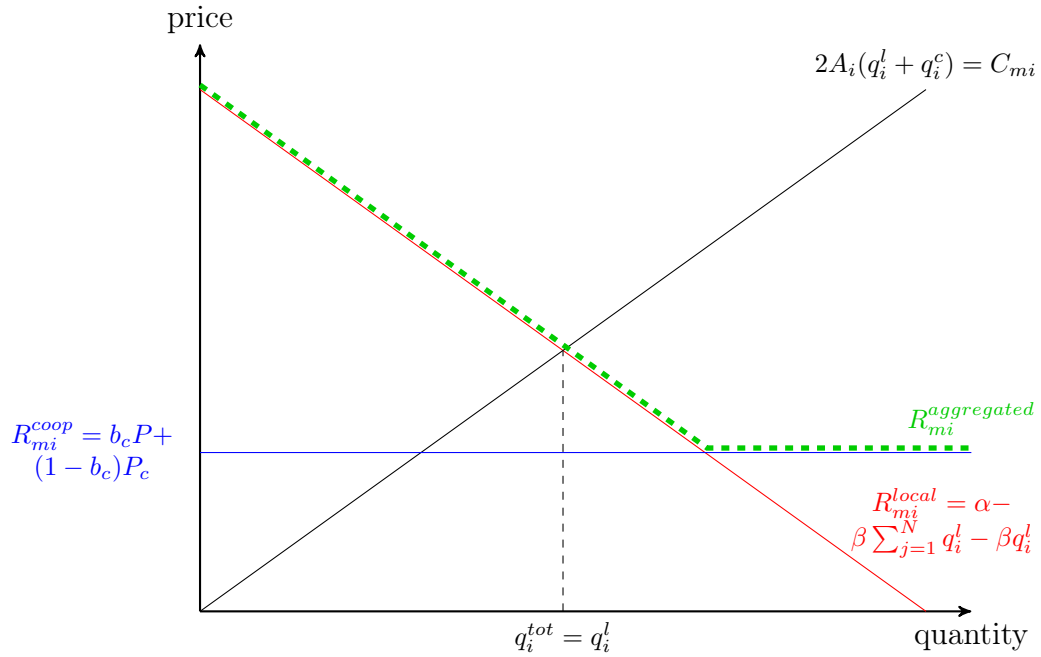


Figure 2: The farmer sells all the production on local market (Case 2).

3.2 Farmers' behaviour on the local market

The following proposition states that the farmers who have the opportunity to deliver to the cooperative sells the same quantity of goods on the local market.

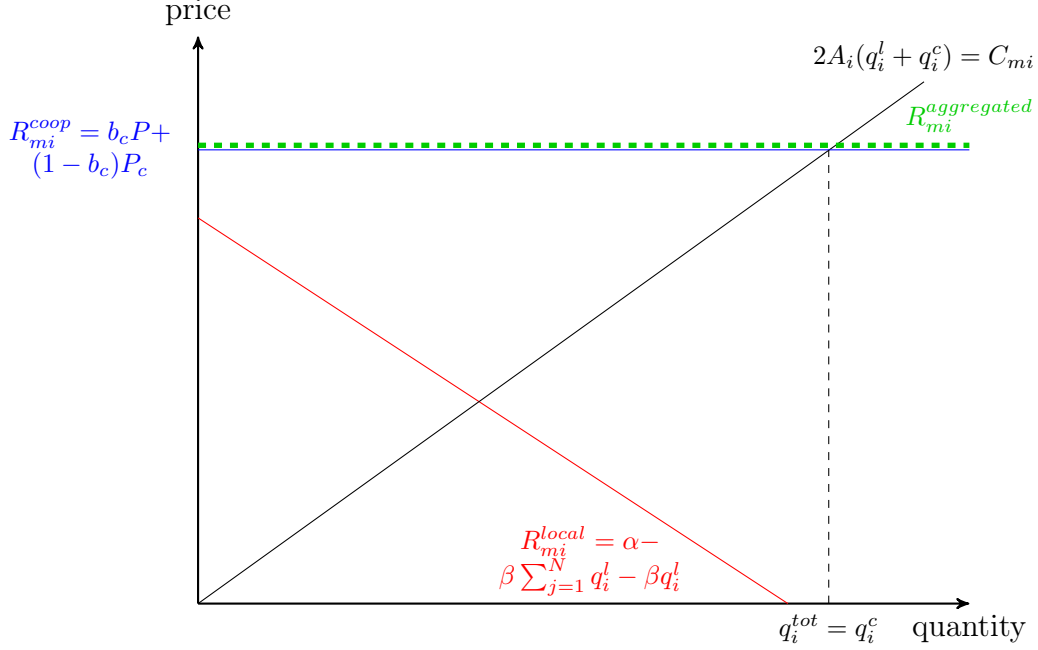


Figure 3: The farmer sells all the production to the cooperative (Case 3).

Proposition 3.1. *Even if they do not produce the same total quantity, all the farmers who deliver a positive quantity to the cooperative sell the same quantity on the local market, i.e, if it exists a subset $I \subset \{1, \dots, N\}$ such that $q_j^c > 0$ for any $j \in I$, then $q_k^l = q_m^l$ for any $(k, m) \in I$.*

Proof. See Appendix A. □

Proposition 3.1 is an implication of the mechanism described in Figures 1 and 3. A farmer sells on the local market at the point where the marginal revenue from the cooperative meets the marginal revenue from the local market. Because the cooperative gives equal opportunity to the farmers through the price P_c and the profit sharing, this intersection point is the same for all the farmers.

From Figures 1-3 and Proposition 3.1, one can realize that the farmers who sell to the cooperative standardize their actions on the local market, and reduce their sales on the local market in comparison with what they would do if they were not delivering to the cooperative. In other words, the cooperative allows the farmers to engage in a sort of tacit collusion.²¹ This farmers' behavior is induced by the combination of two facts that characterize the cooperative. First, beside the local market, the cooperative

²¹Suetens (2008) studied how cooperation on one activity facilitates collusion on the other activity of firms. But the context is different from ours. Suetens (2008) is an experimental laboratory work that shows that R-D cooperation (formation of research joint ventures) facilitates price collusion. Each firm makes two types of decision: R-D decision and price decision (the price of goods the firm sells on the product market). The author found that if the firms cooperate in their R-D decisions they collude in price on the product market.

is considered by farmers as another market opportunity for which they are price takers. The cooperative provides them with a secure fixed price contrary to the local market where they are price makers. Therefore, in order to get better price on the local market they reduce the local offer and sell the excess to the cooperative. Second, by proposing unique price to all the farmers and maximizing a profit that is uniformly shared, the cooperative attaches the same importance to the farmers, even though they are heterogeneous regarding their cost structures. Because farmers feel equal on their most secure market (with no limited demand), this feeling affects their behavior on the local market. Their standardized status inside the cooperative make them use a standardized market power on the local market. In other words, Through the unique price and the uniform profit sharing, the cooperative game played inside the cooperative has an effect on the non cooperative game played on the local market. If the cooperative behaves as an Investor-owned-firm by fixing for each farmer the price at his marginal cost the farmers would not sell the same quantity on the local market.

Proposition 3.1 does not holds if the cooperative has a capacity constraint and cannot accept all the production the farmers would like to deliver.²² Let us give an illustration. Consider for simplicity that all the farmers would like to sell a positive quantity to the cooperative (case 1). Suppose that the cooperative is subject to a capacity constraint and cannot buy from the farmers more than \bar{K} amount of production. We assume that \bar{K} is exogenous. So, the problem of a farmer i is

$$\begin{aligned} \max_{q_i^c, q_i^l} & \left\{ V_i = P_c q_i^c - A_i (q_i^c + q_i^l)^2 + b_c (P - P_c) \sum_{j=1}^N q_j^c + q_i^l \left(\alpha - \beta \sum_{j=1}^N q_j^l \right) \right\} \\ \text{subject to} & \quad \sum_{j=1}^N q_j^c \leq \bar{K} \end{aligned} \quad (13)$$

The first order conditions with respect to q_i^c and q_i^l are:

$$b_c P + (1 - b_c) P_c = 2A_i (q_i^c + q_i^l) - \lambda_i \quad (14)$$

$$\alpha - \beta \sum_{j=1}^N q_j^l - \beta q_i^l = 2A_i (q_i^c + q_i^l) \quad (15)$$

where $\lambda_i \geq 0$ is the Lagrange multiplier corresponding to the capacity constraint for the problem in equation (13). Considering the first-order conditions for each producer,

²²In this paper, we assume that the cooperative accepts to purchase the entire quantity of products the farmers decide to sell. However, sometimes, the cooperative is subject to a capacity constraint (defective storage facilities, governmental quotas, etc.) and cannot buy the whole volume for sale. The capacity constraint \bar{K} is exogenous and known by the cooperative members. For example, it is the case of harvesters cooperatives who manage collective fishing quotas (Deacon, 2012).

we have

$$q_1^l - \frac{\lambda_1}{\beta} = q_2^l - \frac{\lambda_2}{\beta} = \dots = q_N^l - \frac{\lambda_N}{\beta} \quad (16)$$

If the constraint is not bounded, $\lambda_1 = \lambda_2 = \dots = \lambda_N$ and the farmers sell equal quantity on local market. If the constraint is bounded ($\sum_{j=1}^N q_j^c \leq \bar{K}$), the λ 's are not all equal. λ_i is the shadow price of the cooperative's capacity for farmer i . An increase of the capacity are more beneficial for the more efficient farmers (lower A_i) than the less efficient ones. The most efficient farmers are more inclined to deliver to the cooperative. Therefore, even though the cooperative attaches equal importance to the farmers (through the unique price and the profit sharing rule), they do not bear the cost of the capacity constraint in the same way. So, the net marginal revenue from the cooperative (the marginal revenue minus the capacity constraint cost) is not the same for all the farmers. As a consequence, the farmers will not necessary sell equal quantity on the local market. In other words, the cooperatives of higher capacity are more inclined to induce collusion on the local market. Let us mention that capacity constraint does not eliminate completely collusion but limits it.

We have seen that the farmers who deliver to the cooperative (cases 1 and 3) reduce their sales on the local market, in comparison with what happens if they are selling only on the local market. However, for a given price P_c set by the cooperative, some of the farmers could sell only on the local market (case 2). Actually, when the farmers who sell a positive amount to the cooperative decrease their local sales, those who sell only on the local market increase their local sales. Precisely, they do not participate to the collusion in which are involved the farmers who deliver to the cooperative. Therefore, we are now interested in the effect of the cooperative on the total amount of products sold on local market. Specifically, we are going to compare the local sales amount in *full direct selling* (oligopolistic market) to the amount of local sales in *marketing cooperative with direct selling*. The following proposition gives a result.

Proposition 3.2. *The total quantity sold on the local market is always lower in a marketing cooperative with direct selling than in full direct selling, i.e. $\sum_{j=1}^N q_j^l \leq \sum_{j=1}^N q_j^o$.*

Proposition 3.2 states that the increase in local sales by the farmers who sell only on the local market is lower than the decrease in local sales of the farmers who sell to the cooperative. Let us give a simple illustration with two farmers. Consider a game of two farmers 1 and 2 with $A_1 < A_2$. Suppose at the first step that all the two farmers sell only on the local market. Their best response functions are

$$q_1^l = \frac{\alpha}{2\beta + 2A_1} - \frac{\beta}{2\beta + 2A_1} q_2^l \quad \text{and} \quad q_2^l = \frac{\alpha}{2\beta + 2A_2} - \frac{\beta}{2\beta + 2A_2} q_1^l \quad (17)$$

Suppose now that the price proposed by the cooperative incites the farmer 1 to sell to the cooperative ($q_1^c > 0$), but not the farmer 2. In that case the best response functions are

$$q_1^l = \frac{\alpha}{2\beta + 2A_1} - \frac{\beta}{2\beta + 2A_1}q_2^l - \frac{2A_1q_1^c}{2\beta + 2A_1} \quad \text{and} \quad q_2^l = \frac{\alpha}{2\beta + 2A_2} - \frac{\beta}{2\beta + 2A_2}q_1^l \quad (18)$$

So, and as shown in Figure 4, further to the participation to the cooperative the farmer 1's best response moves to (Δ) .²³ As a consequence, the quantities sold on the local market change and the equilibrium moves from A to B . We can see on the figure that the decrease in farmer 1's local sales is higher than the increase in farmer 2 local sales. Analytically, using (7) and (18), we can find that q_1^l decreases by $\frac{2A_1q_1^c\left(1+\frac{\beta}{\beta+2A_2}\right)}{(\beta+2A_1)\left(1+\frac{\beta}{\beta+2A_1}\frac{\beta}{\beta+2A_2}\right)}$

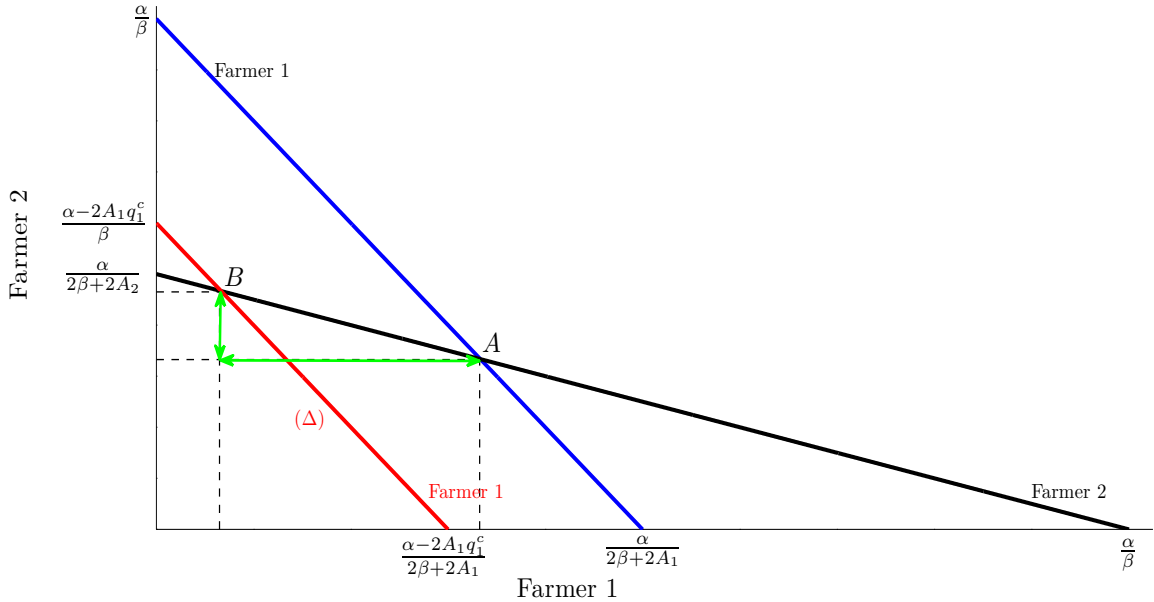


Figure 4: Best responses functions on local market.

while q_2^l increases by $\frac{2A_1q_1^c\left(\frac{\beta}{\beta+2A_1}\right)}{(\beta+2A_2)\left(1+\frac{\beta}{\beta+2A_1}\frac{\beta}{\beta+2A_2}\right)}$. Therefore, the total sales amount on the local market decreases by $\frac{2A_1q_1^c}{(\beta+2A_1)\left(1+\frac{\beta}{\beta+2A_1}\frac{\beta}{\beta+2A_2}\right)}$.

Even though the farmers who are selling only on the local market do not participate to the collusion, they do their best to take advantage of it. Indeed, they increase their local sales but not sufficiently to compensate for the decrease in the local sales made by the farmers who sell to the cooperative. This allows them to sell more at a better

²³In general, the reaction function on the local market for farmer i can be written as $q_i^l = \left(\alpha - 2A_iq_i^c - \beta \sum_{j \neq i} q_j^l\right) / (2A_i + 2\beta)$, which is clearly inward shifted when the quantity that the farmer allocates to the cooperative, q_i^c , increases.

price and to make more profit. Let us remind that, for a given price P_c , the farmers who are more likely to sell only on the local market are the less efficient ones (higher A_i). So, the existence of the cooperative "protects" the smaller (less efficient) farmers on the local market because it helps reduce the competition power of the more efficient farmers. With that "protection", the less efficient farmers have less incentive to operate in both markets. They stick to the local one which benefits them. In fact, this comes from the fact that the farmer who increases his sales to the cooperative become less aggressive on the local market. In other words, selling to the cooperative makes the farmer a softer competitor on the local market.²⁴ As a consequence, he has a strategic disadvantage relative to his local market competitors who get benefit from that strategic disadvantage.

As conclusion, the cooperative has an anti-competitive effect because it is a source of output reduction on the local market. This result contradicts that of some previous work in the literature. Indeed, many authors made the case for the pro-competition effect of the cooperative (Petraglia & Rogers, 1999; Deller *et al.*, 2009; Nourse, 1922; Tennbakk, 1995; Bontems & Fulton, 2009; Giannakas & Fulton, 2005).²⁵ Specifically, there is a pro-competitive effect in the case where the cooperative does not have control over farmers' production decisions. If the cooperative can restrict the farms' production then it might reduce output (Youde, 1978; Sexton & Iskow, 1988; Sexton, 1990). However, in our model, the cooperative does not have control over farmers' production, and yet, it might reduce local market output due to reasons we advanced before. In fact, what we know from the literature is that a cooperative induces a competition effect when challenging an IOF. But little research has been carried out concerning the situation of marketing cooperatives challenging their own members who operate on an oligopolistic local market.

4 Direct selling and delivery to the cooperative

In this section, we examine the effect of the introduction of direct selling on the quantities delivered by farmers to their cooperative. Indeed, there are some concerns about whether the cooperative should allow or not its members to sell their production by themselves directly to the consumers. The legitimacy of these concerns lies in the fact that the marketing cooperative that allows its members to sell directly on a local market is likely to experience supply shortage. However, we show that allowing direct selling might be beneficial for the cooperative. But before going this way, let us determine the price set by the cooperative.

²⁴We thank an anonymous referee for providing us with the term *soft competition*.

²⁵Sexton (1990) used the term "yardstick of competition".

4.1 The unique price of the cooperative: the first step of the game

Given the market conditions (parameters of the model), the farmers decide on quantities to produce for each market by leaning on the price P_c set by the cooperative. Knowing that behavior governing the choice of the farmers, the cooperative managers choose the price in a way to incite them to deliver large quantities to the cooperative. However, their choice is restricted by P , the price at which the cooperative sells the products on the large competitive market. Any conceivable choice could not consist in paying the farmers more than what the cooperative earns on the large competitive market. In other words, P_c is chosen to attract a higher possible number of farmers while taking into account the price P . Proposition 4.1 gives a formal result.

Proposition 4.1. *Consider N farmers indexed by $j = 1, 2, \dots, N$ such that $A_1 < A_2 < \dots < A_N$. The optimal price at which the cooperative buys the product from the farmers is*

- If $\alpha \leq \frac{P}{2}$ then $P_c = \frac{(1-2b_c)P}{2(1-b_c)}$
- If $\alpha > \frac{P}{2}$ then

$$P_c = \frac{\frac{K\alpha}{\beta(K+1+\beta \sum_{m=K+1}^N \frac{1}{2A_m+\beta})}}{2(1-b_c) \left(K \cdot \frac{1+\beta \sum_{m=K+1}^N \frac{1}{2A_m+\beta}}{\beta(K+1+\beta \sum_{m=K+1}^N \frac{1}{2A_m+\beta})} + \sum_{j=1}^K \frac{1}{2A_j} \right)} + \frac{(1-2b_c)P}{2(1-b_c)} \quad (19)$$

where K is the number of farmers who deliver a positive quantity to the cooperative at the price P_c . Specifically $K \in \{1, \dots, N\}$ and $K = \min \Lambda$,

where Λ is a set of $k \in \{1, \dots, N\}$ such that

$$(b_c P + (1-b_c)P_c) \left[2A_{k+1} \cdot k - (2A_{k+1} + \beta) \left(k + 1 + \beta \sum_{m=k+1}^N \frac{1}{2A_m + \beta} \right) \right] > -2\alpha A_{k+1}. \quad (20)$$

If Λ is an empty set then $K = N$.

Proof. See Appendix B. □

If the local market exists but is not interesting (α too low in comparison with P) the cooperative chooses its price equal to that of the *full marketing cooperative*. The cooperative does not need to make more effort to attract all the farmers. However if the local market is a bit interesting and could attract some farmers, the delivery price chosen by the cooperative is always higher in the framework of *marketing cooperative*

with direct selling (eq. 19) than in full marketing cooperative (eq. 5). To incite farmers to deliver their products, the cooperative has to challenge the local market, and this challenge becomes more serious as the conditions on the local market (α and β) allow farmers to get higher local price P^D . On the other hand, unlike the full marketing cooperative, the price proposed by the cooperative does not necessarily decrease with b_c , the part of the cooperative's profit earned by each farmer. Here, the result depends on the characteristics of the local market and the large competitive market as well, i.e the challenge the cooperative has to face due to the existence of the local market. If the challenge is not "serious" enough (α not too much higher than P), then the cooperative has much leeway to adjust downward (decrease) its price P_c to an increase of b_c . On the contrary, if the challenge is too serious, to incite farmers to deliver, the cooperative has to increase the price P_c . Increasing P_c decreases the profit of the cooperative and limits the free riding problem caused by the uniform profit sharing.

The number $K + 1$ represents the most efficient farmer who prefers not to sell to the cooperative. Condition (20) is found by posing $2A_{K+1}q_{K+1}^l > b_c P + (1 - b_c)P_c$ (see Figure 2 for understanding). For example, if $P = 0$ then $K = 0$, $P_c = 0$ and nobody delivers to the cooperative. We can see that K is increasing in P . So, the cooperatives that have the capacity to find a market where the product is valuable are likely to cause collusion on the local market. Higher the number K more intensified the collusion on the local market.

4.2 The effect of direct selling on the volume delivered to the cooperative

We now compare the total amount of production delivered to the cooperative in full marketing cooperative to that of marketing cooperative with direct selling. In other words, we see if the existence of the local market could benefit the cooperative in term of volume delivered. We give an illustration with Figure 5. Consider that the local market conditions change and the parameter α increases. The marginal revenue from selling on local market moves from R_{m2}^{local} to R_{m1}^{local} . As we have seen above, further to the increase of α the cooperative increases its price P_c to challenge the local market. Therefore the marginal revenue from delivering to the cooperative move from R_{m2}^{coop} to R_{m1}^{coop} . As a consequence, the quantity delivered changes. As we can from the figure, the length of the segment CD might be higher than that of the segment AB , showing that the farmer's delivery increases with the parameter α . Proposition 4.2 gives a formal result.

Proposition 4.2. *We denote by \hat{q}_j the delivery of the farmer j to the cooperative in full marketing cooperative. q_j^c denotes the delivery of j in marketing cooperative with*

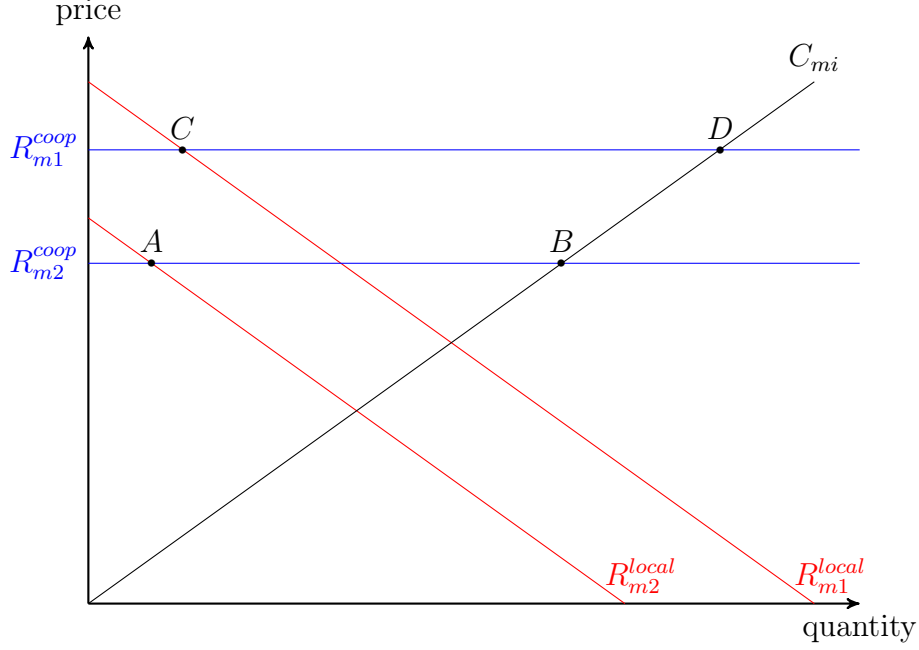


Figure 5: The local market conditions and delivery to the cooperative

direct selling.

$$\text{If } \frac{P}{2} < \alpha < P \quad \text{then} \quad \sum_{j=1}^N q_j^c > \sum_{j=1}^N \hat{q}_j.$$

Proof. See Appendix C. □

Proposition 4.2 states that, if the maximum price farmers get on the local market is lower than the price the cooperative gets on the large competitive market (but not too low), then the farmers will sell more to the cooperative in *marketing cooperative with direct selling* than in *full marketing cooperative*. Indeed, introducing direct selling brings two modifications to the initial *full marketing cooperative*. First, in addition to the cooperative, farmers have access to another market which is interesting because α is not too low. In other words, they have more opportunity to sell their product. Second, direct selling adds an oligopoly structure to the initial cooperation environment. With oligopoly structure, farmers compete with each other more than in cooperation. These two modifications incite farmers to produce more. If the price P is high enough, the cooperative can cause collusion on the local market by increasing P_c and takes advantage of that increase of production. In other words, direct selling may create a *healthy emulation* that could be beneficial for the cooperative. In contrast, if the demand on the local market is promising or the price P is too restrictive the cooperative will be worse off. Therefore, the decision of whether a cooperative should allow direct selling depends on the characteristics of the local market, regarding the price of the large competitive market.

As conclusion, the cooperative has an anti-competitive effect on the local market. In turn the local market brings more competitive structure and could lead to a raise in production. The cooperative game structure brings by the cooperative is of sort alleviated by the non cooperative game of the local market, and vis versa.

5 Discussion: The case where cooperative and members operate on the same local market

Up to now, we have considered that the direct selling market and the market where the cooperative sells are separate in the sense that farmers do not sell directly on the large competitive market, and the cooperative does not operate on the local market. Due to transaction costs, it is reasonable to assume that farmers will not decide to sell on the large competitive market. In contrast, the marketing cooperative can decide to sell on the local market at the same time. In this section, we study what happens if farmers and the cooperative decide to be present on the local market.

Indeed, the farmer i 's total profit is $V_i^L = P_c q_i^c - A_i(q_i^c + q_i^l)^2 + b_c \Pi_c + P^D q_i^l$ where $\Pi_c = (P^D - P_c) \sum_{j=1}^N q_j^c$ and $P^D = \alpha - \beta \left(\sum_{j=1}^N (q_j^c + q_j^l) \right)$. The first order conditions are

$$\text{For } q_i^c : \quad P_c - 2A_i (q_i^c + q_i^l) - b_c \beta \sum_{j=1}^N q_j^c + b_c (P^D - P_c) - \beta q_i^l = 0 \quad (21)$$

$$\text{For } q_i^l : \quad -2A_i (q_i^c + q_i^l) - b_c \beta \sum_{j=1}^N q_j^c + P^D - \beta q_i^l = 0 \quad (22)$$

Using (21) and (22), we find that $P_c = P^D$. Therefore the farmer's profit is $P^D (q_i^c + q_i^l) - A_i(q_i^c + q_i^l)^2$. It turns out that the farmer does not care about the quantities sold directly or through the cooperative. He is rather interested in the total quantity sold. This total quantity is exactly the oligopolistic one we found in Equation (7). As a consequence there is no collusion.

6 Concluding Remarks

In this paper, we base on the market structure of a marketing cooperative with direct selling to investigate a game in which players simultaneously cooperate and compete against each other. Here, many farmers are organized in cooperatives, can sell both to the cooperative and directly to end consumers on a local market. Using a theoretical model, we show that direct selling and marketing through a cooperative might be beneficial for each other. Indeed, the cooperative, by proposing a unique price and

uniform profit sharing, allows farmers to collude on the local market making them softer competitors on that market. When a farmer increases the quantity he sells to the cooperative he becomes less aggressive (decreases his sales) on the local market. Thus, the cooperative can have an anti-competitive effect on the direct selling market and benefit farmers. Conversely, the direct selling characterized by an oligopolistic structure can create a *healthy emulation* and incite farmers to increase production that benefit the cooperative.

The contribution of this paper is twofold. First, it is an attempt to build a theoretical framework of a marketing cooperative coupled with direct selling. To our knowledge, this is among the first theoretical work about direct selling and cooperatives. Jang & Klein (2011) also considered a framework in which farmers simultaneously sell to marketing cooperatives and on local markets. But in Jang & Klein (2011), prices and demand are given. Farmers only decide on how to share production between the two parts. Second, this paper contributes to analyze how a cooperative game can affect non cooperative game outcome, and vice versa.

There are several ways to extend our paper. We have considered that farmers produce a homogeneous unique good. We have also abstracted from the possibility for farmers to sell to IOFs. However, in many cases, they produce more than one good, and decide on which one to sell to the cooperative, through direct selling, or to IOFs. Moreover, cooperatives can demand a minimum volume (fixed volume or percentage of production) from its members. A minimum supply might mitigate the anti-competitive effect we mention in this paper. Finally, it might be interesting to go over the standard oligopolistic setup we consider for the local market, as it is well known that direct selling could involve spatial competition.

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A Proof of Proposition 3.1

Consider any farmer i . His problem is

$$\max_{q_i^c, q_i^l} \left\{ V_i = P_c q_i^c - A_i (q_i^c + q_i^l)^2 + b_c (P - P_c) \sum_{j=1}^N q_j^c + q_i^l \left(\alpha - \beta \sum_{j=1}^N q_j^l \right) \right\}. \quad (23)$$

Let's assume that $q_i^c > 0$. We have two cases: either $q_i^l = 0$ or $q_i^l > 0$. Suppose that $q_i^l = 0$. $q_i^l = 0$ if and only if $\alpha < b_c P + (1 - b_c) P_c$ (the marginal revenue from the cooperative is always higher than the local market marginal revenue). This condition is also met for the other farmers. So $q_j^l = 0 = q_i^l$ for any j . Suppose now that $q_i^l > 0$. The first order conditions for (23) are

$$\text{For } q_i^c: \quad b_c P + (1 - b_c) P_c = 2A_i (q_i^c + q_i^l) \quad (24)$$

$$\text{For } q_i^l: \quad \alpha - \beta \sum_{j=1}^N q_j^l - \beta q_i^l = 2A_i (q_i^c + q_i^l) \quad (25)$$

From (24) and (25) we have

$$\beta q_i^l = \alpha - b_c P - (1 - b_c) P_c - \beta \sum_{j=1}^N q_j^l \quad (26)$$

If $q_i^l > 0$ then $q_j^l > 0$ for any j . Therefore condition (26) holds for any farmer j for whom $q_j^c > 0$. So $q_i^l = q_j^l$.

B Proof of Proposition 4.1

Without loss of generality, we assume that $A_1 < A_2 < \dots < A_N$.

The cooperative maximizes its profit $\Pi_c = (P - P_c) \sum_{j=1}^N q_j^c$. Let us suppose that, given the price chosen by the cooperative, K farmers accept to deliver positive quantity to the cooperative. We then have $\Pi_c = (P - P_c) \sum_{j=1}^K q_j^c = (P - P_c) \sum_{j=1}^K (q_j - q_j^l)$, where q_j is the total production of farmer j .

We know that if $q_i^l = 0$ for any farmer i then $q_j^l = 0$ for any other farmer $j = 1, \dots, N$. In that case $q_j = \frac{b_c P + (1 - b_c) P_c}{2A_j}$ for all $j = 1, \dots, N$. The local market is not interesting and $K = N$. The price is equal to the price of *full marketing cooperative*, i.e.

$$P_c = \frac{(1 - 2b_c)P}{2(1 - b_c)}. \quad (27)$$

Having $q_j^l = 0$ for all farmers $j = 1, \dots, N$ requires the condition $\alpha \leq b_c P + (1 - b_c) P_c$, i.e. $\alpha \leq \frac{P}{2}$.

Suppose now that $q_j^l \neq 0$ for all $j = 1, \dots, N$. For the farmers $1, 2, \dots, K$ who sell positive quantity to the cooperative we have $q_1^l = q_2^l = \dots = q_N^l = \bar{q}^l$. For any farmer i who does not sell to the cooperative we have

$$\alpha - \beta K \bar{q}^l - \beta \sum_{j=K+1}^N q_j^l - \beta q_i^l = 2A_i q_i^l. \quad (28)$$

So the $N - K$ farmers $j = K + 1, K + 2, \dots, N$ who do not deliver to the cooperative satisfy

$$(2A_{K+1} + \beta)q_{K+1}^l = (2A_{K+2} + \beta)q_{K+2}^l = \dots = (2A_N + \beta)q_N^l. \quad (29)$$

$$\text{So for } j = K + 1, \dots, N, q_j^l = \frac{2A_{K+1} + \beta}{2A_j + \beta} q_{K+1}^l. \quad (30)$$

(28) and (30) yield $\alpha - \beta K \bar{q}^l - \beta \sum_{j=K+1}^N \frac{2A_{K+1} + \beta}{2A_j + \beta} q_{K+1}^l - (2A_{K+1} + \beta)q_{K+1}^l = 0$, i.e.,

$$\alpha - \beta K \bar{q}^l - (2A_{K+1} + \beta)q_{K+1}^l \left(1 + \beta \sum_{j=K+1}^N \frac{1}{2A_j + \beta} \right) = 0. \quad (31)$$

For the farmers who sell positive quantity to the cooperative the local sale is determined by

$$\begin{aligned} \alpha - \beta K \bar{q}^l - \beta \bar{q}^l - \beta \sum_{j=K+1}^N q_j^l &= b_c P + (1 - b_c) P_c \\ \alpha - \beta(K + 1)\bar{q}^l - \beta \sum_{j=K+1}^N \frac{2A_{K+1} + \beta}{2A_j + \beta} q_{K+1}^l &= b_c P + (1 - b_c) P_c \\ \alpha - \beta(K + 1)\bar{q}^l - \beta(2A_{K+1} + \beta)q_{K+1}^l \left(\sum_{j=K+1}^N \frac{1}{2A_j + \beta} \right) &= b_c P + (1 - b_c) P_c. \end{aligned} \quad (32)$$

(32) - (31) yields

$$\begin{aligned} -\beta \bar{q}^l + (2A_{K+1} + \beta)q_{K+1}^l &= b_c P + (1 - b_c) P_c \quad \text{i.e.,} \\ q_{K+1}^l &= \frac{b_c P + (1 - b_c) P_c + \beta \bar{q}^l}{2A_{K+1} + \beta}. \end{aligned} \quad (33)$$

(33) into (32) gives

$$\begin{aligned}
& \alpha - \beta(K+1)\bar{q}^l - \beta(b_c P + (1-b_c)P_c + \beta\bar{q}^l) \sum_{j=K+1}^N \frac{1}{2A_j + \beta} = b_c P + (1-b_c)P_c \\
& \beta \left(K+1 + \beta \sum_{j=K+1}^N \frac{1}{2A_j + \beta} \right) \bar{q}^l = \alpha - (b_c P + (1-b_c)P_c) \left(1 + \beta \sum_{j=K+1}^N \frac{1}{2A_j + \beta} \right) \\
& \bar{q}^l = \frac{\alpha - (b_c P + (1-b_c)P_c) \left(1 + \beta \sum_{j=K+1}^N \frac{1}{2A_j + \beta} \right)}{\beta \left(K+1 + \beta \sum_{j=K+1}^N \frac{1}{2A_j + \beta} \right)}. \tag{34}
\end{aligned}$$

The profit of the cooperative is $\Pi_c = (P - P_c) \sum_{j=1}^K (q_j - \bar{q}^l)$. Knowing that $q_j = \frac{b_c P + (1-b_c)P_c}{2A_j}$ and using (34) we can find Π_c as a function of P_c . Deriving Π_c with respect to P_c and considering the first order condition we find that

$$P_c = \frac{\frac{K\alpha}{\beta \left(K+1 + \beta \sum_{j=K+1}^N \frac{1}{2A_j + \beta} \right)}}{2(1-b_c) \left(K \cdot \frac{1 + \beta \sum_{j=K+1}^N \frac{1}{2A_j + \beta}}{\beta \left(K+1 + \beta \sum_{j=K+1}^N \frac{1}{2A_j + \beta} \right)} + \sum_{j=1}^K \frac{1}{2A_j} \right)} + \frac{(1-2b_c)P}{2(1-b_c)} \tag{35}$$

K is the number of farmers delivering a positive quantity to the cooperative. So K is such that $2A_{K+1}q_{K+1}^l > b_c P + (1-b_c)P_c$. Using (33) and (34), K is determined by

$$(b_c P + (1-b_c)P_c) \left[2A_{k+1} \cdot k - (2A_{k+1} + \beta) \left(k+1 + \beta \sum_{j=k+1}^N \frac{1}{2A_j + \beta} \right) \right] > -2\alpha A_{k+1}. \tag{36}$$

C Proof of Proposition 4.2

We assume that all the farmers deliver to the cooperative, i.e. $K = N$. We suppose that $\alpha > \frac{P}{2}$, so the farmers are also interested in the local market ($q_j^l > 0$ for all j). On the local market all the farmers sell the same amount $\bar{q}^l = \frac{\alpha - b_c P - (1-b_c)P_c}{\beta(N+1)}$. So the farmer j delivers to the cooperative the quantity $q_j^c = \frac{b_c P + (1-b_c)P_c}{2A_j} - \frac{\alpha - b_c P - (1-b_c)P_c}{\beta(N+1)}$. Using the expression of P_c for $K = N$, we can find that the total delivery to the cooperative is $\sum_{j=1}^N q_j^c = \frac{P \left(N + \beta(N+1) \sum_{j=1}^N \frac{1}{2A_j} \right) - N\alpha}{2\beta(N+1)}$. In *full marketing cooperative* the total delivery to the cooperative is $\sum_{j=1}^N \hat{q}_j = \frac{P}{2} \sum_{j=1}^N \frac{1}{2A_j}$. We can find that $\sum_{j=1}^N q_j^c - \sum_{j=1}^N \hat{q}_j = \frac{N(P-\alpha)}{2\beta(N+1)} > 0$ if $P > \alpha$.