Networks of Small Producers for Technological Innovation: Some Models

Pankaj Chandra

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Pankaj Chandra
Operations & Technology Management and
Centre for Innovation, Incubation & Entrepreneurship (CIIE)
Indian Institute of Management
Vastrapur, Ahmedabad 380015, India
chandra@iimahd.ernet.in
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Abstract

Small producers face a variety of challenges - some related to markets and others related to capabilities. Inability to develop technological capabilities has often restricted small firms from growing large. In this paper, we present learning from three global networks , i.e., TAMA in Japan, Wenzhou in China and Rajkot in India, that have adopted a variety of mechanisms of coordination between small producers and has led to both capability enhancement and demand enhancement. We argue that the capability enhancement effects play as significant a role as demand enhancement effects in the growth of small firms. Coordination that allows firms to improve their capabilities enhances both productivity as well as innovative capabilities to develop new products and processes. The paper, with the help of these three case studies, presents a generic model for SME development that is based on acquiring distinctive capabilities and linkages with other small producers or other members of the supply chain. We propose distinctive determinants of a collaborative model for engaging SMEs in technological innovation over a period of time. These are : Focus of the Firm, Interactive Producers, Processing and Product Manufacturing, Innovation Investment, Markets, Market Makers (and market making processes), and Regulatory Support.

Introduction

Small producers, especially in emerging economies, face a challenge of becoming part of a capability driven economy. While large firms internalise many of the costs associated with developing capabilities to meet the requirements of the market, small producers do not possess the scale needed drive such activities internally. In addition, they face coordination failures due to a variety of reasons: inability to build capabilities that may be required to develop market driven products, inability to develop channels of distribution, unable to become part of existing supply chains, unable to procure technology at discounted prices, unable to develop new processes to overcome cost barriers in the market etc. Most simply do not have access to complementary resources needed to run their business effectively. Scarcity of working capital also means that many investments required to enhance the product quality, lead times and productivity is not available to them easily. Moreover, the overwhelming power of high channel members vis-à-vis SMEs forces these producers to sell at razor thin margins. This may get exaggerated when the market for the products produced by SME is not located in the vicinity of production units.

Small producers, especially those that might be categorized as tiny or even home workers struggle to become part of market driven production and distribution networks. As a result, opportunities to learn about new products required by the market, efficient processes and effective practices are limited. Their small size, often, limits the requirements of key raw materials hence their inability to negotiate a good price or favourable delivery schedules. As a result, their supply chain becomes extremely fragmented both in terms of supply of intermediates as well as the demand from the market. This one characteristic, i.e., requirement to develop the supplier base simultaneously while developing the customer base, leads to poor conversion of opportunities in emerging markets (Chandra and Tirupati, 2003). Overcoming these challenges requires understanding the logistics of supply as well as the process of accessing capabilities.

In this paper, we explore alternative models of organizing small producers to facilitate improvements in productivity and innovation on product, process and practice related domains. These models illustrate formation and operation of various kinds of networks that help reduce the market failures that small producers face and point towards mechanisms used to coordinate activities of a large numbers of small producers.

2. Challenges facing Small Producers

One of the unique features of modern manufacturing in India has been the dilemma of strategic positioning of SMEs. SMEs desire to become ancillary producers of large plants whereby they can get stable demand (which implies a homogeneous product mix) but where the economics of production favours a large supplier. On the other hand, the role of SME as an innovative job shop (where the SMEs have both cost and capabilities related advantage) is something that small producers shy away from. This issue of strategic positioning is at the heart of many challenges that small firms face. Whether to focus on customization or be tied to a single customer for a guaranteed volume. Often small producers start by developing a new/innovative product or a processes but struggle to develop a lead second or a third equally innovative product/process. In the industrial environment, one finds that many of these small producers are technically sophisticated and highly capable of innovating but constrained for resources. As can be seen from Table 1, the kind of manufacturing environment that supports this capability is a job shop and not an assembly line or a continuous process. In other words, SMEs have a natural cost and technological advantage (which they normally do not exploit) to provide customized service as opposed to large producers (i.e., scope advantage as opposed to scale). Because of their inability to overcome many of the market & capability failures, many desire to become ancillaries of large units (i.e., batch process units without the advantage of scale) rather than becoming producers of variety (i.e., job shops). It become nigh impossible for them to have costs lower than scale producers – a highly price sensitive domestic market penalizes them in the medium and long run and shifts the balance of channel power away from them.

The above highlights the need faced by SMEs to identify areas of innovation that have market value. Those that are able to either secure support from potential customers or are able to pursue opportunities with sustained development or are able to ride the wave with extraordinary process capabilities, turn successful. A related pathology for SMEs is their inability to access markets and the absence of credible market makers. While there have been agents in various sectors of industry, especially the textiles, they have not been able to span the entire supply chain or match innovative capabilities with customer requirements (the exception, however, are the "impanatores" or the market-makers of Italy who source specific weaving, spinning or garmenting capabilities of small producers in the Prato region of Florence and Pistoia provinces to match requirements of different orders from all over.

Nature of Production Process (examples)	**Product Characteristic**	**Process Characteristic**
Job Shop (machine shop, garage, tailor etc.)	Small volume, large variety	Process based layouts, general purpose machines, flexible, requires innovative skills, non-standard tasks, economies of scope
Batch Process (apparel production, paint shop, press shop etc.)	Mid-size volume, mid-size to low variety	Process and product based layout, special & general purpose machines
Assembly Line (car assembly, electronic goods assembly etc.)	Large volume, very low variety, standard product, discrete parts	Product based layout, special purpose machines at each assembly centre, high throughput, requires process discipline, repetitive tasks, economies of scale
Continuous Process (paper, fertilizer, chemicals etc.)	Large volumes, very low variety, standard product	Product based layout, high process control, dedicated pipelines or transport systems, high throughput, process control, economies of scale

Source: Adapted from Hayes and Wheelwright, 1979

Table 1: The Product-Process Matrix

the world (Jaikumar, 1986)) . Many of these agents lost credibility over the years both due to their inability to deploy new practices (or technology) in their business to make the interface efficient for their customers as well as due to their non-transparent business practices.

There does not exist a strong eco-system of process and product manufacturing for SMEs in India. Clusters, though developed in several parts of the country, do not have firms that cover the entire technology supply chain. These are firms of similar type who come together to share some common facilities, e.g., access to common affluent treatment plant in a cluster of chemical plants. Industrial estates have simply become geographical agglomerates of non-interacting firms. The network of capabilities continues to remain incomplete within the cluster. It is often difficult to locate producers who will provide distinctive process support. For example, it is believed that the range of capabilities that exist in the famous Ota ward of Tokyo is so diverse and sophisticated that if one drops any blueprint there is surely going to be some SME that will have process capabilities to develop it. Such an eco-system is largely missing in India.

Regulatory support for SMEs involved in innovative activity has not taken into account some peculiar problems faced by them. Innovation funding is still scarce especially at the seed and prototyping stages. Availability of high quality material in very small volumes or versatile job shop like units that will process a variety or jobs or materials or advanced testing facilities is quite

scarce. The general R&D orientation of these small firms (which should be their natural forte) is weak at best.

The innovator-entrepreneur plays the role of a super-manager – managing the internal processes, markets & channels, finances & accounting as well as getting the requisite permissions from regulatory authorities etc. – a role that leaves the innovator little time and resource to develop their technological and managerial innovations any further. Many of these challenges drive the enterprise towards survival rather than growth driven strategies and these disabling efforts take these firms away from becoming technological leaders in the industry – a goal with which many enterprises had been started.

The task before managers and policy makers is to design structures and strategies aimed at removing hurdles that distract producers from innovating and improving their productivity. In what follows, we present three innovative models of cooperation that have tried to overcome many of the challenges discussed above. These examples are:

- The TAMA Network of Japan
- The Wenzhou Industrial Development Model in China
- The Engineering Network of Rajkot in India

Each of these cases presents an interesting perspective on organizing small producers in some formal or informal network successfully. Next, we discuss key elements of these models and highlight the common characteristics.

3. The TAMA Network of Japan[1]

TAMA stands for Technology Advanced Metropolitan Area – an area in Japan that has produced a large number of innovative products and processes through linkages between a large number of small and a few large producers. The TAMA region, an inland industrial area, covers an area of approximately 3,000 sq km, spans 74 municipalities and is home to over 10 million people of which 4 million work in the TAMA network firms. Geographically, TAMA region today comprises the southwestern region of the Saitama prefecture (including Kawagoe, Sayama, Tokorozawa, Iruma, and Hanno), parts of Tokyo (includes cities like Hachioji and excluded 23 wards of Tokyo), and the central part of Kanagawa prefecture (Shonan area including Sagamihara and Fujisawa) – all comprising the adjoining prefectures of the Greater Kanto Region. Interestingly, two key highways, the Ken-O-Do Expressway and Route 16 run parallel, connecting the entire length of TAMA region. In 1998, the value of goods shipped from TAMA region was US$214 billion. As a comparison, the total value add of all firms in Japan was US$1083.883 billion while TAMA's contribution to it was US$81.862 billion. The same figure for Holland, for example, was US$63.89 billion. The total Value add per worker were US$116,447 for TAMA (as compared to US$110,1184 for all of Japan, US$94,970 for USA and US$58,260 for Germany). In the same year, TAMA had twice the shipment value of the Silicon Valley (TAMA Document, 2004). Lets now look at how such a successful performance emerged from small firms.

TAMA's roots are in the textile industry of Hachioji city in the Tokyo prefecture. By 1930 with war preparations underway, these firms joined the production of arms and related products – airplane parts, measuring instruments and armaments – they also moved away from Central Tokyo and the Keihin Bay Area to what is TAMA region now. It can be hypothesized that the high conformance quality of Japanese manufacturing stems from the stringent requirements of and experience in the measuring instruments and the armament industries. TAMA region along with the Ota Ward of Tokyo emerged as centres of excellence in commercial engineering and processing of metals. With the end of World War II these armament factories transformed

[1] Based on field work in Japan during summer of 2004.

themselves to producing non-military goods (in diversified sectors like instrumentation, electronics, machine control, metal processing, machinery of all types etc.). Many workers with advanced technical skills in design, control, instrumentation etc. started their own firms in TAMA – a transformation of engineers into entrepreneurs took place. By 1950 Japan had seen tremendous industrial growth especially in the Tokyo bay area. The government passed laws to reduce congestion & pollution in Tokyo thereby forcing many firms here to shift base to the neighbouring TAMA region. Subsequently, large firms started to setup their R&D centres in TAMA while moving their mass production units to other regional locations (including outside Japan in 1980s and 90s). Many high-skilled employees of large firms like NEC, Toshiba, Fujitsu, Nissan, Yokogawa Electric etc. decided to stay back in the region or after retirement, they along with employees from the R&D divisions of these firms, started establishing their own small and mid-size processing firms in TAMA. Universities in the region also started to participate in the growth of the region – trained graduates found employment in these firms and Professors were engaged in applied research supported by these firms. The focus, at this time, was to increase efficiency by agglomeration and formation of a network of producers. By mid 90s, TAMA had emerged as the largest and strongest agglomeration of innovation driven manufacturing firms in Japan (and perhaps in the world).

Kodama (2003, 2004a, 2004b) and TAMA Document (2004) trace the findings of surveys done by the Kanto Region Bureau of MITI (in 1996-1997) and the RIETI, Japan (in 2003). As an outcome of the first survey of firms, the formalization of the TAMA cluster was undertaken by the Japanese Ministry of Economy, Trade and Industry (METI). It was felt that the traditional system of mass production (of large volume and standard products) in which the SMEs assembled products for large producers had to be replaced by a more competitive model of linked SMEs that help produce a large variety of innovative products in small volumes. Since different products (or variants & volumes) that a firm produced (i.e., flexible manufacturing) required linkages with different types of subcontractors/SMEs with different kinds of competencies. This required flexible relationships based on needs and competencies, coordination between small companies, and above all strong cooperation between university research and firms to rapidly manage advances in technology and find solutions to customers' needs. This led to the formalization of cooperation in the region through the formation of TAMA Industrial Vitalization Association (or popularly known as the TAMA Association[2]) in 1997. The purpose was to move the industrial agglomeration from mere production towards creation of new technologies (i.e., new products, processes and practices) and enterprises based on them and use the network to produce these technologies competitively and locally. TAMA Association is the coordinating agency that brings together product developing SMEs, product processing SMEs[3], large firms, local universities, local chambers of commerce, local municipalities, and the METI to revitalize Japanese manufacturing.

The DNA of TAMA comprises "creation of new technologies, new products and new businesses by combination of different technologies and knowledge (Kodama, 2004a)" that is achieved through linkages between firms. The TAMA Network consists of R&D units of large enterprises like NEC, Hitachi, Yokogawa, Fuji Electric etc. (about fifteen of them), thirty four Universities and colleges that have department of sciences and faculties of engineering, about 300 product developing SMEs and over 16000 product processing SMEs. All are involved in R&D activities although some may be in the product development domain while the others may be in the process innovation domain. Different entities comprising this network play different roles. Large firms

[2] TAMA Association was founded by the efforts of Yuji Furukawa, Professor at the Tokyo University of Agriculture and Technology, Toshihiro Kodama of RIETI amd Makoto Ibuka of TAMA-TLO.

[3] Kodama (2004a) defines Product Developing SMEs as SMEs that have product designing capabilities, own their designs & products and have a good understanding of the needs of the market. Product Processing SMEs are SMEs engaged in parts processing (but do not have product development & marketing strengths) and whose strength lies in process technologies like cutting, grinding, sanding, casting, forging, pressing, coating, surface treatment, component assembly and metal molding.

enhance the value of the cluster by providing access to new technologies, provide orders to other firms, and seek out cluster firms to meet various requirements. The product developing SMEs serve the market needs through their own products; they focus on planning, design, final-stage assembly, testing, delivery and after-sales service to customers. They have a strong R&D orientation as reflected by the large number of patents filed, significant R&D expenditure, new product introductions etc. (more on this later). They have a strong linkage with University research and researchers to develop new technologies or solve specific engineering problems. In addition to being sources of new technology, the universities provide the valuable science & technology talent for firms in the region. The product processing SMEs form the key manufacturing base for the product developing SMEs. These processing firms produce parts (i.e., components/intermediates) according to designs provided to them by the product developing SMEs. The precision levels in their operations is very high. They excel in improving & developing new process technologies and they compete with each other for orders. The product developing SMEs, on the other hand, rarely compete with one another as they are in different product segments. Instead, there is lot of collaboration on new designs & technology between them. This architecture gives the network enormous flexibility to produce a variety of products with original technologies and helps in strengthening a wide base of processing competencies thus enabling the network to become technologically very versatile. Last but not the least, the TAMA Association forms the glue that keeps the network coordinated and facilitates continuous flow of innovation between firms and the from firms to the market. Figure 1 shows the various elements of the TAMA network.

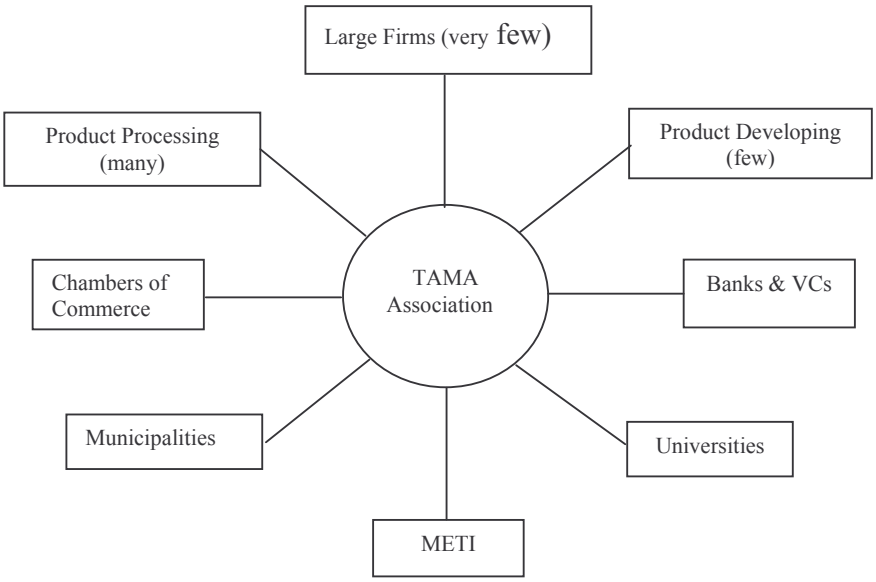

Figure 1: Various Elements of the TAMA Network

TAMA Association is the key linchpin that helps reduce various market and capability failures for small firms in this region. In fact, it helps the network perform like a giant multi-product, multi-technology firm. Interestingly, the association cuts across multiple states, various regional cities & their municipalities (who support firms in their region through TAMA), firms producing variety of products and institutions providing diverse research support. It has emerged as an organization that coordinates industry-university joint research, promotes inter-firm collaboration in research as well as orders and links SMEs with superior processing technologies with product developing SMEs. TAMA secures active involvement of local governments, municipalities and chambers of commerce; manages assistance from METI to the cluster; and solves the diverse problems (technical, managerial or political) faced by it members. In addition, it provides a variety of services to its members:

- *Provides a platform for financial support*: The Association works closely with local financial institutions in arranging loans for startups. Financial institutions seek help from TAMA Association for technical and market based evaluation of loan requests by its firms. Experts from TAMA network help perform the evaluation using a business evaluation methodology developed by the Association. It also provides direct funding through two venture funds that were setup for startups (one is of 500 million Yen[4] while the other is of 1 billion Yen value).
- *Prepares local talent for joining the industrial workforce*: TAMA organizes job fairs for local students involving member firms, conducts a variety of skill enhancing programmes for existing and fresh technicians, runs an internship service etc.
- *Provides new business & incubation support*: It runs a three stage business plan competition (with awards of US$5000 to US$10,000) leading to a matching session between VCs and the entrepreneurs. The Association has also developed a matching scheme (with the help of placement companies that are also members of TAMA Association) which helps staff from major companies to find positions in SMEs, thereby, often, facilitating a smooth transition for both large firms and employees facing closure or staff reduction. For example, in 2002, 25 firms requested help of the Association in finding jobs for their employees. 65 employees were recommended by firms. TAMA helped 12 of these find jobs in 10 firms in functions like technology development, design (maximum number), sales, maintenance, R&D, NC programming and accounting (TAMA Document, 2004). It also organizes an annual technology exchange for facilitating business linkage between local firms and large firms. It provides training to SMEs on presentations skills and helps them with their presentations for this event. In 2003, 100 million Yen worth of orders were received by local firms during this event.
- *Provides information network services*: TAMA through its website provides access to databases on firms and their capabilities, database on university facilities, faculty research and resources, helps companies setup their IT based promotion environment as well as transaction systems like EDI, disseminates information of interest to industry and broadcasts events.
- *Arranges technology exhibitions, disseminates research findings of universities, and provides overseas market support to its members:* TAMA has developed special exchange programmes with industry associations and firms in other countries. One such programme is with Italian SMEs enabling interaction between Italian and Japanese SMEs, especially, the design & technology firms and the universities.
- *Arranges interaction between the technology and entrepreneur communities through "Company Visits" and "Mini-TAMA Meetings*" : It organizes visit of members to other firms in the cluster in order to enhance learning and appreciation of difficulties. It also hold a monthly meeting (or Mini TAMA) to promote exchange of ideas and business between members.

Amongst the six hundred members of TAMA are 300 firms, 34 universities, individual professionals & professors, 78 banks and chambers of commerce etc, city councils (about 20), etc. Most employees of TAMA Association (five out of nine) have been loaned by various organizations and they run the association on a full time basis.

The success of the TAMA network can be gauged by processes that it is able to unleash to integrate the capabilities of SMEs in the local economy and to reduce the market failures faced by small firms. In more quantitative terms, TAMA firms have exhibited excellent performance over other SMEs. For example, the number of new products introduced by TAMA firms in the market in the last three years was 22 as opposed to 4 by non-member SMEs; the percentage of firms collaborating with research universities was 65 which was an increase of 55 per cent over the last five years; 69.2 per cent of TAMA firms held patents as opposed to 29.6 per cent of all SMEs in Japan; the R&D expenditure (per unit of sales) was 5 per cent for Product Developing SMEs and 2 per cent for product processing SMEs; and the profit to sales ratio was 2 per cent for product developing SMEs as compared to a median value of 1 per cent for all Japan Machinery & Metal

[4] 108.22 Yen = 1 US$ in 2004

Manufacturing SMEs (Kodama, 2004, SME Agency, 2002). This data is from a survey done in the year 2001. Interestingly, according to the same survey, while the number of customers of product developing SMEs who are members of TAMA was about the same as those who are not members of TAMA, TAMA product processing SMEs have five time more customers than non-member product processing SMEs. All of the above point towards enhanced capabilities and, consequently, productivity of small firms when they become part of a collaborating network. The TAMA Network is an example of leadership role played by a coordinating agency in bringing horizontal linkages between firms with active support from local and federal government by building capability enhancing infrastructure.

4. The Wenzhou Industrial Development Model in China

Wenzhou, a municipality located in the south-eastern coast of Zhejiang province of China, has become a model of transformation of a weak rural economy into an explosive global manufacturing center dominated by networks of tiny and small producers. In 2002, manufacturing accounted for 49.8 per cent of Wenzhou's GDP. Its main products and market shares are given in the table below:

Product	**Market Share in China (per cent)**
Metal Cigarette Lighter	90 (and 70 per cent of world' reusable lighters)
Spectacle Frame	80
Locks	65
Razors	60
Plastic Products	56
Mechanical Pencils & Ball Pens	30
Footwear	20
Clothing	10
Low-Voltage Electric Appliances	70

Source: TDCTrade.Com, 2004, Barber, 2004

Table 2: Wenzhou's Market Share in China of various Products

In 2002, the number of individually owned (or household) units and private firms stood at 202,458 and 28,430 respectively with a GDP of 106.1 billion RMB[5]. Of these, only 3,700 firms had an annual sales of RMB 5 million or more. The average number of persons working in the individually owned companies was 2.1 while that for private firms was 13 in 2002. Exports from Wenzhou were of the tune of US$ 2.65 billion and imports were valued at US$ 804 million. (Wenzhou Statistical Yearbook, 2003; TDCTrade.Com, 2004). This is impressive when compared with the fact that in 1970, the poverty level in Wenzhou was above China's average (IFC, 2004) and its revenue from industrial and agricultural output was only 191 mn yuan (Parris, 1993). The urban area of Wenzhou, about 488 square km., is barely 4 per cent of the municipality's area. Rural incomes in Wenzhou have grown from 165 yuan[6] per person per year in 1978 (one of the lowest in the nation) to 924 yuan per person per year in 1989 as compared to the national average of 601 yuans (Liu, 1992). This figure grew to 4,683 yuans for rural residents and 13,200 yuans for urban residents in 2001; the average annual growth rate of GDP during 1978-2001 in Wenzhou has been 20.3 per cent (WMDPC, 2002).

Wenzhou is separated from other parts of China by a rugged mountainous territory on three sides and sea on the fourth which had kept it in a bit of an isolation from the rest of China. Absence of arable land led to the development of rural household industries and consequently local markets. Over ages, people from other parts of China have been using the isolated geography of Wenzhou to escape the civil wars of China as well as the "move to farms" movement (see Liu, 1992 for an excellent historical account of the development of Wenzhou). This increase in population put

[5] 1US$ = 8.27 Renminbi Yuan (RMB) in 2002 (also called yuan)

pressure on local resources and led to a heavy "out-migration" from Wenzhou – many of these people carried products made in Wenzhou to markets outside thereby setting up a trading link, initially within China., and subsequently outside. This was the start of the formation of a supply chain. It brought goods from Wenzhou to the world and the feedback from customers on design and quality back to small producers in Wenzhou. It is interesting that until 1990 there was neither a highway nor railway leading to Wenzhou and the city struggled to fight poverty after the revolution of 1949 (Barber, 2004). Today, the city is modern and is even privately funding the re-building of its international airport. It is useful to look at features of this transformation process that helped connect a large number of small producers to the market and the process used to convert this weak sub-economy into an important industrial environment in China.

The Wenzhou model of industrial development exhibits the following characteristics:

a. Large Number of Small Producers:

Most producers in Wenzhou are household units producing a small range of products or parts therein. The large number of such producers gives the cluster a network economy of scale in the output. For instance, in 2001 there were 3000 individual and private enterprises in one of the clusters (in Liushi town) of Wenzhou employing 10,000 people (including the promoters), i.e. , 3.3 employees per enterprise. Of these firms, 220 were ISO certified and 200 had UC & CE certifications. The annual trade volume was 10 billion Yuan and it earned US $0.3 billion in foreign exchange. The cluster produced Industrial Electrical Appliances and was ranked 1st in China. Similarly, Tiger brand lighters (that has the highest market share in the world) are produced by over 300 manufacturers – producing over 0.5 billion lighters and a sales value of 2 billion Yuan (80 per cent of production is exported). The plastic weaving cluster in Wenzhou comprised 1600 enterprises in 2001, employed 42000 people with an annual output value of 20 billion Yuan (accounting for 2/3rd. of sales in the Chinese market). The lock cluster comprised 400 manufacturers in 2001 with a total output of 5 billion Yuan, representing 65 per cent of the domestic market share. This cluster is the first in China in terms of market share and sold its products to 60 countries (WMDPC, 2002).

Firms in Wenzhou have been relying primarily on family labor and, and most often, the house is the site of production. Most producers produce small parts (or "small commodities") which are then assembled by other firms. The production structure is given in Figure 2.

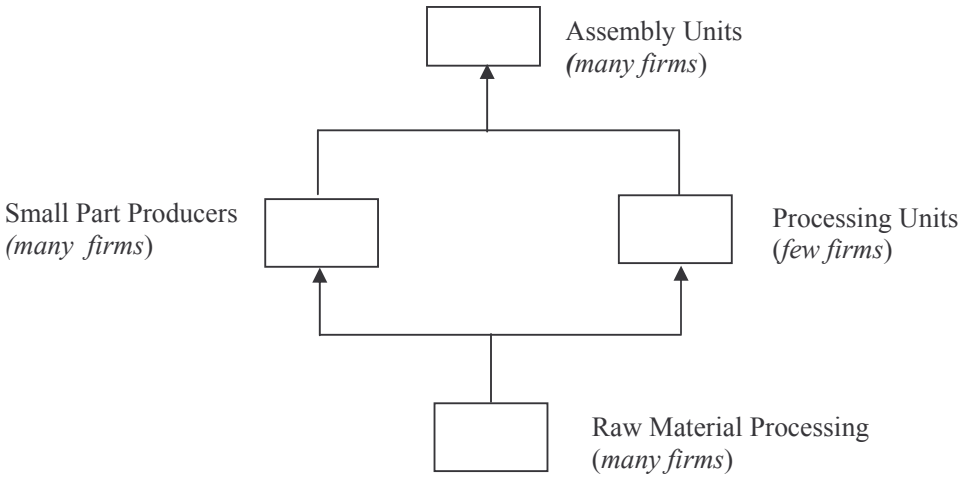

Figure 2: Production Structure in Wenzhou

Production is mostly subcontracted by assembly or exporting firms who place orders (and often provide material either themselves or through specialized raw material procuring firms). Processing firms have special equipment for performing specialized processes on raw material or parts (e.g. electroplating). Sometimes they produced machinery locally. The key concept in this development has been "one village one product" and "one township one trade," thereby, getting the advantage of agglomeration economy while providing diversity in the product market. This has also helped reduce unnecessary competition between villages thereby conserving scarce resources. Often, parts are produced in villages while the assembly is done in larger market towns.

The structure of the industry has evolved in an interesting manner. Some household enterprises (or individual private enterprises) registered their business as a collective enterprise when it really was privately managed and owned (especially in 70's & 80's when private enterprise was forbidden in China). This phenomenon was termed as "wearing a red hat" (Tsai, 2003). The collective enterprise received government support (and escaped social and political ostracization for making profits), paid a fee to local party cadres for registration (often these firms were operated by cadres and their family), received bank loans and tax breaks, could lease land to others etc. Similarly, there were 'hanger-on' firms – small private firms that provided subcontracting services to publicly owned firms. This allowed them to receive assistance such as raw material, use of publicly owned firm's resources, stationery etc.; they could also borrow official identification of the public firm, get legal status for transactions, use public firm's bank account to park money etc. – all for a fee (Liu, 1992b; Young, 1989). Such mechanisms also allowed "interlocking control" by the collective in individual firms or by large public sector firms in small "hanger-on" firms. Of late, many of the collective firms have turned into 'joint stock firms' with no government involvement but jointly owned by many. This helped firms to gradually accumulate capital and knowledge of production and subsequently expand their scale of operation (Liu, 1992b).

Subcontracting and the attendant division of labor has helped considerably in reducing the cost of production in Wenzhou. Clustering of firms in high concentration led to agglomeration economies in terms of scale of output from a single location, information on production technology and practices, subcontracting between small and specialized enterprises and development of skilled labor market (ADB, 2001). This has improved productivity, quality and efficiency of operations and consequently the competitiveness of these small producers.

b. Specialized Markets for Products:

Another unique aspect of the Wenzhou model is the establishment of and access to local and specialized markets for parts and products. The common refrain of Wenzhou has been "small commodities and Big Market." Wenzhou municipality has setup 514 specialized markets whose business volume exceeds 47.5 billion yuan - eight of these had turnover of 1 billion yuan while more than 68 have business volumes greater than 100 yuan (WMDPC, 2002).

These markets ranged from village and town level fairs to permanent local wholesale markets focusing on single or several related commodities. The market brings local parts producers, assemblers, local selling agents, national buyers (and now international buyers) together – they set prices for the products, negotiate orders and lead times and book capacity, and provide valuable feedback on the quality & design of products as well as the delivery process. Another unusual aspect of these markets has been that they have created a market for parts produced by small household producers. Now, part- producers have direct access to buyers as well. Interestingly, small household producers have used 'mail orders' effectively to reach distant markets. These producers send catalogues and order forms to state and collective enterprises, department stores and supply/marketing firms with information on their products and parts (Bai, 1987).

c. Credit

In early 60's and 70's when people of Wenzhou started to move away from agriculture due to low productivity and shrinking incomes, they did not find large industry ready to hire them. Most setup a household or a home firm to produce small goods of daily use that could be sold in the local market and that were not produced by large firms. Initial capital was required for raw material as labor was coming from members of the family. This funding came largely from the family. Over the years these entrepreneurs pooled their resources called the 'folk capital', to run their collective enterprise. Since 1949, Wenzhou has seen a growth of private 'money houses' or individual lenders (or 'specialized financial households') that has provided credit to small producers. They also set their interest rates (which was higher than State banks but most private producers were ineligible for loans from them anyways) with the knowledge of the local government. Collective firms and 'hanger-on' firms could borrow from the State banks. As late as 2001, less than 1% of loans from State banks went to private enterprises (Tsai, 2003). However, as business grew in Wenzhou, credit from non-government sources became plentiful. And several new sources also emerged. For example, social organizations like Rural Cooperation Savings Foundation, Helping the Poor Foundation etc., could collect funds as they paid higher interest rates to their subscribers than State banks. They in turn lent money to local enterprises of Wenzhou. After 1983, many farmers leased (or transferred) their agriculture land to others for a payment which provided the capital needed to invest in small manufacturing enterprises. Growth in manufacturing led to gradual accumulation of capital. Only recently has Wenzhou seen foreign investment in its enterprises. For example, the year 2002 saw implementation of about 46 FDI projects worth about US $80 million (TDC Trade, 2004). By 2003, observing the success of Wenzhou, many banks made it a priority to lend to the small producers of Wenzhou.

d. Sales Network:

In early days of the cluster, most individual household firms relied on peasant traders to carry their goods from one village to another or to another part of China. Since Wenzhou did not have strong agriculture and industry, many people migrated to other parts of China (and subsequently to Europe and USA); these people carried goods from Wenzhou that they sold elsewhere to survive (since travel to another city was often not authorized by a "permit" or by a work unit). This was the start of the formation of a sales network for enterprises of Wenzhou.

Since many of the products were small in size, low tech, and for daily use, producers found a great domestic demand for them in 70's and 80's after years of shortage in the command and control economy of China (Wu, 2004). Several local sales agents emerged. They helped organize roadside markets (in the initial years of liberalizations), took local consumer and industrial products to stores in other parts of China and subsequently helped bring customers to the village trade fairs. These trade fairs also gave opportunity to outside traders and merchants to source goods for their international clients from Wenzhou. This also helped coordinate the linkage between the final buyers and the producers. Many of these were former citizens of Wenzhou who had migrated to other countries. In recent times, 83% of immigrants from Zhejiang province to Europe have been from Wenzhou while the annual number of people migrating to other parts of China from Wenzhou is estimated at 270,000 (Liu, 1992 a). They also helped bigger entrepreneurs to register companies outside China, especially in Bermuda, and raise equity on international stock exchanges.

In early 2000, it was estimated that there were over 10,000 chain stores all over China that were selling only Wenzhou garments (WMDCP, 2002). Migrant sales agents from Wenzhou not only provided valuable information on markets outside but also performed the contracting function for these products. Often they provided the capital needed to produce these products. Many of them brought back information on production technology that was used elsewhere. The agents consolidated the important logistics function for the small producers.

e. Government as a facilitator and coordinator:

Since 1949, the policy of "no undue interference from outside" by local government officials has helped facilitate the spread of small business in Wenzhou. Household enterprises could be kept operating quietly and could be controlled easily at a time when private enterprise was not to be allowed. In that, the interest of the peasants coincided with those of the cadre. Often private business contributed towards public infrastructure like providing offices for party cadres. Several members of the party or their spouses would own household enterprises. Many joined these enterprises after leaving government jobs. State enterprises also subcontracted jobs to smaller firms.

The local government was pro-active in enhancing the status of Wenzhou economy and the enterprises. Many of the fairs/markets were organized and supported by them. It periodically cracks down on counterfeits or products of low quality that are found in Wenzhou markets. In one instance, it setup centers on highways and ports to prevent such products from leaving Wenzhou.

In recent times, the local government has invested in quality testing centers, training programmes, improvements in housing standards, facilitated resident registration procedures, and has argued for higher salaries to attract talent to Wenzhou (WMDPC, 2002). The local government of Liushi city in Wenzhou, for example, even passed laws to ban certain kinds of technology in the low voltage equipment cluster in order to force investment in newer process technologies and thereby improve efficiency of operations (Liu, 1992b). Local government has taken keen interest in the coordination of activities ranging from sheltering small enterprises, organizing local markets, facilitating credit, and in more recent times bringing investments in infrastructure like highways, railways, airports and ports.

Stages of Growth in Wenzhou

The trajectory of development of enterprise in Wenzhou can be categorized in the following three stages:

- **Stage I (70's and early 80's):** This phase marks the development of local markets for simple imitative products for daily need. These were sold mostly within Wenzhou though some merchants carried these products from roadside markets to other places. These were characterized as low cost and low quality products.

- **Stage II (80's and early 90's):** The number of households producing simple commodities increased in this period. Specialized markets emerge in Wenzhou. The volume of output from the network of producers grew considerably. Wenzhou goods were now being increasingly sold in national markets. Products were still low cost and of low quality. Sale of products took place mostly through Wenzhou traders (26.5% of total sales), local wholesale markets (23.5%), sales agencies (22%) and own retail outlets (9.5%) [Sonobe et al., 2004]. Interestingly, most of the part producers had arm's length relationship with assemblers.

  This stage was also characterized by early improvements in quality of products through introduction of inspection (though processes remained, by and large, old) by a few industry leaders.

- **Stage III (1990 onwards):** The last decade has seen a variety of changes in the industry both in terms of its structure as well as value added. Sonobe et al., 2004 surveyed firms in Wenzhou and found an increase in number of enterprises (though the number of independent enterprises initially increased and then decreased), value added, sales revenue, number of employees per firm and capital stock of firms between 1999 and 2000. As incomes in China grew, demand for quality products also increased. Larger firms installed quality systems (predominantly, inspection based) though there was no substantial change in production technology. However, a few independent firms broke

ranks on technology and are emerging as world leaders in their specific product domain. For example, one such group called "Chint Group" which manufacturers low and medium voltage electrical equipment started by setting up a household firm twenty years ago and now employs 13,000 workers in more than 50 of its factories. It has sales of US$2 billion and one of its factory employs Japanese robots for pouring molten plastic around the clock – the factory produces electrical switches on several manual assembly lines employing workers from all over China at an average monthly wage of US$240 (Barber, 2004).

The tools of production have started to change in the last decade even for other smaller producers. Products still remain low cost but of improved quality and are produced in large volume from the cluster. There is evidence of merger of smaller firms into large groups. In the firms sampled by Sonobe et al., the largest group had 70 subsidiaries in 2000. They also found that several small firms exited manufacturing as their operations were inefficient compared to their competitors in the village/township cluster.

Incidentally, this period also saw an increase in export led growth through Wenzhou merchants overseas and recently through investment by some foreign firms. Consistent with the evolving strategy to increase value added in the cluster, lead firms in Wenzhou developed their own brands to distinguish their quality (e.g. Chint and Delixi are now China's largest producers and most well known brands in low and medium voltage appliances); Tiger brand of lighters is known worldwide; Kanghai, Jierda, Aokang, and Dongyi brands have made Wenzhou the shoe capital of China; Baoxiniao and Zhuangji are known garment brands in China; etc). The cluster has also seen changes in the downstream part of its supply chain. It distributes more than 50 per cent of its goods through sales agencies (as opposed to 22 per cent ten years ago) and more than 27 per cent through its own retail outlets (Sonobe et al, 2004). This has been a major shift in 2000's – moving away from local wholesale markets and Wenzhou traders. Large firms are setting up there own stores all over China. There is also evidence of substantial effort to seek national and international certification of the production facilities and products (Sonobe et at, 2004) which reflects an increasing level of awareness of quality and its value.

In summary, the Wenzhou model of development has moved from being a 'merchant led' industrial development model (as termed by Sonobe et al, 2004) where low quality, low cost products were produced by household enterprises and sold in specialized local markets by producers and elsewhere by Wenzhou traders to becoming a 'manufacturing driven' industrial cluster with agglomeration economies, emergence of larger firms through merger of small producers and capacity expansion and distribution through sales agents and own retail networks. It has transformed a poor and rural municipality of Wenzhou into vibrant and more affluent industrial economy whose spirit can be captured by the terms "for a penny" and "to earn a little money" (WPIPDC, 2002), implying work for small margins, to earn whatever one can, and produce large volumes by getting specialized.

5. The Engineering Network of Rajkot in India[7]

The Rajkot Engineering Cluster is an interesting comparison to the organizational forms seen in TAMA and Wenzhou. Rajkot, an industrial town, is located in Gujarat in Western India – about 250 km. south-west of Ahmedabad and about 600 kms north of Mumbai. Rajkot lies in the Saurashtra region of Gujarat which is known for its engineering craftsmanship. The engineering industry of Saurashtra (with industrial cities like Rajkot, Jamnagar, Surendranagar etc.) grew with the arrival of craftsmen from Pakistan after partition of India in 1947. Since then the industry has

[7] This section draws from Basant (1997) and from author's fieldwork in Rajkot during 1999 and 2005.

grown manifold and developed strengths to integrate small processors in an industrial model of assembly by larger firms and production of parts (including specialized processing) by small firms.

The Rajkot cluster started by producing small items in brass like tumblers, cups, bells and other similar items for home use and small industrial parts as substitutes for imported items. This required casting and machining of small brass parts. The industry grew by leaps and bounds with the Government of India announcing subsidies in mid 1960's for low speed, low horsepower diesel engines for implementing its green revolution in agriculture especially in rural India. This sector was reserved for small scale industry (SSI) by the government which was keen on indigenizing a largely imported product. Small firms in Rajkot became the hub of low speed diesel engine manufacturing in India. The customers were chiefly small and mid-size farmers in rural India who required a low cost option for driving irrigation.

At its peak in mid nineties, there were about 8,000 factories employing over 500,000 people that produced about 650,000 diesel engines (of 10 hp.). Annual sales turnover of the industry was about Rs.250 crores[8]. Rajkot accounted for about 60 per cent of country's total production and about half of India's export of these types of diesel engines. This production was supported by about 500 foundry units. Most of the diesel engine and foundry firms were in the SME sector. However, a few large manufacturing and assembly firms like Field Marshall, K. Rasiklal, Ashok etc. had close to fifty percent share of the Rajkot market and would set market prices. Since a diesel engine comprises about 350 parts, a large majority of SMEs either produced parts or performed specialized processing jobwork like finishing, machining, drilling etc. for assemblers and part producers. The rise of the engineering cluster led to a growth of a machine tool industry in Rajkot which catered to local needs. Most firms manufactured conventional machine tools (e.g., lathes, drilling machines, cutting machines etc.). While a few firms produced CNC machines for local use.

However, by 2001 the number of diesel engine sets sold fell to 350,000 and by 2005 this number further reduced to about 100,000. Rajkot's share in export fell to 10 per cent in 2005. In 2005, only 100 diesel engine manufacturers and about 4,000 auxiliary units remained open of which more than half were on the verge of closure (Indian Express, 2005). What led to a virtual collapse of a vibrant industrial cluster is an interesting case study.

Some Salient Characteristics of the Rajkot Cluster

1. **Policy induced cluster**: The growth and subsequent decline of the Rajkot Engineering Cluster appears to be a response to government's policy regarding diesel engines. The government decided to promote the use of low speed, low horsepower diesel engine for introducing automation in irrigation of fields during the agriculture revolution of 1960's. The demand for low speed diesel engines grew tremendously as the government provided subsidy to farmers for its purchase.

   This growth attracted new entrepreneurs to establish manufacturing business. Since, the production of diesel engines and its parts was reserved for SSIs, firms remained small. Whenever the business of a producer grew, a new firm was established at the same location or elsewhere in Rajkot as capacity expansion would send their investments outside the prescribed range and make it ineligible for being an SSI and consequently the accompanying benefits. It can be said that Rajkot producers locked themselves, technologically and product mix-wise, to less than 10 hp diesel engine production.

   In early nineties, the government decided to remove the subsidy on purchase of low speed diesel engines by farmers. It also imposed excise duty on diesel engines. By this time the power situation in the country had also changed considerably and farmers were starting to

[8] US$ 1 = Rupees (Rs.) 31.37 in 1995; US$ 1= Rs 43.62 in 2005 ; 1 crore = 10 million

purchase better quality technology – rotary engines. The demand for low speed diesel engine came down dramatically in the decade following these developments. By early 2000 the industry structure had changed in Rajkot – a number of small firms had closed down while others started to diversify into new manufacturing opportunities.

2. **Intense outsourcing** (or Linkages between firms in Rajkot): Two features of the industry have contributed significantly to the formation of strong and active linkages between small firms in Rajkot (a) diesel engine manufacturing requires fabricating 350-400 components and then assembling these parts; and (b) reservation of diesel engine production for small scale. While the former meant deriving economical relationship between assemblers and producers of parts as the product was amenable to component production in batches and assembly in small to mid volumes. The latter meant that firms had to remain small (even if there was growth in demand for the product) in order to be eligible to produce the product as well as to get various tax related benefits. Another related reason was that small firms did not have the resources needed to integrate vertically. Hence, they would depend on other firms to supply them with components and services to complete an order. This led to the growth of "processing firms"- firms that would do rough casting and finish, machining, drawing etc. – firms performing individual operations for other firms (similar to the 'product processing firms' of TAMA). Basant's survey of firms in 1997 revealed that about 77 percent of sample firms outsourced jobs to other firms in Rajkot. Amongst others, the benefits cited were ability to meet orders from premises of limited size, ability to reduce costs (however, it lead to intense price based competition between assemblers and subcontractors alike) etc. Often the outsourced firms were owned by family, friends or former employees. This was both good and bad – while negotiations on price or delivery dates or expediting an order were facilitated, sometimes this close relationship came in the way of business decisions especially those relating to quality or meeting delivery times.

   Along with outsourcing of orders, one finds outsourcing of labour to be quite prevalent in Rakjot – contract workers who may perform tasks like painting, packing, casting and even assembly. Often these contract workers take complete responsibility of an operation or a section, get incentives for producing more, shift from working on one operation to another based on the requirement (i.e, provide flexibility) and work in the same firm for several years.

   In Rajkot it is also not been uncommon for employees to setup their own small enterprise and become vendors to their former employers. This has helped in minimizing the loss of skills that accompanies the turnover of employees. At the same time, it has assisted in the preparation of suppliers' and strengthening of linkages – a 'deepening' of the Rajkot network. While availability of labour is not a problem, absenteeism is – workers tend to take leave during the sowing and harvesting seasons as they return to their villages during these periods to work on their farms.

   There is intense price competition amongst producers or processors. As a result, intense cooperation has been missing amongst them. Trust is missing and firms would not share orders for fear of losing a customer to a competitor. The Rajkot Engineering Association (REA) has been trying to collectively enhance the capabilities of the firms (more on this later).

3. **Technology and Productivity**: The 'Rajkot engines' – "Lister" and "Petter" types are based on technology that is over hundred years old. They are low (Lister type) to medium speed (Petter type), low horsepower (less than 10hp) and have high weight to power ratios (hence, fuel inefficient). They also have limited application - only in agriculture. Product technology, consequently, was outdated with little scope for innovation in its design. Product design and the application domain also imposed constraints on process technology. As an aside, free power and water to farmers (as part of strategy by political parties in India to gain popular support and votes during elections) also ensured that more efficient technology was not

imperative for rural farmers. The drivers for product innovation were weak and over the years the product did not change.

Since the product mix was low-tech and did not change over the years, capabilities of firms also did not change significantly. With government subsidy, firms could sell and survive. Some firms, needless to say, broke ranks and entered new areas or developed newer technologies and competencies. As Basant (1997) has observed, most entrepreneurs did not have formal engineering education but had picked up skills by working and running their plants. Such a strategy worked well in the initial years- supported by government subsidies for diesel engines, sales were high and technology development or productivity improvements were non-existent. Basant's survey reveals high defect rates amongst sample firms, insignificant design modification, low quality of casting, usage of low quality processing equipment etc. Capabilities that were considered adequate for one product-market segment were inadequate for another. When one of the biggest firms, Field Marshall, tried to produce better performing, higher quality HATZ diesel engines for a German firm, they failed to meet the quality requirements (Basant, 1997). The average capabilities of vendors in Rajkot cluster were not sufficient to meet more stringent requirements of casting, finishing etc. Moreover, with the small volumes of HATZ engine, Field Marshall was not successful in getting the vendors to invest in newer technology and consequently improve their capabilities. More than 50 diesel engine units shut down in the decade of 90's. Since the Rajkot cluster comprises predominantly of processing firms (firms that perform a specialized process like casting, rough finishing, wire drawing, metal removal, lathe operations etc.) for a manufacturer of diesel engines, it was essential for new technology or good manufacturing practices to spread throughout the cluster for the quality of the product to improve. This did not happen in Rajkot. The capabilities of majority of firms did not change substantially. By 2005, barely 20 per cent of the 400 foundries were doing well while the rest were struggling to survive.

On the behavioural side, the cluster suffered due to poor cooperation. During our interviews, several entrepreneurs mentioned 'lack of trust' as a key reason behind low cooperation. It appears that over the years, competition between an increasing number of small producers had become very intense. Since the market for diesel engines was not expanding, firms became very secretive, did not invest much in training with a fear of losing trained worker to a competitor and became technologically and socially very conservative. There was hardly any exchange of ideas between firms and with the decline in the slow speed diesel engine industry, a number of small processors started closing down their plants. The only time they came together, at the initiative of the Rajkot Engineering Association, was to jointly purchase Coal and Pig Iron for their foundries.

While the cluster was declining, a small set of producers (about 20 per cent of the 1100 members of the Rajkot Engineering Association) led by firms like Patel Brass Works (PBW) were slowly diversifying into auto-components, motors, machine tools, bearings etc. that used their existing engineering capabilities. They saw diversification as the only survival strategy. These included some foundries and processing units. The product producing firms also sought OEM customers and started branding for the replacement market. They invested in newer technologies, entered newer product domains with old skills and newer strategies for both domestic and global markets. Rajkot is undergoing a major re-structuring both in terms of the industrial structure but also products and technologies. For example, firms have understood the need to upgrade the tools of productions in order to achieve higher quality. Almost all of these small firms have introduced CNC machines on their shop floor, for example (this has also opened a new market for CNC based machine tools for the machine tool producers of Rajkot). Similarly, auto-forging plants have been set up by some of these SMEs thereby changing the capability environment of the cluster. Larger SMEs like PBW made investment in their exclusive vendors for upgradation of technology (Basant and Chandra 1997).

In this context the trajectory of growth of two SMEs of Rajkot, PBW and MacPower CNC is instructive. PBW started by producing brass tumblers and bearings for diesel engines. It

understood the market dynamics of Rajkot and diversified into bearings for critical applications in turbines, compressors etc. It has patented and improved upon the proprietary technology of centrifugal casting, modernized its shop floor, developed a catalogue of over 2000 compressor parts that it can produce and deliver within 48 hours anywhere in the world, developed capabilities to produce over 4000 bearings for various industrial applications (including bi-metal and tri-metal bearings), has developed a sophisticated testing facility with state-of-art equipments, and has a work force of over 300 people. PBW, now, has a turnover of more than Rs. 30 crore with customers all over the world including General Motors, GE in U.S.A. and in Japan.

Similar to PBW is the story of MacPower CNC. It started designing traditional lathes for producers of Rajkot (many of these firms operated with workers that had no formal education). Today it is one of the most prominent CNC machine tool producers of Rajkot with a turnover reaching Rs. 100 crore. Along with a couple of other similar firms, it has helped Rajkot become the largest producer of conventional machine tools in India and is the third largest cluster of CNC machine tools in India (and is poised to soon overtake the second largest cluster of Pune). MacPower competes with products from abroad that are imported in the Indian market. It designs, fine finishes and assembles its machines in-house while sub-contracting other operations to some of the processing SMEs of Rajkot.

The metal processing industry was the worst hit with the decline of diesel engine manufacturing in Rajkot. After struggling to survive for a decade, in 2000 they started looking for new markets for their skills in engineering. The auto industry in India started to move into growth phase with the ramp up of auto production (including two wheelers) and the entry of several global producers. The number of units producing auto-components rose from 5 in 2002 to 150 in 2005 and the industry has been growing at the rate of 25 per cent per annum. Their turnover has grown from Rs. 100 crore in 2000 to Rs. 1000 crore in 2005 (Indian Express, 2005b). The rate of export orders have also increased from 1.5 per cent to 20 per cent of the total value within a year. Amongst their customers are almost all the auto and tractor producers that are operating in India.

While the formation of the diesel engine oriented manufacturing was induced by policy, the entry of some of these firms into other sectors (due to the decline of the diesel engine industry) has been driven by the conditions of the market. Technological capabilities, that were built over the earlier decades, formed the basis for diversification to new industrial sectors. Rajkot is a good example of how SMEs who build capabilities can deploy them flexibly into new application domains as the market environment changes. Excelling in these newer segments would require building on these skills and acquiring newer ones in the future.

6. The Three Networks: Approximations to a Generic Model

The distinctive strengths of the TAMA and the Wenzhou networks is quite apparent. The resilience of the Rajkot firms speaks highly of its accumulation of technological capabilities that has enabled firms to enter into newer sectors. Table 3 gives a comparative picture of the three networks (i.e., TAMA, Wenzhou and Rajkot) over some key dimensions. Each of the three clusters comprises a variety of different kinds of firms that were playing a distinctive role. TAMA's ability to draw processing firms to develop technological competencies for developing new products stands out. Wenzhou's ability to coordinate across a large number of small firms and to standardize processes in order to improve quality is noticeable. While both of the above had support of the local government, the role played by the government in Rajkot was quite distinctive which was the caused both its growth as well as its decline. Nevertheless, they make a strong case for collaboration amongst SMEs to form a dynamic network. It must be mentioned that in all the three cases there is less direct interaction with large firms though their technology driving and demand generating roles cannot be ignored. While markets for product developing firms may have been away from the respective cluster, market for processing firms as well as part producers was quite local. The TAMA and Wenzhou clusters produced a large variety of products at small volumes – a typical job-shop like characteristics. Rajkot's decline in the diesel engine

	Nature of Firms	Product Characteristics	Markets	Key Intermediaries	Supply Chain Linkages	Technology Linkages	Innovation Pattern	Strategic Focus
TAMA	• Processing • Product Developing • Product firms differentiate by product	• Large Variety • Small to Mid Volume • Innovative Products	• National-Global • Market for End Products • Market for Pocesses	• TAMA Officials • Large Firms	• Large Producers • Other SMEs • Collaborative Growth	• Universities • Propcessing Firms • R&D Units of Large Firms	• Process Innovation • New Products	• Develop New Products through New technology
Wenzhou	• Product Developing • Processing • Part Manufacturing • Large number of firms producing the same end product	• Large Variety • Large volume for cluster (small for each firm) • Old Product-New Product market	• National-Global • Market for Parts • Market for End Products • Local Fairs & Selling Centres	• Local Agents • National & International Agents • Party Officials	• Alliance with Marketing Firms • Local & National Stores • Strong Collaboration between Producers	• Between SMEs	• Innovative Markets • Distributed Processing	• Develop Products for New Markets through distributed manufacturing - large volumes through large number of firms
	Nature of Firms	**Product Characteristics**	**Markets**	**Key Intermediaries**	**Supply Chain Linkages**	**Technology Linkages**	**Innovation Pattern**	**Strategic Focus**
Rajkot	• Processing • Part Assembly • Many firms producing the same end product	• Standard Product • Mid Volume • Old (and Standard) Product	• National • Parts Subcontracted • Market for End Products	• Assemblers	• Assemblers • National Dealers • Poor Collaboration between Producers	• Between SMEs • Technical Centre	• Some Process Innovation – specific to the product	• Develop standard product for local markets at lowest cost

Table 3: Comparison of the three Models on various dimensions

business also points towards lack of variety as a cause. Process innovation and the role of technology driven intermediaries is also seen across the cases though their strategic roles may have varied. These intermediaries planned their role. TAMA Association is the most prominent and visible coordinator. Based on structures, processes, linkages and technologies found in these clusters, we now present some generic observations towards building a network model of collaboration for small producers. dimensions. Each of the three clusters comprises a variety of different kinds of firms that were playing a distinctive role. TAMA's ability to draw processing firms to develop technological competencies for developing new products stands out. Wenzhou's ability to coordinate across a large number of small firms and to standardize processes in order to improve quality is noticeable. While both of the above had support of the local government, the role played by the government in Rajkot was quite distinctive which was the caused both its growth as well as its decline. Nevertheless, they make a strong case for collaboration amongst SMEs to form a dynamic network. It must be mentioned that in all the three cases there is less direct interaction with large firms though their technology driving and demand generating roles cannot be ignored. While markets for product developing firms may have been away from the respective cluster, market for processing firms as well as part producers was quite local. The TAMA and Wenzhou clusters produced a large variety of products at small volumes – a typical job-shop like characteristics. Rajkot's decline in the diesel engine business also points towards lack of variety as a cause. Process innovation and the role of technology driven intermediaries is also seen across the cases though their strategic roles may have varied. These intermediaries planned their role. TAMA Association is the most prominent and visible coordinator. Based on structures, processes, linkages and technologies found in these clusters, we now present some generic observations towards building a network model of collaboration for small producers.

There are appear to be six distinctive determinants of a collaborative model for engaging SMEs in technological innovation over a period of time. These are : Focus of the Firm, Interactive Producers, Processing and Product Manufacturing, Innovation Investment, Markets, Market Makers (and market making processes), and Regulatory Support.

Focus of the Firm: SMEs thrive best in an innovative environment as they can provide flexibility at least cost (more of job shop type producers). They are also able to switch over to new products with shifts in demand with much lower penalties as compared to large producers. This also mean that SMEs need to develop focused capabilities. This focus, in addition, forms a strong basis of collaboration between other firms in the cluster. It also allows the development of an eco-system with a breadth of capabilities that would be available in the network. This has a significant demand enhancing effect – customers tend to prefer networks where they can source all their requirements thereby reducing the need for information search and consequently higher transactions cost. Firms get distinguished by distinctive capabilities that allow them to compete successfully in the market. Small producers are more vulnerable to price based competition hence flexibility allows them to survive better in markets where presence of "similar" competitors helps a buyer or an agent to negotiate the price downward.

SMEs are also more willing to reduce the price to win an order (only to find their inability to supply at the reduced price hence the temptation to reduce quality) rather than offer higher value product through flexibility and quality of design and processes.

***Interactive Producers*:** Small producers who either share orders (over and above their production capacities) or have an outsourcing relationship or are part of a sales network (or umbrella branding), create strong synergies for sustaining growth. It ameliorates both, market failures as well as capabilities failure in a cluster of small. While the former is recognized well in literature and practice, the latter has not been emphasized. It is the inability of small firms to constantly upgrade their technological and managerial capabilities (i.e., either due to isolation or 'single-manager congestion' effect or lack of opportunities and high fixed costs for doing the same) that renders them less innovative and less effective given their size. Interactive producers also broaden the market for skills and capabilities.

***Processing and Product Manufacturing*:** Small firms need to distinguish between those that would develop an end product or even a component versus those that could excel in specialized processes like anodizing or welding or embroidery or precision drawing or precision milling or die making etc. While the competitive requirements of a product developing firm are well understood, those for the processing firms are not very clear in minds of most producers. The need for capability enhancement and R&D in processing firms can yield significant returns – proprietary technology helps build natural barriers to competition (as well as through intellectual property rights) and delivers a competitive edge that would win orders. Processing firms provide product manufacturers an opportunity to invest in product enhancing technologies rather than spreading their precious resource over processing technology. This has a capability spreading effect and makes the cluster move towards higher capabilities and more profitable markets. Presence of strong and a large number of processing firms in a cluster also allows the product firms to be more flexible in changing their product mix as demand changes (due to access to diverse capabilities in developing and processing new products).

***Innovation Investment*:** An ability to change the product mix requires investment in development of distinctive capabilities and its continuous upgradation. While fixed costs deter producers from investing in capability enhancing or quality enhancing training as well as in equipment and R&D, common facilities (on a pay and use basis) or service firms that help spread the overhead across many such firms help improve capabilities considerably. For instance, a small producer may not be able to hire a Quality consultant (who may need a minimum number of hours of consulting) but several producers could jointly do the same where each gets the services for a part of the contracted time). Linkages with Universities are extremely valuable here. Such a shared investment in innovative processes also acts as an incentive to change more frequently and keep up with any changes in the market.

***Markets*:** The key to successful integration of small producers in a growing network is to develop a "market" for parts, components and processing services. While this is related to subcontracting (with or without supply of blueprints and raw materials), it allows small firms to link up with other small intermediate producers thereby widening (or broadening) the market. This diversification has two benefits: it creates opportunities for a range of producers and it also allows tiny producers to enter the market domain by producing a small element of the end product. This effect is further intensified for processing firms. There are three things that this market needs to signal for it to become "valid": it must be of credible size for buyers to show interest (i.e., through a large number of producers either producing a wide variety or volumes that may help reduce the search/transaction cost of the buyer), reflect desirable quality and price (i.e., through effective operations & logistics management), and periodically bring newer upgrades on their parts or processes that add value to the buyer and the products that she produces (i.e., through innovation and flexibility of a job shop). Markets become the funnel for focusing buyer and seller's attention. A "wide" market (one that reflects variety) also reduces the commitment that each seller has to make in producing goods upfront in an uncertain market. One probably might be able to argue that this widening could be uncertainty reducing as well. Such markets favour the SME producer.

The question, of course, remains as to who will bring these part producers or processing firms together? While it is tempting to hypothesize that the market will bring them together, small firms face information asymmetry hence may not be able to predict needs a priori or may want to establish a unit once there is an evidence of demand. Hence, the need for a coordinating agency – individuals, government bridge-programmes, associations or private firms that specialize in this particular activity.

***Market Makers** (and market making processes)*: Market intermediaries perform many functions of which the following are extremely useful for SME development: making private information public, helping small producers develop market driven capabilities, and provide a platform for SMEs to collaborate on common infrastructure. In the first role, market intermediaries like agents,

wholesalers, retailers or even the government bring producers capabilities to buyers and buyer's requirements to producers. The State (especially in emerging markets) provides the infrastructure – both physical and informational (through the internet) – for markets to be identified. Examples being Special Economic Zones, Regional Produce Markets, Bazaars & Haats, Hawker Centres, Craft Markets, etc. Recent experiments of ITC eChaupal in India is a good example of private initiative in the same direction. Similarly, intermediaries like TAMA help SMEs develop specialized innovative capabilities by linking small producers to R&D firms and University laboratories. TAMA meetings are mechanisms used to bring them together. Industry Associations could also perform the same task – enhancing the capabilities of specific firms by exposing them to new technologies, managerial practices, and specialized training. There are also examples of intermediaries existing as independent firms that provide services (e.g., logistics) whose absence may cause market failure for small producers. Credit Unions run by a group of producers or agencies for common purchase of raw materials are quite common. Japanese automobile firms have often formed an association of their small suppliers (Supplier Association) to assist in their development. Sometimes, agents play the role of subcontractors that provide credit for production of goods by a network of producers. In summary, their role is one of keeping a set of diverse specialized firms integrated and independent.

Effective Market Coordinators (either individuals, institutions or firms) have often been the difference between successful clusters of small producers and a collection of struggling SMEs. They bring producers together in a network by leveraging the strengths of the group and thereby helping the network become diverse and attractive to customers. Operationally, they assist in pooling of diverse resources which allows small firms to manage uncertainty better. The motivation of the intermediaries, often, varies ranging from seeing economy grow to technology push to profits. Two interesting questions arise in this context: how to keep the market makers engaged with low short term benefits and distinguishing the role of the coordinator at the time of start-up of the network and then through its growth phase (i.e., manage the transition from variety to volumes).

Regulatory Support: Focused support from the government helps reduce the market and capability failures would deliver maximal benefits to small producers. These can be categorized as follows:

- Incorporation and Closure Support: There is a need for processes that will facilitate setting up a small firm within a few days and at a low incorporation fee. Same for closure especially when the number of people working in the enterprise is low. This will allow risk taking and encourage firms to invest in innovative activities. Self reporting and high penalties for violation of norms will address the monitoring issue without expending high overheads. Local industry associations and "better business bureaus" are best suited for providing potential customers with an objective evaluation of the business practices of the small firm. This kind of intermediation requires professional management of these associations rather than government intervention.
- Access to Markets and Market Information: Organized markets in the form of clusters, SEZs or local "haats" (weekly bazaars) etc. provide the necessary access to local markets. The only question that remains is – who sets them up and who manages them? Ideally a "sellers association" would be most suited for running such an organization and would require a private enterprise approach to running the markets. Alternatively, an independent market making firm might coordinate this activity between the buyers and the sellers. Buyers also find this mode of identification of markets easy. Liberal resources for participating in national & international fairs provide the necessary opportunities to identify external linkages. There appears to be a need for development of strong product trading houses (some do exist in the garment sector in India, for instance). So, the regulatory role becomes one of assisting in the formation of the supply chain and in ensuring that all elements of the chain are present to form an eco-system. Once it gets formed, local institutions take over to manage its development and growth.

- Market for Credit: While informal mechanisms do develop for funding innovative enterprises, formal channels require arrangements that lead to lending both for capital as well as working-capital expenses. Funding to support prototype building activities help promote innovation amongst small producers. The market for this kind of funding is most under-developed (same is true for other "epoch funding" requirements – funds needed at crucial junctures of the development of an SME). As a result, regulatory support that helps link the SME with credit guarantee trusts or venture capitalists or large producers or banks supportive of SMEs becomes crucial.
- Capability Building Support: This remains the key differentiator between SME programmes that have succeeded and those that have not. Three elements of capability building requires attention:
    - Development of Skills – of both entrepreneurs (or potential entrepreneurs) as well as of employees of SMEs; this would included continuous training on new technology and processes, skills for managing business (including lean manufacturing practices), seeking funds and evaluating risks, processing market information and accessing new sources of business, innovation and new application domains etc.
    - Formation of Linkages – it has been seen that firms that expend effort in forming linkages (or are a part of a larger network) with customers, technology and material suppliers, research institutions, consultants etc. develop strong capabilities in the product, process and practice domains (Chandra, 1995, Basant, Chandra and Sastry, 1999, Basant, Chandra, Upadhyayula, 2005). Firms learn from these linkages and develop distinctive capabilities to compete in the market.
    - Continuous Upgradation of Tools of Production - SMEs often suffer in terms of quality and productivity due to a prolonged use of inappropriate tools of production. For example, most small producers in the machine shops of Taiwan operate CNC machines while those in India will use "addas" or manual lathes that require enormous operator effort, have short life and are not capable of producing precision products. This prevents the small producers from playing up their strengths of a low volume, high variety, value producer. Similarly, use of a pneumatic wrench controls the torque better and renders an application (e.g., wheel fitting in an automotive vehicle) more safe and conforming to precise specifications. Use of manual wrench, in this case, could lead to inappropriate application of torque hence may lead to unsafe usage of a machine and decreases operator productivity. In the long run, this increases the cost of operations.

  Policies that strengthen the above or provide incentives for the same help small producers build distinctive capabilities and become innovative.

Needless to mention, all other infrastructure support (i.e., road, power, water, etc.) that are required by any other firm would be required by small producers as well. In essence, SME support programmes should try to reduce the risk of operations for a small producers thereby increasing the probability that a small producer will continuously invest in her enterprise.

7. Conclusions

Small producers have an inherent advantage in performing innovative activities within their organization. However, they also face coordination failures due to a variety of reasons. To overcome these disadvantages, firms need to design ways and means of cooperation, especially on those issues that cause market and capabilities failure.

In this paper, we have presented learning from three global networks that have adopted a variety of mechanisms of coordination between small producers that has led to both capability enhancement and demand enhancement. We argue that the capability enhancement effects play as significant a role as demand enhancement effects in the growth of small firms. Coordination that

allows firms to improve their capabilities enhances both productivity as well as innovative capabilities to develop new products and processes. Here the focus of the firm, i.e., its key line of business, its recognition of its variety producing abilities, understanding its role as product developing firm or a product processing firm etc. and its linkages with key suppliers (both of raw material and equipment) and customers become extremely crucial. Firms learn from each other through consultants, suppliers, customers, employees who transit from one firm to another, etc. thereby influencing the productivity and innovation regimes within the firm. On the other hand, cooperation within a network enhances the demand faced by the entire network as potential customers are assured of availability of various price-technology-quality options, a large variety of product offerings at the same location, and a higher opportunity to experiment with new designs, new materials, etc. The key to success in this structuring is the extent of trust and reliability within the members of the network. Many a firms have failed to cooperate because of their inability to trust others or forge trustworthy partnerships. Once again, individuals often emerge as role models in the local eco-system who play the coordinators role and make the market for network operations. It should not be construed that this coordination is limiting in competition - anecdotal evidence from the field is just the opposite – customers are able to create intense competition between small producers when they are located in a cluster due to access to more number of firms. Another aspect relates to creation of markets. These examples show that wherever markets are created in close proximity to small producers, it helps in focusing buyers' attention as well as in reducing the information asymmetry regarding choices of customers. It also reduces the market related search cost for SMEs. The challenge then is to link the local market to a distant consumer.

Policy makers who are facilitating establishment of clusters in the form of Special Economic Zones or SEZs have a special lesson to learn from these examples. Organizing small producers to enhance their productivity and innovativeness requires a network of complementary assets that overcome the disadvantage of size and access. This would require firms representing various elements of the supply chain (products as well as processes) to be co-located in such a cluster so as to facilitate the formation of a network of product developing and process developing firms (as opposed to having firms of similar product type or similar processing capabilities being located together in a SEZ or a product park). It also opens up opportunities for increasing variety in such a network. It must also be recognized that the process of building capabilities is one that has to be facilitated and not left to chance. Consequently, the role of a coordinator(s) must be emphasized. There appears to be a need for a market driven coordinating agency (e.g., GCMMF in the AMUL network [Chandra and Tirupati, 2003] or TAMA Association) which can earn the trust of the firms to coordinate the network on their behalf. In there, there is an interesting model that is worth considering – a network of diverse firms (in terms of end products, intermediate products and processing capabilities) which may produce diverse products under the same umbrella brand of a marketing firm which in turn is equally owned by each of the production firms. The production firms own property rights on the marketing firm and can exit without affecting the common brand. The marketing firm makes the quality and pricing decisions while the production firms make the production quantity and technology choices. The former also does the certification of the product quality (in order to ensure a uniform offering from the network) and provides support for enhancing capabilities of small producers. Variants of such models have been found to work effectively around the world.

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