Cooperation in Developing Country Industrial Clusters: Marketing in an Age of Globalization

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I. Introduction

In recent years, there has been an increase in interest in clusters of small firms in developing countries. A cluster is defined as a group of firms specialized by sector, located in close geographic proximity, and comprised of mostly small and medium sized enterprises.[1] Many clusters have become major exporters by selling their goods through foreign agents to large firms from developed countries who then market the goods to consumers in developed countries. These clusters merit greater attention in view of the fact that, despite their small size, they make sizeable contributions to developing countries' economies in terms of employment, output, and exports.[2]

The benefits to firms from clustering are sometimes referred to as "collective efficiency." Passive collective efficiency refers to benefits accruing to a firm by virtue of being in a cluster.[3] Active collective efficiency, on the other hand, stems from purposeful cooperation between firms to upgrade the cluster's production by streamlining production processes, producing higher value-added goods, or entering into design and marketing activities.[4]

Our paper focuses on one aspect of active collective efficiency and develops a model to examine the conditions under which clustered firms in a less developed country

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[1] For example, clusters in Sinos Valley (Brazil), Agra (India), and Guadalajara and Leon (Mexico) all produce footwear. Other clusters that have been studied specialize in the production of textiles, leather goods, and surgical instruments.

[2] Clusters produce a significant amount of output, with a great deal of this output bound for the export market. For example, India's Palar Valley clusters produce 45 percent of the country's leather, where there are at least 600 tanneries in five clusters. In Tiruppur, India, there were at least 2000 clustered cotton knitwear firms in 1995, which produced about 70% of India's exports of this commodity (Banerjee and Munshi (2000)). In Ludhiana, India, there were 10,000 firms and 200,000 workers producing Rs 241 billion (almost $10 billion in U.S. 1991 dollars) of woolen knitwear in 1991 (Tewari (1999)). In Agra, India, 5000 clustered firms were producing 300,000 pairs of shoes per day in 1991-92 (Knorringa (1999)).

[3] The perceived benefits of passive collective efficiency include access to credit, market access, access to a large pool of skilled labor, technological spillovers, flexible specialization, and reduced transactions costs.

[4] Schmitz and Nadvi (1999), pg. 1504.

may cooperate to carry out a "joint action" initiative to market their output in a developed country, rather than sell it through a middleman. The joint action initiative eliminates the role of an intermediary firm in the developed country. Cooperation among the clustered firms is necessary since they are too small individually to make the investments required to carry out a successful marketing campaign. The firms in the cluster are modeled as heterogeneous in expected quality of output. There are two types of firms, high and low quality, and the high quality firms have a greater probability of producing high quality output than the low quality firms. In the model, clustered firms know the quality type of other firms, but the foreign intermediary does not. The foreign intermediary, however, has a lower marketing cost than the clustered firms. The main result of the model is that joint action can occur among high quality firms, but the low quality firms always use the foreign intermediary to distribute their output. In the equilibrium where the high quality firms carry out the joint marketing initiative, the cluster firms receive a larger share of the smaller total producer surplus.

Section II of this paper discusses some of the economic literature related to the study of clusters and presents two case studies pertinent to the discussion of joint action. Section III introduces the model's fundamentals and assumptions. Section IV describes how the model is solved. In Section V, equilibrium refinements are introduced and several propositions are derived. The welfare implications of joint action are briefly discussed in Section VI, and conclusions are presented in Section VII.

II. Literature and Case Studies

Since we present a model of a large multinational firm potentially buying goods from a cluster consisting of many heterogeneous producers, the adverse selection framework provides a useful starting point.[5] In this context, we assume that the cluster maintains a local information advantage about the probability with which each firm in the cluster produces high quality output. However, our model differs somewhat from the standard model of adverse selection where there is typically a competitive market with many buyers, because our model features a monopsonist purchaser of goods.[6]

Most models of vertical control in the industrial organization literature assume that an upstream firm (a manufacturer) exerts control over downstream firms (wholesalers or retailers) through vertical restraints, such as franchise fees or resale-price maintenance (Rey and Tirole (1986a) and (1986b)). The upstream firm's bargaining power is derived from its ability to set a "take it or leave it" price. In our model, the direction of control is reversed, and the downstream firm, a large multinational retailer from a developed country, exerts control over upstream firms, who are small clustered manufacturers in a less developed country.[7]

There are also various studies that have focused on the benefits of clustering. The literature on economic geography (Krugman (1991), Krugman and Venables (1995)) has focused on the process of agglomeration, where low transport costs and economies of scale can lead to geographic concentration of manufacturing in equilibrium. A

[5] Information asymmetry about quality was first formalized by Akerlof (1970) in his seminal work on market for "lemons." Since then, adverse selection has been applied to a variety of economic problems, particularly in the study of credit and insurance markets (Stiglitz and Weiss (1981), Rothschild and Stiglitz (1976)).

[6] Barriers to entry due to language, culture, government restrictions, information or other fixed costs may restrict the number of developed country firms operating in the developing country and purchasing from the cluster. Such barriers to entry or economies of scale make the competitive consumer market consistent with profits being made by the developed country retailer.

[7] In addition, our model simplifies the final goods market by assuming a fixed price in the retail market, eliminating the externalities caused by double (price) marginalization that typically lead to contraction of consumer demand in vertical control models (Spengler (1950)).The assumption of a fixed price in the

substantial case study literature on clusters in developing countries has stressed the role of inter-firm cooperation to overcome problems that clustered exporters have collectively encountered.[8] In addition, some have suggested that clustered firms may be able to cooperate in order to "break out" of the relationship with foreign buyers and carry out their own design and marketing in order to gain a greater share of producer surplus (Humphrey and Schmitz (2000), Kaplinsky (2000), Schmitz (1999)).[9] The industrial clusters in the Sinos Valley (Brazil) and Sialkot (Pakistan) have both attempted joint action initiatives, with mixed results:

Sinos Valley, Brazil[10]*:* As of 1991, the Sinos Valley shoe cluster (Brazil) consisted of more than 1,800 firms and 153,000 employees, which included shoe manufacturers, suppliers, marketing firms, and other specialized service firms. Since the late 1980s, the cluster has been faced with increased competition from China for U.S. buyers. The "Shoes from Brazil Programme," a major joint action initiative to improve marketing abroad, failed because the largest five exporting firms (that were vertically integrated and had a close relationship with the largest U.S. buyer) opposed the plan and undermined it by exerting their influence in the shoe manufacturer's association, Abicalcados.

Sialkot, Pakistan[11]*:* A cluster of firms consisting of approximately 220 producers and 1500 subcontractors in Pakistan produce surgical instruments mainly for foreign markets in the United States and Western Europe. The cluster exported $124 million worth of

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consumer market can be justified in the context of this model. For the goods that clusters typically produce (such as shoes and textiles), the consumer market is generally highly competitive.

[8] Problems that clusters have collectively experienced have been due to trade liberalization (Mexico, India), quality or environmental standards (Pakistan, Palar Valley India), increased global competition (Brazil), or loss of traditional markets (India).

[9] A related area of research, called Global Commodity Chain (GCC) analysis, documents "buyer-driven commodity chains" where multinationals in developed countries design and market goods produced in third world factories (Gereffi (1994)).

[10] Schmitz (1995), (1998).

goods in 2000-2001.[12] Since doctors and hospitals in the U.S. often purchase disposable surgical instrument as "kits," or packages of surgical instruments that are sterilized and specialized for use in particular medical procedures, a new joint action initiative has been proposed including a plan for these kits to be produced locally and sold directly to hospitals, rather than through a third party. This is precisely the type of joint action that this paper wishes to examine.

While many studies have focused on the benefits of clustering, others have pointed out the distortionary effects of social network-based relationships in clusters (Ilias (2001) and Banerjee and Munshi (2000)).[13] Although industrial clusters in developing countries have generated interest as an instrument for promoting employment and growth in poor countries, these studies highlight the need to consider both their advantages and drawbacks.

Firm-level characteristics that determine clustered firms' interest in intra-cluster cooperation are empirically examined in Thompson (2004), using the responses of firms in the Sialkot surgical instrument cluster about a hypothetical "joint action" initiative to market their own goods. The results demonstrate that firms are more likely to be interested in such initiatives when: i) they have already had some direct experience in marketing, and ii) firms have a lower opportunity cost of leaving their current customers, where opportunity cost is measured by the length of the trading relationship.

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[11] Nadvi (1999).

[12] SMEDA (2001), pg. 13.

[13] Ilias (2001) focuses on the role of family labor in the Sialkot surgical instrument cluster and the distortionary effects of the decision to use family versus non-family labor. He concludes that there exists a labor market distortion such that family managers are preferred to non-family and therefore firm output is correlated with family size. Banerjee and Munshi (2000) present a theoretical model and empirical testing of social network based lending, comparing the investment and earnings profiles of migrants and established producers (a caste called the Gounders) in the Tiruppur knitwear cluster in India. They find that the established producers, with access to cheaper informal credit through a social lending network,

III. Features of the Model

The "joint action" model presented in this paper incorporates two key assumptions. First, the cluster firms (or LDC firms) maintain a local information advantage about the probability of the individual cluster firms producing high quality. Given that many clusters consist of hundreds of producers, this is a reasonable assumption. Second, the developed country firm has an established marketing and distribution network through which it can sell the cluster's output, but it does not have manufacturing capacity of its own.[14] We consider a model where the cluster firms must decide between selling their output to the developed country firm (or DC firm) or marketing their goods themselves, where the DC firm has a cost advantage in marketing. Since production capacity, consumer demand, and consumer prices are fixed, this is a zero sum game.[15]

Information Structure and Timing of the Model: There will be two types of firms in the cluster, type A or "high quality" firms and type B or "low quality" firms. The numbers of high quality and low quality firms in the cluster are fixed and predetermined. High quality firms have a higher probability of producing high quality goods than the low quality firms. Quality of the output is important since only high quality goods can be sold to consumers. Each LDC firm has perfect information about its type as well as the

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have lower output growth but invest more at all levels of experience as compared to the migrants.

[14] In the case of Torreon (Mexico) a textiles cluster that has experienced a significant expansion since the introduction of NAFTA, cluster firms have taken over all parts of the production process *except* design and product development, marketing, and retailing (Bair and Gereffi (2001)). Almost 100 percent of Sialkot's (Pakistan) surgical instruments exported to Europe and North America as subcontracting work for large firms or sold through agents in the U.S. Towards the late 1980s, about half of Sinos Valley's (Brazil) shoe production was exported, mostly through American export agents.

type and output quality of all other firms in the cluster. The DC firm only knows N_A and N_B, the numbers of high and low quality firms respectively that exist in the cluster. It cannot distinguish the quality type of individual firms and only observes the quality of goods after they have been purchased from the cluster.

The model takes place in three periods. In the first period, the DC firm announces a price, p, that it is willing to pay for the goods from the cluster, and will buy one unit from each LDC firm that is willing to sell to it at that price.[16] Each cluster firm's production capacity is one unit of the good. Since the DC firm cannot observe the quality of the goods until after they have purchased them from the cluster, it must offer the same price for the goods of all LDC firms, regardless of the LDC firm's type. In the second period, each LDC firm simultaneously decides to participate in a joint action initiative by paying a share of the total joint action cost, M, or to sell to the DC firm at the price announced in the first period. The cost of joint action, M, is known by all participants. Firms participating in the joint action initiative sell their goods directly to consumers in the developed country market.[17] In the final period, production takes place in the cluster and each LDC firm sells its output according to its decision in the second period, either to the DC firm (who then sell the goods to consumers in its home market) or directly to consumers in the developed country through the joint action initiative.[18] In the developed

[15] In equilibrium, the least expected profit that a cluster firm can receive is zero, the same that it would earn if it did not produce. Since the firms are risk neutral, it is harmless to assume that each cluster firm always produces one unit (full capacity).

[16] The DC firm exercises a degree of vertical control over the cluster firms since it offers them a "take it or leave it" price at which it is willing to purchase the cluster's output. There is evidence that this structure reflects the relations between clustered firms and their customers. A case study of the Sinos Valley described how there used to be an auction system of taking orders by the foreign buyers (Schmitz (1999)).

[17] It is possible that some cluster firms engage in joint action while at the same time others sell their goods to the DC firm. Only those firms participating in the joint action pay a portion of the joint action cost.

[18] Since no strategic action takes place in the third period, we can incorporate the payoff functions into the second period so that we effectively have a two-period game.

country, high quality goods are sold to consumers (either by the DC firm or the LDC firms who market their own goods) at a price R per unit and low quality goods cannot be sold.[19] Information about the unit cost of production, c, and the price paid by consumers of high quality goods, R, is publicly known. Each cluster firm that sells to the DC firm receives p, regardless of the quality of its output. On the other hand, a cluster firm that markets its output through the joint action receives R only if its output is high quality.

The Less Developed Country (LDC)/Cluster Firms: The cluster consists of N firms. Each firm in the cluster (also referred to as an LDC firm) produces the same good, and has a production capacity of one unit of the good. Firms are risk neutral and maximize expected profit. There are two types of firms, A and B, and they have uncertain quality of output. Each type of firm can produce two levels of quality, V. Type A or "high quality" firms produce low quality, V^{LOW}, with probability q_A, and type B or "low quality" firms produce low quality with probability q_B where $q_A < q_B$.[20] The number of high quality and low quality firms are fixed before any action takes place in the model. Let $j = 1, \ldots, N_A$ denote the high quality firms and $k = 1, \ldots, N_B$ denote the low quality firms where $N_A + N_B = N$. Then $a = N_A/N$ is the proportion of high quality firms, and $1-a = N_B/N$ is the proportion of low quality firms in the cluster. Each cluster firm knows its type and the types of all other firms in the cluster. All LDC firms face the same unit cost of production, c.

[19] The reader may note that with this ordering of the stages, the DC firm commits to a price before production takes place in the cluster. If production took place first, then only the firms that produced low quality output would want to sell to the DC firm, leading to market failure similar to the result obtained in Akerlof's (1970) lemons model. In addition, the DC firm announces its price before the cluster firms make a decision about joint action so that the DC firm does not have an opportunity to respond to the cluster's decision for or against joint action. If the DC firm were given the opportunity to respond with a counter-offer price (if, for instance the cluster decided to carry out joint action), the results would be very similar to those obtained in the present model.

In the second stage, the cluster firms simultaneously choose either to sell their goods either to a monopsonist buyer from a developed country (the DC firm) at a price, *p*, or pay a fixed cost, *M,* to engage in "joint action" and market the goods themselves as a cooperative, eliminating the DC firm as the middle-man.[21] The action space is therefore $s_i \in \{0, 1\}$ for each cluster firm $i=1, \ldots, N$, where 0 denotes that the LDC firm sells to the DC firm and 1 signifies that the firm participates in the joint action initiative. Let the type A firms' choice of action in the second stage, given p announced by the DC firm, be defined as $s_j(p)$ for $j = 1, \ldots, N_A$ and type B firms' strategies as $s_k(p)$ for $k = 1, \ldots, N_B$. The collective decisions of the cluster generate $l\,(p)$, the proportion of all cluster firms that participate in joint action in response to p. Then, $l\,(p)= \frac{1}{N}\left[\sum_{j=1}^{N_A} s_j(p) + \sum_{k=1}^{N_B} s_k(p)\right]$.

$l\,(p)$ can also be expressed as $a\, l_A(p) + (1-a)\, l_B(p)$ where $l_A(p)$ and $l_B(p)$ are the proportions of type A and type B cluster firms participating in joint action respectively.

The cost of joint action is modeled as a fixed cost because it represents the large up-front investments required to set up a distribution network and marketing campaign. Equal division of this cost among the participating cluster firms is appealing from a "fairness" perspective since each firm markets one unit of the good.[22] Each cluster firm is too small to pay the cost of developing a marketing and distribution network itself so that $R(1-q_A) - M - c \le 0$; in other words, it is never profitable for a single cluster firm

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[20] Type A firms will also be referred to as "high quality firms" and type B as "low quality firms." We can set $V^{LOW}=0$ without loss of generality.

[21] While it is theoretically possible for there to be multiple joint action initiatives taking place simultaneously, we will only allow a single joint action to occur. This assumption simplifies analysis of the model and is the most efficient given the strong economies of scale derived from the high fixed cost, *M*, of joint action.

to market its output alone. We assume that the unit cost of production, c, is always positive, and represents the costs of raw materials and labor.[23]

Since cluster firms are risk neutral, they maximize their utility by maximizing expected profit. Profit maximization takes place by weighing the benefits of joint action against the opportunity cost of selling to the DC firm. Each LDC firm would earn $\Pi_i^{LDC} = p - c$, where i=*A,B* by selling to the DC firm, and by engaging in joint action, each firm in expectation would earn $E\Pi_i^{LDC} = R(1-q_i) - c - \frac{M}{N\lambda(p)}$ for i=*A,B*. Since cluster firms receive the actual price at which their output is sold, then with probability q_i each cluster firm receives $R - c - \frac{M}{N\lambda(p)}$ and with probability $(1- q_i)$ receives $-c - \frac{M}{N\lambda(p)}$ since low quality goods cannot be sold.[24] If a firm receives the same expected payoff from joint action as selling to the DC firm, we assume that it sells to the DC firm, even though cluster firms are risk neutral.

In order to focus on the most interesting cases, we will limit most of the analysis to cases where joint action is potentially profitable for all cluster firms, so that $R(1-q_B) - \frac{M}{N} \geq c$ (Assumption A). Later we consider cases where Assumption A fails but joint action is still potentially profitable for type A firms.[25]

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[22] Equal division of M also simplifies the solution of the model. However, even if there were an unequal division of the cost between the high and low quality firms, it would not change the main results of the model such that the DC firm would still always purchase the output of low quality firms in equilibrium.

[23] We assume that it is always efficient for all firms to produce so that $R(1-q_B) - c > 0$.

[24] Recall that there is perfect information among the cluster firms about the output quality of each firm.

[25] Note that Assumption A (that joint action is potentially profitable for all firms) is not a subset of cases where joint action is potentially profitable for type A firms. It can be the case that $R(1-q_B) - \frac{M}{N} \geq c$ even

The Developed Country (DC) Firm: The developed country firm (DC firm) has no manufacturing capacity of its own, and is strictly specialized in the marketing and retailing of goods. If an LDC firm sells its one unit of output to the DC firm at the announced price, *p*, the DC firm sells it (if it is high quality) in its home country final goods market at a price *R*, effectively acting as a middleman between the cluster and the consumers. The announced price $p \in [0, \infty)$ is assumed to be a continuous variable.

The quality of output produced by the cluster matters for the DC firm if it is buying goods from the cluster since only high quality goods can be sold to consumers. The DC firm maximizes its expected profit subject to the constraint that the LDC firms are willing to sell their products at the announced price. We assume that the DC firm, as an established player, does not have to pay a marketing cost, *M*. This captures the idea that it has already built a distribution/marketing network.[26] The expected proportion of high quality goods that the DC firm purchases from the cluster depends on which LDC cluster firms sell to the DC firm at the announced price.[27] The DC firm's problem is:

$$\max_p E\Pi^{DC} = N\left[R\left[\alpha(1-\lambda_A(p))(1-\theta_A)+(1-\alpha)(1-\lambda_B(p))(1-\theta_B)\right]-p(1-\lambda(p))\right]$$

After the DC firm announces *p*, all cluster firms simultaneously decide to sell to the DC firm or carry out the joint action initiative. The DC firm's choice of *p* can be

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though it is not possible for type A firms alone to carry out a joint action initiative, for example when α is small so that $R(1-\theta_B)-\frac{M}{N} > R(1-\theta_A)-\frac{M}{N\alpha}$.

[26] The same results of the model would be obtained if instead we supposed that the DC firm has to pay a marketing cost, *M'*, as long as *M'*<*M*. This is because the results of the model depend on the fact the DC firm has a cost advantage in marketing and distribution. It is reasonable to assume that the DC firm's marketing cost would be lower than what the cluster firms pay because it likely has some advantages in its home market, such as better information on local market conditions, preferential tax treatment, government subsidies, or economies of scale in marketing if it markets goods procured from producers other than the cluster.

[27] Note that while the DC firm cannot observe the type of individual cluster firms, in equilibrium it will be able to determine which type of cluster firm will sell to it.

expressed as a function of $\lambda(p)$ since the DC firm does not know the quality type of individual firms and therefore only takes into consideration the expected number of high quality goods that it buys from the cluster. For a given *p*, the DC firm receives higher expected profits from type A firms due to their higher expected output quality. At the same time, the type of cluster firm that sells to the DC firm may also depend on the announced price.

First Best Outcome: The first best outcome maximizes the joint profits of the DC firm and the cluster firms, and is Pareto efficient as elaborated in Proposition 1.

Proposition 1: It is always Pareto efficient for the DC firm to market the high quality goods of both high (type A) and low (type B) quality firms.

Given the assumptions on the cost structure, it is efficient for all cluster firms to produce. Production capacity, consumer demand, and consumer prices are fixed. If the LDC firms (or a sub-set) market their own goods, they must pay an entry cost, *M*, to build a distribution network. The DC firm already has a network through which it can sell the cluster's goods, and does not need to pay the entry cost, making upstream foreclosure more efficient (see also Appendix 1 for a proof).[28] Global welfare is higher when the DC firm markets all of the cluster's output. However, as will be discussed later, joint action also affects the division of surplus between the DC firm and the cluster.

IV. Solving the Model

We now solve this two-stage model where in period one, the DC firm announces

[28] Upstream foreclosure is the restriction of buyers' (in this case, the consumers in the developed country) access to other suppliers (the clustered manufacturers). Tirole (1988) noted that fixed costs of production might lead to downstream foreclosure due to efficiency considerations (see footnote 49, pg. 193).

the price at which it will buy goods from the cluster and in period two, the cluster firms decide to sell to the DC firm or engage in joint action. In the second stage, the cluster firms simultaneously decide whether to engage in joint action or sell to the DC firm at the price *p* that is announced by the DC firm in the first stage. Each possible *p* that the DC firm may announce in the first stage leads to a unique second stage subgame. The model is a dynamic game of imperfect information. However, since there is no signaling stage and no opportunity for the DC firms to update its beliefs about the types of cluster firms, we can proceed to solve the game by backwards induction.

Solving the Second Stage: We restrict the model to the consideration of pure strategies.[29]

Lemma 1: For any announced price, p such that $p \geq c$, there exists at least one pure strategy second stage equilibrium where all cluster firms sell to the DC firm.

To see why Lemma 1 holds, recall that the model assumes that no single cluster firm can make positive profits from marketing goods alone. Therefore, if all cluster firms sell to the DC firm, there is no incentive for a single firm in the cluster to deviate from that strategy since it would receive negative profits from doing so (see Appendix 1, proof of Lemma 1).

Lemma 2: For any announced price, p such that $p \geq c$, the second stage game has at most three equilibria. These are: i) all cluster firms sell to the DC firm; ii) all cluster firms participate in the joint action initiative; and iii) type A firms carry out the joint action initiative and type B firms sell to the DC firm.

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[29] We should note that the second stage of the game is supermodular even though we will not exploit this characteristic of the game. Supermodular games were first described by Topkis (1979) and economic applications were developed by Vives (1990) and Milgrom and Roberts (1990). In this class of games, players' strategies are strategic complements. In our model, the payoff to selecting "do joint action" is increasing in the number of LDC firms choosing to participate in the joint action initiative (in other words, the actions exhibit strategic complementarities) because the fixed cost of marketing their own goods is divided equally among all firms participating in the joint action initiative.

To see why Lemma 2 holds, we begin by noting: i) in any continuation equilibrium, all firms of certain quality type will have the same strategy, and ii) joint action cannot take place without the participation of type A firms (see Appendix 1, Lemmas 2a and 2b for proofs).[30] Given these restrictions, the three possible equilibria of the second stage of the game are those presented in Lemma 2. The existence of the continuation equilibria depend on the parameter values *R, M, N, c,* $\mathbf{q}_A$, and $\mathbf{q}_B$ in addition to the price, *p*, announced by the DC firm in the first stage.[31] The first continuation equilibrium, "all sell to the DC firm", was discussed in Lemma 1.

The outcome in which all firms carry out joint action is always an equilibrium of the second stage game provided that the announced price, *p*, is below a certain threshold. Formally, "all do joint action" is a continuation equilibrium for all parameter values and for all *p* such that $p < R(1-\mathbf{q}_B) - \frac{M}{N}$. Any firm that deviates from the "do joint action" strategy would earn lower expected profits (see Appendix 1, Lemma 2c).

A third continuation equilibrium exists for some parameter values and for *p* in the range $R(1-\mathbf{q}_A) - \frac{M}{N\mathbf{a}} > p \geq R(1-\mathbf{q}_B) - \frac{M}{N\mathbf{a}+1}$.[32] In this case, a separating equilibrium is obtained where type A firms engage in joint action and type B firms sell to the DC

[30] That all type A firms follow the same strategy and all type B firms follow the same strategy follows from the assumptions that only pure strategies are played, that benefits to joint action are increasing in the number of participating firms, and that all cluster firms of a certain type have the same profit function. Joint action cannot take place without the participation of type A firms because for any strategy where it is profitable for type B firms to carry out joint action, then it is also profitable for all type A firms to participate in the joint action since $R(1-\mathbf{q}_A)>R(1-\mathbf{q}_B)$ and the cost of joint action is shared equally.

[31] All three continuation equilibria do not exist for all parameter values. The possible second stage equilibria for various parameter values are given in Appendix 3.

[32] Note that the second part of the condition requires that $\mathbf{q}_A$ and $\mathbf{q}_B$ are not too similar in magnitude.

firm.[33] The first part of the condition says that it is profitable for type A firms to carry out a joint action initiative (with all type A firms participating). The second part of the condition ensures that "sell to the DC firm" is a best response for type B firms; in other words if all type B firms sell to the DC firm, there is no incentive for an individual type B firm to join type A firms in carrying out joint action.[34]

Since there are multiple equilibria in the second stage of the game for many values of the announced price p that may be offered in the first stage, we will have to specify a selection of a continuation equilibrium for each p. How this second stage equilibrium is chosen will be dealt with in more detail in Section V of the paper through the introduction of a cooperative equilibrium refinement. For now, however, we derive results for the first stage that are obtained for any selection.

Solving the First Stage: Now, we move to the first stage to find a solution to the whole game. The DC firm always has a single best response (in the first period solved by backwards induction) which is determined by the cluster firms' strategies and the parameter values of the particular game. Given that all firms of the same type have the same strategy, $l\ (p)$ (the proportion of all cluster firms that participate in joint action) summarizes the payoff relevant information for the DC firm.

In equilibrium, the DC firm knows which continuation equilibrium will be realized at each price it might announce in the first stage.[35] The DC firm maximizes its

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[33] For some parameter values, i.e. for $R(1-q_B)\frac{M}{Na+1} > R(1-q_A)\frac{M}{Na}$, the third continuation equilibrium does not exist.

[34] When $R(1-q_A)\frac{M}{Na} > p \geq R(1-q_B)\frac{M}{Na+1}$, it may even be more profitable (in expectation) for type B firms to participate in the joint action initiative along with the type A firms if all type B firms were to participate. Even so, it is still a continuation equilibrium for type B firms to sell to the DC firm.

[35] A semi-pooling equilibrium cannot exist where only some of the firms of a certain type sell to the DC firm. Suppose that some type A firms sell to the DC firm while the rest carry out the joint action. Then the

profits by offering the lowest price necessary to buy goods from the LDC firms, given the strategy profiles of the cluster firms. In this way, the DC firm's choice of p in the first stage depends on the anticipated second stage equilibrium corresponding to each p.

The multiplicity of second stage equilibria, combined with the assumption that the announced price is a continuous variable, implies that there is a continuum of equilibria in this game. Despite this multiplicity, and without placing any restrictions on the selection of equilibria, we can derive Proposition 2 regarding the ability of type B firms to engage in joint action.

Proposition 2: The DC firm always prevents the participation of type B firms in joint action. That is, there does not exist a subgame perfect Nash equilibrium where type B firms participate in a joint action initiative.

Intuitively, the DC firm will always prevent the participation of type B firms in joint action due to the cost advantage that the DC firm maintains since it does not have to pay a fixed cost to build a marketing/distribution network.[36] The DC firm offers a high enough price to purchase the output of type B firms because the DC firm can always make positive profits from re-selling type B firms' goods in the developed country's consumer market.[37] The price that the DC firm needs to pay to procure the goods of type B firms is less than (or at most equal to) the price needed to buy the goods of type A

DC firm could raise the announced price by a small amount "e" and buy from all type A firms. The same argument applies to type B firms.

[36] The result is robust even if type B firms had to only pay a nominal marketing fee, for example any $e > 0$, because the DC firm would still have a cost advantage since it does not have to pay any marketing cost.

[37] The DC firm receives expected revenues of $R(1-q_B)$ from each type B firm that it buys from, and the most that the DC firm would have to pay to buy goods only from type B firms is $p = R(1-q_B) - \frac{M}{N}$. The DC firm's strategy to offer a higher purchase price to the cluster firms in order to deter entry into the retail sector is similar in spirit to the limit pricing model where a firm charges a sufficiently low price to consumers deter entry of other firms.

firms, due to type B firms' lower probability of producing high quality goods.[38]

V. Application of Equilibrium Refinements

Given that there are multiple equilibria, we examine possible refinements that may be used to select an equilibrium of the second stage game, which will allow us to solve for a unique equilibrium of the two-stage game. The idea of applying a cooperative refinement is appealing because the objective of this model is to determine the conditions under which intra-cluster cooperation can be successful. This leads us to consider Aumann's strong equilibrium (1959) and Bernheim, Peleg and Whinston's (1987) coalition-proof equilibrium.[39]

Aumann's strong equilibrium (1959) and Bernheim, Peleg and Whinston's (1987) coalition-proof equilibrium propose that an equilibrium be chosen such that no subset of players can jointly deviate in a way that increases the payoffs of all members. Since this includes the grand coalition of all players, the selected equilibrium is the unique, payoff dominant equilibrium. While they are slightly different concepts, both lead to the same result in the joint action model.[40] We proceed with the coalition-proof equilibrium, since

[38] The expected profit from joint action is always lower for type B firms than for type A firms because of their lower probability of producing high quality goods, since cluster firms participating in joint action receive *R* only if they produce high quality.

[39] Other possible equilibrium refinements include focal points (Schelling (1960)), the maximin strategy (Von Neumann and Morgenstern (1953)), correlated equilibria (Aumann (1974) and Myerson (1986)), and the global games approach (Carlsson and van Damme (1993) and Morris and Shin (2002)). Of these, the global games approach may be of interest for this game because it has been applied to games characterized by multiple equilibria caused by self-fulfilling beliefs, such as speculative currency attacks and bank runs. An extension of the joint action model may incorporate the global games approach since the actions "do joint action" are strategic complements for the cluster firms, possibly causing them to have self-fulfilling beliefs about whether or not joint action will occur.

[40] Aumann's strong equilibrium is a slightly stronger refinement. In Bernheim, Peleg and Whinston's coalition-proof equilibrium, once a sub-set of players has deviated, they are allowed to deviate again. (This second potential deviation is not permitted in Aumann's strong equilibrium.) The "strong equilibrium" and the "coalition-proof equilibrium" give equivalent results in this model because if it is more profitable for

it is a slightly weaker concept than Aumann's strong equilibrium.

Equilibrium Selection in the Second Stage: Our first result is that the coalition proof equilibrium results in a unique continuation equilibrium.

Lemma 3: ***For each price, p, the coalition-proof equilibrium refinement results in a unique second stage equilibrium. The selected equilibrium is payoff dominant for the cluster firms.***

The coalition-proof equilibrium refinement ensures that the payoff dominant equilibrium is chosen in the second stage.[41] The selection of the continuation equilibrium depends on the announced price, since the coalition-proof equilibrium refinement uses a comparison of the announced price to the expected joint action return and selects the action leading to the highest expected payoff. In this way, we know which continuation equilibrium will be selected (and which cluster firms will sell to the DC firm) for a given announced price.

The proportion of firms selling to the DC firm increases monotonically with the announced price, since type A firms have a higher expected return to joint action than type B firms. If the DC firm announces a low price (i.e. a price that is less than the payoff any cluster firm would receive from joint action with all firms participating), then the cluster firms cooperatively market their output. If the DC firm announce a price greater than what type B firms would earn from joint action (with all firms participating) but less than type A firms' payoff from joint action (with type A firms only), the second

the cluster firms to carry out joint action than to sell to the DC firm, then there is no incentive to deviate and sell to the DC firm.

[41] Recall that the three possible continuation equilibria are: i) all cluster firms sell to the DC firm; ii) all cluster firms participate in a joint action initiative; and iii) type A firms carry out the joint action initiative and type B firms sell to the DC firm.

continuation equilibrium is selected.[42] If the DC firm announces a price that is higher than the payoff from joint action, then the DC firm markets all of the cluster's output.[43,44]

S*olving the First Stage:* Given the selection of the second stage equilibrium defined by the coalition-proof equilibrium, the DC firm must offer the LDC firms a price equal to what they would earn from joint action if it wishes to procure the cluster's output.

The DC firm's expected profits are decreasing in the price that it offers to the cluster and increasing in the type of LDC firm that is willing to sell to it at a given price. In the first stage, the DC firm chooses a price to maximize profits given this tradeoff, by tailoring the announced price accordingly in the first stage.

The following two propositions give a full characterization of the game for different values of the game parameters *R, M, N,* $\boldsymbol{q}_A$, and $\boldsymbol{q}_B$ (see also Appendix 2). We assume for Propositions 3 and 4 that Assumption A holds. In order to make the analysis more tractable, we will divide the game parameters into two regions. In Region I, $R(1-\boldsymbol{q}_A)-\frac{M}{N\boldsymbol{a}} \leq R(1-\boldsymbol{q}_B)-\frac{M}{N}$, so that there cannot be a separating equilibrium where the DC firm buys from type B firms only. This can happen, for example, when the

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[42] Recall from the earlier discussion of the second stage that the third continuation equilibrium does not exist for all parameter values. We will discuss the implications of non-existence of the third equilibrium shortly.

[43] The payoff from joint action that the DC firm would exceed in order to purchase all of the cluster's output depends on the parameter values. If $R(1-q_A)-\frac{M}{Na} < R(1-q_B)-\frac{M}{N}$ so that there is no possibility of a separating equilibrium where type B firms sell to the DC firm and type A carry out joint action, then the highest price the DC firm must pay to procure all of the cluster's output is $p = R(1-q_B)-\frac{M}{N}$. If, on the other hand $R(1-q_B)-\frac{M}{N} < R(1-q_A)-\frac{M}{Na}$, the DC firm must pay $p = R(1-q_A)-\frac{M}{Na}$ to buy from all cluster firms.

[44] Another way to state these results is as follows. Whenever the continuation equilibrium, "all do joint action" exists, it is payoff dominant (and therefore chosen). "All sell to DC firm" is only selected if it is the only continuation equilibrium. If the parameter values and announced price are such that only the first and third continuation equilibria exist, the third is chosen so that type A firms carry out joint action and type B firms sell to the DC firm.

proportion of high quality firms in the cluster, $\boldsymbol{a}$, is very small so that joint action with the participation of only type A firms is not profitable. All other parameter values fall into Region II, so that $R(1-q_B)-\frac{M}{N} < R(1-q_A)-\frac{M}{N\boldsymbol{a}}$.

Proposition 3: For all game parameters in Region I, there exists a unique subgame perfect Nash equilibrium where the DC firm offers p= $R(1-q_B)-\frac{M}{N}$ ***and markets all of the cluster's output.***

Since there is no p that leads to the third continuation equilibrium, the DC firm can effectively choose to buy from all or none of the cluster firms. Its profit maximizing strategy is to announce the minimum price necessary to purchase the cluster's output.[45]

In Region II, on the other hand, the DC firm can effectively choose to buy from all cluster firms, from type B only, or from none of the cluster firms, depending on the announced price.[46] In order to procure the higher average quality goods from type A firms, the DC firm must pay the highest price ($p= R(1-q_A)-\frac{M}{N\boldsymbol{a}}$) to all cluster firms to compensate for the higher opportunity cost of the type A firms. The DC firm's choice of p in Region II requires further specification of the parameter values, as formalized in Proposition 4.

Proposition 4: For game parameters in Region II and $\frac{M}{NR(q_B-q_A)}<\frac{1}{3}$***, the***

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[45] If the DC firm offers $p< R(1-q_B)-\frac{M}{N}$, all firms carry out joint action, and if $p\geq R(1-q_B)-\frac{M}{N}$, all cluster firms sell to the DC firm.

coalition-proof equilibrium refinement results in a unique subgame perfect Nash equilibrium where for $a \in (a_1, a_2)$ ***the high quality firms market their own goods and the DC firm procures the goods of the low quality firms at price*** $p = R(1 - q_B) - \frac{M}{N}$.[47] ***For all other game parameters in Region II, that is, for i)*** $\frac{M}{NR(q_B - q_A)} \geq \frac{1}{3}$ ***or ii)*** $\frac{M}{NR(q_B - q_A)} < \frac{1}{3}$ ***and*** $a \notin (a_1, a_2)$***, the DC firm buys all of the cluster's output at*** $p = R(1 - q_A) - \frac{M}{Na}$.

The DC firm faces a price-quality trade-off because it can either announce a low price and buy only from type B firms or it can offer a high price and procure all of the cluster's goods. The intuition underlying Proposition 4 is that for some parameter values, the losses accruing to the DC firm as a result of paying the high price (required to procure type A's output) to type B firms is not made up by the higher expected quality from type A firms. Therefore, the DC firm does not always market the goods of type A firms, even when it can earn positive profits from doing so.[48]

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[46] If the DC firm offers $p < R(1-q_B) - \frac{M}{N}$, all firms carry out joint action. If $R(1-q_B) - \frac{M}{N} \leq p < R(1-q_A) - \frac{M}{Na}$, type B firms sell to the DC firm and type A firms carry out joint action. If $p \geq R(1-q_A) - \frac{M}{Na}$, all cluster firms sell to the DC firm.

[47] $a_{1,2} = \frac{1}{2} \pm \frac{\sqrt{\left[R(q_B - q_A) + \frac{M}{N}\right]^2 - 4\left(\frac{M}{N}\right)\left[R(q_B - q_A) + \frac{M}{N}\right]}}{2\left[R(q_B - q_A) + \frac{M}{N}\right]}$. Note that since $a_1 < \frac{1}{2}$, the high quality firms do not need to be in the majority for them to carry out a joint action initiative.

[48] Within Region II, a sub-region exists where the DC firm would receive negative profits if it paid type A firms what they would earn from joint action. Call this Region III. It exists for game parameters such that $R(1-a)(q_B - q_A) - \frac{M}{Na} > 0$. In Region III, the DC firm only markets the goods of type B firms. We can re-

In the next sub-section, we see how small changes in the parameter values alter the equilibrium strategies in the game, using the solution given in Proposition 4. This will tell us under what conditions joint action can occur.

Comparative Statics for Proposition 4: We now analyze how the values of a (described in Proposition 4) depend on the exogenous parameter values *R, N,* or $(1-q_A)$, *M,* and $(1-q_B)$.[49] Increasing *R, N,* or $(1-q_A)$ or decreasing *M* or $(1-q_B)$ relaxes the equilibrium constraint so that joint action takes place with the participation of type A firms for more values of a.[50]

Increasing the probability of producing high quality by type A firms $(1-q_A)$ or increasing the retail margin, *R*, increases both the benefits and costs to the DC firm of buying from all cluster firms. However, the net effect is that changes in either make type A firms less desirable to the DC firm as suppliers. Even though buying from type A firms raises the average quality of the goods that the DC firm purchases, the DC firm pays a higher price not just to the type A firms, but to all cluster firms due its inability to

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write the condition for Region III to exist as: $\frac{M}{NR(q_B-q_A)}<\frac{1}{4}$ and $a \in (a_3, a_4)$, where

$$a_{3,4}=\frac{1}{2}\pm\sqrt{\frac{[R(q_B-q_A)]^2-4\left(\frac{M}{N}\right)R(q_B-q_A)]}{2[R(q_B-q_A)]}}$$

. Since the interval $a\in(a_1,a_2)$ from Proposition 4 defining when the DC firm chooses to buy only the goods of type B firms is larger than the interval $a \in (a_3, a_4)$, we can infer that the DC firm does not market type A's goods for all parameters where it can earn positive profits.

[49] Technically, a (the proportion of high quality firms) cannot take every value between 0 and 1, since the size of the cluster, *N*, is finite. However, if the cluster is large, then we can effectively treat a as a continuous variable.

[50] In other words, for parameter values such that the DC firm is indifferent between buying from all cluster firms (announcing $p=R(1-q_A)-\frac{M}{Na}$) and buying only type B's output (announcing $p=R(1-q_B)-\frac{M}{N}$), the DC firm offers the lower price and buys from type B firms only if there is an increase in *R, N,* or $(1-q_A)$, or a decrease in *M* or $(1-q_B)$. The DC firm is indifferent when $\frac{M}{NR(q_B-q_A)}<\frac{1}{3}$ and $a=a_1$ or $a=a_2$. We assume that the DC firm offers the higher price and buys from all firms at indifference points.

distinguish type A and B firms ex ante. In other words, the information effect (negative) dominates the productivity effect (positive) through the impact on equilibrium prices.

Changes in *M* and *N* affect the per firm cost of joint action. Since each type A firm has to pay at least $\frac{M}{N\boldsymbol{a}}$ to carry out a joint action initiative, then changes in *M* or *N* that reduce the required contribution per firm for joint action (such as increasing the number of firms, *N,* and/or reducing the total cost of joint action, *M*), increases the potential benefits of joint action to type A firms and therefore raises the price that the DC firm would have to pay all firms if it decided to buy from both firm types.

Ceteris paribus, a decrease in $(1-\boldsymbol{q}_B)$, the probability that type B firms produce high quality, reduces the price that the DC firm has to pay to type B firms if it buys only from them. At the same time it makes the high price demanded by the type A firms less palatable since the DC firm must also pay the higher price to type B firms in return for lower expected quality.

Relaxing Assumption A: Next, we briefly explore the possibility of joint action occurring when Assumption A fails, so that it is potentially profitable for type A firms to carry out joint action alone, but is not profitable for type B firms to participate in a joint action initiative even with the participation of all firms. That is, we consider parameters such that $R(1-\boldsymbol{q}_B)-\frac{M}{N}<c$, but $R(1-\boldsymbol{q}_A)-\frac{M}{N\boldsymbol{a}}\geq c$. Similar to the discussion for Proposition 4, the DC firm has to pay a higher price to all cluster firms to compensate for the higher opportunity cost of type A firms in order to buy from all cluster firms rather than type B firms only. Proposition 5 specifies the parameter values for which the DC firm chooses to buy from all cluster firms or from the low quality firms only.

Proposition 5: When joint action is potentially profitable only for the high quality firms, then for values of game parameters s.t. $\frac{M}{N[R(1-\theta_A)-c]} < \frac{1}{4}$ ***the coalition-proof equilibrium refinement results in a unique subgame perfect Nash equilibrium where for*** $\alpha \in (\alpha_5, \alpha_6)$ ***the high quality firms market their own goods and the DC firm procures the goods of the low quality firms at price p=c.***[51] ***For all other game parameters, that is, for i)*** $\frac{M}{N[R(1-\theta_A)-c]} \geq \frac{1}{4}$***; or ii)*** $\frac{M}{N[R(1-\theta_A)-c]} < \frac{1}{4}$ ***and*** $\alpha \notin (\alpha_5, \alpha_6)$***, the DC firm buys all of the cluster's output at price p=***$R(1-\theta_A) - \frac{M}{N\alpha}$***.***

The intuition is very similar to that described under Proposition 4, since the DC firm again faces a price-quality trade-off because it can either announce a low price and buy only from type B firms or it can offer a high price and procure all of the cluster's goods. The major difference from the results in Proposition 4 is that since type B firms would not participate in a joint action initiative under any conditions when Assumption A fails, the DC firm only has to pay the unit cost of production, *c*, in order to secure the output of type B firms.

Comparative Statics for Proposition 5: We now analyze how the values of α (described in Proposition 5) depend on the exogenous parameter values *R, N,* or $(1-\theta_A)$, *M,* and $(1-\theta_B)$. Increasing *R, N,* or $(1-\theta_A)$ or decreasing *M* or $(1-\theta_B)$ relaxes the equilibrium constraint so that joint action takes place with the participation of type A firms for more

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[51] $\alpha_{5,6} = \frac{1}{2} \pm \frac{\sqrt{[R(1-\theta_A)-c]^2 - 4\left(\frac{M}{N}\right)[R(1-\theta_A)-c]}}{2[R(1-\theta_A)-c]}$. Note that since $\alpha_5 < \frac{1}{2}$, the high quality firms do not need to be in the majority for them to carry out a joint action initiative.

values of α.[52] These conditions are similar to those discussed in the comparative statics section of Proposition 4 (where Assumption A held), except that $(1-\theta_B)$ is replaced here with the unit cost, *c*. The intuition for changes in *R, N,* $(1-\theta_A)$, and *M* is identical to the discussion accompanying Proposition 4. A small reduction in the unit production cost, *c*, to the extent that it does not make joint action potentially profitable for type B firms, would cause the DC firm to allow type A joint action by reducing the price that the DC firm pays type B firms if it only buys from them.[53]

VI. Welfare Analysis

In this section, we discuss the welfare implications of joint action. Since it is a zero sum game, an increase in profits for the cluster firms will necessarily result in a decrease in profits for the DC firm. We determine changes in welfare by comparing what the cluster firms earn when the coalition-proof equilibrium is applied to the joint action model versus what the cluster firms earn when participation in joint action is not an option, i.e. choosing joint action is not part of the cluster firms' action space. In this section, we return to Assumption A so that joint action is potentially profitable for all cluster firms. See Appendix 4 for welfare implications when Assumption A fails.

[52] For parameter values such that the DC firm is indifferent between buying from all cluster firms and only buying from type B firms, the DC firm will offer the lower price and only buy from type B firms if there is an increase in *R, N,* or $(1-\theta_A)$, or a decrease in *M* or *c*. The DC firm is indifferent between buying from all cluster firms and only buying from type B firms when $\frac{M}{N[R(1-\theta_A)-c]}<\frac{1}{4}$ and $\alpha = \alpha_5$ or $\alpha = \alpha_6$. We assume that the DC firm offers the higher price and buys from all firms at indifference points.

[53] Under Assumption A, the price that the DC firm pays type B firms (if it only buys from them) depends on their joint action payoff (which depends on $(1-\theta_B)$). However, when Assumption A fails so that joint

Proposition 6: Under Assumption A, the coalition-proof equilibrium refinement results in weakly higher welfare for all cluster firms than if joint action was not possible.

The cluster firms are always better off simply whenever the option of joint action exists as a potentially profitable alternative to selling their goods to the DC firm and the coalition-proof equilibrium refinement is applied to select equilibrium strategies in the second stage, even though type B firms never engage in joint action and type A firms only carry out joint action for limited values of the game parameters. The intuition is simple; under the coalition-proof equilibrium refinement, the cluster firms carry out joint action if the announced price is less than the joint action payoff. In Region II, each type A firm earns expected profits of $R(1-\theta_A)-\frac{M}{N\alpha}-c$, the payoff from joint action with the participation of type A firms, regardless of whether joint action takes place or not. However, type A firms only receive $R(1-\theta_B)-\frac{M}{N}$ - c in Region I. Type B earn $R(1-\theta_B)-\frac{M}{N}$ - c, the payoff from joint action with the participation of all firms in Region I. In Region II type B firms can earn as much as $R(1-\theta_A)-\frac{M}{N\alpha}-c$ if the DC firm offers the price necessary to stop type A firms from carrying out joint action. Otherwise, they receive the same payoff as Region I (also see Appendix 4).

action would yield negative profits for type B firms, the DC firm only pays them c for their output if it only buys from type B.

VII. Conclusions

The model has provided several results relating to joint action and the viability of breaking into the functions of marketing by a cluster of small firms when the final goods market is dominated by an established multinational firm. We have proved that joint marketing by the cluster may exclude low quality producers and that it cannot take place without the participation of high quality firms. In this sense, successful joint action initiatives may be associated with high quality output. This may shed some light on the failure of joint action in the Sinos Valley (Brazil), where the largest firms with close ties to U.S. multinationals opposed the initiative.[54] In order to bypass the middle-man, firms in industrial clusters may need to focus on improving the quality of their output. However, even without venturing into marketing, clustered firms may still be able to increase their profits through improvements in product quality.

Extensions and Future Research: We use the predictions of the comparative statics exercises to expand on ideas for further research. Recall that under Assumption A, increasing *R, N,* or $(1-q_A)$ or decreasing *M* or $(1-q_B)$ relaxes the equilibrium constraint so that joint action takes place among the high quality firms for more values of a.

The high quality firms may therefore increase their chances of a successful joint action through the adoption of technologies that reduce the probability of low quality output. Also, new technologies (such as the internet) leading to an exogenous decrease in the cost of marketing, *M,* may make it more likely that clusters market their output without a middleman.

Since, according to the existing model, increasing the size of the cluster (*N*) has beneficial effects by way of decreasing the per firm cost of a joint action initiative, existing firms should not erect barriers to entry. This assumes, however, that the fixed cost *(M)* of joint action does not increase with the size of the cluster. If instead the cost of joint action rises with the size of the cluster (for example, due to free-riding), this issue may require further investigation.

Future research may attempt to incorporate some of the ideas above, in addition to considering how results would change if as mentioned previously, the Global Games approach is applied as an equilibrium selection device in place of the coalition-proof equilibrium refinement.

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[54] The largest firms in the Sinos Valley are more vertically integrated, which is correlated with having greater control over quality.

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Appendix 1: Proofs

Proof of Proposition 1: ***It is always Pareto efficient for the DC firm to market the high quality goods of both high and low quality firms.***

If the LDC firms (or a sub-set) decide to market their own goods, the cluster must pay an entry cost, M, in order to build a distribution network. (The manner in which the entry cost is divided among the firms is irrelevant). Therefore, the total expected surplus of the goods produced and marketed by the cluster firms is $NR[a(1-q_A)+(1-a)(1-q_B)]-Nc-M$.

The DC firm already has a distribution network through which it can sell the cluster's goods, and the entry cost does not need to be paid. The total expected surplus of the goods produced by the cluster that can be earned by selling the goods through the DC firm is simply $NR[a(1-q_A)+(1-a)(1-q_B)]-Nc$.

Therefore, total expected surplus is reduced when the clustered firms decide to market their own goods.

Lemma 1: ***For any announced price, p such that p≥c, there exists at least one pure strategy second stage equilibrium, where all cluster firms to sell to the DC firm.***

Proof:

For type A firms: Suppose that for a given $p = p^* \geq c$, *N-1* of the cluster firms decide to sell to the DC firm. For the remaining firm, firm *i*, (suppose it is type A), it is a best response to also sell to the DC firm. By selling to the DC firm, it earns $\Pi_{Ai}^{LDC} = p^* - c \geq 0$. By deciding to market its output alone, it would earn $E\Pi_{Ai}^{LDC} = R(1-q_A) - M - c < 0$.

For type B firms: Similar arguments prove the proposition for type B firms.

Lemma 2a: ***In any continuation equilibrium, all type A firms will follow the same strategy, and all type B firms will follow the same strategy.***

Proof: Proof is by contradiction. Consider two type B firms *i* and *j* that might be following different strategies. Suppose that type B firm *i* follows a strategy such that if the announced price $p=p^*$ then firm *i* sells to the DC firm. For type B firm *j*, if $p=p^*$ then the firm engages in joint action.

If firm *j*'s strategy is a best response, it must be that $R(1-q_B) - \frac{M}{Ng} \geq p^*$ where g is the proportion of all cluster firms participating in joint action when $p=p^*$.[55] If this is true, then firm *i*'s strategy is not a best response to the other LDC firms' strategies because *i*'s payoff from following the strategy when $p=p^*$ is $\Pi_{Bi}^{LDC} = p^* - c$ which is strictly lower than *i*'s payoff from deviating from the strategy by engaging in joint action and earning

[55] If no firms other than *j* are participating in joint action, let $Ng = 1$.

$\Pi_{Bi}^{LDC} = R(1-q_B) - \frac{M}{Ng+1}$.

If, instead $R(1-q_B) - \frac{M}{Ng} < p^*$, then firm *j*'s strategy is not a best response, and it will join firm *i* in selling to the DC firm.
Therefore firm *i* must follow the same strategy as firm *j* in equilibrium. The argument can be extended to consider any three type B firms that have different strategies and so on up to $N(1-a)$ type B firms. Therefore, all type B firms will follow the same strategy. Similar arguments prove the proposition for type A firms.

*Lemma 2b**: There does not exist a set of continuation equilibrium strategies such that type B firms participate in the joint action and type A firms sell to the DC firm.***

Proof: Proof is by contradiction. Suppose that a type A firm *i* follows a strategy where if the announced price $p=p^*$ then firm *i* sells to the DC firm. For a type B firm *j*, if $p=p^*$ then the firm engages in joint action. For firm *j*'s strategy to be a best response, it must be that $R(1-q_B) - \frac{M}{Ng} \geq p^*$ where g is the proportion of all cluster firms participating in joint action when $p=p^*$.[56] If this is true, then firm *i*'s strategy is not a best response to the other LDC firms' strategies because *i*'s payoff from following the strategy when $p=p^*$ is $\Pi_{Ai}^{LDC} = p^* - c$ which is strictly lower than *i*'s payoff from deviating from the strategy by engaging in joint action and earning $E\Pi_{Ai}^{LDC} = R(1-q_A) - \frac{M}{Ng+1}$. Therefore, there does not exist a set of strategies in equilibrium such that type B firms can engage in joint action while type A firms sell to the DC firm.

Lemma 2c: ***Given Assumption A, for any given p<$R(1-q_B) - \frac{M}{N}$ (in other words, p is less than the expected profit from joint action for type B firms when all firms participate), there exists a pure strategy continuation equilibrium where all cluster firms engage in joint action.***

If $p^* < R(1-q_B) - \frac{M}{N}$ and all cluster firms participate in joint action, type B firms earn $E\Pi_{Bi}^{LDC} = R(1-q_B) - \frac{M}{N} - c$ and type A firms earn $E\Pi_{Ai}^{LDC} = R(1-q_A) - \frac{M}{N} - c$. A cluster firm (type A or B) that deviates and sells to the DC firm will earn $\Pi_i^{LDC} = p^* - c$ which is lower than the payoff to joint action.

[56] If no firms other than *j* are participating in joint action, let Ng =1.

Figures 1 and 2: Characterizations of the Profit Functions for Some Parameter Values

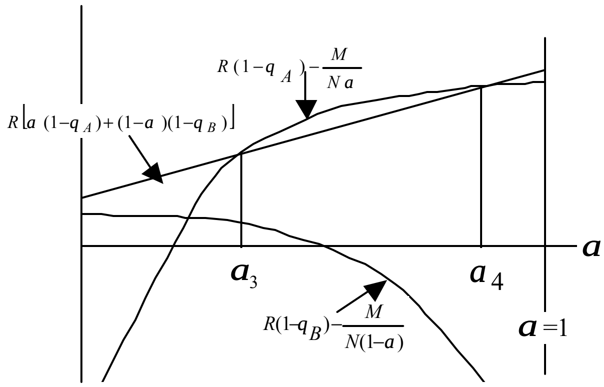

Figure 1

In figure 1, the DC firm would receive negative profits if the coalition-proof equilibrium refinement is applied and it buys from type A firms for $a \in (a_3, a_4)$.

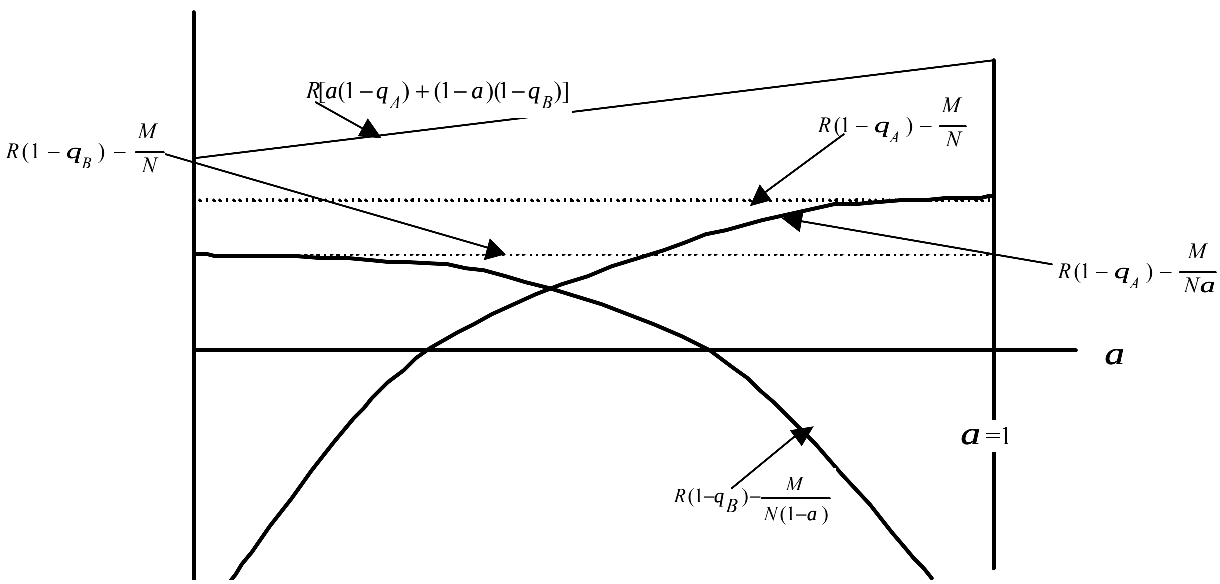

Figure 2

In figure 2, the DC firm can obtain positive profits by procuring goods from all cluster firms, for all values of a and for all equilibrium refinements.

Appendix 2: Nash Equilibria of the Game for Various Parameter Values When the Coalition-Proof Equilibrium Refinement is Applied to the Second Stage

A. Case 1: Joint action is potentially profitable for type A firms only

Case 1: $R(1-q_B)-\frac{M}{N} < c$ and $c < R(1-q_A)-\frac{M}{N\alpha}$

The DC firm can always buy from only the type B firms at a price $p=c$ since joint action would never yield positive profits for them under these parameter values.

If the coalition-proof equilibrium refinement is applied, then type A firms adopt the strategy that they will carry out joint action for any announced price $p < R(1-q_A)-\frac{M}{N\alpha}$. Whether or not offering a higher price to the type A firms is profitable for the DC firm depends on all the parameter values. Since the DC firm cannot distinguish between type A and type B firms, the DC firm would have to offer the higher price ($p = R(1-q_A)-\frac{M}{N\alpha}$) to all the cluster firms, not just type A firms.

Given $E\Pi^{DC}_{BuyBonly} = N(1-\alpha)[R(1-q_B)-c]$ and

$E\Pi^{DC}_{BuyA\&B} = NR[\alpha(1-q_A)+(1-\alpha)(1-q_B)] - N\left[R(1-q_A)-\frac{M}{N\alpha}\right] =$

$NR(1-\alpha)(q_A-q_B)+\frac{M}{\alpha}$, $E\Pi^{DC}_{BuyA\&B} > E\Pi^{DC}_{BuyBonly}$ requires that

$-NR(1-\alpha)(1-q_A)+\frac{M}{\alpha}+N(1-\alpha)c > 0$.

Given the roots of $E\Pi^{DC}_{BuyA\&B}$ - $E\Pi^{DC}_{BuyBonly}$=0, then for $\frac{M}{N[R(1-q_A)-c]} > \frac{1}{4}$, no real roots exist, so that $E\Pi^{DC}_{BuyA\&B} > E\Pi^{DC}_{BuyBonly}$ for all α. And for $\frac{M}{N[R(1-q_A)-c]} < \frac{1}{4}$, $E\Pi^{DC}_{BuyA\&B} > E\Pi^{DC}_{BuyBonly}$ for $\alpha \in (\alpha_5, \alpha_6)$.[57]

Summary of results for case 1:

Type B firms sell their goods to the DC firm since joint action would not yield positive profits. If the coalition-proof equilibrium refinement is applied, and $\frac{M}{N[R(1-q_A)-c]} \le 1/4$, then a pure strategy subgame perfect Nash equilibrium exists

[57] $\alpha_{5,6} = \frac{1}{2} \pm \frac{\sqrt{1-4\frac{M}{N[R(1-q_A)-c]}}}{2}$

such that for all $\alpha \in (\alpha_5, \alpha_6)$ the DC buys goods from type B firms at $p=c$ and type A firms carry out a joint action marketing initiative.
If the coalition-proof equilibrium refinement is applied, and either i) $\frac{M}{N[R(1-\theta_A)-c]} \leq 1/4$ where $\alpha \notin (\alpha_5, \alpha_6)$ or ii) $\frac{M}{N[R(1-\theta_A)-c]} > 1/4$, then a pure strategy subgame perfect Nash equilibrium exists such that the DC firm buys from all cluster firms at a price $p = R(1-\theta_A) - \frac{M}{N\alpha}$.

B. Cases 2 – 15: Joint action is potentially profitable for both types of cluster firms, but it is not possible for the DC firm to only buy from type B firms

Cases 2 - 15:

$R(1-\theta_B) - \frac{M}{N} > c$, $R(1-\alpha)(\theta_B - \theta_A) - \frac{M}{N\alpha} \leq 0$, and $R(1-\theta_A) - \frac{M}{N\alpha} < R(1-\theta_B) - \frac{M}{N}$

In cases 2-15, the DC firm can only buy from all or none of the cluster firms since $R(1-\theta_A) - \frac{M}{N\alpha} < R(1-\theta_B) - \frac{M}{N}$.
Since the DC firm receives positive profits by buying and reselling the cluster's output, the DC firm will always buy from all of the cluster firms in this case.

If the coalition-proof equilibrium refinement is applied, then the DC firm would earn $E\Pi^{DC} = NR[\alpha(1-\theta_A) + (1-\alpha)(1-\theta_B)] - N\left[R(1-\theta_B) - \frac{M}{N}\right]$ by offering $p = R(1-\theta_B) - \frac{M}{N}$ and would earn zero profits if it offers $p < R(1-\theta_B) - \frac{M}{N}$.

Summary of results for cases 2 – 15:
If the coalition-proof equilibrium refinement is applied, then a pure strategy subgame perfect Nash equilibrium exists such that the DC firm buys from all cluster firms and pays $p = R(1-\theta_B) - \frac{M}{N}$ to all cluster firms.

C. Cases 16 – 21: Joint action is potentially profitable for both types of cluster firms, and it is possible for the DC firm to either buy from all cluster firms or buy only from type B firms

For cases 16 - 21:

$R(1-\theta_B)-\frac{M}{N}>c$, $R(1-\alpha)(\theta_B-\theta_A)-\frac{M}{N\alpha}\leq 0$, and

$R(1-\theta_B)-\frac{M}{N}<R(1-\theta_A)-\frac{M}{N\alpha}$

In cases 16-21, the DC firm can effectively buy from all cluster firms, type B only, or from none of the cluster firms, depending on the price that it announces. The DC firm will always buy from at least the type B firms because it makes positive profits by buying and marketing the output of type B firms. It will be shown that there will be some instances where the DC firm could make positive profits procuring the whole cluster's output, but chooses to buy from type B firms only.

If the coalition-proof equilibrium refinement is applied, the DC firm can buy the whole cluster's output by offering $p=R(1-\theta_A)-\frac{M}{N\alpha}$ to all firms, or it buy only from type B firms by offering $p=R(1-\theta_B)-\frac{M}{N}$ as long as $E\Pi^{DC}_{BuyA\&B}>E\Pi^{DC}_{BuyBonly}$. Recall that if the DC firm is buying all of the cluster's output, it must pay the same price to all firms since it cannot distinguish the quality type of individual cluster firms.

Given $E\Pi^{DC}_{BuyBonly}=N(1-\alpha)\left[R(1-\theta_B)-\left[R(1-\theta_B)-\frac{M}{N}\right]\right]=M(1-\alpha)$ and

$E\Pi^{DC}_{BuyA\&B}=N(1-\alpha)(\theta_B-\theta_A)+\frac{M}{\alpha}$, $E\Pi^{DC}_{BuyA\&B}>E\Pi^{DC}_{BuyBonly}$ requires that

$N\left[-R(1-\alpha)(\theta_B-\theta_A)+\frac{M}{N\alpha}-\frac{M(1-\alpha)}{N}\right]>0$. However, the DC firm can profitably buy from type A (and therefore the entire cluster) whenever $-R(1-\alpha)(\theta_B-\theta_A)+\frac{M}{N\alpha}\geq 0$. Therefore, the condition allowing for DC to make positive profits by buying all of the cluster's output is not sufficient for the DC firm to want to do so.

When the difference between the benefit that the DC firm receives by buying from both firms ($R[\alpha(1-\theta_A)+(1-\alpha)(1-\theta_B)]$) and the price that the DC firm has to pay in order to procure the output of type A firms ($p=R(1-\theta_A)-\frac{M}{N\alpha}$) is sufficiently small, such that $R[\alpha(1-\theta_A)+(1-\alpha)(1-\theta_B)]-\left[R(1-\theta_A)-\frac{M}{N\alpha}\right]<\frac{M(1-\alpha)}{N}$, then the DC firm will choose to only buy the type B firms' output, even though it can make positive profits by procuring and marketing all of the cluster's output.

Given the roots of $E\Pi^{DC}_{BuyA\&B}$ - $E\Pi^{DC}_{BuyBonly}$=0, then for $\frac{M}{NR(\theta_B-\theta_A)}>\frac{1}{3}$, no real roots exist, and $E\Pi^{DC}_{BuyA\&B}>E\Pi^{DC}_{BuyBonly}$ for all α[58]. And for $\frac{M}{NR(\theta_B-\theta_A)}<\frac{1}{3}$, the DC firm will choose to only buy the type B firms' output for $\alpha\in(\alpha_1,\alpha_2)$.

Summary of results for cases 16 - 21:

If the coalition-proof equilibrium refinement is applied, then for parameter values such that $\frac{M}{NR(\theta_B-\theta_A)}>\frac{1}{3}$, or for $\frac{M}{NR(\theta_B-\theta_A)}<\frac{1}{3}$ where for $\alpha\notin(\alpha_1,\alpha_2)$ a pure strategy subgame perfect Nash equilibrium exists such that the cluster firms sell their goods to the DC firm at a price $p=R(1-\theta_A)-\frac{M}{N\alpha}$. For all other parameter values such that $\frac{M}{NR(\theta_B-\theta_A)}<\frac{1}{3}$ where for $\alpha\in(\alpha_1,\alpha_2)$ a pure strategy subgame perfect Nash equilibrium exists such that the type B firms sell their goods to the DC firm at a price $p=R(1-\theta_B)-\frac{M}{N}$ and type A firms will market their own goods.

D. Cases 22 – 27: Joint action is potentially profitable for all firms, but the DC firm would earn negative profits if it were to offer type A firms what they would earn from joint action

For cases 22 - 27:

$$R(1-\theta_B)-\frac{M}{N}>c\,,\ R(1-\alpha)(\theta_B-\theta_A)-\frac{M}{N\alpha}>0$$

In cases 22 – 27, the DC firm would earn negative profits if it were to offer $p=R(1-\theta_A)-\frac{M}{N\alpha}$, i.e. what type A firms what they would earn from joint action.

However, in order to have positive profits, the DC firm must at least buy from the type B firms. If the coalition-proof equilibrium refinement is applied, the DC firm buys from

[58] $$\alpha_{1,2}=\frac{1}{2}\pm\frac{\sqrt{\left[R(\theta_2-\theta_A)+\frac{M}{N}\right]^2-4\left(\frac{M}{N}\right)\left[R(\theta_B-\theta_A)+\frac{M}{N}\right]}}{2\left[R(\theta_B-\theta_A)+\frac{M}{N}\right]}$$

type B firms at a price $p = R(1-\theta_B) - \frac{M}{N}$.

If the coalition-proof equilibrium refinement is applied, then the DC firm will only make positive profits if it purchases goods from the type B firms. Buying from the type B firms, the DC firm would earn

$E\Pi^{DC} = N(1-\alpha)R[\alpha(1-\theta_A) + (1-\alpha)(1-\theta_B)] - N(1-\alpha)\left[R(1-\theta_B) - \frac{M}{N}\right]$ by offering $p = R(1-\theta_B) - \frac{M}{N}$ and would earn zero profits if it offers $p < R(1-\theta_B) - \frac{M}{N}$.

Summary of results for cases 22 - 27:
If the coalition-proof equilibrium refinement is applied, then a pure strategy subgame perfect Nash equilibrium exists such that the type A firms carry out a joint action initiative and the DC firm markets the goods of the type B firms at price $p = R(1-\theta_B) - \frac{M}{N}$.

Appendix 3: Continuation Equilibria of the Second Stage for Various Parameter Values, Taking *p* as Given

A. Case 1: Joint action is potentially profitable for type A firms only

Case 1: $R(1-\boldsymbol{q}_B)-\frac{M}{N}<c$ and $c<R(1-\boldsymbol{q}_A)-\frac{M}{N\boldsymbol{a}}$

For $c \le p < R(1-\boldsymbol{q}_A)-\frac{M}{N\boldsymbol{a}}$, there are two pure strategy continuation (or second stage) equilibria, taking *p* as given. In the first, type B firms sell to the DC firm and type A firms engage in joint action. In the second, all cluster firms sell to the DC firm. For $p \ge R(1-\boldsymbol{q}_A)-\frac{M}{N\boldsymbol{a}}$, there is one continuation equilibrium where all cluster firms to sell to the DC firm.

B. and C. Cases 2 – 15 and 16 - 21: Joint action is potentially profitable for both types of cluster firms

B. For Cases 2 – 15, the following hold: $R(1-\boldsymbol{q}_B)-\frac{M}{N}>c$ **,**

$R(1-\boldsymbol{a})(\boldsymbol{q}_B-\boldsymbol{q}_A)-\frac{M}{N\boldsymbol{a}}\le 0$ **, and** $R(1-\boldsymbol{q}_A)-\frac{M}{N\boldsymbol{a}}<R(1-\boldsymbol{q}_B)-\frac{M}{N}$ **.**

2. For $R(1-\boldsymbol{q}_B)-\frac{M}{N\boldsymbol{a}+1}<c<R(1-\boldsymbol{q}_A)-\frac{M}{N\boldsymbol{a}}<R(1-\boldsymbol{q}_B)-\frac{M}{N(1-\boldsymbol{a})}$ we have the following equilibria in the second stage of the game, taking *p* as given.
For $c \le p < R(1-\boldsymbol{q}_B)-\frac{M}{N}$, there are three continuation equilibria. In the first, all cluster firms sell to the DC firm. In the second, all cluster firms carry out joint action. In the third continuation equilibrium, type A firms carry out a joint action initiative while type B firms sell to the DC firm. For $p \ge R(1-\boldsymbol{q}_B)-\frac{M}{N}$, there is one continuation equilibrium where all cluster firms to sell to the DC firm.

3. For $c<R(1-\boldsymbol{q}_B)-\frac{M}{N\boldsymbol{a}+1}<R(1-\boldsymbol{q}_A)-\frac{M}{N\boldsymbol{a}}<R(1-\boldsymbol{q}_B)-\frac{M}{N(1-\boldsymbol{a})}$ we have the following equilibria in the second stage of the game, taking *p* as given.
For $c \le p < R(1-\boldsymbol{q}_B)-\frac{M}{N\boldsymbol{a}+1}$ there are two continuation equilibria. In the first, all cluster firms sell to the DC firm. In the second, all cluster firms carry out a joint action initiative. For $R(1-\boldsymbol{q}_B)-\frac{M}{N\boldsymbol{a}+1}\le p<R(1-\boldsymbol{q}_B)-\frac{M}{N}$, there are three pure strategy

continuation equilibria. In the first, all cluster firms sell to the DC firm. In the second, all cluster firms carry out a joint action initiative. In the third continuation equilibrium, type A firms carry out a joint action initiative while type B firms sell to the DC firm. For $p \geq R(1-\theta_B)-\frac{M}{N}$, there is one continuation equilibrium where all cluster firms to sell to the DC firm.

4. For $c < R(1-\theta_A)-\frac{M}{N\alpha} < R(1-\theta_B)-\frac{M}{N\alpha+1} < R(1-\theta_B)-\frac{M}{N(1-\alpha)}$, we have the following equilibria in the second stage of the game, taking p as given.
For $c \leq p < R(1-\theta_B)-\frac{M}{N}$, there are two continuation equilibria. In the first, all cluster firms engage in joint action and in the second, all sell to the DC firm. For $p \geq R(1-\theta_B)-\frac{M}{N}$, there is one continuation equilibrium where all cluster firms sell their goods to the DC firm.

5. For $R(1-\theta_A)-\frac{M}{N\alpha} < c < R(1-\theta_B)-\frac{M}{N(1-\alpha)}$ we have the following equilibria in the second stage of the game, taking p as given.
For $c \leq p < R(1-\theta_B)-\frac{M}{N}$, there are two continuation equilibria. In the first, all cluster firms engage in joint action and in the second, all sell to the DC firm. For $p \geq R(1-\theta_B)-\frac{M}{N}$, there is one continuation equilibrium where all cluster firms sell their goods to the DC firm.

6. For $R(1-\theta_A)-\frac{M}{N\alpha} < R(1-\theta_B)-\frac{M}{N(1-\alpha)} < c < R(1-\theta_A)-\frac{M}{N(1-\alpha)+1}$ we have the following equilibria in the second stage, taking p as given.
For $c \leq p < R(1-\theta_B)-\frac{M}{N}$, there are two continuation equilibria. In the first, all cluster firms engage in joint action and in the second, all sell to the DC firm. For $p \geq R(1-\theta_B)-\frac{M}{N}$, there is one continuation equilibrium where all cluster firms sell their goods to the DC firm.

7. For $R(1-\theta_A)-\frac{M}{N\alpha} < R(1-\theta_B)-\frac{M}{N(1-\alpha)} < R(1-\theta_A)-\frac{M}{N(1-\alpha)+1} < c$, we have the following equilibria in the second stage of the game, taking p as given.
For $c \leq p < R(1-\theta_B)-\frac{M}{N}$, there are two continuation equilibria. In the first, all cluster

firms engage in joint action, and in the second, all sell to the DC firm. For $p \geq R(1-q_B)-\frac{M}{N}$, there is one continuation equilibrium where all cluster firms sell their goods to the DC firm.

8. For $R(1-q_B)-\frac{M}{N} > R(1-q_A)-\frac{M}{Na} > R(1-q_B)-\frac{M}{N(1-a)} > R(1-q_B)-\frac{M}{Na+1} > c$ we have the following equilibria in the second stage of the game, taking p as given. For $c \leq p < R(1-q_B)-\frac{M}{Na+1}$, there are two continuation equilibria. In the first, all cluster firms engage in joint action, and in the second, all sell to the DC firm. For $R(1-q_B)-\frac{M}{Na+1} \leq p < R(1-q_A)-\frac{M}{Na}$, there are three possible pure strategy continuation equilibria. In the first, all cluster firms engage in joint action, and in the second, all sell to the DC firm. In the third continuation equilibrium, type A firms carry out a joint action initiative while the type B firms sell to the DC firm. For $R(1-q_A)-\frac{M}{Na} \leq p < R(1-q_B)-\frac{M}{N}$, there are two continuation equilibria. In the first, all cluster firms engage in joint action, and in the second, all sell to the DC firm. For $p = R(1-q_B)-\frac{M}{N}$ there is one continuation equilibrium where all cluster firms sell their goods to the DC firm.

9. For $R(1-q_B)-\frac{M}{N} > R(1-q_A)-\frac{M}{Na} > R(1-q_B)-\frac{M}{N(1-a)} > c > R(1-q_B)-\frac{M}{Na+1}$ then we have the following equilibria in the second stage of the game, taking p as given. For $c \leq p < R(1-q_A)-\frac{M}{Na}$ there are three pure strategy continuation equilibria. In the first, all cluster firms to engage in joint action, and in the second, all cluster firms sell to the DC firm. In the third pure strategy continuation equilibrium, type A firms carry out a joint action initiative and type B firms sell to the DC firm. For $R(1-q_B)-\frac{M}{Na} \leq p < R(1-q_B)-\frac{M}{N}$ there are two pure strategy continuation equilibria. In the first, all cluster firms to engage in joint action and in the second, all cluster firms sell to the DC firm. For $p \geq R(1-q_B)-\frac{M}{N}$, there is one continuation equilibrium where all cluster firms sell to the DC firm.

10. For $R(1-q_B)-\frac{M}{N} > R(1-q_A)-\frac{M}{Na} > c > R(1-q_B)-\frac{M}{N(1-a)} > R(1-q_B)-\frac{M}{Na+1}$ then we have the following equilibria in the second stage of the game, taking p as given.

For $c \leq p < R(1-q_A) - \frac{M}{N\alpha}$ there are three pure strategy continuation equilibria. In the first, all cluster firms to engage in joint action, and in the second, all cluster firms sell to the DC firm. In the third pure strategy continuation equilibrium, type A firms carry out a joint action initiative and type B firms sell to the DC firm. For $R(1-q_B) - \frac{M}{N\alpha} \leq p < R(1-q_B) - \frac{M}{N}$ there are two pure strategy continuation equilibria. In the first, all cluster firms to engage in joint action and in the second, all cluster firms sell to the DC firm. For $p \geq R(1-q_B) - \frac{M}{N}$, there is one continuation equilibrium where all cluster firms sell to the DC firm.

11. For $R(1-q_B) - \frac{M}{N} > c > R(1-q_A) - \frac{M}{N\alpha} > R(1-q_B) - \frac{M}{N(1-\alpha)} > R(1-q_B) - \frac{M}{N\alpha+1}$ we have the following equilibria in the second stage of the game, taking p as given.

For $c \leq p < R(1-q_B) - \frac{M}{N}$ there are two continuation equilibria. In the first, all cluster firms engage in joint action and in the second, all sell to the DC firm.

For $p \geq R(1-q_B) - \frac{M}{N}$, there is one continuation equilibrium where all cluster firms sell their goods to the DC firm.

12. For $R(1-q_B) - \frac{M}{N} > R(1-q_A) - \frac{M}{N\alpha} > R(1-q_B) - \frac{M}{N\alpha+1} > R(1-q_B) - \frac{M}{N(1-\alpha)} > c$ then we have the following equilibria in the second stage of the game, taking p as given.

For $c \leq p < R(1-q_B) - \frac{M}{N\alpha+1}$ there are two pure strategy continuation equilibria. In the first, all cluster firms engage in joint action and in the second, all sell to the DC firm.

For $R(1-q_B) - \frac{M}{N\alpha+1} \leq p < R(1-q_A) - \frac{M}{N\alpha}$ there are three pure strategy continuation equilibria. In the first, all cluster firms engage in joint action, and in the second, all sell to the DC firm. In the third pure strategy continuation equilibrium, type A firms carry out a joint action initiative and type B firms sell to the DC firm.

For $R(1-q_B) - \frac{M}{N\alpha} \leq p < R(1-q_B) - \frac{M}{N}$ there are two pure strategy continuation equilibria. In the first, all cluster firms to engage in joint action and in the second, all cluster firms sell to the DC firm. For $p \geq R(1-q_B) - \frac{M}{N}$, there is one continuation equilibrium where all cluster firms sell to the DC firm.

13. For $R(1-q_B) - \frac{M}{N} > R(1-q_A) - \frac{M}{N\alpha} > R(1-q_B) - \frac{M}{N\alpha+1} > c > R(1-q_B) - \frac{M}{N(1-\alpha)}$ then we have the following equilibria in the second stage of the game, taking p as given.

For $c \le p < R(1-q_B) - \frac{M}{N\alpha+1}$ there are two pure strategy continuation equilibria. In the first, all cluster firms engage in joint action and in the second, all sell to the DC firm. For $R(1-q_B) - \frac{M}{N\alpha+1} \le p < R(1-q_A) - \frac{M}{N\alpha}$ there are three pure strategy continuation equilibria. In the first, all cluster firms engage in joint action, and in the second, all sell to the DC firm. In the third pure strategy continuation equilibrium, type A firms carry out a joint action initiative and type B firms sell to the DC firm. For $R(1-q_B) - \frac{M}{N\alpha} \le p < R(1-q_B) - \frac{M}{N}$ there are two pure strategy continuation equilibria. In the first, all cluster firms to engage in joint action and in the second, all cluster firms sell to the DC firm. For $p \ge R(1-q_B) - \frac{M}{N}$, there is one continuation equilibrium where all cluster firms sell to the DC firm.

14. For $R(1-q_B) - \frac{M}{N} > R(1-q_A) - \frac{M}{N\alpha} > c > R(1-q_B) - \frac{M}{N\alpha+1} > R(1-q_B) - \frac{M}{N(1-\alpha)}$ then we have the following equilibria in the second stage, taking p as given.
For $c \le p < R(1-q_A) - \frac{M}{N\alpha}$, there are three pure strategy continuation equilibria. In the first, all cluster firms engage in joint action, and in the second, all sell to the DC firm. In the third pure strategy continuation equilibrium, type A firms carry out a joint action initiative and type B firms sell to the DC firm. For $R(1-q_B) - \frac{M}{N\alpha} \le p < R(1-q_B) - \frac{M}{N}$ there are two pure strategy continuation equilibria. In the first, all cluster firms to engage in joint action, and in the second, all cluster firms sell to the DC firm.
For $p \ge R(1-q_B) - \frac{M}{N}$, there is one continuation equilibrium where all cluster firms sell to the DC firm.

15. For $R(1-q_B) - \frac{M}{N} > c > R(1-q_A) - \frac{M}{N\alpha} > R(1-q_B) - \frac{M}{N\alpha+1} > R(1-q_B) - \frac{M}{N(1-\alpha)}$ then we have the following equilibria in the second stage of the game, taking p as given.
For $c \le p < R(1-q_B) - \frac{M}{N}$ there are two pure strategy continuation equilibria. In the first, all cluster firms engage in joint action, and in the second all cluster firms sell to the DC firm. For $p = R(1-q_B) - \frac{M}{N}$, there is one continuation equilibrium where all cluster firms sell to the DC firm.

C. For cases 16 – 21, the following hold: $R(1-q_B) - \frac{M}{N} > c$,

$R(1-\alpha)(\theta_B-\theta_A)-\frac{M}{N\alpha}\leq 0$, **and** $R(1-\theta_B)-\frac{M}{N}<R(1-\theta_A)-\frac{M}{N\alpha}$

16. For $R(1-\theta_A)-\frac{M}{N\alpha}>R(1-\theta_B)-\frac{M}{N}>R(1-\theta_B)-\frac{M}{N\alpha+1}>R(1-\theta_B)-\frac{M}{N(1-\alpha)}>c$ then we have the following equilibria in the second stage of the game, taking p as given. For $c\leq p<R(1-\theta_B)-\frac{M}{N\alpha+1}$ there are two pure strategy continuation equilibria. In the first, all cluster firms engage in joint action and in the second all cluster firms sell to the DC firm. For $R(1-\theta_B)-\frac{M}{N\alpha+1}\leq p<R(1-\theta_B)-\frac{M}{N}$ there are three pure strategy continuation equilibria. In the first, all cluster firms engage in joint action and in the second all cluster firms sell to the DC firm. In the third continuation equilibrium, type A firms carry out a joint action initiative and type B firms sell to the DC firm. For $R(1-\theta_B)-\frac{M}{N}\leq p<R(1-\theta_A)-\frac{M}{N\alpha}$, there are two pure strategy continuation equilibria. In the first, type B firms sell to the DC firm and type A firms carry out a joint action initiative. In the second continuation equilibrium, all cluster firms to sell to the DC firm. For $p\geq R(1-\theta_A)-\frac{M}{N\alpha}$ there is one continuation equilibrium where all cluster firms sell to the DC firm.

17. For $R(1-\theta_A)-\frac{M}{N\alpha}>R(1-\theta_B)-\frac{M}{N}>R(1-\theta_B)-\frac{M}{N\alpha+1}>c>R(1-\theta_B)-\frac{M}{N(1-\alpha)}$ then we have the following equilibria in the second stage of the game, taking p as given. For $c\leq p<R(1-\theta_B)-\frac{M}{N\alpha+1}$ there are two pure strategy continuation equilibria. In the first, all cluster firms engage in joint action and in the second all cluster firms sell to the DC firm. For $R(1-\theta_B)-\frac{M}{N\alpha+1}\leq p<R(1-\theta_B)-\frac{M}{N}$ there are three pure strategy continuation equilibria. In the first, all cluster firms engage in joint action and in the second all cluster firms sell to the DC firm. In the third pure strategy continuation equilibrium, type A firms carry out a joint action initiative and type B firms sell to the DC firm. For $R(1-\theta_B)-\frac{M}{N}\leq p<R(1-\theta_A)-\frac{M}{N\alpha}$ there are two pure strategy continuation equilibria. In the first, type A firms carry out joint action while type B firms sell to the DC firm, and in the second equilibrium all cluster firms sell to the DC firm. For $p\geq R(1-\theta_A)-\frac{M}{N\alpha}$ there is one continuation equilibrium where all cluster firms sell to the DC firm.

18. For $R(1-q_A)-\frac{M}{N\alpha} > R(1-q_B)-\frac{M}{N}$ >c> $R(1-q_B)-\frac{M}{N\alpha+1} > R(1-q_B)-\frac{M}{N(1-\alpha)}$ then we have the following equilibria in the second stage of the game, taking p as given. For $c \leq p < R(1-q_B)-\frac{M}{N}$ there are three pure strategy continuation equilibria. In the first, all cluster firms engage in joint action, and in the second all cluster firms sell to the DC firm. In the third pure strategy continuation equilibrium, type A firms carry out a joint action initiative and type B firms sell to the DC firm.
For $R(1-q_B)-\frac{M}{N} \leq p < R(1-q_A)-\frac{M}{N\alpha}$, there are two pure strategy continuation. In the first, type B firms sell to the DC firm and type A firms carry out a joint action initiative. In the second continuation equilibrium, all cluster firms to sell to the DC firm.
For $p \geq R(1-q_A)-\frac{M}{N\alpha}$ there is one continuation equilibrium where all cluster firms sell to the DC firm.

19. For $R(1-q_A)-\frac{M}{N\alpha} > R(1-q_B)-\frac{M}{N} > R(1-q_B)-\frac{M}{N(1-\alpha)} > R(1-q_B)-\frac{M}{N\alpha+1} > c$ then we have the following equilibria in the second stage, taking p as given. For $c \leq p < R(1-q_B)-\frac{M}{N\alpha+1}$, there are two pure strategy continuation equilibria. In the first, all cluster firms sell to the DC firm and in the second, all cluster firms carry out joint action. For $R(1-q_B)-\frac{M}{N\alpha+1} \leq p < R(1-q_B)-\frac{M}{N}$ there are three pure strategy continuation equilibria. In the first, all cluster firms sell to the DC firm, and in the second, all cluster firms carry out joint action. In the third, type A firms carry out joint action and type B firms sell to the DC firm. For $R(1-q_B)-\frac{M}{N} \leq p < R(1-q_A)-\frac{M}{N\alpha}$, there are two pure strategy continuation equilibria. In the first, type B firms sell to the DC firm and type A engage in joint action and in the second, all cluster firms sell to the DC firm. For $p \geq R(1-q_A)-\frac{M}{N\alpha}$ there is one continuation equilibrium where all cluster firms sell to the DC firm.

20. For $R(1-q_A)-\frac{M}{N\alpha} > R(1-q_B)-\frac{M}{N} > R(1-q_B)-\frac{M}{N(1-\alpha)}$ >c> $R(1-q_B)-\frac{M}{N\alpha+1}$ then we have the following equilibria in the second stage, taking p as given. For $c \leq p <$ $R(1-q_B)-\frac{M}{N}$ there are three pure strategy continuation equilibria. In the first, all cluster firms sell to the DC firm, and in the second, all cluster firms carry out joint action. In the third, type A firms carry out joint action and type B firms sell to the DC firm. For $R(1-q_B)-\frac{M}{N} \leq p < R(1-q_A)-\frac{M}{N\alpha}$, there are two pure strategy

continuation equilibria. In the first, type B firms sell to the DC firm and type A engage in joint action and in the second, all cluster firms sell to the DC firm.

For $p \geq R(1-q_A) - \frac{M}{N\alpha}$ there is one continuation equilibrium where all cluster firms sell to the DC firm.

21. For $R(1-q_A) - \frac{M}{N\alpha} > R(1-q_B) - \frac{M}{N} > c > R(1-q_B) - \frac{M}{N(1-\alpha)} > R(1-q_B) - \frac{M}{N\alpha+1}$ then we have the following equilibria in the second stage, taking p as given.

For $c \leq p < R(1-q_B) - \frac{M}{N}$ there are three pure strategy continuation equilibria. In the first, all cluster firms sell to the DC firm and in the second, all cluster firms carry out joint action. In the third, type A firms carry out joint action and type B firms sell to the DC firm. For $R(1-q_B) - \frac{M}{N} \leq p < R(1-q_A) - \frac{M}{N\alpha}$, there are two pure strategy continuation equilibria. In the first, type B firms sell to the DC firm and type A engage in joint action, and in the second, all cluster firms sell to the DC firm.

For $p \geq R(1-q_A) - \frac{M}{N\alpha}$ there is one continuation equilibrium where all cluster firms sell to the DC firm.

D. Cases 22 – 27: Joint action is potentially profitable for all firms, but the DC firm would earn negative profits if it were to offer type A firms what they would earn from joint action

For Cases 22 – 27, the following hold: $R(1-q_B) - \frac{M}{N} > c$ **and** $R(1-\alpha)(q_B - q_A) - \frac{M}{N\alpha} > 0$. The second inequality tells us that DC firm would earn negative profits if it were to offer type A firms $p = R(1-q_A) - \frac{M}{N\alpha}$

22. For $R(1-q_B) - \frac{M}{N(1-\alpha)} > R(1-q_B) - \frac{M}{N\alpha+1} > c$ then we have the following equilibria in the second stage of the game, taking p as given.

For $c \leq p < R(1-q_B) - \frac{M}{N\alpha+1}$ there are two pure strategy continuation equilibria. In the first, all cluster firms carry out joint action and in the second, all cluster firms sell to the DC firm. For $R(1-q_B) - \frac{M}{N\alpha+1} \leq p < R(1-q_B) - \frac{M}{N}$, there are three pure strategy continuation equilibria. In the first, all cluster firms sell to the DC firm and in the second, all cluster firms carry out joint action. In the third continuation equilibrium, type A firms carry out joint action and type B firms sell to the DC firm. For $p = R(1-q_B) - \frac{M}{N}$, there are two pure strategy continuation equilibria. In the first, type A firms carry out joint action and type B firms sell to the DC firm and in the second, all cluster firms sell to the DC firm.

23. For $R(1-q_B) - \frac{M}{N(1-a)} > c > R(1-q_B) - \frac{M}{Na+1}$ then we have the following equilibria in the second stage of the game, taking p as given.
For $c \le p < R(1-q_B) - \frac{M}{N}$ there are three pure strategy continuation equilibria. In the first, all cluster firms sell to the DC firm and in the second, all cluster firms carry out joint action. In the third, type A firms carry out joint action and type B firms sell to the DC firm. For $p = R(1-q_B) - \frac{M}{N}$, there are two pure strategy continuation equilibria. In the first, type A firms carry out joint action and type B firms sell to the DC firm and in the second, all cluster firms sell to the DC firm.

24. For $c > R(1-q_B) - \frac{M}{N(1-a)} > R(1-q_B) - \frac{M}{Na+1}$ then we have the following equilibria in the second stage of the game, taking p as given.
For $c \le p < R(1-q_A) - \frac{M}{N}$ there are three pure strategy continuation equilibria. In the first, type B firms sell to the DC firm and type A firms engage in joint action. In the second continuation equilibrium, all cluster firms engage in joint action. In the third, all cluster firms sell to the DC firm. For $p = R(1-q_A) - \frac{M}{N}$, there are two pure strategy continuation equilibria. In the first, all cluster firms sell to the DC firm and in the second, type B firms sell their goods to the DC firm and type A firms engage in joint action.

25. For $R(1-q_B) - \frac{M}{Na+1} > R(1-q_B) - \frac{M}{N(1-a)} > c$, then we have the following equilibria in the second stage of the game, taking p as given.
For $c \le p < R(1-q_B) - \frac{M}{Na+1}$ there are two pure strategy continuation equilibria. In the first, all cluster firms engage in joint action and in the second, all cluster firms sell to the DC firm. For $R(1-q_B) - \frac{M}{Na+1} \le p < R(1-q_A) - \frac{M}{N}$, there are three pure strategy continuation equilibria. In the first, all cluster firms engage in joint action. In the second, type B firms sell to the DC firm and type A firms engage in joint action. In the third, all

cluster firms sell to the DC firm. For $p = R(1-q_A) - \frac{M}{N}$, there are two pure strategy continuation equilibria. In the first, type B firms sell their goods to the DC firm and type A firms engage in joint action and in the second, all cluster firms sell to the DC firm.

26. For $R(1-q_B) - \frac{M}{N a + 1} > c > R(1-q_B) - \frac{M}{N(1-a)}$, then we have the following equilibria in the second stage of the game, taking p as given.
For $c \le p < R(1-q_B) - \frac{M}{N a + 1}$ there are two pure strategy continuation equilibria. In the first, all cluster firms engage in joint action and in the second all cluster firms sell to the DC firm. For $R(1-q_B) - \frac{M}{N a + 1} \le p < R(1-q_A) - \frac{M}{N}$, there are three pure strategy continuation equilibria. In the first, all cluster firms engage in joint action. In the second, type B firms sell to the DC firm and type A firms engage in joint action. In the third, all cluster firms sell to the DC firm. For $p = R(1-q_A) - \frac{M}{N}$, there are two pure strategy continuation equilibria. In the first, type B firms sell their goods to the DC firm and type A firms engage in joint action, and in the second, all cluster firms sell to the DC firm.

27. For $c > R(1-q_B) - \frac{M}{N a + 1} > R(1-q_B) - \frac{M}{N(1-a)}$ then we have the following equilibria in the second stage of the game, taking p as given.
For $c \le p < R(1-q_A) - \frac{M}{N}$, there are three pure strategy continuation equilibria. In the first, all cluster firms engage in joint action. In the second, type B firms sell to the DC firm and type A firms engage in joint action. In the third, all cluster firms sell to the DC firm. For $p = R(1-q_A) - \frac{M}{N}$, there are two pure strategy continuation equilibria. In the first, type B firms sell their goods to the DC firm and type A firms engage in joint action, and in the second, all cluster firms sell to the DC firm.

Appendix 4: Welfare Implications of Joint Action

A. Case 1: Joint action is potentially profitable for type A firms only

Case 1: $R(1-q_B)-\frac{M}{N}<c$ and $c<R(1-q_A)-\frac{M}{Na}$

If the coalition-proof equilibrium refinement is applied and $\frac{M}{N[R(1-q_A)-c]}\leq 1/4$, then for all $a\in(a_5,a_6)$, then type B firms receive $p=c$ selling to the DC firm, and type A firms earn $R(1-q_A)-\frac{M}{Na}$ - c in expected profits. In this case, type B firms receive the same level of welfare as when there is no possibility of joint action, type A firms are better off, and the DC firm is worse off.

$$E\Pi_A^{LDC}=R(1-q_A)-\frac{M}{Na}-c$$

$$\Pi_B^{LDC}=0$$

$$E\Pi^{DC}=N(1-a)[R(1-q_B)-c]$$

If the coalition-proof equilibrium refinement is applied and either i) $a_z\leq 1/4$ where $a\notin(a_5,a_6)$ or ii) $\frac{M}{N[R(1-q_A)-c]}>1/4$, the DC firm buys from all cluster firms at a price $p=R(1-q_A)-\frac{M}{Na}$. In this case, all cluster firms are better off, and the DC firm is worse off than if there were no possibility of joint action.

$$E\Pi_i^{LDC}=R(1-q_A)-\frac{M}{Na}-c \quad \text{for } i=A,B$$

$$E\Pi^{DC}=NR[a(1-q_A)+(1-a)(1-q_B)]-N\left[R(1-q_A)-\frac{M}{Na}\right]$$

B. Cases 2 – 15: Joint action is potentially profitable for both types of cluster firms, but it is not possible for the DC firm to only buy from type B firms

Cases 2 - 15:

$$R(1-q_B)-\frac{M}{N}>c,\; R(1-a)(q_B-q_A)-\frac{M}{Na}\leq 0,\text{ and } R(1-q_A)-\frac{M}{Na}<R(1-q_B)-\frac{M}{N}$$

Even if the coalition-proof equilibrium refinement is applied, the DC firm procures the goods of all cluster firms, paying $p=R(1-q_B)-\frac{M}{N}$ for their goods. In this case, the LDC firms are better off (and the DC firm is worse off) as a result of the opportunity for joint action. The firms receive:

$\Pi_i^{LDC} = R(1-q_B) - \frac{M}{N}$ -c where i=A,B; and

$$E\Pi^{DC} = NR[a(1-q_A)+(1-a)(1-q_B)] - N\left[R(1-q_B) - \frac{M}{N}\right]$$

C. Cases 16 – 21: Joint action is potentially profitable for both types of cluster firms, and it is possible for the DC firm to buy from all cluster firms or only buy from type B firms

For cases 16 - 21:

$R(1-q_B) - \frac{M}{N} > c$, $R(1-a)(q_B - q_A) - \frac{M}{Na} \le 0$, and

$R(1-q_B) - \frac{M}{N} < R(1-q_A) - \frac{M}{Na}$

If the coalition-proof equilibrium refinement is applied, for parameter values such that $\frac{M}{NR(q_B - q_A)} > \frac{1}{3}$, then no joint action takes place, and the DC firm pays $p = R(1-q_A) - \frac{M}{Na}$ to all LDC firms for their goods. In this case, the LDC firms are better off (and the DC firm is worse off) as a result of the opportunity for joint action. The firms receive:

$\Pi_i^{LDC} = R(1-q_A) - \frac{M}{Na}$ - c where i=A,B; and

$$E\Pi^{DC} = NR[a(1-q_A)+(1-a)(1-q_B)] - N\left[R(1-q_A) - \frac{M}{Na}\right]$$

Even though no joint action occurs, the cluster firms are better off and the DC firm is worse off than if there were no joint action option.

If the coalition-proof equilibrium refinement is applied, for parameter values such that $\frac{M}{NR(q_B - q_A)} < \frac{1}{3}$, then joint action happens with type A participation for $a \in (a_1, a_2)$.
The cluster firms are better off than if there were no possibility of joint action, and the DC firm is worse off.

$E\Pi_A^{LDC} = R(1-q_A) - \frac{M}{Na} - c$

$\Pi_B^{LDC} = R(1-q_B) - \frac{M}{N} - c$

$E\Pi^{DC} = N(1-a)R(1-q_B) - N(1-a)\left[R(1-q_B) - \frac{M}{N}\right]$. Even though no joint action occurs, the cluster firms are better off and the DC firm is worse off than if there were no joint action option.

D. Cases 22 – 27: Joint action is potentially profitable for all firms, but the DC firm would earn negative profits if it were to offer type A firms what they would earn from joint action

For cases 22 - 27:

$R(1-q_B) - \frac{M}{N} > c$, $R(1-a)(q_B - q_A) - \frac{M}{Na} > 0$

If the coalition-proof equilibrium refinement is applied, then joint action takes place with the participation of type A firms and the DC firm buys the output of the type B firms at $p = R(1-q_B) - \frac{M}{N}$. The cluster firms are better off than if there were no possibility of joint action, and the DC firm is worse off.

$E\Pi_A^{LDC} = R(1-q_A) - \frac{M}{Na} - c$

$\Pi_B^{LDC} = R(1-q_B) - \frac{M}{N} - c$

$E\Pi^{DC} = N(1-a)R(1-q_B) - N(1-a)\left[R(1-q_B) - \frac{M}{N}\right]$.