Introduction to Clusters of Firms in Developing Countries

In recent years, there has been an increase in interest in clusters of small firms in developing countries. They have been viewed optimistically as a source of growth in developing countries, especially for small firms.

Clusters consist of firms which are sectorally specialized and geographically clustered, and often consist of firms of various sizes. Young clusters are mostly composed of small firms. Among the more mature clusters, though, it is common for there to exist medium-sized and large firms.

There are a growing number of case studies detailing the characteristics and growth paths of clusters in developing countries. These case studies provide one with a wealth of information about the functioning of clusters, but more fundamentally it displays the prevalence of clusters across sectors and countries. Among the clusters that have been studied include Sinos Valley, Brazil (shoes), Tiruppur, India (knitwear), Ludhiana, India (knitwear), Eastlands, Kenya (garments), Kamukunji, Kenya (metal products), Ziwani, Kenya (vehicle repair), Lake Victoria (fish), Suame, Ghana (vehicle repair and metal work), Western Cape, South Africa (clothing), Guadalajara and Leon, Mexico (shoes), Agra, India (knitwear), Gamarra (Lima), Peru (clothing), and Sialkot, Pakistan (surgical instruments).

The major characteristics of the industrial model, as described in Rabellotti (1995) are:

- geographically clustered small and medium sized firms which are sectorally specialized
- forward and backward linkages based on market and non-market exchanges of goods, information, and people
- common cultural and social background linking economic agents and creating a behavioral code, sometimes explicit but often implicit

- network of public and private local institutions supporting the economic agents acting within the cluster

It is important to notice that production does not take place within one firm. Various separate firms carry out the production process, which includes input production, manufacturing, and complementary services. This displays the need for cooperation to take place between firms for production to take place.

There are various perceived benefits from clustering. The notion that small firms could benefit from clustering is not a new idea. Alfred Marshall, in his *Principles of Economics,* recognized that the grouping together of firms involved in related activities resulted in positive externalities such as a pool of specialized workers, access to various suppliers of specialized inputs and services, and rapid diffusion of information. Other perceived benefits of clustering are that it helps firms to grow in "riskable steps."[1] Since clusters consist of manufacturers as well as suppliers focussed on specialized inputs, a firm starting up within the cluster can start small and focus on a particular stage of the production process or producing a single specialized input for other firms. This significantly reduces start-up costs and lowers barriers to entry.

One must distinguish between two kinds of collective efficiency that clusters may enjoy. Passive collective efficiency refers to benefits that accrue to firms by virtue of being part of a cluster. Each article about clusters presents a slightly different list, but the "passive" benefits of clustering can be summarized as follows. Firms in clusters often benefit from *market access,* referring to the fact that clusters often attract the attention of buyers which improves the chances for firms to sell their products. As a result of the large number of firms operating in the same geographical area, firms have access to a large *pool of (usually skilled) labor*. *Technological spillovers* may occur because technical information can be easily diffused among producers.

Specialization and division of the production process by phases leads to *flexibility* which allows firms to take advantage of different economies of scale afforded at different stages of production. This flexible specialization also leads to higher social welfare when firms face idiosyncratic demand uncertainty, as described by Kranton and Minehart.[2] There is also potential for *reduced transaction costs* within the cluster due to the availability of alternate suppliers, repeated interactions between firms, and ease of conveying information on cheaters. On the other hand, *active* collective efficiency stems from joint action taken by the firms of the cluster. Many clusters have associations whose purpose is to support the cluster. The associations may help or hinder cooperation within the cluster.

The Pressures of Globalization

Most clusters have experienced some type of crisis or challenge in recent years. This challenge has taken various forms. In the case of Sialkot (surgical instruments), it came in the form of FDA restrictions on imports due to quality concerns. For other clusters, the challenge was increased global competition. Clusters of shoe producers in Brazil and Mexico have both had to deal with increased international competition. In the case of the Indian knitwear clusters, it was the loss of the Soviet market and the need to search for new export markets.

Upgrading

One can think of three ways that individual firms or clusters may upgrade. First, firms may engage in *process upgrading*, which consists of reducing costs either by re-organizing production or by implementing new technology. The second type of upgrading is

[1] Schmitz and Nadvi, pg. 1503.
[2] "Networks versus Vertical Integration" (2000)

referred to as *functional upgrading*, leading to a greater involvement of (manufacturers) firms in the design and marketing process. The last category of upgrading, *product upgrading*, entails producing more sophisticated (higher value-added) goods.

The first type of upgrading, process upgrading, involves a transformation of firms' relationships with their suppliers. This type of upgrading may also be referred to as vertical cooperation. Upgrading may take the form of introducing new production technologies (such as new machines) or may be a reorganization of production relationships using the same production technology. Whatever form the upgrading takes, the desired result is generally higher and more reliable quality and shorter delivery times in the processing of orders which often come from foreign buyers.

The second and third type of upgrading may necessitate joint action or horizontal cooperation between the firms of the cluster. This is especially true in the case of clusters because most of the firms are too small to make the necessary investments to carry out the activities of product development, marketing, and retailing individually. One must also add to the equation the fact that international buyers are already established members of the market structure. Joint action by the cluster to break into the activities traditionally carried out by foreign buyers is likely to be opposed by the international buyers from developed countries.

Case Studies:

There have been various case studies concerning networks of firms in developing countries. The following summaries of the case study literature will include the following.

1. Basic characteristics of cluster
2. What crisis has cluster experienced?
3. What is the nature of vertical cooperation and did it change after the crisis?

4. What is the nature of horizontal cooperation/joint action and did it change after the crisis?

5. What is the nature of relationship with buyers?

Brazil

Schmitz (1995) carried out a similar study, in an attempt to discern whether Brazilian shoe producers followed the pattern of the Italian "industrial district" framework. The Sinos Valley of Brazil contained not only 400 shoe firms, but also additional firms that functioned to provide inputs, marketing, and other special services had also developed.[3] Shoe production was characterized in the Sinos Valley as taking place (in most instances) in stages that were carried out in different firms.[4] There were some firms that were vertically integrated, though.

There were numerous positive consequences of the geographic clustering. There was widespread division of labor and specialization. The procurement of specialized products and services took place at short notice. Suppliers emerged to provide various goods such as raw materials, components, machinery, and spare parts. Specialized agents appeared to sell goods at long distances, or provide technical, financial, or accounting services.[5] Some of the technical services included freelance designers, consultants, and transport services.[6]

Informal contacts were also deemed important in the Brazilian cluster, as information was said to have been diffused among friends, family, neighborhood, and church.[7]

Since the late 1980s, the Sinos Valley shoe cluster has had to deal with changes in the external environment that have involved great challenges for the cluster. One of these challenges has been increased global competition from China for U.S. buyers. U.S. imports

[3] Schmitz (1995) pg. 9.
[4] Ibid, pg. 17.
[5] Ibid, pg. 11.
[6] Ibid, pg. 12.
[7] Ibid, pg. 12.

from China have grew 17 fold between 1987 and 1997.[8] At around the same time, U.S. retailers began to place smaller orders so that they could maintain smaller inventories. In addition, high inflation in Brazil forced firms to turn attention to short-run financial management, and the end of inflation in the form of a currency anchored in the U.S. dollar led to a fall in exporters' receipts.[9] The next two statistics are not being presented as hard evidence, rather they are more casual evidence of a general trend. Despite rising quality, shorter delivery times, and smaller batches (to satisfy retailers' demand for smaller inventory), the average price received by Brazilian firms (in constant dollars) between 1989 and 1997 was lower (except for 1995-1996) than the average price in 1988.[10] Also, according to a survey of 65 firms, more than 80% reported stagnant or falling profits between 1992 and 1997.[11]

Case study evidence seems to support an increase in vertical cooperation, that is, cooperation between shoe manufacturing firms and suppliers of leather and soles. In the survey of 65 firms, an average of over 60% of firms reported greater cooperation with suppliers in matters of information/experience exchange, improving quality, and speeding up delivery.[12]

A major attempt at horizontal cooperation failed in the cluster. An initiative called the "Shoes from Brazil Programme" intended to take action on marketing abroad and in Brazil, reorganization at the firm level, and improving relationships within the supply chain.[13] The initiative failed because the largest five exporting firms (which were vertically integrated and had a close relationship with the largest U.S. buyer) were opposed to the plan. They

[8] Schmitz: (1998), pg. 11.
[9] Schmitz: (1998), pg. 11.
[10] Schmitz: (1998), pg. 12.
[11] Schmitz: (1998), pg. 15.
[12] Schmitz: (1998), pg. 16.
[13] Schmitz: (1998), pg. 31.

undermined the joint action initiative by exerting their influence in the shoe manufacturer's association, Abicalcados.[14]

Pakistan

A cluster of firms in about 300 producers and 1500 subcontracting firms Sialkot, Pakistan, produce surgical instruments and exporting $100 million worth of goods in 1992-1993. Sixty percent of exports are destined for the United States. Other markets include Western Europe.

The cluster faced a crisis situation when the United States' FDA (Food and Drug Administration) restricted imports in 1994 of surgical instruments from Pakistan because they did not meet quality assurance standards (such as ISO 9000). These quality assurance qualifications assure the implementation of standardized and accountable quality control processes at each stage of the production process, including design, development, manufacture, and distribution.[15]

The crisis had implications both for manufacturer-supplier relationships as well as buyer-manufacturer relations. The transformation in manufacturer-supplier relations is more obvious. In order to comply with quality assurance at each stage of production, cooperation would be necessary. Some firms hired consultants themselves to help them gain the required quality assurance standards. Eventually, the cluster convinced the government to hire consultants help the firms gain certification on a wider scale. In this case, joint action on the part of the cluster was successful.

Some Common Characteristics of the Clusters

[14] Schmitz: (1998), pg. 34.
[15] Nadvi (1999), pg. 1606.

It most cases it appears to be the larger firms in the cluster that export goods.[16] Also, the larger firms tend to be more vertically integrated.

Manufacturing firms learn about organization of production, quality control, and technology from foreign and domestic buyers.[17]

Global Commodity Chain Analysis

Global Commodity Chain (GCC) or global value chain analysis takes into account the fact that the design, production, and marketing of products is a chain of activities that do not necessarily occur in the same location. In some cases, such as the ones examined here, the value chain extends across national borders. Developing country clusters are often part of a "buyer-driven commodity chain", as defined by Gereffi. According to him,

> Buyer-driven commodity chains refer to those industries in which large retailers, marketers, and branded manufacturers play the pivotal roles in setting up decentralized production networks in a variety of exporting countries, typically located in the third world. This pattern of trade-led industrialization has become common in labor-intensive, consumer goods industries such as garments, footwear, toys, housewares, consumer electronics and a variety of handicrafts. Production is generally carried out by tiered networks of third world contractors that make finished goods for foreign buyers. The specifications are supplied by the large retailers or marketers that order the goods…these companies design and/or market-but do not make-the branded products they order. They are part of a new breed of 'manufacturers without factories' that separate the physical production of goods from the design and marketing stages of the production process.[18]

The implication in the previous quote is that developed country firms "govern" or basically exercise control over the global commodity chain. The question then arises, do the buyers (usually from developed countries) control the value chain to an extent that inhibits upgrading of the cluster?

[16] Mexico: Rabellotti (1999), pg. 1578.
[17] Mexico: Rabellotti (1999), pg. 1577-1578.
[18] Gereffi (1999), pg. 4.

Model I:

This model looks at the relationship between developing country firms (LDC firms) in a cluster and developing country firms (DC firms) that purchase manufactured goods from LDC firms. The question that I wish to examine is: How does the market structure of the DC firms affect the LDC firms' ability to upgrade into design, marketing, and branding? This is an issue for clusters of firms because usually they are too small to individually undertake these activities, and therefore would have to engage in some form of joint action (in other words horizontal cooperation between manufacturers) in order to do so.

$F(Q;\theta_i)$ is the distribution of quality for LDC (Less Developed Country) firm i.

θ is a mean preserving spread of the distribution *F(Q)*. For $\theta_i > \theta_j$, $F(Q;\theta_j)$ is a mean preserving spread of $F(Q;\theta_i)$. This means that:

i) $F(Q;\theta_j)$ second order stochastically dominates $F(Q;\theta_i)$ and

ii) $E(Q,\theta_j) = E(Q;\theta_i)$.

If $F(Q;\theta_i)$ is a mean preserving spread of $F(Q;\theta_j)$, then we can find a random variable, Z,

with $E(Z \mid Q) = 0$ for all Q such that $F(Q;\theta_i) = F(Q + Z;\theta_j)$

Therefore with a mean preserving spread (meaning a higher value of θ), the expected value of *Q, E(Q)* does not change, but the distribution becomes more spread out.

A DC (Developed Country) firm announces a price p^A and a minimum quality level, Q^{MIN}. Then, each LDC firm decides whether it is willing to produce at that price and quality level. The DC firm buys output from the LDC firms that agreed to produce for them, and pays each LDC firm according to the quality of each LDC firm's product. An LDC firm receives the announced price, p^A , if the quality of their good is at least Q^{MIN} or else they receive a proportion of the announced price if quality falls short of the minimum level. That is, each LDC firm receives:

p^A if $Q > Q^{MIN}$ or

$\frac{p^A Q}{Q^{MIN}}$ if $Q < Q^{MIN}$

where Q^{MIN} is a minimum quality standard. For now, the focus will be on the price that the DC firm offers and its effects rather than on the minimum quality level set.

The cost of production is *c* for the LDC firm. As one can see in figure 1, the LDC firm's profit function is non-decreasing but concave in quality. Q^{MIN} must be strictly less than *E(Q)* because an LDC firm, with risk aversion due to concavity of profits in *Q*, would never accept a less than fair bet.

For an LDC firm:

$$E(\Pi_i^{LDC}) = \int_0^{\infty} \min\left(\frac{p^A Q}{Q^{MIN}}; p^A\right) f(Q;\theta_i)dQ - c = \int_0^{Q^{MIN}} \frac{p^A Q}{Q^{MIN}} f(Q;\theta_i)dQ + p^A[1 - F(Q^{MIN};\theta_i)] - c \quad (1)$$

Different LDC firms have different values of θ.

$$\frac{\partial E(\Pi_i^{LDC})}{\partial \theta} < 0 \quad (2)$$

because $E(\Pi_i^{LDC})$ is concave. (Proof in Appendix)

For given values of p^A and Q^{MIN}, $\hat{p}^A$, $\hat{Q}^{MIN}$, $\hat{\theta}$ is implicitly defined by the following expression:

$$E(\Pi_i^{LDC}) = \int_0^{Q^{MIN}} \frac{\hat{p}^A Q}{\hat{Q}^{MIN}} f(Q;\hat{\theta})dQ + \hat{p}^A[1 - F(\hat{Q}^{MIN};\hat{\theta})] - c = 0 \quad (3)$$

$\hat{\theta}$ is the critical value of θ. Only those firms with $\theta \le \hat{\theta}$ are willing to accept the contract from the DC firm. Therefore, the firms that are most likely to export are those with low θ. The firms that do not export sell their goods at p = c, and they have zero profits.

Why should firms in LDC's be modeled this way?

For a given cost of production (which is the same for all firms), firms with low θ have a lower variance of quality, that is, they produce an average quality level more reliably. Firms with lower θ may be view in some respects as being more efficient, although this is not a standard interpretation of efficiency. According to Clerides, Lach, and Tybout (1998), exporting firms

from developing countries are not more efficient because of "learning by exporting" but because the more efficient firms self-select into the export market.[19]

What is the relationship between the price offered by a DC firm (p^A) and the type of LDC firm willing to take the contract?

Using the Implicit Function Theorem, $\frac{d\hat{\theta}}{dp^A} = -\frac{E\Pi^{LDC}_{p^A}}{E\Pi^{LDC}_{\theta}}$

$$E\Pi^{LDC}_{p^A} = \frac{\partial E\Pi^{LDC}}{\partial p^A} = \int_0^{Q^{MIN}} \frac{Q}{Q^{MIN}} f(Q;\theta_i)dQ + [1 - F(Q^{MIN};\theta_i)] > 0 \qquad (4)$$

Since it was established in (2) that $E\Pi^{LDC}_{\theta} < 0$, then $\frac{d\hat{\theta}}{dp^A} > 0$. This means that by raising the price offered to the LDC firm, the value of the critical θ, $\hat{\theta}$ rises. With firms' decisions modeled this way, the export supply function is upwardly sloped.

The price offered by a DC firm, along with the distribution of θ in the cluster will determine the quantity of goods that the cluster is willing and able to produce for DC firms. Therefore the total quantity of goods, *n*, that the cluster is willing to produce for DC firms is $n = NG(\hat{\theta}(p^A))$, where *N* is the total number of firms in the cluster, and $G(\theta)$ is the distribution of θ in the cluster.

[19] Clerides, Lach, and Tybout, "Is Learning by Exporting Important? Micro-dynamic Evidence from Colombia, Mexico, and Morocco," 1998.

Case I: A Single DC Firm and Multiple LDC Firms

For now, I will look at the relationship between the cluster of LDC firms and a single DC firm buying output from the cluster. I will suppose that there is some barrier to entry so that only one DC firm is permitted to buy from the cluster.

The cost for the DC firm is the price it pays to the LDC firm. The DC firm can sell output for $P(Q) = R*\overline{Q}$, where R is the mark-up and $\overline{Q}$ is the average quality of the goods they purchase.

The expected profits accruing to the DC firm (if there is only one firm) are:

$$E(\Pi^{DC}) = NG(\hat{\theta}(p^A))\left[RE(Q) - p^A\right]$$

The DC firm expects to pay p^A to each LDC that accepts the contract because the expected quality from each LDC producer is $E(Q) > Q^{MIN}$. Since a mean preserving spread does not affect the mean of a distribution, E(Q) does not depend on $\hat{\theta}$. If R is determined by market conditions in the DC firm's home country, then the DC firm maximizes:

$$\max_{p^A} E(\Pi^{DC}) = NG(\hat{\theta}(p^A))\left[RE(Q) - p^A\right]$$

$$FOC: \frac{\partial E(\Pi^{DC})}{\partial p^A} = Ng(\hat{\theta}(p^A))\frac{d\hat{\theta}}{dp^A}[RE(Q) - p^A] - NG(\hat{\theta}(p^A)) = 0$$

(5)

$$SOC: \frac{\partial^2 E(\Pi^{DC})}{\partial (p^A)^2} = g'(\hat{\theta}(p^A)) * \left(\frac{d\hat{\theta}}{dp^A}\right)^2 - 2g(\hat{\theta}(p^A))\frac{d\hat{\theta}}{dp^A}$$

(6)

The second order conditions are satisfied if $g'(\hat{\theta}(p^A)) \leq 0$ or if

$\{ g'(\hat{\theta}(p^A))(RE(Q) - p^A)\frac{d\hat{\theta}}{dp^A} < 2g(\hat{\theta}(p^A)) \}$ ←I don't think this is necessary, because for most distributions, $g'(\hat{\theta}(p^A)) \leq 0$ should hold.

The expected profit per unit, $RE(Q) - p^A$ is equal to:

$$RE(Q) - p^A = \frac{G(\hat{\theta}(p^A))}{g(\hat{\theta}(p^A)) * \frac{d\hat{\theta}}{dp^A}} \quad (7)$$

Opportunities for Joint Action Among Cluster Firms

How can the firms of the cluster upgrade into designing new products, marketing, and finding new customers given the framework described above? This type of upgrading is likely to involve a significant investment on the part of the firms in the cluster. This may be a difficult activity to carry out for various reasons. First, one of the benefits of clustering described in the literature is the ability to do things in small and riskable steps. Secondly, DC firms that may be controlling the value chain will likely try to oppose this development. Third, since most of the firms in the cluster are small and medium size, upgrading into marketing and design will require investment from all of the firms. Each of the firms individually are too small to do this themselves.

In the first example, I will suppose that joint action takes the following form. Joint action requires an investment of M. This investment in joint action, M, may be used for creating new production designs and marketing the cluster's products. A majority of firms must agree for the joint action to occur. If a majority of firms agree to the joint action plan, then each firm receives R*E(Q) as the price for their manufactured good. There is no uncertainty about the success of the the plan once a majority of the LDC firms agree to it. Effectively the DC firm has been cut out, and the LDC firms receive the full benefit from design, production, and marketing.

For the joint action to succeed, greater than one-half of the LDC firms must agree to the project. I will assume for simplicity that if only half of the LDC producers agree to joint action, it will not take place.

The DC firm would prefer that the joint action plan not take place, because its profits would be zero if the joint action plan succeeded. There are certain conditions under which the DC firm can defeat the joint action initiative. The LDC firm with the median θ, θ^m, will decide the outcome of the "vote" on whether or not joint action occurs, regardless of which firms were previously selling to the DC firm under the status quo described at the beginning of the model. Recall that the expected profits accruing from selling to the DC firm decrease with θ since $E(\Pi_i^{LDC})$ is concave. Then, the benefits to joint action increase with θ. If the median θ firm opposes joint action, then all LDC firms with $\theta < \theta^m$ will also oppose the joint action proposal.

The DC firm's response to the joint action vote will focus on convincing the median θ^m to oppose the plan. The median LDC firm will oppose the joint action plan if:

$$\int_0^{Q^{MIN}} \frac{p^A Q}{Q^{MIN}} f(Q;\theta^m)dQ + p^A[1 - F(Q^{MIN};\theta^m)] - c \geq R * E(Q) - M - c$$

The offered price must rise as M falls. The maximum price that the DC firm will offer to the LDC firms is p^A=R*E(Q). At this offered price, the DC firm is indifferent between buying or not buying from the cluster. With this information, the critical level of M can be solved for. This critical M, $\overline{M}$, is the minimum level of M for which the DC firm can defeat the joint action initiative.

$$R*E(Q)-R*E(Q)F(Q^{MIN};\theta^{m})+\int_{0}^{Q^{MIN}}\frac{R*E(Q)Q}{Q^{MIN}}f(Q;\theta^{m})dQ\geq R*E(Q)-\overline{M}\ \text{ or}$$

$$\overline{M}\geq R*E(Q)F(Q^{MIN};\theta^{m})[\frac{Q^{MIN}-1}{Q^{MIN}}]$$

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